DRIP
Dam Rehabilitation & Improvement Project

GOVERNMENT OF ODISHA
DEPARTMENT OF WATER RESOURCES

OPERATION & MAINTENANCE (O&M) MANUAL OF SALIA DAM

Project ID Code: OR10MH0013

PREPARED BY

CHIEF ENGINEER & BASIN MANAGER
R.V.N BASIN, BERHAMPUR

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DISCLAIMER

This Operation and Maintenance Manual for Salia Dam in no way restricts the dam owner in digressing from her/his responsibilities. The Central Dam Safety Organization or the Central Water Commission cannot be held responsible for the efficacy of this Manual developed based on documents provided by the dam owner. The Dam Owner and her/his Operators must exercise appropriate discretion while implementing and using this Operation and Maintenance Manual for the O&M of Salia Dam and its appurtenant structures.

The Manual was developed for the purposes of organizing and managing the Operation, Inspection and Maintenance of Salia Dam for reducing its risk and optimizing its performance.

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Government of Odisha
Department of Water Resources

PREFACE

This Operation and Maintenance (O & M) Manual for Salia Dam contains procedures for carrying out Reservoir and Gates operations, Inspections and Maintenance. It will assist in ensuring that the dam is functioning safely and is being properly operated and maintained. Timely inspection and maintenance is necessary for the safe functioning of the dam and continued productive use of the dam and reservoir. The term "O & M" as employed in this Manual includes operations, inspection, maintenance and repair of dam components, replacement of equipment and appurtenant structures, as required.

This Manual is provided to assist the dam owner in management of Salia Dam in a safe and efficient manner.

This Manual was prepared following the Guidelines for preparing O&M Manuals for dams (Doc. No. CDSO_GUD_DS_03_v1.0) published by CWC in the year 2018 under DRIP.

Director,
State Project Management Unit,
DRIP,
Bhubaneswar

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TEAM MEMBERS INVOLVED IN PREPARING THIS O&M MANUAL

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CHAPTER-1

GENERAL INFORMATION

This Operation and Maintenance (O&M) Manual contains procedures for carrying out Reservoir and Gates operations, Inspections and Maintenance for Salia dam. It will assist in ensuring that the dam is functioning safely and to keep it in a good condition by periodic repairs/maintenance. Timely maintenance is important for the continued safe functioning of the dam and productive use of the dam and reservoir.

The term "O&M" as employed in this Manual includes operation, maintenance, general repairs of dam components including replacement, as necessary.

The Manual is prepared primarily for the dam operations staff and their supervisors who are assigned the responsibility for the physical operations and maintenance of the dam. It contains all information and instructions necessary for them to perform their allotted tasks. In addition to instructions for dam operations staff, the Manual defines responsibilities of various dam officials and provides the systematic procedures, guidance and standard forms to ensure safe operation, extend the life and achieve the intended purpose of the dam.

If any unusual and emergency condition arises, then the procedures laid down in the Emergency action Plan (EAP) are to be followed.

1.1. Purpose, Location, Description of Dam

1.1.1. Purpose

Salia irrigation Project is an irrigation project situated near village Panasadihi of Banpur Tehsil in Khurda District of the state of Odisha. The main purpose of the dam is to provide Irrigation facility to Khurda & Ganjam Districts. A total of 9615 ha of land in Khariff and 2970 ha. in Rabi season is irrigated through a canal network consisting of Banpur canal system in Khurda district (6815 ha) and Sumandal canal system in Ganjam District (2800 ha.).

1.1.2. Description of Dam

Salia Irrigation Project is a reservoir scheme across river Salia. The construction of the dam was started in the year 1962 & commissioned in the year 1972.The project consists of an Earth dam with an un-gated spillway on the left flank. Salia Earth dam is a zoned section. It consists of an inner impervious section and outer semi

impervious section. The total length of the dam is 423.67m and the maximum height is 32.91m. The top width of the dam is 4.57m.

An un-gated chute spillway has been provided at left side in three blocks with two divide walls of 2'-0" (0.61m) top width. The length of the spillway is 98.68m.

There are two canals which take off from the reservoir. The Banapur Main Canal located on the right flank takes off at RD 450m of Earth dam and the Sumandal canal takes off from RD 550m of right Dyke.

The project site is about 7 km from historical place Banapur and is well connected with Panchayat road. The length of dam is 423.67 m, T.B.L is 63.41 m & F.R.L is 58.5 m.

1.1.3. Location

Salia Dam is located near village Panasadihi of Banapur Tahasil of Khurda District. The dam is located at Latitude 19^0-48'-8" E and longitude 85^0-5'-8" N at a distance of about 22 km from Balugaon town (Refer Topo sheet No.74E/1).

The dam site is approachable by all-weather B.T Road from Nuagarh village on NH-16 which is at a distance of 17 km from it. Balugaon is nearest railway station at a distance of 22 km from the dam site. Nearest town is Banapur which is 12 km from dam site. Bhubaneswar airport is 113 km away from project site.

1.2. Assignment of Responsibility

Sl. No.	Function	Officers having responsibility
1.	Project Administration-Officer-in-Charge	Executive Engineer, Khurda Irrigation Division, Khurda
2.	Operations of Equipment at the dam	Deputy Executive Engineer
3.	Authorizing releases for Irrigation water supply,	Executive Engineer, Khurda Irrigation Division, Khurda
4.	Recording Reservoir data	Junior Engineer (Civil)
5.	Routine inspection	Executive Engineer, Khurda Irrigation Division, Khurda & Deputy Executive Engineer, Salia Dam Sub-Division, Banapur
6.	Maintenance	Executive Engineer, Khurda Irrigation Division, Khurda & Deputy Executive Engineer, Salia Dam Sub-Division, Banapur
7.	Dam Safety Surveillance including Instrumentation.	Executive Engineer, Khurda Irrigation Division, Khurda

1.3. Collection & Reporting of Dam and Reservoir Data

Routine data for the following is to be recorded:

(a) Reservoir water surface elevation – on daily basis during non-monsoon and hourly basis during monsoon

(b) Spillway outflow on hourly basis during monsoon.

(c) Irrigation releases on daily basis.

(d) Hydro-Meteorological data on daily basis.

(e) Surveillance and monitoring

(f) Water supply releases to INS Chilika on daily basis.

(g) Seepage through V- Notch

1.4. Public Utilities and Safety

Inconformity to the public safety norms a signboard is provided near observatory tower of the dam containing the safety instructions & protection measures for convenience of the public.

Nearest medical assistance and police station is at Banapur town which is about 12 km. from the dam site.

The following safety equipment's are available at the dam site.

a) Helmet

b) First Aid Kit

1.5. Restricted Area

Restricted areas of Salia Dam are:

a) Dam, Spillway approach areas, Ogee spillway and stilling basin.

b) Head regulator wells.

Parapet walls and Barricading has been constructed at danger prone areas to restrict the entry of public.

1.6. Communication & Warning system

1.6.1. Communication System

During monsoon a Control room is opened at Division office, Khurda to monitor flood situation and its effect on safety of project. All the officers of the project are

connected telephonically and through WhatsApp Group. Hence any unusual development in project is communicated to highest level with immediate effect and appropriate action is taken. The Reservoir water level recorder and Total Weather Station have been installed at dam site. Further rain fall, wind speed, its direction and humidity are also monitored daily.

Directory of contact numbers of key persons of Civil Administration, Police, Ambulance, Fire Station etc. is available in Control room. Regular revision / updating of the Directory is being carried out from time to time.

The proper accessibility with motor able all-weather roads has been ensured to the dam site for constant monitoring during emergent situations.

1.6.2. Warning System

There is no warning system in the Dam.

During spill from dam, announcement is made through public addressing system with correspondence to all local bodies.

1.7. Distribution of Operation & Maintenance Manuals

The following officers/ field staff at different levels in the Division under the supervision of Superintending Engineer, CIC, Bhubaneswar and Administrative control of Chief Engineer, Flood Control & Basin Manager, Lower Mahanadi Basin, Bhubaneshwar have been entrusted with the specific responsibility for carrying out O & M activities for Salia Dam.

a) Executive Engineer, Khurda Irrigation Division, Khurda

b) Deputy Executive Engineer, Salia Dam Sub-Division , Banapur

c) Junior Engineer, Salia Dam Section, Panasdihi

The list of offices to whom the O&M Manual of Salia Dam are to be distributed are :

a) Chief Engineer, RVN Basin, Berhampur

b) Superintending Engineer, Central irrigation Circle, Bhubaneswar.

c) Executive Engineer, Khurda Irrigation Division, Khurda

d) Deputy Executive Engineer, Salia Dam Sub-Division , Banapur

e) Junior Engineer, Salia Dam Section, Panasdihi

1.8. List of Supporting Documents & Reference Material

The O&M manual contains following supporting documents:

a) Operating criteria for the reservoir & outlets.

b) Emergency action plan.

c) Irrigation operating instructions.

d) Administrative procedures.

e) Maintenance procedures

f) Maintenance schedules

g) Manufacturer's instructions & drawings.

h) Instrumentation reports and/or results

i) Report of review of design flood and flood routing study carried out under DRIP.

j) Drawings of the dam.

1.9. Schedule of duties for operating personnel

The duty schedules for operating personnel are given below. All activities should be recorded in dam log book /site registers.

Sl. No.	Component	Frequency	Personnel
1.	Visual inspection of crest of the dam& dyke (dam top) and visible portions of dam& dyke (upstream and downstream faces), foundation, abutment contacts, spillway, outlets and appurtenant structures.	Weekly	Junior Engineer/ Deputy Executive Engineer
2.	Record water surface elevation	Daily in non-monsoon and hourly in monsoon	Junior Engineer
3.	Record Depth of flow over spillway during monsoon.	Hourly in monsoon	Junior Engineer
4.	Outflow over spillway during monsoon (To be estimated from depth of flow over the spillway).	Hourly in monsoon	Junior Engineer
5.	Record releases from outlets /sluices.	Daily	Junior Engineer
6.	Record seepage from Earth dam& Dyke - Toe drains, etc.	Daily	Junior Engineer

Sl. No.	Component	Frequency	Personnel
7	Record meteorological data.	Daily	Junior Engineer
8.	Check security and safety devices.	Daily	Junior Engineer.
9.	Drainage systems - Toe drains, etc.	Weekly	Junior Engineer.
10.	Drainage systems - Toe drains, etc.	Fortnightly	Deputy Executive Engineer
11.	Inspection of crest of dam& Dyke (i.e. dam top) and Drainage Systems in Toe drains, etc.,	Fortnightly	Deputy Executive Engineer.
12.	Inspection of crest of dam& dyke (i.e. dam top) & Drainage systems - Toe Drains, Spillway, Outlets and Appurtenant structures. etc.	Monthly	Executive Engineer
13.	Measuring devices/Instruments.	Monthly	Deputy Executive Engineer.
14.	Communication Devices.	Monthly	Deputy Executive Engineer.
15.	Status of Vegetation growth.	Monthly	Deputy Executive Engineer.
16.	Check Sign/Warning display boards near vulnerable locations.	Monthly	Deputy Executive Engineer.
17	Rodent problems.	Monthly	Deputy Executive Engineer
18	Damage in spillway, energy dissipation arrangement, d/s area etc. of spillway.	Quarterly	Executive Engineer
19.	Checking condition of V-notch/other seepage measuring devices.	Quarterly	Deputy Executive Engineer
20	Checking Gear systems & Rubber seals, leakage in Head regulator. Check steel / metal surface and weld joints for corrosion, pitting, erosion etc. Check condition of paints , Tightness of all bolts/connections, movement of gate	Bi-annual	Deputy Executive Engineer
21	Review Dam operation procedures and EAP	Every 10 years	Executive Engineer

CHAPTER-2

PROJECT OPERATION

The operation of Salia dam will involve regulation of its reservoir as per project specific requirements, keeping records and ensuring public safety. Proper operating procedures are crucial for maintaining a safe structure.

2.1. Basic Data

2.1.1. Salient Features

A. HYDROLOGY DATA

i.	Catchment Area at Dam Site	: 245.00 km^2.
ii.	Maximum Annual Rainfall	: 3316.92 mm
iii.	Minimum Annual Rainfall	: 1197.92 mm
iv.	Mean Annual Rainfall	: 2137.17 mm
v.	Average monsoon Run-Off	: 68.97 Mm^3
vi.	Maximum monsoon Run-Off	: 259.22 Mm^3
vii.	75% Dependable monsoon Run-Off	: 123.40 Mm^3.

B. RESERVOIR

i.	Gross Storage	: 60.00 Mm^3
ii.	Dead Storage	: 7.90 Mm^3
iii.	Live Storage	: 52.10 Mm^3
iv.	F.R.L	: 58.53 m
v.	M.W.L	: 61.28 (Original)
vi.	D.S.L	: 48.32m
vii.	T.B.L	: 63.40 m

C. DAM

i.	Type	: Zoned Rolled Fill Earth Dam.
ii.	Length of Dam	: 423.67 m
iii.	Maximum height of dam	: 32.91 m

iv.	Top Width	: 4.57 m
v.	Slope U/S	: 3 (H):1(V)
vi.	Slope D/S	: 2 (H):1(V)

D. DYKE

i.	Type	: Earth fill.
ii.	Length of Dyke	: 2240.00 m
iii.	Maximum height of dam	: 12.50 m
iv.	TBL	: 63.40 m
v.	MWL	: 61.28 (Original)

E. SPILLWAY

i.	Location	: Right Saddle
ii.	Type	: Chute with Ogee (Un gated)
iii.	Length	: 98.68 m.
iv.	Crest level of Spillway	: 58.53 m.
v.	Discharge Capacity	: 1992.37 m^3/s

F. IRRIGATION OUTLET

(i) BANAPUR MAIN CANAL

a. Location	: RD 0.282 Km of Dam
b. Number and Size	: 3 nos. each of size 1.3 m (W) x 1.30m (H) at entry combining into one duct on the downstream.
c. Invert Level	: 46.71 m
d. Discharge	: 8.117 m^3/s

(ii) SUMANDAL MAIN CANAL

a. Location	: 1.680 Km of Dyke
b. Number and Size	: 2 no of size 1.30 m (W) x 1.50 m (H) each at two different levels at the entry combining into one duct on the downstream
c. Invert Level	: 48.76 m and 51.054 m.
d. Discharge	: 3.474 m^3/s

G. GATES & HOISTS OF IRRIGATION OUTLET

(i) BANAPUR MAIN CANAL

- **Service Gate (Slide type)**

a. Nos. & Size : 3 x 1.65 m (W) x 1.40 m (H)

b. Sill Level : 46.71 m

c. Operation arrangement : Through screw rod with help of gear Box fitted with worm and worm wheel (Screw hoist).

d. Capacity of Hoist : 5.00 TONNE

e. Maximum Vertical lift of Gate : 1.60 m

- **Emergency Gate (Slide type)**

a. Number & Size : 1x 1.85m (W) x 1.85 m (H)
1x 1.72m (W) x 1.85 m (H)
1x 1.85m (W) x 1.85 m (H)

b. Sill Level : 46.71 m

c. Operation arrangement : Through screw rod with help of gear box fitted with worm and worm wheel (Screw hoist).

d. Capacity of Hoist : 5.00 TONNE

e. Maximum Vertical lift of Gate : 2.00 m

(ii) SUMANDAL MAIN CANAL

- **Service Gate (Slide type)**

a. Size : 2 nos. 1.7 m (W) x 1.30 m (H)

b. Sill Level : 48.76 m and 51.054 m

c. Operation arrangement : Through screw rod with help of gear box fitted with worm and worm wheel (Screw hoist).

d. Capacity of Hoist : 5.00 TONNE

e. Maximum Vertical lift of Gate : 1.35 m

- **Emergency Gate (Slide type)**

  a. Number and Size : 1 no., 1.75 m (W) x 3.50 m (H)

  b. Sill Level : 48.76 m

  c. Operation arrangement : Through screw rod with help of gear box fitted with worm and worm wheel (Screw hoist).

  d. Capacity of Hoist : 5.00 TONNE

  e. Maximum Vertical lift of Gate : 4.00 m

H. DISTRIBUTION SYSTEM

i. Gross Command Area : 10796.00 ha.

ii. Culturable Command Area : 9615.00 ha.

iii. Irrigation during Khariff : 9615.00 ha.

iv. Irrigation during Rabi : 2970 ha.

I. LENGTH OF CANALS

i. Banpur Main Canal : 19.751 km.

ii. Sumandal Main Canal : 23.110 km.

iii. Vallery Distry. : 11.567 km.

iv. Saradhapur Distry. : 13.080 km.

v. Kumaranga Minor : 4.877 km.

vi. Sahaspur Distry. : 5.852 km.

vii. Galua Distry. : 5.000 km.

viii. Mamubhanaja Distry. : 4.980 km.

J. FULL SUPPLY DISCHARGE AT HEAD

(i) Banapur Main Canal

a) Full Supply Discharge at Head : 8.177 m^3/s

b) Bed Level : 46.78 m

c) Canal Width : 10.67 m

d) FSD : 1.22 m

e) FSL : 48.00 m

f) Longitudinal Slope : 1(H):0.0002 (V)

g) Side slope : 1.5 (H):1.0 (V)

(ii) Sumandal Main Canal

a) Full Supply Discharge at Head : 3.474 m^3/s

b) Bed Level : 49.454 m

c) Canal Width : 5.50 m

d) FSD : 0.929 m

e) FSL : 50.383 m

f) Longitudinal Slope : 1(H):0.00027 (V)

g) Side slope : 1.5 (H):1.0 (V)

2.1.2. Area capacity curve.

A drawing showing area-capacity curves of Salia dam is at Appendix-IV.

In tabular form it is given as under

Reservoir Level (m)	Area (ha.)	Capacity (ha.m)
48.5	173.26	34.04
48.8	181.64	85.11
49.1	190.96	141.85
49.4	203.28	207.72
49.7	218.9	269.52
50.0	237.53	340.45
50.3	256.16	411.37
50.6	274.79	496.48
50.9	295.75	595.78
51.2	315.39	680.89
51.5	344.66	794.37
51.8	374.93	922.04
52.1	395.89	1035.52
52.4	423.83	1149.01
52.7	447.12	1290.86
53.0	465.75	1432.71
53.3	493.7	1602.93

Reservoir Level (m)	Area (ha.)	Capacity (ha.m)
53.6	516.98	1773.16
53.9	535.61	1915.01
54.2	558.9	2085.23
54.5	582.19	2241.27
54.8	605.48	2425.68
55.1	624.15	2567.53
55.4	645.04	2737.75
55.7	666.02	2936.35
56.0	680.00	3191.68
56.3	712.60	3390.27
56.6	735.89	3645.61
56.9	754.52	3815.83
57.2	782.46	4127.91
57.5	815.06	4411.61
57.8	847.67	4666.95
58.1	875.61	4979.02
58.4	894.24	5205.99
58.7	907.85	5518.06
59.0	922.19	5745.03
59.3	933.83	5979.39
59.6	947.80	6255.7

2.1.3. Data of Historic Floods

The project was commissioned during the year 1972.The dam has faced severe floods during the year 1990,1995,2003 ,2009 and 2013 due to deep depression in Bay of Bengal. The maximum depth of flow and corresponding spillway outflow during flood period in Salia dam is given below in tabular format.

Sl. No	Year	Maximum Depth of flow over crest of spillway (m)	Spillway Outflow (m^3/s)
1	1990	0.71	134.31
2	1995	0.60	105.44
3	2003	0.66	157.71
4	2009	0.75	147.41
5	2013	1.18	287.21

2.1.4. Latest Design Inflow Flood and Flood Routing Studies:

In terms of the Indian Standard IS 11223:1985 classification criteria, Salia Dam is classified as an "Intermediate Dam" and, therefore, qualifies for SPF (Standard project Flood) as the design flood. The State DSO reviewed the inflow design flood with "Synthetic Unit Hydrograph Approach" using the Mahanadi Sub Zone, 3rd report (Revised 1997) of CWC. The revised design flood (SPF) computed by the State DSO and approved by the Engineer-in-Chief, P & D, Water Resources Department for adoption is 2398 m^3/s.

Based on flood routing studies, a revised MWL of 62.79 m has been obtained. The routed outflow is 1992.37 m^3/s. The TBL of the dam is 63.40 m.

2.2. Operation Plan

The operation of the dam includes reservoir and gate operations, observation of reservoir levels, keeping records and ensuring public safety. This Manual covers the normal operation procedures to be followed during both monsoon and non-monsoon.

Special operational procedures are to be followed during an emergency situation as per the Emergency Action Plan.

Proper communication and information is provided for the downstream inhabitants regarding discharge of flood water through the spillway when there is a forecast of heavy rain fall in catchment areas.

Mock drill in respect of operation of Outlet gates of Head Regulator is carried out prior to the release of water to the canal.

Exercising of the service gates of the head regulator is carried out at least twice in a year.

Before operation, all the gates and hoists are inspected and their parts lubricated and repaired as necessary.

The O&M Manuals of the Gates manufacturer's would however govern the overall maintenance of Gates & Hoists whenever there is any contradiction with the instructions given in the Manual.

2.3 Normal Operation Procedures

2.3.1. Rule Curve/Reservoir Operations.

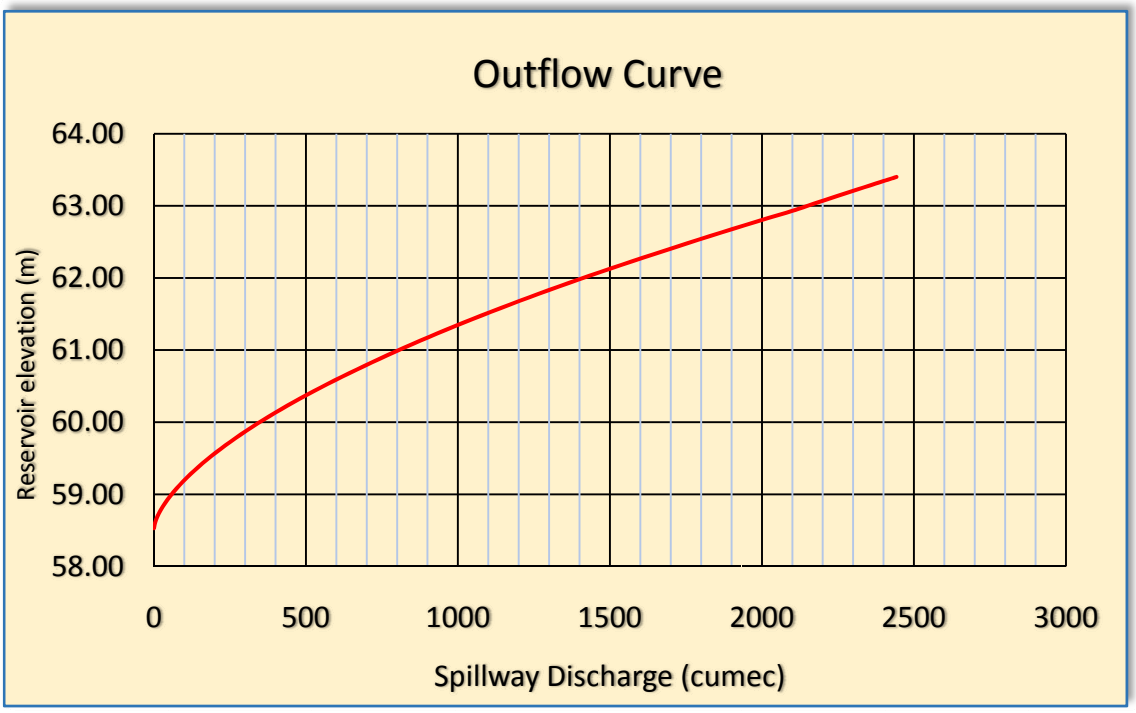
Salia dam has an un-gated spillway. Presently there is no rule curve. The reservoir generally starts to fill from RL. 52.15m (MDDL) in the 2nd week of June to RL. 58.53 m (FRL) and it is maintained at same level till end of October. Then it slowly starts to deplete as per irrigation requirement taking into consideration the reservoir position.

2.3.2 Discharge through Un-gated Spillway for different Reservoir Levels

Spillway discharge calculations have been carried out as per IS 6934 and are given in tabular form as shown below. They are however required to be verified as per hydraulic model studies and modified, if required.

Sl. No.	Reservoir elevation in m.	Spillway Discharge in m^3/s
1	58.53	0.00
2	58.63	5.44
3	58.73	15.58
4	58.83	28.99
5	58.93	45.21
6	59.03	63.99
7	59.13	84.99
8	59.23	107.97
9	59.33	132.99
10	59.43	159.96
11	59.53	188.84
12	59.63	219.58
13	59.73	251.90
14	59.83	285.96
15	59.93	321.73
16	60.03	359.19
17	60.13	398.32
18	60.23	439.11
19	60.33	481.55

Sl. No.	Reservoir elevation in m.	Spillway Discharge in m^3/s
20	60.43	525.62
21	60.53	571.31
22	60.63	618.62
23	60.73	667.55
24	60.83	717.41
25	60.93	768.79
26	61.03	821.67
27	61.13	876.06
28	61.23	931.95
29	61.33	989.34
30	61.43	1048.22
31	61.53	1108.60
32	61.63	1170.46
33	61.73	1233.81
34	61.83	1298.65
35	61.93	1364.98
36	62.03	1432.79
37	62.13	1502.09
38	62.23	1572.87
39	62.33	1645.14
40	62.43	1718.17
41	62.53	1791.86
42	62.63	1866.93
43	62.73	1943.37
44	62.83	2021.19
45	62.93	2100.38
46	63.03	2171.85
47	63.13	2244.08
47	63.23	2317.07
47	63.33	2390.81
47	63.40	2442.87



2.3.3. Operating instructions for Gates and Hoists of Irrigation Outlet.

The gates are raised or lowered as and when it is desired to release water for irrigation purposes. The gates are operated manually. Skilled and authorized personnel need only be allowed to operate the gates.

The maintenance instructions shall be strictly followed to ensure smooth and trouble free operation of gates.

The gates, hoists and allied structures are being inspected as specified below before every crop season.

Embedded Parts

All debris and blockages over the embedded parts (sill beam, side seal seats, top seal seat, guide and wheel track) should be cleared. The surfaces of embedded parts should be checked for pitting and should be suitably rectified if pitting is noticed. The welding of stainless steel plates on side seal seat, sill beam, top seal seat and wheel track should be checked for weld cracks and shall be repaired if crack is noticed in weld joint. Due to wear and tear, surface may become uneven and may have indentations such as roller mark over the track path. The entire gate track should be thoroughly checked so that there is no obstruction for travel of gate.

Gate Leaf with Accessories

All debris and scaling should be removed from the gate leaf. The skin plate and other components should be tapped lightly by hammer to examine the soundness.

The weld joint between skin plate to horizontal stiffeners and end vertical girders, end vertical girders to horizontal stiffeners and hoist bracket to top horizontal stiffeners should be checked thoroughly and suitably rectified if defects are noticed. The hoisting connection on the gate should be checked for shearing and wear and tear and should be rectified if any defect is noticed.

Alignment of seals should be checked by means of feeler gauge. The rubber seals should be checked for twist, over tapping, bulb flatness, deformation etc. All un-desirable materials on the rubber seal and between the rubber seal and skin plate should be cleaned thoroughly and should be free from oil and grease etc. All nuts and bolts fixing the rubber seal to the skin plate should be checked for slackness and rusting and should be tightened/replaced as considered necessary. Rubber seals when damaged or found leaking profusely should be adjusted, repaired or replaced as considered necessary.

The guide shoes shall be inspected for any damage or bending and shall be repaired if damaged or bent. The welding between the end vertical girder and guide shoe should be checked and defects if found should be suitably rectified.

The hoist pin should be lubricated. All nuts, bolts and screws etc should be checked for slackness and should be tightened if necessary.

Restraining Arrangements

The welding of eye piece and flanges to the stems should be checked thoroughly and defects, if noticed, shall be rectified suitably. The split bushes and the stems should be lubricated properly. All bolts and nuts should be checked for slackness and shall be tightened if necessary. The defective Bolts, nuts and screws etc. should be replaced. The stem nuts should be checked for straightness and shall be rectified if found bent. The screw rod and the intermediate stems should be checked for binding and rectified it found bent.

Testing

a. The gate should be tested for smooth travel throughout the groove without appreciable swing.

b. The gate should neither be subjected to under pressure nor any extra effort be needed to operate the gate in no load condition.

c. There should not be undue vibration in the gate and structure during its travel while on load. If undue vibrations are noticed the reasons should be investigated and the reservoir level at which this occurs should be recorded. The gate shall not be kept in the position where vibration is noticed until remedial measures are taken.

d. In closed position, the gate should be watched against any leakage under maximum head condition during the year.

2.3.4. Methodology to work out gate opening for passing the required discharge through the irrigation outlet at different reservoir levels.

Flows are required to be released as per irrigation requirements. For this purpose suitable gate opening is to be worked out. After lifting the outlet gates corresponding to the discharge to be passed in the canal, the gates of both the head regulator and the cross regulator in the canal are required to be closed and water level in the canal in the reach u/s of the two regulators brought to FSL by storing additional water in the reach. The head regulator gates are to be then opened and requisite quantity of water drawn into the distributary / branch canal/outlet. The irrigation canal has been so designed that the flow in the system is to be maintained at FSL all the time during supply .The Outlet openings are provided at 2/3rd height of FSD from bed level of canal. Depending upon requirement the flow through these outlets are controlled to optimize the use .The shutter in head regulator is operated following rotational method. The flow into the canal system depends upon the Reservoir water level and gate opening.

The tables used for the purpose for the two canals in the project are given below:

Table for Banpur Main Canal

	Opening in inch		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Opening in cm.		2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	40	42.5	45	47.5	50	52.5	55	57.5	60
Reservoir Level in ft	158.50	Discharge in cusec	4.00	8.11	12.14	16.27	20.28	24.34	28.40	32.46	36.51	40.58	44.68	48.60	52.74	56.80	60.86	64.96	68.98	73.03	77.09	81.15	85.20	89.87	93.32	97.38
Reservoir Level in mtr	48.31	Discharge in m^3/s	0.11	0.23	0.34	0.46	0.57	0.69	0.80	0.92	1.03	1.15	1.26	1.38	1.49	1.61	1.72	1.84	1.95	2.07	2.18	2.30	2.41	2.54	2.64	2.76
Reservoir Level in ft	159.00	Discharge in cusec	4.20	8.49	12.71	17.03	21.22	25.48	29.72	33.97	38.21	42.47	46.76	50.96	55.20	59.44	63.69	67.98	72.19	76.43	80.68	84.92	89.17	93.42	97.67	101.91
Reservoir Level in mtr	48.46	Discharge in m^3/s	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.20	1.32	1.44	1.56	1.68	1.80	1.92	2.04	2.16	2.28	2.40	2.52	2.64	2.76	2.88
Reservoir Level in ft	160.00	Discharge in cusec	4.55	9.20	13.77	18.45	22.99	27.60	32.20	36.80	41.40	46.01	50.66	55.21	59.81	64.41	69.00	73.66	78.22	82.81	87.41	92.01	96.61	101.22	105.82	110.42
Reservoir Level in mtr	48.77	Discharge in m^3/s	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.30	1.43	1.56	1.69	1.82	1.95	2.08	2.21	2.34	2.47	2.60	2.73	2.86	2.99	3.12
Reservoir Level in ft	161.00	Discharge in cusec	4.87	9.85	14.75	19.76	24.64	29.58	34.51	39.43	44.36	49.30	54.29	57.16	64.08	69.01	73.94	78.92	83.81	88.74	93.66	98.69	103.52	108.46	113.39	118.31
Reservoir Level in mtr	49.07	Discharge in m^3/s	0.14	0.28	0.42	0.56	0.70	0.84	0.98	1.12	1.26	1.40	1.54	1.62	1.81	1.95	2.09	2.23	2.37	2.51	2.65	2.79	2.93	3.07	3.21	3.35
Reservoir Level in ft	162.00	Discharge in cusec	5.18	10.47	15.68	21.00	26.18	31.43	36.66	41.90	47.14	52.39	57.68	62.86	68.09	73.38	78.57	83.86	89.05	94.29	99.52	104.76	109.99	115.25	120.48	125.72
Reservoir Level in mtr	49.38	Discharge in m^3/s	0.15	0.30	0.44	0.59	0.74	0.89	1.04	1.19	1.33	1.48	1.63	1.78	1.93	2.08	2.22	2.37	2.52	2.67	2.82	2.96	3.11	3.26	3.41	3.56
Reservoir Level in ft	163.00	Discharge in cusec	5.46	11.05	16.55	22.17	27.68	33.18	38.70	44.23	49.76	55.30	60.89	66.35	71.88	77.41	82.93	88.52	94.00	99.53	105.06	110.58	116.11	121.65	127.18	132.71
Reservoir Level in mtr	49.68	Discharge in m^3/s	0.15	0.31	0.47	0.63	0.78	0.94	1.10	1.25	1.41	1.56	1.72	1.88	2.03	2.19	2.35	2.51	2.66	2.82	2.97	3.13	3.29	3.44	3.60	3.76
Reservoir Level in ft	164.00	Discharge in cusec	5.74	11.61	17.38	23.28	29.02	34.84	40.64	46.44	52.25	58.07	63.94	69.67	75.48	81.28	87.08	92.95	98.71	104.51	110.31	116.12	121.92	127.74	133.54	139.35
Reservoir Level in mtr	49.99	Discharge in m^3/s	0.16	0.33	0.49	0.66	0.82	0.99	1.15	1.31	1.48	1.64	1.81	1.97	2.14	2.30	2.46	2.63	2.79	2.96	3.12	3.29	3.45	3.62	3.78	3.94
Reservoir Level in ft	165.00	Discharge in cusec	6.00	12.13	18.17	24.34	30.34	36.42	42.49	48.59	54.62	60.71	66.34	72.81	78.91	84.98	91.04	97.18	103.19	109.26	115.33	121.40	127.46	133.55	139.62	145.68
Reservoir Level in mtr	50.29	Discharge in m^3/s	0.17	0.34	0.51	0.69	0.86	1.03	1.20	1.38	1.55	1.72	1.88	2.06	2.23	2.40	2.58	2.75	2.92	3.09	3.26	3.44	3.61	3.78	3.95	4.12

	Opening in inch		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Opening in cm.		2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	40	42.5	45	47.5	50	52.5	55	57.5	60
Reservoir Level in ft	166.00	Discharge in cusec	6.25	12.64	18.92	25.35	32.60	37.94	44.26	50.58	56.90	63.24	69.63	75.88	82.20	88.52	94.84	101.23	107.50	113.82	120.14	126.46	132.78	139.12	145.44	151.76
Reservoir Level in mtr	50.60	Discharge in m^3/s	0.18	0.36	0.54	0.72	0.92	1.07	1.25	1.43	1.61	1.79	1.97	2.15	2.33	2.51	2.68	2.86	3.04	3.22	3.40	3.58	3.76	3.94	4.12	4.29
Reservoir Level in ft	167.00	Discharge in cusec	6.49	13.13	19.65	26.33	32.82	39.40	45.96	52.58	59.09	65.67	72.31	78.80	85.36	91.92	98.49	105.12	111.63	118.20	124.76	131.32	137.89	144.47	151.05	157.59
Reservoir Level in mtr	50.90	Discharge in m^3/s	0.18	0.37	0.56	0.75	0.93	1.12	1.30	1.49	1.67	1.86	2.05	2.23	2.42	2.60	2.79	2.97	3.16	3.35	3.53	3.72	3.90	4.09	4.27	4.46
Reservoir Level in ft	168.00	Discharge in cusec	6.72	13.60	20.35	27.27	33.99	40.81	47.60	54.40	61.20	68.02	74.89	81.60	88.41	95.21	102.00	108.88	115.62	122.42	129.22	136.01	142.81	149.63	156.43	168.21
Reservoir Level in m	51.21	Discharge in m^3/s	0.19	0.38	0.58	0.77	0.96	1.15	1.35	1.54	1.73	1.92	2.12	2.31	2.50	2.69	2.89	3.08	3.27	3.46	3.66	3.85	4.04	4.23	4.43	4.76
Reservoir Level in ft	169.00	Discharge in cusec	6.95	14.05	21.03	28.18	35.12	42.17	49.19	56.22	63.24	70.28	77.39	84.33	88.41	95.21	102.00	108.88	115.62	122.42	129.22	136.01	142.81	149.63	156.43	168.21
Reservoir Level in m	51.51	Discharge in m^3/s	0.20	0.40	0.60	0.80	0.99	1.19	1.39	1.59	1.79	1.99	2.19	2.39	2.50	2.69	2.89	3.08	3.27	3.46	3.66	3.85	4.04	4.23	4.43	4.76
Reservoir Level in ft	170.00	Discharge in cusec	7.16	14.48	21.64	29.06	36.22	43.48	50.30	57.97	65.22	72.48	79.81	86.97	91.36	98.38	105.10	112.51	119.48	126.50	133.52	140.55	147.57	154.62	161.64	168.67
Reservoir Level in m	51.82	Discharge in m^3/s	0.20	0.41	0.61	0.82	1.03	1.23	1.42	1.64	1.85	2.05	2.26	2.46	2.59	2.78	2.97	3.18	3.38	3.58	3.78	3.98	4.18	4.38	4.57	4.77
Reservoir Level in ft	171.00	Discharge in cusec	7.37	14.91	22.33	29.91	37.29	44.76	52.22	59.68	67.14	74.61	82.15	89.53	94.21	101.46	108.70	116.03	123.21	130.45	137.70	144.94	152.19	159.45	166.69	173.94
Reservoir Level in m	52.12	Discharge in m^3/s	0.21	0.42	0.63	0.85	1.06	1.27	1.48	1.69	1.90	2.11	2.32	2.53	2.67	2.87	3.08	3.28	3.49	3.69	3.90	4.10	4.31	4.51	4.72	4.92
Reservoir Level in ft	172.00	Discharge in cusec	7.58	15.33	22.95	30.74	38.32	46.01	53.67	61.34	69.00	76.69	84.44	92.02	96.98	104.44	111.90	119.44	126.83	134.29	141.75	149.21	153.66	164.14	171.60	179.06
Reservoir Level in m	52.43	Discharge in m^3/s	0.21	0.43	0.65	0.87	1.08	1.30	1.52	1.74	1.95	2.17	2.39	2.60	2.74	2.96	3.17	3.38	3.59	3.80	4.01	4.22	4.35	4.65	4.86	5.07
Reservoir Level in ft	173.00	Discharge in cusec	7.78	15.73	23.55	31.55	39.33	47.22	55.08	62.95	70.82	78.70	86.66	94.44	99.68	107.34	115.00	122.76	130.36	138.02	145.69	153.35	161.02	168.76	176.37	184.03
Reservoir Level in m	52.73	Discharge in m^3/s	0.22	0.45	0.67	0.89	1.11	1.34	1.56	1.78	2.00	2.23	2.45	2.67	2.82	3.04	3.25	3.47	3.69	3.91	4.12	4.34	4.56	4.78	4.99	5.21

Table for Sumandal Main Canal

	Opening in inch		1	2	3	4	5	6	7	8	9	10	11	12
	Opening in cm.		2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30
Reservoir Level in ft	161.00	Discharge in cusec	1.70	3.35	5	6.76	8.35	10.00	11.76	13.35	15.00	16.76	18.35	20.00
Reservoir Level in m	49.0728	Discharge in m^3/s	0.048	0.095	0.142	0.191	0.236	0.283	0.333	0.378	0.425	0.474	0.519	0.566
Reservoir Level in ft	162.00	Discharge in cusec	2.40	4.74	7.07	9.48	11.81	14.14	16.55	18.88	21.21	23.62	25.95	28.28
Reservoir Level in m	49.3776	Discharge in m^3/s	0.068	0.134	0.200	0.268	0.334	0.400	0.468	0.534	0.600	0.668	0.734	0.800
Reservoir Level in ft	163.00	Discharge in cusec	2.94	5.8	8.66	11.6	14.46	17.32	20.26	23.12	25.98	28.93	31.78	34.64
Reservoir Level in m	49.6824	Discharge in m^3/s	0.083	0.164	0.245	0.328	0.409	0.490	0.573	0.654	0.735	0.819	0.899	0.980
Reservoir Level in ft	164.00	Discharge in cusec	3.40	6.70	10.00	13.40	16.70	20.00	23.40	26.70	30.00	33.40	36.70	40.00
Reservoir Level in m	49.9872	Discharge in m^3/s	0.096	0.190	0.283	0.379	0.473	0.566	0.662	0.756	0.849	0.945	1.039	1.132
Reservoir Level in ft	165.00	Discharge in cusec	3.80	7.49	11.18	14.98	18.67	22.36	26.16	29.85	33.54	37.34	41.03	44.72
Reservoir Level in m	50.292	Discharge in m^3/s	0.108	0.212	0.316	0.424	0.528	0.633	0.740	0.845	0.949	1.057	1.161	1.266
Reservoir Level in ft	166.00	Discharge in cusec	4.16	8.2	12.25	16.41	20.45	24.49	28.66	32.70	36.74	40.91	44.95	48.99
Reservoir Level in mtr	50.5968	Discharge in m^3/s	0.118	0.232	0.347	0.464	0.579	0.693	0.811	0.925	1.040	1.158	1.272	1.386
Reservoir Level in ft	167.00	Discharge in cusec	4.50	8.86	13.23	17.73	22.09	26.46	30.96	35.32	39.69	44.18	48.55	52.92
Reservoir Level in m	50.9016	Discharge in m^3/s	0.127	0.251	0.374	0.502	0.625	0.749	0.876	1.000	1.123	1.250	1.374	1.498
Reservoir Level in ft	168.00	Discharge in cusec	4.81	9.48	14.14	18.95	23.62	28.28	33.09	37.76	42.43	47.23	51.9	56.57
Reservoir Level in m	51.2064	Discharge in m^3/s	0.136	0.268	0.400	0.536	0.668	0.800	0.936	1.069	1.201	1.337	1.469	1.601
Reservoir Level in ft	169.00	Discharge in cusec	5.10	10.05	13.00	20.10	25.05	30.00	35.10	40.05	45.00	50.10	55.05	60.00

	Opening in inch		1	2	3	4	5	6	7	8	9	10	11	12
	Opening in cm.		2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30
Reservoir Level in m	51.5112	Discharge in m^3/s	0.144	0.284	0.368	0.569	0.709	0.849	0.993	1.133	1.274	1.418	1.558	1.698
Reservoir Level in ft	170.00	Discharge in cusec	5.38	10.59	15.81	21.19	26.41	31.62	37	42.22	47.43	52.81	58.03	63.25
Reservoir Level in m	51.816	Discharge in m^3/s	0.152	0.300	0.447	0.600	0.747	0.895	1.047	1.195	1.342	1.495	1.642	1.790
Reservoir Level in ft	171.00	Discharge in cusec	5.64	11.11	16.58	22.22	27.69	33.17	38.8	44.28	49.75	55.39	60.86	66.33
Reservoir Level in m	52.1208	Discharge in m^3/s	0.160	0.314	0.469	0.629	0.784	0.939	1.098	1.253	1.408	1.568	1.722	1.877
Reservoir Level in ft	172.00	Discharge in cusec	5.89	11.6	17.32	23.21	28.93	34.64	40.53	46.25	51.96	57.85	62.57	69.28
Reservoir Level in m	52.4256	Discharge in m^3/s	0.167	0.328	0.490	0.657	0.819	0.980	1.147	1.309	1.470	1.637	1.771	1.961
Reservoir Level in ft	173.00	Discharge in cusec	6.13	12.08	18.03	24.16	30.11	36.06	42.18	48.13	54.08	60.21	66.16	72.11
Reservoir Level in m	52.7304	Discharge in m^3/s	0.173	0.342	0.510	0.684	0.852	1.020	1.194	1.362	1.530	1.704	1.872	2.041
Reservoir Level in ft	174.00	Discharge in cusec	6.36	12.53	18.71	25.07	31.24	37.42	48.78	49.95	56.12	62.49	68.66	74.83
Reservoir Level in m	53.0352	Discharge in m^3/s	0.180	0.355	0.529	0.709	0.884	1.059	1.380	1.414	1.588	1.768	1.943	2.118
Reservoir Level in ft	175.00	Discharge in cusec	6.58	12.97	19.36	25.95	32.34	38.73	45.31	51.70	58.09	64.68	71.07	77.46
Reservoir Level in m	53.34	Discharge in m^3/s	0.186	0.367	0.548	0.734	0.915	1.096	1.282	1.463	1.644	1.830	2.011	2.192
Reservoir Level in ft	176.00	Discharge in cusec	6.80	13.40	20.00	26.80	33.40	40.00	46.80	53.40	60.00	66.80	73.40	80.00
Reservoir Level in m	53.6448	Discharge in m^3/s	0.192	0.379	0.566	0.758	0.945	1.132	1.324	1.511	1.698	1.890	2.077	2.264

2.3.5. Safety Aspects:

The safety and security of dam against the structural damages by vandals, public and unauthorized operation of outlet gates is of paramount importance. The Division has formed the Pani Panchayat (Water Users' Association) among the cultivators as per the Pani Panchayat Act 2003.The combined effort of the both dam authorities and Pani Panchayat ensures proper O & M of the irrigation outlet. The Pani Panchayat people are imparted capacity building training from time to time by WALMI, Govt. of Odisha.

2.4. Emergency Operation

The emergency operation will be carried out following the Emergency Action Pan (EAP). The emergency conditions are outlined in chapter 4 under clause 4.2.1 on Immediate Maintenance. The EAP together with this Manual will be present at site at all times.

2.5. Reservoir Capacities

The reservoir capacity may reduce with time because of reservoir sedimentation. Bathymetric survey on a periodic basis is to be considered after every 10 years.

2.6. Record Keeping

Following records of reservoir operations are being maintained:

(a) Rainfall record on daily basis throughout the year.

(b) Reservoir levels on daily basis during non-monsoon and hourly basis during monsoon.

(c) Depth of outflow over the spillway on hourly basis during monsoon.

(d) Estimated spillway outflows during monsoon on hourly basis.

(e) Irrigation releases.

(f) Water audit register to be maintained for estimating the inflows on hourly basis during monsoon and daily basis during non-monsoon by accounting all the releases/outflows and the incremental change in storage in the reservoir.

(g) All operating procedures

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CHAPTER-3

PROJECT INSPECTION

An effective inspection programme is essential for identifying problems and ensuring a safe performance of the dam.

3.1. Objective of Dam Inspection

The principal purpose of Dam safety inspections is to determine whether the structural and operational aspects of the dam and its component parts are functioning safely in accordance with the design and established standard/ acceptable practices. It helps to identify deficiencies or concerns that potentially affect the safety of the dam and to take corrective actions to remedy those deficiencies before serious consequences develop.

Detailed description on project inspections is available in the Guideline for Safety Inspection of dams(DocNo.CDSO_GUD_DS_07_ v1.0), CWC 2018 (https://damsafety.in/ecmincludes/PDFs/Guidelines_for_Safety_Inspection_of_Dams.pdf). However an overview of the various types of inspections to be carried out in Salia dam is given below. Note that for uploading Inspection Data into DHARMA, the Inspection Instructions & Forms given in the aforementioned Guideline for Safety Inspection of Dams should be used (see Appendix - I)

3.2. Types of Dam Safety Inspections

The type of inspection to be conducted will depend on the purpose of the inspection. Dam safety inspections are conducted to determine the status of a dam and its features relative to its structural and operational safety.

Four types of dam safety inspections are to be carried out. They are:

a) Informal inspections
b) Scheduled inspections
c) Special (unscheduled) inspections
d) Comprehensive evaluation inspections.

3.2.1. Informal Inspections

The informal inspections are performed by the Engineer-in-charge of the dam and his staff while carrying out their regular duties (See duty schedules in Chapter 1).

Informal inspections assist in a continuous surveillance of the dam which is critical to proper operation and maintenance of the dam. They consist of frequent inspections for observing the general issues/problems and functioning of the dam and appurtenant structures. The informal inspections are important and performed at every available opportunity. The informal inspections are not as detailed as comprehensive, scheduled, and special inspections. They require that a formal report be submitted to the dam authorities only if a condition is detected that might endanger the dam.

3.2.2. Scheduled Inspections

Scheduled inspections are performed to gather information on the current condition of the dam and its appurtenant works. The scheduled inspections consist of pre-monsoon and post monsoon inspections and other scheduled inspections. The Pre-monsoon& Post- monsoon inspections are conducted by field engineers every year as per the inspection schedule below. Special attention is to be given to the HM Equipment's (See Chapters on Operation and Maintenance).

The deficiencies, thus noticed, shall be endorsed to State Dam Safety Organization for scrutiny and suggestion for possible remedial measures.

Inspection Schedules

Type of Inspection Executive Engineer, Khurda Division, Khurda and S.E., Central Irrigation Circle, Bhubaneswar	Last date for	
	Completion of inspection	Sending inspection reports to SDSO
1. Pre- monsoon	15th May	30th June
2. Post-monsoon	30th November	31st December

Other scheduled inspections are conducted at least once in every 5 years by the engineers of State DSO along with Geologist and representative of Mechanical Wing.

All scheduled inspections are to be carried out as per the Guideline for Safety Inspection of dams (Doc No. CDSO_GUD_DS_07_ v1.0), CWC 2018 (https://damsafety.in/ecm-includes/PDFs/Guidelines_for_Safety_Inspection_of_Dams.pdf).
These inspections will include the following components as a minimum:

a) Review of the past inspection reports, Monitoring data & photographs, Maintenance of records and other pertinent data.

b) Inspection of the dam and its appurtenant works.

c) Preparation of a report with relevant documentation and photographs

3.2.3. Special (Unscheduled) Inspections

Special inspections are performed to resolve specific problems of the dam. This is performed by an independent Expert Panel or Dam Authorities. Special inspections are not regularly scheduled activities but are usually made before or immediately after the dam or appurtenant works have been subjected to unusual events or conditions, such as an unusually high flood or a significant earthquake.

Japan Water Agency (JWA) has developed an excellent system of carrying out inspections after an earthquake event. For details refer "Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand (CDSO_GUD_DS_0_v1.0, September2017). The manual is available at the following link: https://damsafety.in/ecm-includes/PDFs/Inspection_Manual_for_Dam_Field_Engineers_After_Seismic_Events.pdf.

3.2.4. Comprehensive Evaluation Inspections

For comprehensive dam safety evaluation an independent panel of experts known as Dam Safety Review Panel (DSRP), is to be set up by the OWRD which shall consist of experts from the fields of Geology, Hydrology, Designs, and Construction for determining the condition of dam and appurtenant works. The main objective of the DSRP is to carry out an independent expert review of the overall health status of the dam and to propose remedial action, prior to the initiation of rehabilitation activities. The panel would undertake the evaluation of the dam once in 10years or after occurrence of any extreme events, if required. The State Dam Safety Organization arranges the meetings and site visits of DSRP.

Terms of Reference (ToR) of comprehensive dam safety evaluation shall include but will not to be limited to:

(a) General assessment of hydrologic and hydraulic conditions, review of design flood, flood routing for revised design flood and mitigation measures.

(b) Review and analysis of available data of dam design, construction, operation maintenance and performance of dam structure and appurtenant works.

(c) A visual inspection or field examination of the dam, its appurtenant works, and the surrounding areas.

(d) Review of the instrumentation records and structural behavior reports, if any.

(e) Evaluation of procedures for operation, maintenance and inspection of dam and to suggest improvements / modifications.

(f) Evaluation of any possible hazardous threat to the dam structure such as dam abutment slope stability failure or slope failures along the reservoir periphery.

3.2.4.1. Details to be provided to DSRP before inspection

All relevant details / data / drawings for the dam project to be examined by the DSRP shall be provided at least 3 months in advance of the proposed visit. This will include:-

a) General Information

(i) Scope of project

(ii) Basic data and salient features

(iii) Issues related to safety of dam including any earlier dam safety related incidents

(iv) Emergency preparedness–Communications, Auxiliary power, Downstream Warning system and security at site.

b) Hydrology

(i) Description of drainage basin

(ii) Original inflow design flood, MWL and routed outflow

(iii) Revised design flood and flood routing study carried out by the project authorities and approved by CWC.

(iv) Area – Capacity curves.

c) Geology

(i) Dam site geology including geological reports.

(ii) Any special problems and their treatment.

(iii) Reservoir competency as per geological report.

(iv) Slope stability issues along reservoir rim.

d) Drawings of the Dam and HM works

(i) Layout plan

(ii) Upstream & Downstream Elevation.

(iii) Cross – Sections of the Dam and Spillway

(iv) Foundation treatment details

(v) Junction between Earthen embankment & Concrete abutment of spillway.

(vi) Irrigation Outlet details

(vii) Layout details of gates and hoists of irrigation outlet

(viii) Instrumentation details

e) Dam and Spillway

(i) Geological reports

(ii) Special problems encountered, if any.

(iii) Foundation treatment including treatment of faults / shear zones / weak zones, curtain / consolidation grouting, drainage provisions, any other special treatment, cut-off trench, etc.

(iv) Design criteria and result of stability analysis

(v) Adequacy of design – from dam safety considerations

(vi) Hydraulic design of Spillway

(vii) Pre-construction material testing reports including adequacy of field and laboratory investigations, appropriateness of materials selected etc.

(viii) Post-construction testing reports, if any,

3.2.4.2. Field Inspection – Observation & Recommendations regarding Remedial Measures

Each component of the project is inspected; evaluated and specific problems are to be brought out. Recommendations for necessary remedial measures need to be included in the panel's report.

Various project components to be inspected include:

a) Dam

i. Upstream face

ii. Downstream face

iii. Top of dam

iv. Structural behaviour as observed visually and as per evaluation of instrumentation data (any visible cracking, deflections etc.)

v. Seepage assessment

vi. Condition of natural / excavated slopes in the abutments, both on u/s and d/s of the dam.

vii. Any specific problems / deficiencies.

b) Surplus Escape (Spillway)

i. Civil structure

ii. Spill channel, drop structures etc.

iii. Downstream safe carrying capacity of river / channel

c) River / Canal Outlets

i. Civil structures

ii. Conduits / outlets through Embankment dam.

d) Flood Hydrology

i. Extent & Sufficiency of data available

ii. Method used for estimating the design flood.

iii. Design flood review study.

iv. Flood routing studies with the revised flood.

v. Adequacy of free board available.

e) Miscellaneous Services / Facilities

i. Access Roads

ii. Communication facilites (Telephone, Mobile etc.)

3.2.4.3. Components Involved

A comprehensive evaluation inspection of a dam typically consists of five components:

a) Project records review (i.e., study of all design / construction records / drawings, history of the dam's performance, past inspection notes / reports, notes on distress observed etc.).

b) Inspection of the dam and its appurtenant works.

c) Preparation of a detailed report of the inspection.

d) Education and training of the dam engineers on the issues observed during dam inspection, identification of potential dam failure modes & to carryout additional field investigations & laboratory testing as required. Dam engineers should be made part of the inspection process so that they take ownership and are committed to implementing the recommended remedial measures.

e) Design studies e.g. review of design flood, checking of the adequacy of spillway capacity, freeboard requirements, dam stability, any special study as required & submission of the report.

CHAPTER-4

PROJECT MAINTENANCE

A good maintenance program will protect a dam against deterioration, prolong its life, and greatly reduce the chance of failure. The dam authorities and operating and maintenance personnel must be aware of the potential problems which can lead to failure of a dam. Nearly all the components of a dam and its materials are susceptible to damage and deterioration if not well maintained.

This Manual is to be referred to mainly for routine maintenance works.

For most of the rehabilitation works in respect of condition based and immediate maintenance works the designs/drawings/technical specifications will need to be provided by the State DSO/Designs offices. Guidance of experienced engineers/panel of experts will need to be taken.

4.1. Maintenance Plan

Timely maintenance assures that a dam and reservoir would remain in a good working condition and prevents more harmful conditions from developing.

4.2. Maintenance Priorities

Maintenance activities need to be prioritized.

4.2.1. Immediate Maintenance

The following conditions are critical and require immediate action by Dam authorities.

a) Evidence of excessive seepage through the Earth dam, exiting on its downstream face or anywhere on the downstream of the dam and increasing in volume.

b) Earth Dam showing signs of piping or internal erosion indicated by increasingly cloudy seepage or other symptoms.

c) An increase in the reservoir level to near the top of the dam.

d) Water overtopping the Earth dam.

e) Earth dam about to be breached by erosion, slope failure etc.

An EAP is to be activated when any of the above conditions are noted.

4.2.2. Condition based Maintenance

The following maintenance works are undertaken as soon as possible after the defective condition is noted which may include:

a) Removal of all vegetation and bushes from the dam and restoring any eroded areas and to establish good grass cover.

b) Fill animal burrows.

c) Repair livestock trails and fences to keep livestock off dam.

d) Restore and reseed eroded areas and gullies on embankment dams.

e) Repairs of any cracks in earth dam.

f) Cleaning and repair of drains.

g) Repair of defective gates and other hydro-mechanical equipment.

h) Repair any concrete or metal components that have deteriorated.

i) Repair for any damages on the spillway including its glacis, piers, training walls/abutments, energy dissipaters, downstream areas etc.

4.2.3. Routine Maintenance

Following tasks are performed on a continuous basis. These include:

a) To measure flow rate of seepage and turbidity from Earth dam.

b) Maintain turfing on d/s slope of Earth dam.

c) Repair any gullies formation in Earth dam

d) Clean the surface drains on the downstream slope of Earth dam

e) Remove silt from outfall drains of Earth dam.

f) **Rodent damage:** The rodents are removed or destroyed, and any burrow holes are filled immediately.

g) **Upstream slope riprap:** The upstream riprap is normally observed annually and may occasionally need repairs because of high water or wave action.

h) **Noxious weeds:** Noxious weeds on and around the dam embankment, reservoir, and spillways is removed.

i) Any vegetation growing in any of the joints is removed.

j) Ensure approach road to the dam to be in good condition.

k) Test the communication equipment.

l) Checking the operation of instruments in the dam.

m) Servicing and lubrication of gates of Head Regulator,

n) Keeping the gate slots clear of silt/debris.

4.3. Procedures for undertaking Routine Maintenance

4.3.1. Earth work in Earthen Dam

The surfaces of an earthen dam may deteriorate due to several reasons. For example, wave action may cut into the upstream slope, vehicles may cause ruts in the crest or slopes, trails left by livestock can result in erosion, or runoff waters may leave erosion gullies on the downstream slope. Other special problems, such as shrinkage cracks or rodent damage, may also occur. Damage of this nature must be repaired constantly.

The maintenance procedures to be described in the O&M Manual will be used for repairs of routine earthwork problems. However, this section is not intended to be a technical guide, and the methods discussed should not be used to solve serious problems. Conditions such as embankment slides, structural cracking, and sinkholes threaten the immediate safety of a dam and require immediate repair under the directions of experienced engineers/Expert panels.

The material selected for repairing embankments should be free from vegetation, organic materials, trash, and large rocks.

If flow-resistant portions of an embankment (such as impervious core) are being repaired, materials that are high in clay or silt content should be used. If the area is to be free draining or highly permeable (such as pervious shell of an embankment dam) the material should have a higher percentage of sand and gravel. It is usually satisfactory to replace or repair damaged areas with soils like those originally in place.

An important soil property affecting compaction is moisture content. Soils that are too dry or too wet do not compact well. One may test repair material by squeezing it into a tight ball. If the sample keeps its shape without cracking and falling apart (which means it is too dry), and without depositing excess water onto the hand (which means it is too wet), the moisture content is near the proper level.

Before placement of earth, the repair area needs to be prepared by removing all inappropriate material. All vegetation, such as bushes, roots, and tree stumps, along with any large rocks or trash need to be removed. Also, unsuitable earth, such as organic or loose soils, should be removed, so that the work surface consists of exposed, firm, clean embankment material.

Following cleanup, shape and dress the affected area so that the new fill can be compacted to the level specified in the technical specifications. Also it should properly key with the existing fill for which benches of suitable dimensions need to be made in the existing fill. Further trim the slopes and roughen the surfaces by scarifying or plowing to improve the bond between the new and existing fill and to provide a good base to compact against.

Place soils in loose layers up to 20 centimeters thick and compact manually with pneumatic tampers or mechanically to form a dense mass free from large rock or organic material. Keep soil moisture in the proper range. The fill should be watered and mixed to the proper wetness and allowed to dry if too wet.

Erosion is one of the most common maintenance problems in embankment structures. Erosion is a natural process and its continuous forces will eventually wear down almost any surface or structure. Periodic and prompt maintenance is essential to prevent continuous deterioration and possible failure.

Turfing, free from weeds and bushes, is an effective means of preventing erosion.

Rills and gullies should be filled with suitable soil, compacted, and then seeded for growing the turfing. Erosion in large gullies can be slowed by stacking bales of hay or straw across the gully until permanent repairs can be made.

Paths due to pedestrian, livestock, or vehicular traffic (two and four-wheeled) are a problem on many embankments. If a path has become established, vegetation will not provide adequate protection and more durable cover will be required unless traffic is eliminated. Stones may be used effectively to cover such footpaths.

Repair of Dam top road and Dyke top road under DRIP

In addition, steps can be provided/ constructed at regular intervals along the length of the dam for going from downstream toe to the dam top. All vehicular traffic, except for maintenance, should be restricted from the dam.

Erosion is also common at the point where an embankment and the concrete walls of a spillway or other structure meet. Poor compaction adjacent to such walls during construction and later settlement can result in an area along the wall that is lower than the grade of the embankment.

Runoff, therefore, often concentrates along these structures, resulting in erosion. People also often walk along these walls, wearing down the vegetative cover. Workable solutions include re-grading the area so that its slopes away from the wall, adding more resistant surface protection, or constructing steps.

4.3.2. Upstream Riprap

The upstream face of a dam is required to be protected against wave erosion. Rip-rap is normally provided for the purpose with filter layers below.

Nonetheless, erosion can still occur in existing riprap. Water running down the slope under the riprap can erode the embankment. Sections of riprap that have slumped downward are often signs of this kind of erosion.

Effective slope protection must prevent soil from being removed from the embankment.

When erosion occurs on the upstream slope of a dam, repairs should be made as soon as possible. Repairs can be made following the same design details as provided in the embankment dam. Proper preparation of surface of the existing embankment as described in para 4.2.1 including cutting benches as per site conditions for better bonding is necessary. IS 8237- Code of practice for protection of Slopes for Reservoir Embankments may also be referred to

Repair of Upstream Slope Guard Wall at Salia Dam Under DRIP Project

4.3.3. Controlling Vegetation

Keep the entire dam clear of unwanted vegetation such as bushes or trees. Excessive growth may cause several problems:

a) It can obscure the surface of an embankment and not allow a proper inspection of the dam.

b) Large trees can be uprooted by high wind or erosion and leave large holes that can lead to breaching of the dam.

c) Some root systems can decay and rot, creating passageways for water, and thus causing erosion.

d) Growing root systems can lift concrete slabs or structures.

e) Rodent habitats can develop.

All bushes/trees should be as far as possible removed by roots. The resulting holes should be filled with well compacted earth. It would be desirable to remove the plants/vegetation at their early stage to prevent their growing into big tree/bushes. In cases where trees and bushes cannot be removed, the root systems should be treated with herbicide (properly selected and applied) to retard further growth. Use of harmful chemicals should be avoided. Concerned Government Agencies should be consulted for selection of appropriate herbicides & their use for control of vegetation on dam structures.

Further, it is desirable that there are no trees or bushes within 500 m of the toe drain on the downstream side of the dam.

4.3.4. Controlling Animal Damage

Livestock should not be allowed to graze on an embankment surface. When soil is wet, livestock can damage vegetation and disrupt the uniformity of the surface. Moreover, livestock tend to walk in established paths and thus can promote erosion. Such paths should be re-graded and seeded, and the livestock permanently fenced out of the area.

The burrows and tunnels of burrowing animals (beaver, muskrat, groundhogs and others) weaken earthen embankments and serve as pathways for seepage from the reservoir. Large burrows on an embankment should be filled by mud packing. This method involves placing vent pipe in a vertical position over the entrance of the den. Making sure that the pipe connection to the den does not leak, the mud-pack mixture

is poured into the pipe until the burrow and pipe are filled with the soil-water mixture. The pipe is removed and more dry earth is tamped into the entrance. As per some US publications, the mud pack is generally made by adding water to 90% earth & 10% cement mixture until a slurry or thin cement consistency is attained. For bigger holes, bentonite coated stones can also be used. All entrances should be plugged with well-compacted earth & vegetation re-established. Dens should be eliminated without delay. Different repair measures will be necessary if a dam has been damaged by extensive small rodent tunneling or large rodent activity. The area around the entrance can be excavated and then backfilled with impervious material. This plugs the passage entrance so that water is prevented from saturating the dam's interior.

4.3.5. Controlling Ants and Termites (White Ants)

Ants and termites have become one of the most serious pests for Embankment dams. They both need water to survive and have been found on most of the embankment dams in India including in the Salia Dam These insects can create problems in the dam itself and with any of its electrical components.

In some habitats, ants and termites can move as much or more soil as earthworms, thereby reducing soil compaction. Nest galleries can penetrate in a V-shaped pattern below the nest, penetrating as much as more than one meter deep in the soil. These galleries can create pathways for surface water to penetrate in the dam, resulting in internal erosion and collapse of the surface.

Ants and termites left undisturbed can build mounds that can become quite large. These can create problems for mowing. However, frequent mowing can induce the colonies to migrate to neighboring, undisturbed areas.

There are many options for managing ants and termites. Use only pesticides labeled as suitable for the location you want to treat. Make every effort to avoid contaminating water with pesticides.

4.3.6. Controlling Damage from Vehicular Traffic

Vehicular traffic is restricted on top of dam. Regular maintenance of the road at dam top is mandatory.

Salia Dam Gate

4.3.7. Masonry / Concrete Spillway (Surplus Escape)

Vegetation growth on the surfaces of the spillways is removed.

Minor repairs of concrete/masonry can be carried out during routine maintenance.

4.3.8. Gates and Hoisting Equipments

A satisfactory operation of Salia Dam envisages proper operation of the Gates & their Hoisting Equipment of its Irrigation outlet.

If routine inspection of the Hydro-Mechanical Equipment shows the need for maintenance, the work should be completed as soon as possible.

The O&M Manuals of the Gates manufacturer's would however govern the overall maintenance of Gates & Hoists whenever there is any contradiction with the instructions given in the Manual.

Head Regulator of Banapur Main Canal

4.3.8.1. Head Regulator Gates of Irrigation Outlet

The maintenance of head regulator gates, hoists and ancillary components are being done regularly. Proper records of inspection, testing and maintenance should be kept by the officers in charge of the work.

The following maintenance works should be attended to:

a) The worn out bolts, screws etc. should be replaced. Any pitting to embedded portion should be filled up by welding and finished by grinding. Weld joints of major components should be checked thoroughly and defects if any should be rectified by welding and grinding.

b) The gates, hoists and allied structures should be painted once in three years normally. However painting of gate, hoist and allied parts may be carried out earlier, as necessary, based on regular inspection for the condition of paint/ surface. The original specification of painting done at the time of commissioning of gate and hoists should be kept in view while painting in subsequent years.

c) The rubber seals of the gate should be checked for leakage, wear and tear and damage and should be repaired /replaced as considered necessary.

d) The bolts and nuts fixing the rubber seals to the skin plate should be checked for slackness and should be tightened if found loose. Damaged bolts and nuts should be replaced.

e) Drain holes provided in horizontal stiffeners of the gates should be cleaned to avoid stagnation of water on the horizontal stiffeners.

f) The lifting pin and lifting bracket bush if provided should be lubricated properly as specified in Table-1.

g) The sill beam, side seal seat, top seal seat, guide and wheel track should be checked for pitting and should be rectified suitably. The welding of stainless steel flats on wheel tracks, bottom sill beam, side seal seats and top seal seats should be checked for weld cracks and should be re-welded and ground smooth if weld cracks are noticed.

h) Gap between guide and guide shoe should be checked and suitably rectified if excessive sway on gate is noticed.

i) Distance between face to face of guide, centre to centre of track and side seal seats and distance between the bottom sill beam and centre of top seal seat should be checked and remedial measures may be taken if felt necessary.

j) The stems of restraining arrangement and the split bushes should be lubricated properly as specified in Table-1.

k) The bolts and nuts of restraining brackets and stem flanges should be checked for slackness and should be tightened if found loose.

l) The stem should be checked for straightness and suitable remedial measures may be taken if the stems are found bent.

m) The welding of eye piece to the bottom stem and other weld joints shall be checked and suitably rectified if defects are noticed.

n) The worm, worm wheel, worm shaft, bronze bushes, thrust bearings and screw rod should be lubricated properly as specified in Table-1.

o) The screw rod, worm and worm wheel should be checked for damage to teeth or hair cracks etc. and should be rectified / replaced as considered necessary.

p) The thrust bearings should be opened and checked for damage to the inner/ outer cones & rollers etc. & shall be rectified/replaced as considered necessary.

q) The guide, side seal seat and top seal seat should be lubricated properly.

r) The emergency gates, provided in the dam are also maintained in the similar method.

In addition to the above, other defects noticed during pre-monsoon inspection shall also be attended to before onset of monsoon, if the defects need immediate attention.

All other defects can be rectified during the working season i.e. between 1st November to 15th June of every water year.

Maintenance Schedule:

a. Quarterly Maintenance

i. **Stems and Split bushes**.

The stems and split bushes should be lubricated.

ii. **Lifting bracket bush and pin**.

The lifting bracket bush and pin should be lubricated.

iii. **Gear Box Assembly**.

- The screw rod should be lubricated.
- The worm, worm wheel, worm shaft & thrust bearing should be lubricated.

b. Yearly maintenance

i. Grease shall be applied to guide, side seal seat and top seal seat.

ii. All bolts and nuts should be checked for slackness and shall be tightened if found loose.

iii. The rubber seals should be checked for deformation and damage etc and shall be repaired / replaced.

4.3.8.2. Painting of Head Regulator Gates and Hoists

a. Protection of painted surfaces is considered essential for protection & enhancement of service life.

Gates, its embedded parts, gate leaf, hoists and its supporting structures need to be protected against corrosion due to climatic condition, weathering, biochemical reaction and abrasion etc. These equipment are likely to deteriorate/ damage to the extent that replacement of parts may become necessary and such replacement may become difficult and costly.

b. Surface preparation & Painting requirements.

Painting for hydro-mechanical works is to be carried out as prescribed in IS 14177 for both newly manufactured as well as old & used gates, hoists and associated works after proper surface preparation. The preparation includes thorough cleaning, smoothing irregular surfaces, rusted surfaces, weld spatters, oil, grease, dirt, earlier applied damaged layers of primers/paint by use of mechanical tools, by use of solvents, wire brush etc. The sand/grit blasting process is used for surface preparation to a level of Sa 2½ of the Swedish standard.

c. Surfaces not requiring painting & their protection during surface preparation, painting & transportation process.

i. The following surfaces are not to be painted unless or otherwise specified:

- Machine finished or similar surface
- Surfaces which will be in contact with concrete
- Stainless steel overlay surfaces.
- Surfaces in sliding or rolling contact
- Galvanized surfaces, brass and bronze surfaces.
- Aluminum alloy surfaces

ii. The Surfaces of stainless steel, nickel, bronze and machined surface adjacent to metal work being cleaned or painted shall be protected by using sticky protective tape or by other suitable means over the surfaces not to be painted.

iii. All embedded parts which come in contact with concrete shall be cleaned as detailed above and given two coats of cement latex to prevent rusting during the shipment while awaiting installation.

d. Application of primer & finish coats on embedded parts and gates

i. Embedded parts

- The prescribed primer shall be applied as soon as the surface preparation is complete and prior to the development of surface rusting and within the specified time prescribed by Indian Standards or the Paint Manufacturer.

In case there is lapse of considerable time beyond the prescribed time limit, the surfaces shall be again cleaned prior to priming.

- Two coats of zinc rich primer with epoxy resin shall be applied to all embedded parts surfaces which are not in contact with concrete and shall remain exposed to atmosphere or submerged in water to obtain a dry film thickness of 75 microns.
- This shall be followed by three coats at an interval of 24 hours of coal-tar blend epoxy resin so as to get a dry film thickness of 80 microns in each coat. Total dry film thickness of paint shall not be less than 300 microns.

ii. Gates

- **Primer Coat**

Over the prepared surface one coat of inorganic zinc silicate primer giving a dry film thickness of 70 ± 5 microns should be applied. Alternatively two coats of zinc rich primer, which should contain not less than 85% zinc on dry film should be applied to give a total dry film thickness of 75 ± 5 microns.

- **Finished paint**

Two coats of solvent less coal tar epoxy paints. These shall be applied at an interval of about 24 hours. Each coat shall give a dry film thickness of 150±5 microns. The total dry film thickness of all the coats including primer coating shall not be less than 350 microns.

Table – 1:
Head Regulator Gates and Screw Hoists

Sl. No.	Parts to be Lubricated	Method of Lubrication	When to Lubricate	Lubricants Recommended
1.	Worm Wheel, Worm, Worm shaft and screw rod	Smear	Quarterly	Mobil Grease
2.	Bushes of Gear Box	By Oilcan	Quarterly	DTE Oil
3.	Restraining stems & split bushes	Smear	Quarterly	Mobil Grease
4.	Lifting Bracket Bush and Pin	Smear	Quarterly	Mobil Grease
5.	Thrust Bearing	Smear	Quarterly	Mobil Grease No. 2
6.	Guide, side Seal Seat & Top Seal Seat	Smear	Yearly	Dorcia 150

Note: Lubricants of other make equivalent to the lubricants specified above can also be used.

4.3.9. Electrical System

Head regulator shutters are operated manually and spillway is un-gated. There is no supply of electricity to the project site. No lighting arrangement has been made at site till date.

4.3.10. Metal Component maintenance

Head regulator shutters of bare ferrous metal will tend to rust. To prevent corrosion, shutters must be either appropriately painted (following the paint manufacturer's directions) or heavily greased in respect of moving parts & on surfaces like guide channels on which there is movement of gates. When areas are repainted, it should be ensured that paint is not applied to gate seals, wedges, or stems (where they pass through the stem guides), or on other friction surfaces where paint could cause binding. Heavy grease should be applied on friction surfaces to avoid binding. As rust is especially damaging to contact surfaces, existing rust is to be removed before periodic application of grease.

4.3.11. Access Road

For a dam to be operated and maintained there must be a safe means of access to it at all times. Access road surfaces must be maintained to allow safe passage of automobiles and any required equipment for servicing the dam in any weather conditions. Routine observations of any cut and fill slopes along the sides of the road should be made. If unstable conditions develop assistance of experienced Engineers/Expert Panels should be obtained and remedial measures initiated.

Drains are required to be provided and maintained along roads to remove surface and subsurface drainage. This will prolong the life of the road and help reduce deterioration from rutting. Road surfacing should be repaired or replaced as necessary to maintain the required traffic loadings. In most cases, specialized contractors will be required to perform this maintenance.

An all-weather black topped approach road with carriage way width of 3.66 m to the dam has been constructed for movement of machines and dam authorities throughout the year.

4.3.12. General cleaning

For proper operation of spillways, sluiceways, approach channels, inlet and outlet structures, stilling basin/ energy dissipation arrangements, discharge conduit, dam slopes, trash racks, debris control devices etc. cleaning and removal of debris is necessary. Cleaning is especially important after large floods, which tend to send more debris into the reservoir.

4.4. Material Requirements during monsoon period

Materials required during monsoon period for both immediate maintenance and preventive maintenance should be stocked in adequate quantity. A 24x7 hour patrolling is to be carried out during the monsoon period.

The materials normally required to be stocked in sufficient quantity are:-

a) Gunny Bags

b) Sand, Boulders/Wire crates

c) Bamboos/ Balli's

d) Baskets, ropes

e) Petromax Lamps with Spares

f) Torches with spare cells

g) Kerosene Oil

h) Match Boxes

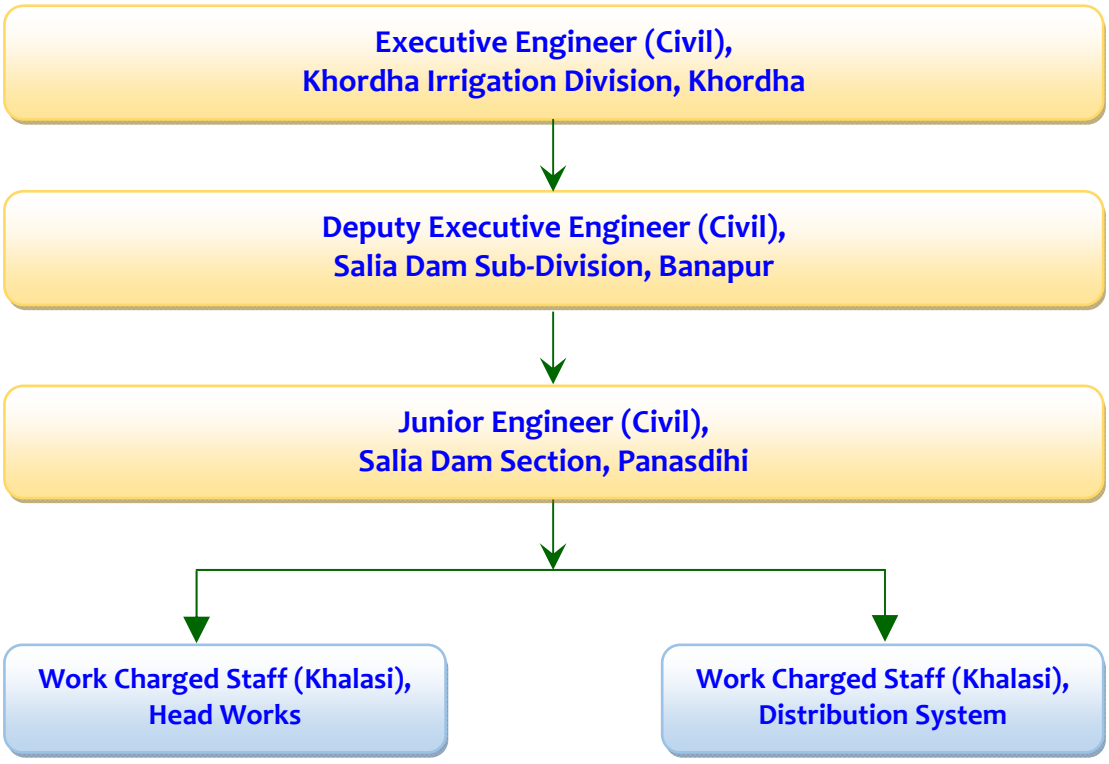
i) Rain Coats

j) Gum Boots

k) Warning sign indicator

l) Danger zone lights

4.5. Establishment structure at Salia dam



4.6. Preparation of O&M Budget

The O&M budget for Salia Dam should essentially include but not be limited to the following items:

Establishment Cost of Regular Staff - Salaries and allowances, Bonus, Medical Reimbursement, LTC, Leave Encashment, TA and DA, pension benefits, etc. (as applicable).

Establishment Cost of Work charged Staff - Salaries and allowances, Bonus, Medical Reimbursement, LTC, Leave Encashment, Pension benefits, TA and DA , etc. (as applicable).

Motor Vehicles - Running and Maintenance cost of inspection vehicles, Cost of hiring of vehicles as required

Works - Painting, oiling, greasing, Repair/replacement of gates seals, specific requirements for all Civil, works, vegetation removal and mowing of turfing on earth dams, maintenance/cleaning of drains in dam, maintenance ,maintenance of access roads & basic facilities, provision for flood contingency works during monsoon, unforeseen events/items etc.

A summary table for the O&M budget is given in **Annex III**.

4.7. Maintenance of records

Maintenance records are of utmost importance. A record should be kept of all maintenance activities-Immediate, Preventive and Routine maintenance works. Information that should be recorded includes the following as a minimum:

a) Date and time of maintenance,

b) Weather conditions,

c) The type of maintenance,

d) Name of person or contractor performing maintenance,

e) Description of work performed,

f) The length of time it took to complete the work with dates,

g) Equipment and materials used, and

h) Before and after photographs.

The data should be recorded by the person responsible for maintenance.

CHAPTER-5

INSTRUMENTATION AND MONITORING

At present the following instruments are installed in the dam.

A. V-Notch : 3 nos.

B. Piezometer : 4 nos.

C. Automatic Reservoir level recorder : 1 no

D. Automatic Rain Gauge : 1 no

The frequency of measurement is given below

Sl. No.	Instrument	Location and Number	Parameter measured	Frequency	Condition of instrument
1	V-Notch	RD 233 m at toe of Salia Earth Dam	Recording seepage	Daily	In working order
2	Automatic Rain Gauge	Over the top rest shed	Recording Rain fall	Daily as per Rain fall	In working order
3	Automatic Reservoir level Recorder	At Head Regulator of Banapur Main Canal	Recording water level	Daily	In working order
4	Piezometer	On D/S slope of the dam	Measuring Pore water pressure	Daily	In working order

The Instruments are maintained by the Deputy Executive Engineers / Junior Engineers.

Note:-

Monsoon – 15th June to 31st October

Non - Monsoon – 1st Nov. to 14th June of the water year.

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CHAPTER-6

PREVIOUS REHABILITATION EFFORTS

The maintenance of Dam is carried out from the approved annual maintenance budget of Salia Dam. Before DRIP, maintenance activities were limited to routine greasing, oiling, and patch painting of shutter gates, routine mowing, vegetation removal, repair of eroded section, etc. Apart from these routine maintenance activities, no major rehabilitation was carried out before the involvement of DRIP.

Under DRIP, major rehabilitation Works have been carried out for Salia Dam at a total cost of about INR 3.851 Crores (during the year 2015 to 2018).

The rehabilitation works carried out under DRIP include:

a) Re-sectioning of earthen embankment of dam (D/S) & dyke (D/S) including repairs to u/s rip rap of dyke, turfing on the d/s slope of dam & dyke.

b) Construction of cement concrete horizontal & vertical drains on D / S face of Earth dam & dyke.

c) Restoration/Reconstruction of old downstream masonry guard wall with cement concrete guard wall at the top of Earth dam & dyke.

d) Restoration of Dam top road & dyke top road.

e) Fixing of barbed wire fencing around the downstream of dam.

f) Electrification of dam.

g) Anti- termite treatment in Earth dam & dyke.

h) Instrumentation of dam.

i) Clearance of vegetation.

Other non-structural measures carried out under DRIP include preparation of Inundation maps and Emergency Action Plan (EAP); Review of design flood; Preparation of O&M Manual; Data entry into DHARMA; etc.

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CHAPTER-7

UPDATING THE MANUAL

The O & M Manual is to be reviewed and updated periodically. Updating of O&M Manual should be done whenever any major changes occur like revision of design flood, construction of additional Surplus Escape (Spillway), construction of dam on the upstream etc.

Aspects to be considered when updating include:

A) Increase/decrease in the frequency of inspection or routine maintenance based on additional data/ experience acquired.

B) Changes in the operation and/or maintenance procedures based on additional data/experience acquired.

C) Alterations to the project data because of changes/modifications in the dam by way of construction of any additional surplus escape (Spillway), u/s and d/s developments etc.

All up-dates/revisions of the O&M Manual need to be sent to all the locations/addresses to which the copies of the original O&M Manual had been sent earlier. The O&M Manual is to be normally reviewed/ updated after every 10 years or earlier by the Executive Engineer, Khurda Irrigation Division, Khurda.

Updates in the O & M Manual will be approved by the Chief Engineer of the project after getting the needful checking done through the DSO of OWRD.

7.1 Training and Exercises

Training: The training of the personnel, involved in implementation of the O & M Manual will be conducted by the SE once in a year so as to make the implementing staff familiar with the elements of the O&M plan, their responsibilities and duties, the available equipment, detection of problems and remedial measures.

A sufficient number of people will be trained to ensure adequate coverage at all the time.

Exercises (Testing): The SE shall carry out orientation meetings with personnel involved in implementation of the O&M Manual and organize mock drills for head regulator gates before onset of monsoon.

REFERENCES

(A) CWC: 2018 Guidelines for preparing O&M Manuals for dams (Doc. No. CDSO_GUD_DS_O3_v1.0)

(B) Japan Water Agency: 2017 Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand (CDSO_GUD_DS_0_v1.0,).

(C) CWC:2018 Guidelines for Safety Inspection of Dams (Doc. No. CDSO_GUD_DS_O7_v1.0)

(D) IS 14177: 1994 Guidelines for Painting system for Hydraulic Gates and Hoists

(E) IS 8237:1985 Code of Practice for protection of slopes for Reservoir Embankments

(F) IS 11223:1985 Guidelines for fixing Spillway Capacity

(G) CWC: 2018 Guidelines for preparing O&M Manuals for dams (Doc. No. CDSO_GUD_DS_O3_v1.0)

(H) Japan Water Agency: 2017 Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand (CDSO_GUD_DS_0_v1.0,).

(I) CWC:2018 Guidelines for Safety Inspection of Dams (Doc. No. CDSO_GUD_DS_O7_v1.0)

(J) IS 14177: 1994 Guidelines for Painting system for Hydraulic Gates and Hoists

(K) IS 8237:1985 Code of Practice for protection of slopes for Reservoir Embankments

(L) IS 11223:1985 Guidelines for fixing Spillway Capacity

APPENDIX - I

Scheduled Dam Safety Inspection Form

Part 1a - Inspection Details:

Dam Name:		Project ID Code (PIC):	
Dam Type:		Dam Purpose:	
Dam Owner:		Hazard Classification:	
Dam Operator:		Type of Inspection:	
Commissioning Date:		Inspection by:	
City/State/PIN:		Date of Inspection:	
District:		Reservoir water level in metre on the date of inspection:	
Latitude:		Storage Capacity (MCM):	(i) Gross ……..(ii) Live……
Longitude:		Weather Conditions:	
Important Controlling Level	a) TBL RL ……. b) MWL RL …… c) FRL RL …….. d) Spillway Crest RL …… e) MDDL RL …… f) Lowest River bed RL …….. g) Deepest foundation level RL ……..		

Part 1b - Inspection Remarks:

Please provide any additional information or comments not covered by Part 1a form above.

Part 2a - Inspection Checklist:

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
A-	**Reservoir**					
A-1.1	**General Condition**					
1.1.1	Is the reservoir water level unusually high or low?					
1.1.2	Are there signs of decline in water quality?					
1.1.3	Are there signs of recent sediment deposition?					
1.1.4	Is floating debris present?					
1.1.5	Any indications of major active or inactive landslide area in the reservoir rim If so, indicate their locations and extent.					
1.1.6	Are there people or livestock in and around reservoir?					
1.1.7	Any other issues?					
B-	**Dam and Dam Reach (Embankment)**					
B-1.1	**General Condition**					
1.1.1	Any major alterations or changes to the dam since the last inspection?					
1.1.2	Is there any new nearby development in the downstream floodplain?					
1.1.3	Any misalignment of poles, fencing or walls due to dam movement?					
B-1.2	**Upstream Slope**					
1.2.1	Any signs of bulging or concavity (depressions)? If so, indicate their locations and extent. (Check up the cross-sections with tape and level at random locations, at least two)					
1.2.2	Does the section of the dam and upstream slope appear structurally sound and stable?					
1.2.3	Presence of longitudinal or transverse cracks?					
1.2.4	Whether any signs of distress to stability of slopes noticed at any time in any part of the dam? If so, give brief details of the incidents and location, the method of treatment adopted and its effectiveness. Indicate the general condition of upstream pitching.					
1.2.5	Any degradation to slope protection (rip-rap)?					
1.2.6	Is there any profuse growth of bushes or weeds over any portion of the dam? If so, indicate the locations.					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.2.7	Does the upstream slope shows existence of crab holes or holes made by rodents or burrowing animals or ant hills? If so, indicate the locations.					
1.2.8	Any Other issues?					
B-1.3	**Crest of Dam**					
1.3.1	Is the crest profile at proper elevation? (To be test checked at random locations by taking level)					
1.3.3	Does it show any signs of excessive and/or uneven settlement? If so, indicate such locations and extent of settlement. (Surface settlement points must be installed for observing this aspect)					
1.3.4	Is the surface of the crest free from undulations and local depressions or heaving?					
1.3.5	Does it provide an all-weather road surface? Any degradation to access road (sealed/unsealed)					
1.3.6	Does it develop any visible cracks in transverse or longitudinal directions? If so, attach a map showing their locations and extent. Depth of cracks must be ascertained by taking open trenches extending below the bottom of cracks.					
1.3.7	What is the condition of the edges of crest? Have got eroded and cut up resulting in reduced effective width?					
1.3.8	Is the crest free from local slips throughout its length on either sides?					
1.3.9	Do the headers, guard stones and parapet wall provided at the edges of the crest appear in proper profile and plumb?					
1.3.10	Any degradation to upstream parapet or downstream curb wall?					
1.3.11	Evidence of livestock on dam crest?					
1.3.12	Trees or profuse growth of weeds/bushes at any location?					
1.3.13	Proper lighting arrangement at dam top?					
1.3.14	Any other issues?					
B-1.4	**Downstream Slope**					
1.4.1	Any signs of bulging or concavity (depressions)?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.4.2	Are there any wet or slushy patches or any concentrated leaks, springs or trickles observed on the downstream slopes or the toe? If so, indicate their locations and extent. Please look out for patches of extensive vegetation growth and examine them carefully and record the findings.					
1.4.3	Presence of longitudinal or transverse cracks?					
1.4.4	Any signs of distress to the stability of slopes?					
1.4.5	Are rain cuts/erosion channels present at any location?					
1.4.6	Are all the rain cuts and erosion channels properly treated and made good? Please indicate location of recurring damages, if any.					
1.4.7	Is there any profuse growth of bushes or weeds over any portion of the dam? If so, indicate the locations.					
1.4.8	Does the downstream slope shows existence of crab holes or holes made by rodents or burrowing animals or ant hills? If so, indicate the locations.					
1.4.9	Any other degradation to slope protection (turfing)? Indicate the general condition of downstream pitching/ turfing and rock toe.					
1.4.10	Is the downstream area clear of debris and free draining?					
1.4.11	Any other issues?					
B-1.5	**Downstream Drainage**					
1.5.1	Are there any signs of water logging, slushy conditions or growth of aquatic weeds on the downstream of the dam? To be checked upto 300 m downstream of toe					
1.5.2	Are there any standing pools of water in the downstream of dam? If so, give their locations and extent. To be checked upto 300 m downstream of toe					
1.5.3	Are there any boils observed in the vicinity of the downstream toe of the dam? If so, give locations.					
1.5.4	Is the downstream area sufficiently clear and free draining?					
1.5.5	What is the depth of ground water table on the downstream as evident from the existing wells in the vicinity of the dam To be checked up to 300 m downstream of toe. Does the water table show any marked variation in accordance with the variations in reservoir water level?				a) Max. ground water level..... b) Location ..... c) Date..... Corresponding Reservoir level.....	

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.5.6	Are all the exposed drains working satisfactorily?					
1.5.7	Toe drains and cross drains. I. Are the portions of longitudinal toe drain and exposed cross drains beyond the downstream toe of the dam in regular section and freely draining? II. Is the pitching to these drains intact? III. Is there any weed growth in these drains? IV. Indicate other defects noticed in the drains, if any.					
1.5.8	Outfall Drain a) Is the outfall drain in proper shape and grade and freely draining? b) Is the outfall drain properly cleaned and maintained? Does the outfall drain show any stagnant pools of water or weed growth?					
B-1.6	**Surface Drainage of Downstream slope**					
1.6.1	Is the condition of the downstream slope drainage arrangements, if provided, satisfactory?					
1.6.2.	Is the paving to these drains intact?					
1.6.3	Are all the drains properly maintained and free of vegetation growth and debris?					
1.6.4	Does the slope have a tendency to develop severe rain cuts at any location?					
1.6.5	Enumerate any other defects noticed in the surface drainage of downstream slope.					
B-1.7	**Seepage Measurement**					
1.7.1	Is the quantity of seepage being daily or periodically measured and recorded? Please check the registers and record observations.					
1.7.2	Does it show any abnormal rise or fall? If so, does it have any relation to a certain reservoir level elevation?					
1.7.3	Does the seepage show a turbid colour at any stage? Was such a phenomenon observed at any stage at any location in the past?					
1.7.4	What is the measured rate of seepage flow with date and reservoir level; i. On the day of present inspection ii. Maximum since last June iii. Minimum since last June				a) Date b) Rate of seepage flow (lpm) c) Reservoir level (m)	

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.7.5	Is the portion upstream and downstream of measuring points of seepage easily accessible with proper steps and paths and free of vegetation growth?					
1.7.6	Are the measuring points properly located, constructed and maintained so as to give accurate and reliable measurements of seepage in accordance with the relevant IS Codes?					
1.7.7	Is the method of taking seepage measurements satisfactory?					
B-1.8	**Breaching Section (if provided)**					
1.8.1	Is the breaching section easily accessible?					
1.8.2	Is the condition of the breaching section satisfactory?					
1.8.3	Is the note of instructions as to when and how to operate the breaching section available on record?					
1.8.4	For reconstruction after the breach are the following items decided in advance? a) Quarry for embankment material b) Suitable routes of access Is the maintenance staff fully aware of the instructions related to operation of the beaching section and for reconstruction after the breach					
1.8.5	Ascertain and indicate the latest event of operation of breaching section and its performance.					
1.8.6	Evidence of recent degradation?					
1.8.7	Any other issues?					
B-1.9	**Junction of Earth work with Masonry/Concrete dam sections and outlets**					
1.9.1	Is there any existence of leaks, springs or wet spots in the earth work in the vicinity of the junctions between earth work and masonry works? If so, what is the approximate rate and colour of the leakage? Does it turn turbid at any time? Please ascertain from enquiries and record the findings.					
1.9.2	Is there any tendency for separations, cracking, settlement or upheaval of the earth work in the vicinity of masonry or concrete? If so, indicate the locations and the exact nature of deficiency.					
1.9.3	Is there any tendency for surface erosion or slope instability at the junction?					
1.9.4	If the outlet conduit is located in the earth dam section, is the entire length of the conduit in perfect order and profile and free from offsets, open joints, cracks and leakage?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
	Examine the conduit carefully from the downstream or from inside, if possible, and indicate the deficiencies observed, if any.					
1.9.5	Any other issues?					
B-1.10	**Relief Wells**					
1.10.1	Are the relief wells in good working condition and functioning well?					
1.10.2	Are the relief properly surged and cleaned periodically?					
1.10.3	Please indicate the dates of last surging and cleaning and the next surging due.					
1.10.4	Are the necessary plant and equipment for cleaning the relief wells, available with the office?					
1.10.5	Is the record of periodical measurements of discharge from each relief well maintained? If so, indicate total discharge and maximum discharge observed from a single well on the date of inspection.					
B-1.11	**Abutment Contacts**					
1.11.1	Any presence of leaks, springs or wet spots near the abutment?					
1.11.2	Any presence of cracking, settlement or upheaval of earthwork?					
1.11.3	Any evidence of erosion or slope instability?					
1.11.4	Trees or profuse growth of weeds/bushes?					
1.11.5	Any degradation to up/downstream slope protection (rip-rap, turfing)?					
1.11.6	Any other issues?					
C-1	**Dam and Dam Block/Reach (Concrete/Masonry)**					
C-1.1	**General Condition**					
1.1.1	Any major alterations or changes to the dam since the last inspection?					
1.1.2	Is there any new nearby development in the downstream floodplain?					
1.1.3	Any misalignment of poles, fencing or walls due to dam movement?					
C-1.2	**Upstream Face**					
1.2.1	Evidence of surface defects (honeycombing, staining, stratification)?					
1.2.2	Concrete/masonry deterioration (spalling, leaching, disintegration)?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.2.3	Is cracking present (structural, thermal, along joints)?					
1.2.4	Evidence of differential settlement (displaced/offset/open joints)?					
1.2.5	Presence of vegetation (growth in joints between blocks)?					
1.2.6	Evidence of any other damage to joints and/or water stops?					
1.2.7	Any other issues?					
C-1.3	**Crest of Dam**					
1.3.1	Evidence of differential settlement (displaced/offset/open joints)?					
1.3.2	Presence of cracking (structural, thermal, along joints) ?					
1.3.3	Profuse growth of weeds/grass/plants at any location?					
1.3.4	Any degradation to access road?					
1.3.5	Any degradation to upstream parapet or downstream curb wall?					
1.3.6	Any other issues?					
C-1.4	**Downstream Face**					
1.4.1	Evidence of surface defects (honey-combing, staining, stratification)?					
1.4.2	Concrete/masonry deterioration (spalling, leaching, disintegration)?					
1.4.3	Presence of cracking (structural, thermal, along joints)?					
1.4.4	Evidence of differential settlement (displaced/offset/open joints)?					
1.4.5	Presence of vegetation (growth in joints between blocks)?					
1.4.6	Evidence of any other damage to joints and/or water stops?					
1.4.7	Excessive seepage/sweating at any location on downstream face?					
1.4.8	Significant leakage at any location on downstream face?					
1.4.9	Any other issues?					
C-1.5	**Abutment Contacts**					
1.5.1	Any presence of leaks, springs or wet spots in vicinity of abutment?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.5.2	Any presence of cracking or settlement?					
1.5.3	Profuse growth of weeds/grass/plants at any location?					
1.5.4	Any other issues?					
D-	**Gallery/Shaft and Drainage (Concrete/Masonry)**					
D-1.1	**General Condition**					
1.1.1	Slushy condition or water logging immediately downstream of dam?					
1.1.2	Any evidence of boiling in vicinity of dam toe?					
D-1.2	**Gallery/Shaft Condition**					
1.2.1	Any problems accessing or inspecting gallery/shaft (obstruction)?					
1.2.2	Any safety issues (inadequate handrails, lighting or ventilation)?					
1.2.3	Problems of inadequate drainage (slippery stairs, water logging of gallery, clogged porous or foundation drains)?					
1.2.4	Evidence of differential settlement (displaced/ offset/ open joints)?					
1.2.5	Excessive seepage/sweating at any location along gallery/ shaft?					
1.2.6	Significant or excessive leakage at any location along gallery/ shaft/ porous drain? If yes, provide location(s).					
1.2.7	Are proper arrangements made for the measurement of seepage into the gallery? Is the seepage measured separately from- 1. Porous pipes? 2. Foundation drains? And 3. Monolith Joints? Are the above arrangements satisfactory?					
1.2.8	Has there been substantial progressive reduction in the seepage through the foundations? Is it due to choking of the drain holes? If so, indicate number of holes choked.					
1.2.9	Are all the foundation and porous holes periodically cleaned with reaming tool and air water jetting? Indicate the last date of such cleaning and extent of variation observed in the seepage discharge before and after the cleaning.					
1.2.10	Is the seepage water and the deposit, if any, from the seepage being regularly examined for chemical composition? If so, indicate the result and the probable source of dissolved salts, if any.					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.2.11	Are any seepage water springs observed in the downstream area anywhere? If so, indicate the locations and state the physical nature of this seepage. Look out for such seepage spots particularly near the dykes, fault zone etc. Ascertain if chemical testing are made of water samples from such springs for dissolved salts.					
1.2.12	Is there any leachate deposition? If yes provide location					
1.2.13	Any other issues?					
D-1.3	**Drain Condition**					
1.3.1	Is the flow in the drain unusually high or low?					
1.3.2	Presence of calcium or other deposits in drain?					
1.3.3	Is dewatering pumping station fully operational?					
1.3.4	Any problem inspecting pump?					
1.3.5	Any obstruction preventing or impairing smooth operation?					
1.3.6	Any deterioration of pump and associated equipment?					
1.3.7	Is sump well clean and maintained?					
1.3.8	Is V-notch before sump well clean and maintained?					
1.3.9	Any other evidence of the drain being blocked/having reduced section?					
1.3.10	Is the flow in the drain noticeably sporadic/irregular?					
1.3.11	Does the drainage water have unusual color (leachate)?					
1.3.12	Any other issues?					
D-1.4	**Body Wall (Masonry/Concrete) of 'NOF' Dam & Spillway**					
1.4.1	What is the total seepage into gallery from the porous pipes in the dam at lake full condition? How does it compare with the seepage when the reservoir was first filled? (For the corresponding water level)					
1.4.2	If there has been substantial reduction in this seepage? Ascertain and indicate the probable reasons therefore.					
1.4.3	Has there been a tendency for gradual reduction of drainage through pipes and progressive appearance of sweating on the downstream face of the dam?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.4.4	Has there been considerable leaching from the seepage water and deposition of lime near the seepage exit spots?					
1.4.5	Are the samples of the seepage water and reservoir water being regularly tested for reactive and corrosive properties?					
1.4.6	Is there excessive seepage, sweating at any locations on the downstream face of the dam? (Examine the monolith or construction joints for such seepage and leaching and indicate the findings)					
1.4.7	Is there any swelling or cracking observed on the downstream face especially near the points of concentration of stresses like the toe or locations of abrupt change in geometry of the face of the opening? If so, indicate the details of observations.					
1.4.8	Is the pointing on upstream face of the dam in good condition? If not, indicate the nature and extent of deficiency.					
1.4.9	Are the registers and graphs showing the periodical measurements of seepage discharge from the porous drains in the gallery and from the downstream face at various lake levels maintained at site?					
D-1.5	**Waste Weir Bar and Tail Channel**					
1.5.1	Is the Concrete/masonry spillway bar in good condition? Is there any leakage through the masonry or from the foundation? If so, what remedial measures are proposed / taken for minimizing the leakage? Is the record of leakage measurement maintained? What is the quantity of Seepage/Leakage on the date of inspection?					
1.5.2	Is the coping over the spillway bar in good condition?					
1.5.3	Does the upstream and downstream face of waste weir bar need pointing?					
1.5.4	Is there any scouring on downstream side of the bar and/or EDA? If so what remedial measures are proposed/taken?					
1.5.5	Are there any damages or undermining to guide walls, divide wall and other appurtenants? If so, what remedial measures are proposed/taken?					
D-1.6	**Structural performance of the 'NOF' and 'OF' Portions of Dam Foundations**					
1.6.1	Are there any signs of structural distress noticed in the dam spillway and foundations in the form of- i. Excessive deflection with respect to permissible deflection at the time of design					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
	ii. Tendency of gradual sliding iii. Cracking and upheaval or settlement in any part of the body wall or foundations, iv. Excessive uplift, v. Excessive seepage and leaching through the body of the dam and the foundation.					
1.6.2	Conspicuous weathering of materials or components in any portion of the body wall or the foundations.					
E-	**Spillway and Energy Dissipation Structure**					
E-1.1	**Spillway**					
1.1.1	Any problems inspecting spillway (obstructed access, damaged catwalk)?					
1.1.2	Any obstructions in or immediately downstream of the spillway?					
1.1.3	Evidence of abrasion, cavitations or scour on glacis (e.g. exposed reinforcement)?					
1.1.4	Presence of displaced, offset or open joints?					
1.1.5	Presence of cracking (structural, thermal, along joints)?					
1.1.6	Evidence of surface defects (honeycombing, staining, stratification)?					
1.1.7	Concrete/masonry deterioration (spalling, leaching, disintegration)?					
1.1.8	Presence of vegetation (growth in joints between blocks)?					
1.1.9	Evidence of any other damage to joints and/or water-stops?					
1.1.10	Excessive seepage/sweating at any location on spillway glacis?					
1.1.11	Significant leakage at any location on spillway glacis?					
1.1.12	Any other issues?					
E-1.2	**Energy Dissipation Structure**					
1.2.1	Any problems inspecting energy dissipation structure?					
1.2.2	Any obstructions in or immediately downstream of dissipation structure?					
1.2.3	Evidence of abrasion, cavitations or scour on dissipation structure?					
1.2.4	Presence of displaced, offset or open joints?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.2.5	Presence of cracking (structural, thermal, along joints)?					
1.2.6	Evidence of surface defects (honeycombing, staining, stratification)?					
1.2.7	Concrete/masonry deterioration (spalling, leaching, disintegration)?					
1.2.8	Presence of vegetation (growth in joints between blocks)?					
1.2.9	Evidence of any other damage to joints?					
1.2.10	Any problems with under-drainage (blockage of open drain holes)?					
1.2.11	Can the tail pond be drained easily for inspection of the stilling basin or bucket? If not, what are the alternatives available for dewatering? Please ascertain and indicate the last event of inspection of stilling basin (or bucket).					
1.2.12	From the examination of the levels and contour plans and reference marks in tail channel; ascertain if there is progressive erosion and retrogression in the tail channel. If so, indicate the extent and location of such erosion with reference to the various components of dam, spillway, outlet, power house etc.					
1.2.13	Is the concrete surface of the stilling basin and apron (or bucket) in good condition? Are there any indications of pitting, cracking, spalling or wearing of the surface of bedding concrete? If so, please give details of the nature and extent of the damage.					
1.2.14	Is there any indication of abrasion and cavitations damage (pitting of concrete) especially at friction blocks, chute blocks and slotted roller teeth, the surface near the lower tangent point and the end sill? If so, please give the details of nature and extent of damage.					
1.2.15	Is the under drainage of the stilling basin (or bucket) satisfactory? Are all the open drain holes clear and functioning well?					
1.2.16	Any other issues?					
F-	**Intake/Outlet and Water Conveyance Structure**					
F-1.1	**Intake/Outlet Structure**					
1.1.1	Any problems inspecting intake/outlet structure (obstructed/unsafe access)?					
1.1.2	Any obstructions in, upstream or downstream of intake/outlet structure?					
1.1.3	Evidence of abrasion, cavitations or scour on intake/outlet structure?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.1.4	Any evidence of structural distress (displaced/offset/open joints, cracking)?					
1.1.5	Any evidence of surface defects and/or concrete/masonry deterioration?					
1.1.6	Any other issues?					
F-1.2	**Water Conveyance Structure**					
1.2.1	Any problems inspecting intake/outlet structure (obstructed/unsafe access)?					
1.2.2	Any obstructions in, upstream or downstream of water conveyance structure?					
1.2.3	Evidence of abrasion, cavitations or scour on structure?					
1.2.4	Any evidence of structural distress (displaced/offset/open joints, cracking)?					
1.2.5	Any evidence of surface defects and/or material deterioration?					
1.2.6	Any evidence of seepage or leakage from water conveyance structure?					
1.2.7	Any other issues?					
G-1	**Hydro-Mechanical Component and Pump**					
G-1.1	**Spillway Gates (Radial gates, Vertical lift gates, Automatic gates)**					
1.1.1	Any problems inspecting gate/Stop-logs (obstructed/unsafe access)?					
1.1.2	Is the condition of the steel surface and the surface paint deteriorated?					
1.1.3	Are any connection bolts of rubber seals loosened or damaged? If so, indicate the details of defects.					
1.1.4	What is the general condition of rubber seals? Do any of the rubber seals show signs of weathering, hardening, cracking or tearing and damage?					
1.1.5	Are the rubber seals of side and bottom touching uniformly all along the sealing surface?					
1.1.6	Do the rollers (wherever applicable) touch the track plates uniformly? Are the rollers well lubricated?					
1.1.7	Are the embedded parts of spillway gates, emergency gates and stop-logs in sound condition and free from corrosion, uneven wear, cracking, chipping and dents? If not, state the nature of defects or deficiencies and observation, if any, regarding such defects.					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.1.8	Check the following for structural soundness of all members and welded, bolted and riveted connections, uneven wear, uneven bearing, cracking, chipping and dents and indicate the findings: (1) Gate leaf and stiffeners (2) End arms (3) Trunnion girders / Yoke girder (4) Stop logs (5) Lifting beams (6) Gantry cranes (7) Tracks (8) Trunnion bracket (9) Chains/ wire ropes (10) Bridge structure					
1.1.9	Are the trunnion bearings of radial gates properly lubricated?					
1.1.10	Is there any damage or wear caused to the seal plates? If so, indicate the nature of damage noticed.					
1.1.11	Are any of the mechanical or structural components and fasteners or seals subjected to excessive wear? If so, please give details. Is there any tendency for recurring damage to any particular component? If so, please give details.					
1.1.12	Is sufficient stock of spares which need frequent replacement maintained at the site?					
1.1.13	Any issues with storage of equipment (emergency stop logs, lifting beam and gate leaves)?					
1.1.14	Any deterioration, corrosion? scaling? pitting? or cracking? of equipment (connecting bolts, welds?)					
1.1.15	Any obstructions preventing or impairing smooth operation?					
1.1.16	Any problems with the rollers (not touching tracks, inadequate lubrication)?					
1.1.17	Any debris, etc., in the gate grooves?					
1.1.18	Any damages to Radial Gate trunnion pins? gate arms? lubrication? etc.?					
1.1.19	Any damage to embedded parts above waterline? access structure?					
1.1.20	Any damage to concrete grooves?					
1.1.21	Is the staff posted at the site for maintenance and operation of gates, hoists, equipments and electrical installations, well experienced, fully trained and conversant with the job requirements and responsibilities?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.1.22	Are the following documents maintained at the respective location of all the units? (1) Maintenance schedules specifying each operation, its frequency and 'due' and' done' dates. (2) Operating instructions with 'dos' and 'don't' for all operational units.					
1.1.23	Are the trunnion hub and the brackets well maintained?					
1.1.24	Are the trunnions likely to get submerged during actual working of the spillway? if so, ascertain the causes for the same and specify. Please enquire for occurrence of such events, if any.					
1.1.25	Are all the nuts of connecting bolts and anchorages properly tightened?					
1.1.26	Any other issues?					
G-1.2	**Hoists, Cranes and Operating Mechanisms**					
1.2.1	Are the hoists working satisfactorily?					
1.2.2	Any problems inspecting hoist/ crane/ operating mechanism?					
1.2.3	Is sufficient stock of spares which need frequent replacement maintained at the site?					
1.2.4	Is the full length of the chains or wire rope of the hoist in sound condition and free from broken strands?					
1.2.5	Is the electrical wiring in sound condition?					
1.2.6	Is the alternative power system for gate operation working properly?					
1.2.7	Is the alternate hand operation system of hoist working					
1.2.8	Any deterioration of equipment (connecting bolts, welds, surface, paint work?)					
1.2.9	Any wear or damage to wire cables and other moving parts?					
1.2.10	Any obstructions preventing or impairing smooth operation?					
1.2.11	Any health and safety concerns (e.g. lack of "danger" sign during maintenance)?					
1.2.12	Any other issues?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
G-1.3	**Spillway Bridge, Hoist Bridge, Trunnion Level Bridge Catwalks**					
1.3.1	Are the decking, girders and structural supports of spillway bridge, hoist bridge, trunnion level bridge and catwalks structurally sound?					
1.3.2	Is the chequered platform of the bridge structurally sound and safe?					
1.3.3	Is there satisfactory arrangement to prevent unauthorized entry into the control structures and bridges?					
1.3.4	Are the structural members and joints sound and free from corrosion?					
1.3.5	When were the steel components painted last?					
1.3.6	Is the surface of steel work and paints satisfactory?					
1.3.7	Is the parapet or railing over the bridges sound, safe and painted?					
1.3.8	Is the walkway properly anchored to the piers?					
1.3.9	Are the track rails for gantry cranes structurally sound and intact?					
G-1.4	**Valves**					
1.4.1	Any problems inspecting valve?					
1.4.2	Any obstructions preventing or impairing smooth operation?					
1.4.3	Any deterioration of valve and associated equipment?					
1.4.4	Any other issues?					
G-1.5	**Walls: Guide walls/Divide walls/Junction walls/ Return walls/ Spray walls etc. (Strike out whichever is not applicable)**					
1.5.1	Are all the locations of such wall accessible for inspection, maintenance and repairs?					
1.5.2	Is the drainage of back sides of the walls (wherever applicable) from the weep holes satisfactory? If not, indicate the nature of deficiencies.					
1.5.3	Is there any tendency for the water to undercut the ends of the walls?					
1.5.4	Is there any foundation erosion or scour noticed in the vicinity of such walls? If so, give the details of nature and extent of such damage.					
1.5.5	Is there any surface erosion/damage caused, to face or body of such walls?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.5.6	Do any of the walls show symptoms of unusual settlement, developments of cracks and tilting? If so, give details of the defects noticed.					
1.5.7	Is there any damage to guide bunds? If so, give details of the damage.					
G-1.6	**End Weir**					
1.6.1	Is it accessible?					
1.6.2	Is there any erosion, pitting or spalling of the concrete or masonry surface? If so, give details					
1.6.3	Is there any scour noticed on the immediate downstream of such weir? If so, give details of location and extent of such damage.					
G-1.7	**Hydraulic Performance of Energy Dissipation Arrangements**					
1.7.1	Do the flow conditions in the stilling basin (or bucket) have a tendency to draw material into the bucket and cause its churning and abrasion damage to the surface of buckets baffle blocks, apron and end sill? Is the hydraulic performance in agreement with the results of model studies? (wherever applicable) Ascertain the performance from observed tail water rating curves and deficient observation, if any, such as sweep outs and excessive erosion under plunge pools and locations of secondary rollers and retrogression.					
G-1.8	**Trash Racks**					
1.8.1	Is the trash rack fixed or movable?					
1.8.2	What is the mode of cleaning? Is it manual or by TRCM?					
1.8.3	Is the welding work on Trash Rack in sound health?					
1.8.4	Any problems inspecting trash rack?					
1.8.5	Problems of excessive debris and/or inadequate cleaning?					
1.8.6	Any deterioration of trash rack (rust, corrosion, and damaged blades)?					
1.8.7	Any other issues?					
G-1.9	**Trash Rack Cleaning Machines**					
1.9.1	Any problems inspecting trash rack cleaning machine?					
1.9.2	Missing or inadequate spare parts (particularly requiring regular replacement)?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.9.3	Any deterioration of equipment (wheel trolleys, gantry structures, operating mechanism, connecting bolts, welds, surface, paint work?)					
1.9.4	Any wear or damage to wire cables and other moving parts?					
1.9.5	Any obstructions preventing or impairing smooth operation?					
1.9.6	Missing or inadequate provision of back-up/standby power supply?					
1.9.7	Any health and safety concerns (e.g. lack of "danger" sign during maintenance)?					
1.9.8	Any other issues?					
G-1.10	**Pumps**					
1.10.1	Any problems inspecting pump?					
1.10.2	Any obstructions preventing or impairing smooth operation?					
1.10.3	Any deterioration of pump and associated equipment?					
1.10.4	Any other issues?					
G-1.11	**Approach bridge, operation platform and cabin (for outlets):**					
1.11.1	Are the decking, girders and structural supports of approach bridge structurally sound?					
1.11.2	Is the floor of the operating platform structurally sound and safe?					
1.11.3	Is there satisfactory arrangement to prevent unauthorized entry into the control structures of the outlet?					
1.11.4	Are the structural members and joints sound and free from corrosion?					
1.11.5	When were the steel components painted last?					
1.11.6	Is the surface of steel work and paint satisfactory?					
1.11.7	Is the parapet or railing over the control tower, operating platform and approach bridge sound and safe?					
G-1.12	**Outlet**					
1.12.1	Is the air vent periodically cleaned?					
1.12.2	Are there any structural damages to the intake well?					
1.12.3	Is there any leakage observed through the well proper and the conduit concrete or masonry? If so, give details of its location and extent.					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.12.4	Is there any damage noticed to the conduit concrete, breast wall and gate slots?					
1.12.5	Is the bye-pass valve/ filling-in-valve (wherever provided) operating satisfactory? (a) Take operation trials of the following as provided and record the observations and defects noticed, if any. (1) Service gate(s). (2) Emergency gate(s). (3) Stop-log gate(s). (4) Sluice valves. Note- (i) The operating trial for the emergency gate shall be taken with service gate in partially open position to test the capability of emergency gate for self-closing under these conditions. The trial for the operation of the emergency gate under balanced condition of water pressure also needs to be taken (ii) To guard against the possibility of outlet gate hoist being operated forcibly after closed position of gate a "Distinctive Mark" should be insisted or check the functioning of the limit switches.					
1.12.6	Aretherevibrationsandnoisenoticedinoperationofout-letgatesatanytime? If so, are any periodical observations taken to ascertain their severity?					
1.12.7	Is the energy dissipation arrangement working satisfactorily for all the discharges? Is there any structural damage to the energy dissipation structure? If so, give details of nature and extent of damage.					
1.12.8	Is the conduit structurally sound and reasonably leak proof? If not, give details of nature and extent of the defects.					
1.12.9	Is there any seepage noticed around the conduit as ascertained from the observations of the downstream conditions? If so, is it likely to cause (In case of earth dams) erosion and piping?					
G-1.13	**Outlet Gates**					
1.13.1	Is the surface of gates and the paint deteriorated?					
1.13.2	Are the connecting bolts of rubber seals properly tightened or damaged?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.13.3	Do the rubber seals show signs of weathering and damage and need replacements?					
1.13.4	Are the rubber seals of sides and bottom touching the bearing surface uniformly?					
1.13.5	Do all the rollers touch the track plates?					
1.13.6	Are the rollers well lubricated?					
1.13.7	Are the stem rods for lifting the gates perfectly straight?					
1.13.8	Is the operation of outlet gates smooth? Are the actual operations of lifting and lowering of the gates and hoist mechanisms adequate and smooth?					
1.13.9	Are all the gears and hoist mechanisms well lubricated?					
1.13.10	Is the storing arrangement for emergency gate leaves and the stop logs in satisfactory condition?					
1.13.11	Are the seal plates / seats in sound condition?					
1.13.12	Is the full length of wire rope (wherever applicable) of the hoist in serviceable condition and free from any broken strands?					
1.13.13	Are all the nuts of connecting bolt and anchors properly tightened?					
1.13.14	Are all the lifting beams in proper working order and in levelled condition. If not ascertain the nature and extent of problems. Do any of the mechanical or structural parts of the gate, fasteners of hoist show signs of excessive wear? If so, please give details.					
1.13.15	Is there any tendency for recurring damage to any particular component or components? If so, please give details.					
1.13.16	Is sufficient stock of spares, which need frequent replacement, maintained at the site?					
G-1.14	**River Outlet/River Sluice**					
1.14.1	Is the overall condition of river outlet works/river sluices satisfactory? Is the operation of the gate (Service/ Emergency/ Stop-log) satisfactory as ascertained by taking operating trial? If not, indicate the defects noticed.					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.14.2	Are the trash racks (wherever provided) cleaned before monsoon?					
1.14.3	Is there excessive silting on the upstream of the sluice?					
1.14.4	When were the gates last opened for desilting, etc.?					
1.14.5	Please indicate the approximate quantity of the leakage through the gates, if any.					
1.14.6	Is there any seepage or leakage through the conduit surface?					
1.14.7	Is there any damage to the upstream and downstream convergence of the conduit?					
1.14.8	Is the condition of energy dissipation arrangement satisfactory? If not, indicate nature and extent of damage. Is there any retrogression noticed in the downstream channel? If so, give details of nature and extent of damage.					
H-1	**Access Road**					
H-1.1	**General Condition**					
1.1.1	Any problems ensuring security of dam site (including gates and fencing)?					
1.1.2	Is there a properly constructed and well maintained all weather access road to the dam site?					
1.1.3	What is the type of the pavement of the access road and its condition?					
1.1.4	Are there properly constructed and well maintained access road arrangements to the following components for inspection, maintenance and repairs? Top of Dam Spillway Gates and hoisting arrangement Drainage gallery, adits and exits Bridge structure Downstream stilling basin Junction and abutments Outlet control tower Outlet gates Toe of earth dam, downstream drainage arrangements and berms. All saddle dams.					
1.1.5	What is the general condition of all the masonry structures on various access roads?					
1.1.6	Are all the structures on the access roads adequately safe for allowing passage of plant machinery for emergent repairs?					
1.1.7	Any obstructions along or at entrance to access road (temporary or long-term)?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
1.1.8	Any slope stability issues (road embankment or adjacent slopes)?					
1.1.9	Profuse growth of weeds/grass on or in vicinity of access road?					
1.1.10	Any drainage problems (standing water on or adjacent to road)?					
1.1.11	Any other degradation to road surface (ruts, potholes, cavities, cracking)?					
1.1.12	Any other issues?					
I-1	**Instrumentation**					
I-1.1	**General Condition**					
1.1.1	Are all the instruments installed accessible? (Attach separate list). Are all the locations properly lighted, ventilated and adequately protected from possibilities of damage?				As per Annexure-I	
1.1.2	Any problems inspecting instrument (obstructed/unsafe access)?					
1.1.3	Is the instrument vulnerable to damage or theft (inadequate protection)?					
1.1.4	Any problems ensuring correct functioning of instrument (lighting, ventilation)?					
1.1.5	Any evidence of degradation to condition of instrument (rusting, vandalism)?					
1.1.6	Are all the instruments in working order? Ascertain the cases of instruments going out of order and indicate.					
1.1.7	Are all the registers of observations posted up-to-date? Please take test observations and initial the register.					
1.1.8	Are all the plotting of the instrumentation data completed up-to-date? Are sufficient stocks of spares, gauges, master gauges, stationary items etc., maintained at the site for uninterrupted data collection?					
1.1.9	Operator or public safety issues?					
1.1.10	Any other issues?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
I-1.2	**Communication Facilities**					
1.2.1	Are following facilities available at dam site? **(1)** Wireless Telephone / mobile/Fax/Internet					
1.2.2	Any other issue (please indicate part, location, etc., as necessary)					
K-1	**Emergency Preparedness**					
K-1.1	**Emergency Action Plan**					
1.1.1	Is the Emergency Action Plan (EAP) prepared for the dam as per the national guidelines? If not, the expected date of preparation of guidelines					
1.1.2	When EAP was last updated?					
1.1.3	If not, are any dam staff unaware or insufficiently conversant with the EAP?					
1.1.4	Any concerned authorities unaware or insufficiently conversant with the EAP?					
1.1.5	Are communication directories/contact details and other dynamic information are being updated annually?					
1.1.6	Any problems accessing or operating the communication/ warning system?					
1.1.7	Are inundation maps updated and available to concerned authorities?					
1.1.8	Are the concerned authorities informed about the system of emergency reporting procedures and warning?					
1.1.9	Are available safety spots on the downstream of the dam identified and made known to the concerned authorities? Are adequate warning devices and facilities provided at the dam?					
1.1.10	Are proper arrangements made for security of the dam and preventing cases of unauthorized trespass, vandalism and sabotage to the dam works?					
1.1.11	Date of last annual stakeholder consultation meeting along with mock drill exercise conducted					
1.1.12	Does the EAP disseminated to all the concerned stakeholders?					
1.1.13	Any other issues?					

Sl. No.	Inspection Item	Response[a]			Observations & recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory/ Poor/ Fair/ Satisfactory)
		Y	N	NA		
K-1.2	**Inspection of Records**					
1.2.1	Whether following Dam Safety Documents are prepared and approved by the competent authority? **I.** As Built Drawings **II.** EAP **III.** Completion Report **IV.** Data Book **V.** O and M Manual					
1.2.2	Are the relevant documents reviewed and updated from time to time?					
1.2.3	Are all the members of the maintenance staff adequately trained and fully conversant with their responsibilities concerning. (a) Designer's Operation Criteria. (b) Standing Operating Procedures. (c) Maintenance and Vigilance Procedures of the dam. (d) Maintenance and operation of all control equipment's. (e) Reservoir Operation Schedules, Gate Operation Schedule (f) Maintenance and Operation of all instruments. (g) Identification of signs of deficient behaviour. (h) Reporting Procedures of emergency situations. (i) Emergency repairs					

L-1.1	**Inspection Photographs**					
1.1.1	**Information to be furnished as per Annexure - II**					

[a]Respond either yes (Y), no (N) or not applicable (NA).

[b]Condition: Please rate the condition as either Satisfactory, Fair, Poor or Unsatisfactory as described below:

1. **Satisfactory -** No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
2. **Fair -** No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
3. **Poor -** A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. Poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.
4. **Unsatisfactory -** A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

Part 2b – Consolidated Dam Health Status Report:

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
1.		
2.		
3.		
4.		
..		
..		
10.		

Overall condition of dam based on above inspection – Unsatisfactory/Poor/Fair/Satisfactory (tick appropriate)

Overall Safety Category* of the Dam -

*Category I– deficiencies which may lead to failure;

Category II – major deficiencies requiring prompt remedial measures;

Category III – minor remedial measures which are rectifiable during the year

Name of Official(s) and Signature(s):

Date:

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APPENDIX-II

CHECKLIST OF VARIOUS INSTRUMENTS INSTALLED ON LARGE DAMS

Name of Dam: **Location:**

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/No)	Remarks
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
HYDRO-METEOROLOGICAL INSTRUMENTS											
1.	Rain gauge on Dam										
2.	Rain gauge in the Catchment										
3.	Pan Evaporimeter										
4.	Wind Velocity Recorder										
5.	Wind Direction Recorder										
6.	Wave Height Recorder										
7.	Wet and dry bulb Thermometer										
8.	Barometer										
9.	Thermometers for air Temp.										
10.	Thermometers for Reservoir Water Temp.										
11.	Automatic Weather Station										
12.	Reservoir level gate **(i)** Staff gauge **(ii)** Automatic										

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/No)	Remarks
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
13.	Other Hydro-meteorological Instruments, if any (i) . (ii) . (iii) .										
GEO-TECHNICAL INSTRUMENTS											
1.	Piezometers (i) Stand pipe (ii) Casagrande (iii) Twin Tube (iv) Vibrating wire										
2.	Uplift pressure cell (i) For permeable foundation (ii) For Rock foundation										
3.	Strain Gauge (i) Mechanical Strain Gauge (ii) Electrical Strain Gauge										
4.	Strain Meter (i) Vibrating wire										
5.	Thermometers (i) Resistance (ii) Vibrating Wire										
6.	Stress Meter (i) Mechanical (ii) Electrical (iii) Vibrating wire										
	Seepage Measurement (i) V-Notch (ii) Other devices										

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/No)	Remarks
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
7.	Automation (i) Data logger (ii) Data Acquisition system (iii) Computers										
8.	(i) Plumb Bob – Direct (ii) Plumb Bob – Inverted (iii) Detachable Gauges for Surface Displacement (iv) Joint meter for internal joint movement (v) Tilt Meter (vi) Foundation Settlement Deformation Meter (vii) Inclinometer										
9.	Other Geotechnical Instruments, if any (i) . (ii) . (iii) .										
GEODETIC INSTRUMENTS											
1.	Total Station										
2.	Survey Markers										
3.	Settlement Plates										
SEISMIC INSTRUMENTS											
1.	Seismograph										
2.	Accelerograph										

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APPENDIX-III

SUMMARY TABLE FOR ANNUAL O&M BUDGET

NO.	BUDGET ITEM	PREVIOUS YEAR COST (Rs)	CURRENT YEAR BUDGET (YR ……..) (Rs)	REMARKS
A.	**ESTABLISHMENT**			
1	SALARY OF REGULAR STAFF INCLUDING ALL OTHER BENEFITS			
2	TRAVEL EXPENSES			
3	OFFICE EXPENSES			
4	MOTOR VEHICLE EXPENSES			
5	MAINTENANCE OF OFFICE & COLONY COMPLEX			
	SUB-TOTAL – A			
B.	**WORKS**			
1	CIVIL WORKS			
1.1	CONCRETE / MASONRY DAM			
1.2	EARTHEN DAM			
1.3	INTAKE &OUTLETS IN EARTHEN DAMS/ ABUTMENTS			
1.4	SLUICES IN CONCRETE / MASONRY DAMS			
1.5	APPROACH / INSPECTION ROADS WITHIN DAM AREA			
2	HYDRO-MECHANICAL WORKS			
2.1	SPILLWAY GATES & HOISTS			
2.2	SPILLWAY STOP-LOG & GANTRY CRANE			
2.3	OUTLETS IN EARTHEN DAMS - SERVICE / EMERGENCY GATES, HOISTS& GANTRY CRANE			

NO.	BUDGET ITEM	PREVIOUS YEAR COST (Rs)	CURRENT YEAR BUDGET (YR ……..) (Rs)	REMARKS
2.4	SLUICES IN CONCRETE / MASONRY DAMS – SERVICE / EMERGENCY GATES, HOISTS& GANTRY CRANE			
3	ELECTRICAL WORKS			
3.1	ELECTRICAL FITTINGS, MOTORS, CONTROLS FOR ALL GATE HOISTS			
3.2	POWER SUPPLY LINES			
3.3	ELECTRICAL FITTINGS ON DAM TOP, DAM GALLERIES, ETC.			
3.4	STANDBY POWER / DIESEL GENERATOR			
3.4	REMOTE CONTROL/CCTV			
4	INSTRUMENTATION			
5	MISCELLANEOUS WORKS			
6	SALARY OF WORK-CHARGED STAFF INCLUDING ALL BENEFITS			
7	MATERIALS TO BE STORED BEFORE MONSOON			
	SUB-TOTAL – B			
8	CONTINGENCY (10%) ON SUB-TOTAL OF A & B			
9	TOOLS & PLANTS			
	SUB-TOTAL- C			
10	TOTAL ANNUAL COST			

APPENDIX-IV

BASIC DRAWINGS OF THE DAM & SPILLWAY

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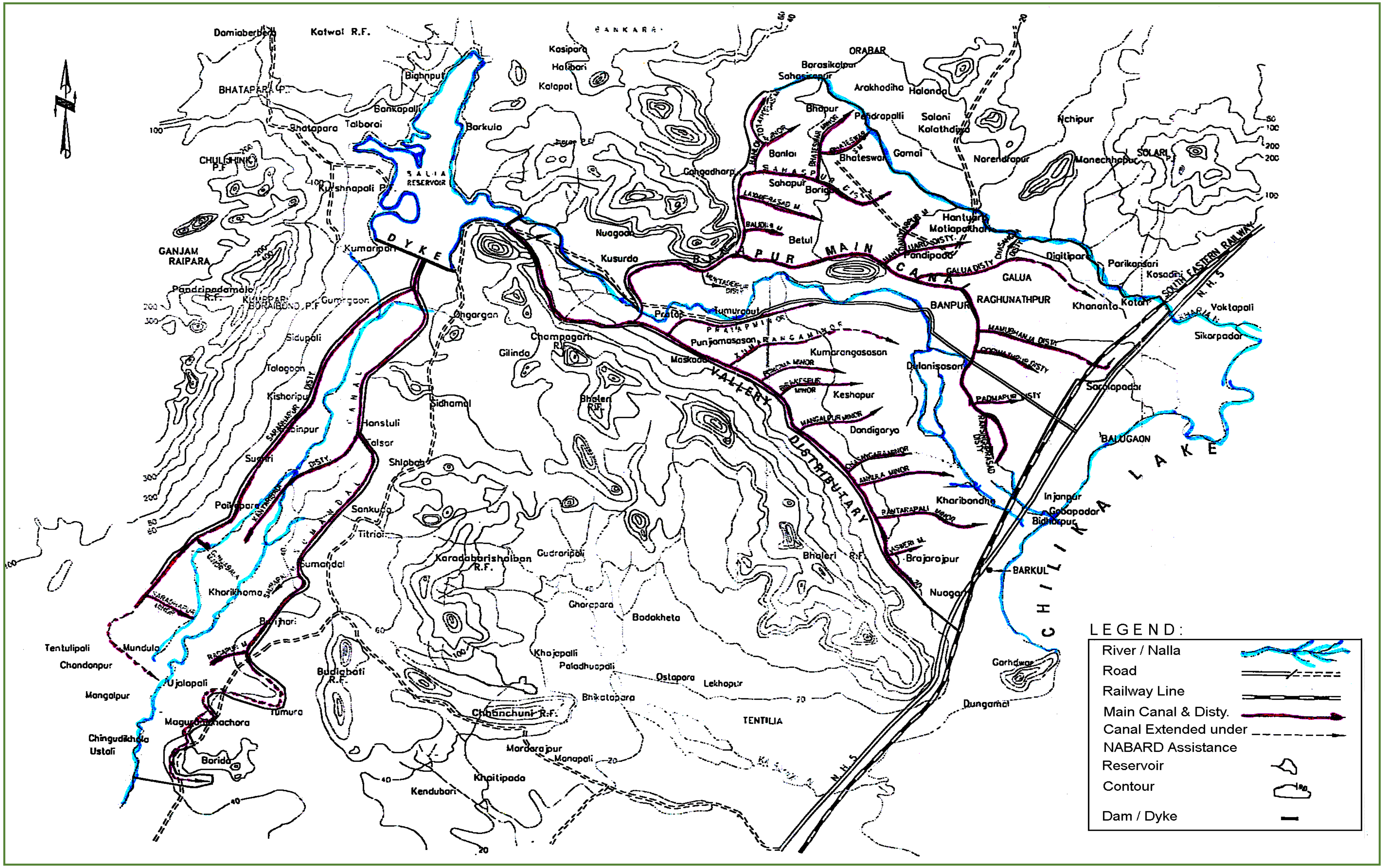
1. INDEX MAP

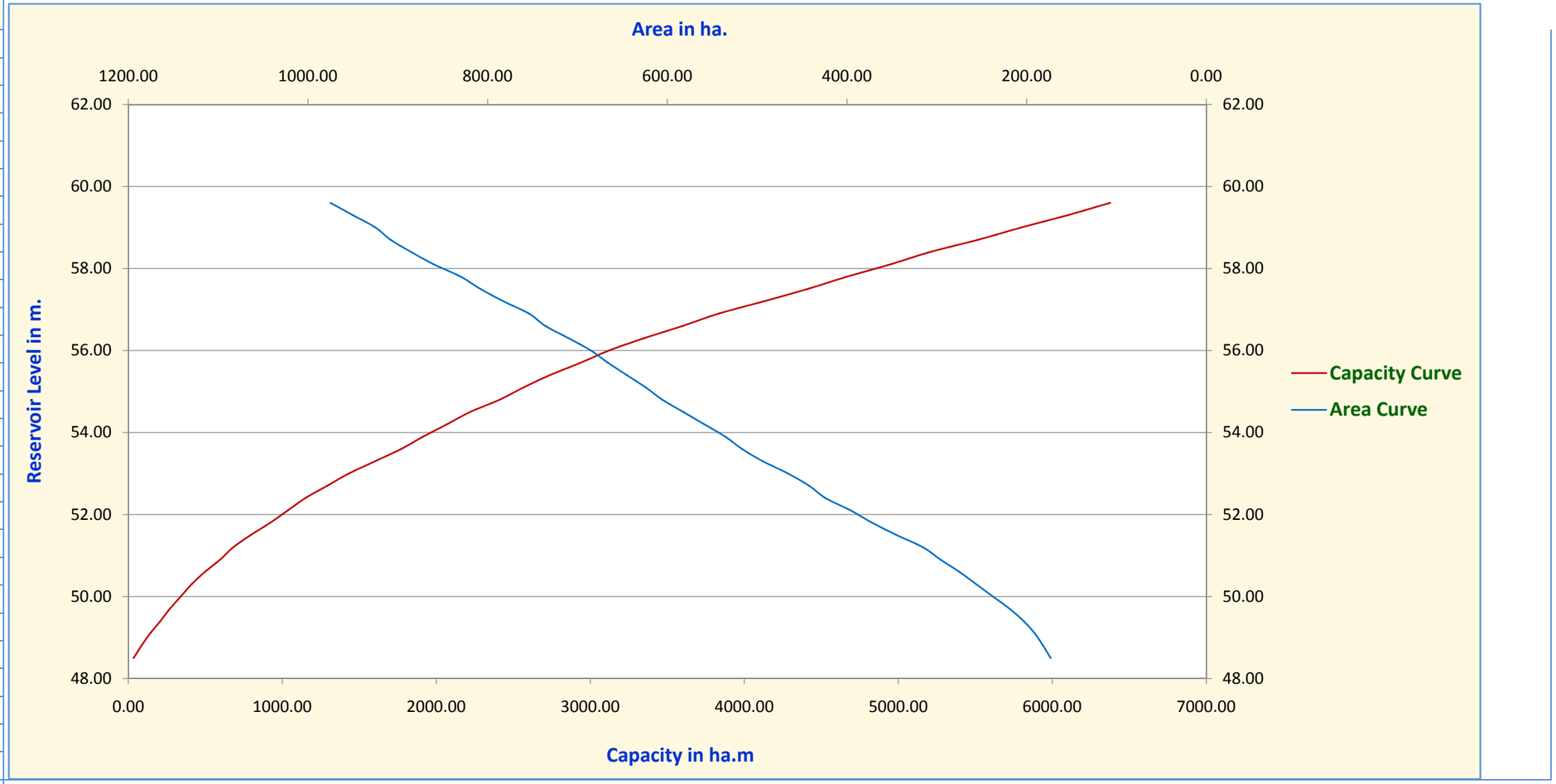

LEGEND:
River / Nalla
Road
Railway Line
Main Canal & Disty.
Canal Extended under NABARD Assistance
Reservoir
Contour
Dam / Dyke
SALIA RESERVOIR
DYKE
CHILIKA LAKE
SOUTH EASTERN RAILWAY
BANPUR
BALUGAON
BARKUL
TENTILIA

2. GOOGLE MAP

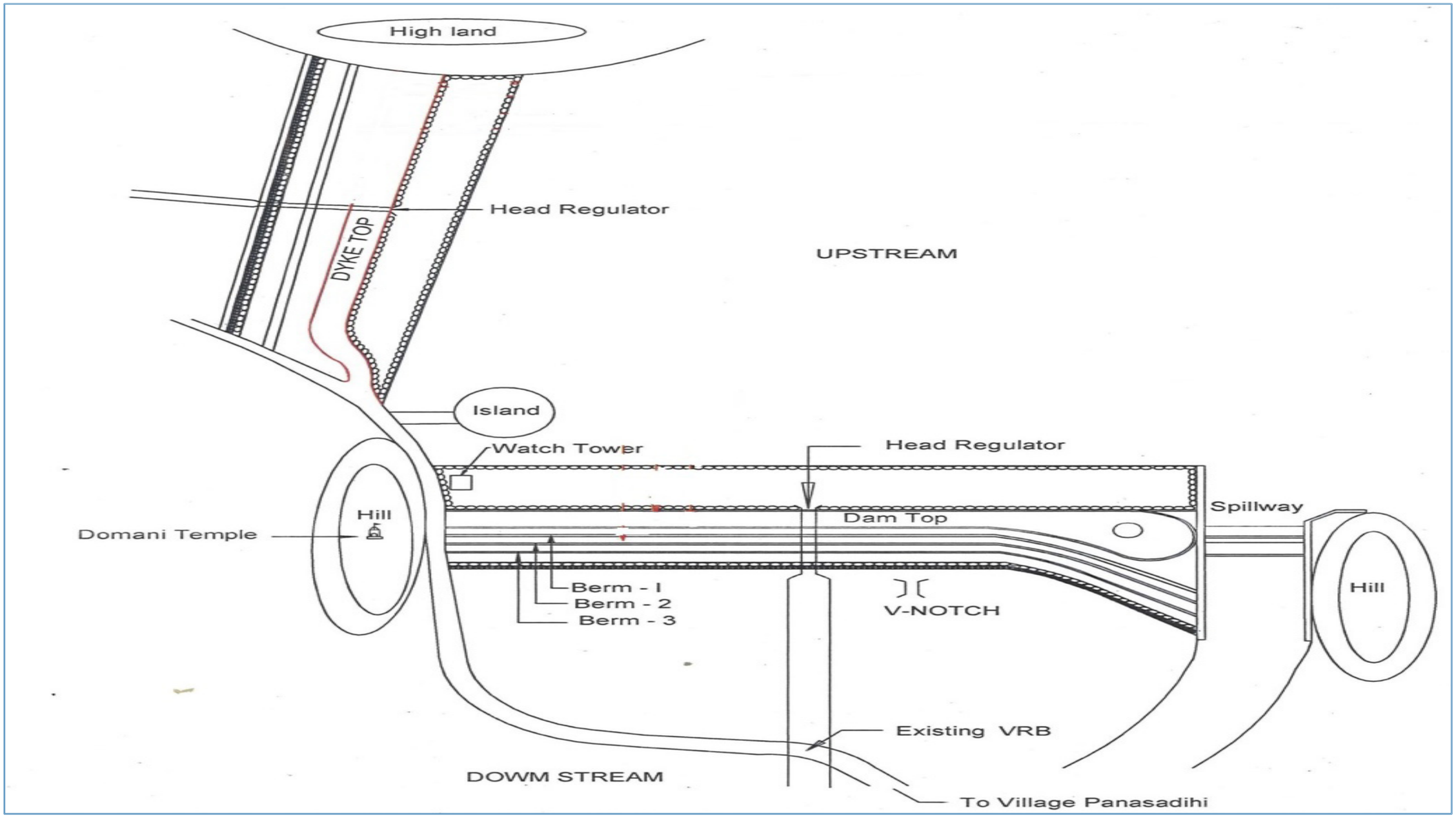

Salia Dam
Legend
Salia Dam
Spillway
Salia Dam
Head Regulator
Head Regulator
Google Earth
Image © 2019 Maxar Technologies
©2018 Google
N
3 km

3. AREA-CAPACITY CURVE

RL (in m)	Area (in ha.)	Capacity (in ha.m)	Capacity (in Mcum)
48.50	173.26	34.04	0.34
48.80	181.64	85.11	0.85
49.10	190.96	141.85	1.42
49.40	203.28	207.72	2.08
49.70	218.90	269.52	2.70
50.00	237.53	340.45	3.40
50.30	256.16	411.37	4.11
50.60	274.79	496.48	4.96
50.90	295.75	595.78	5.96
51.20	315.39	680.89	6.81
51.50	344.66	794.37	7.94
51.80	372.00	922.04	9.22
52.10	395.89	1035.52	10.36
52.40	423.83	1149.01	11.49
52.70	442.00	1290.86	12.91
53.00	465.75	1432.71	14.33
53.30	493.70	1602.93	16.03
53.60	516.98	1773.16	17.73
53.90	535.61	1915.01	19.15
54.20	558.90	2070.00	20.70
54.50	582.19	2220.00	22.20
54.80	605.48	2410.00	24.10
55.10	624.15	2567.53	25.68
55.40	645.04	2737.75	27.38
55.70	666.02	2936.35	29.36
56.00	685.00	3121.00	31.21
56.30	710.00	3350.00	33.50
56.60	735.89	3600.00	36.00
56.90	754.00	3835.00	38.35
57.20	782.46	4127.91	41.28
57.50	808.00	4411.61	44.12
57.80	830.00	4666.95	46.67
58.10	860.00	4950.00	49.50
58.40	885.00	5205.99	52.06
58.70	908.00	5518.06	55.18
59.00	925.00	5800.00	58.00
59.30	950.00	6100.00	61.00
59.60	975.00	6375.70	63.76



4. LAYOUT MAP OF SALIA IRRIGATION PROUJECT

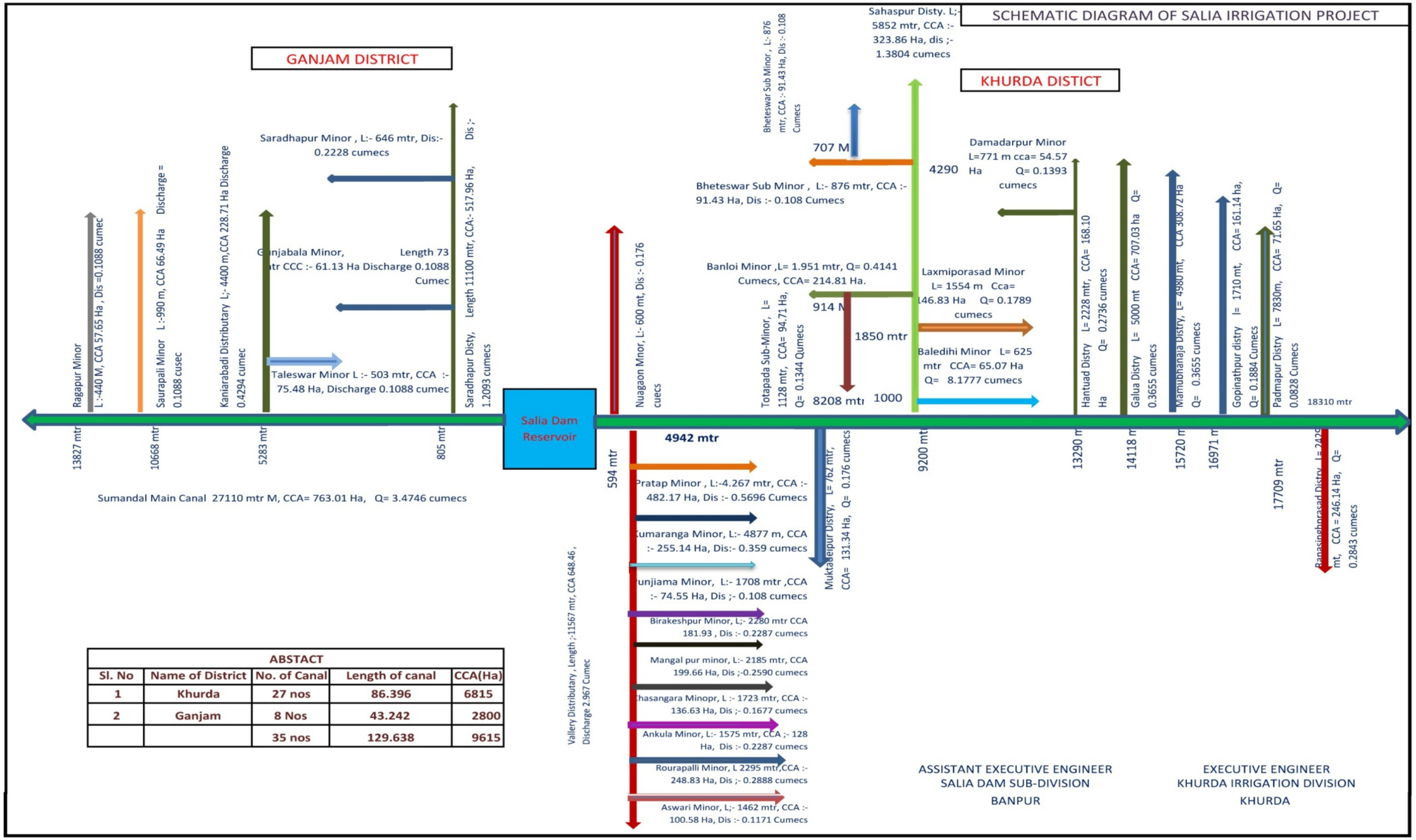


Sd/-
Junior Engineer
Salia Dam Section

Sd/-
Assistant Engineer
Salia Dam Sub-Division

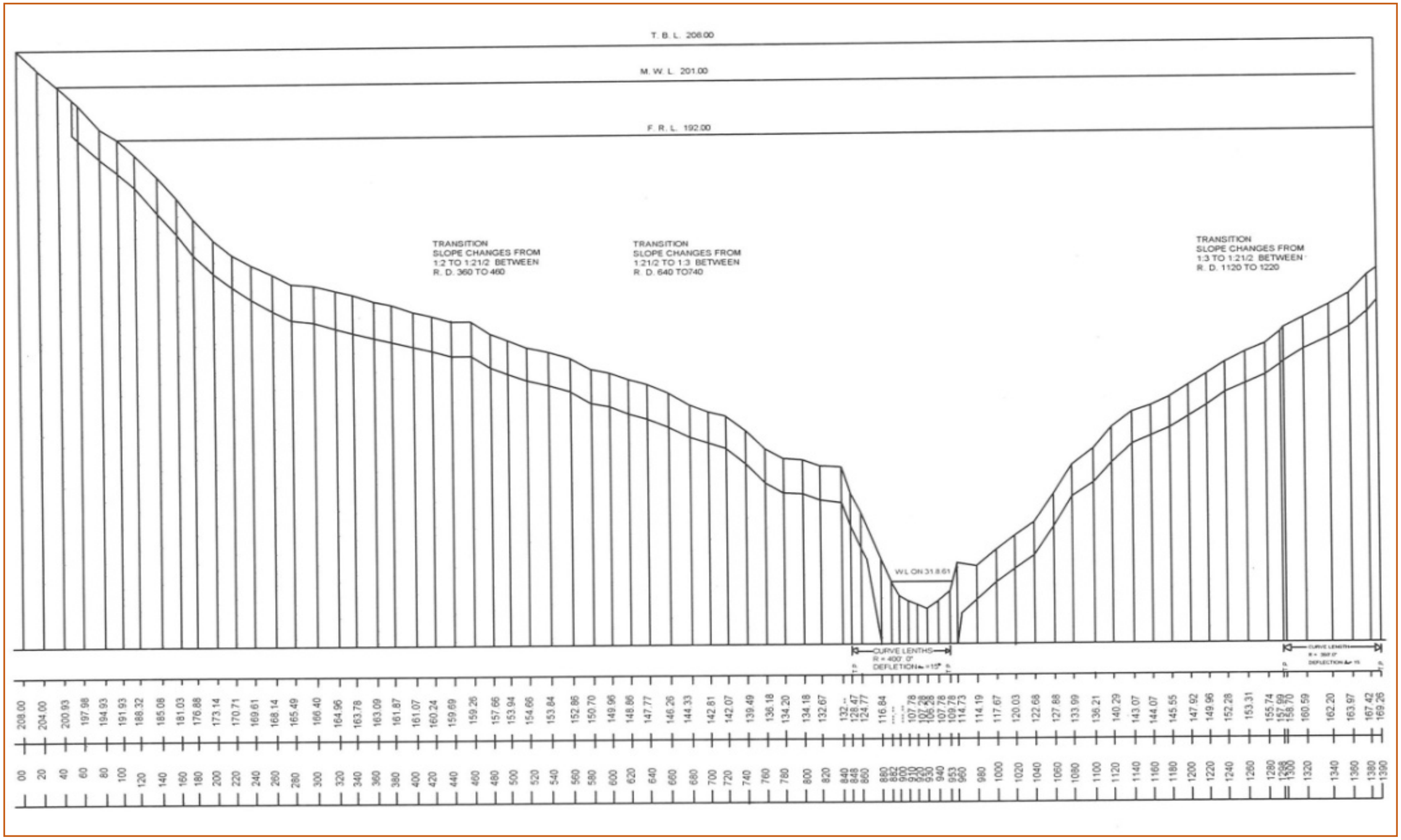
Sd/-
Executive Engineer
Khordha Irrigation Division

5. SCHEMATIC DIAGRAM

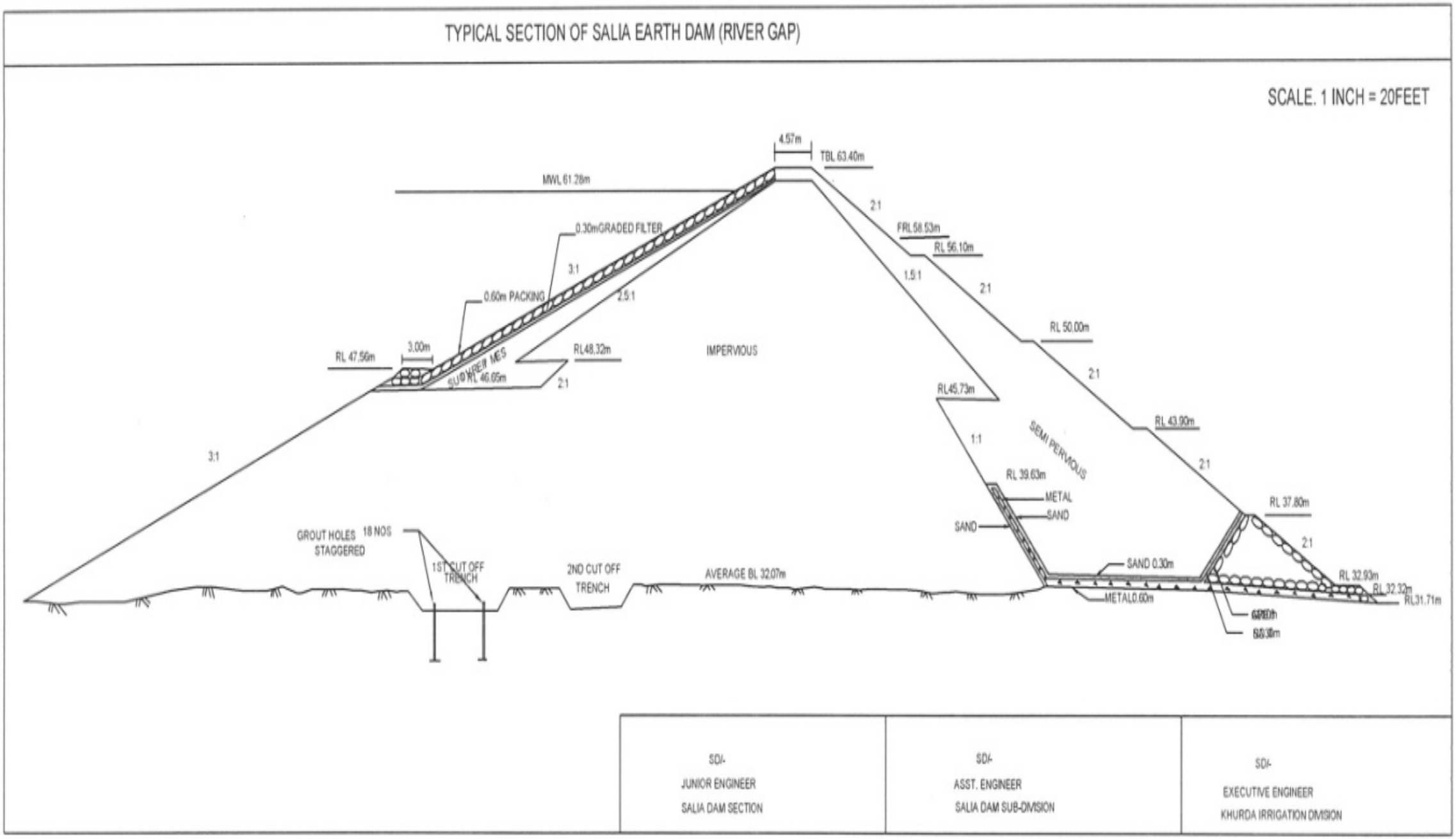


ABSTACT				
Sl. No	Name of District	No. of Canal	Length of canal	CCA(Ha)
1	Khurda	27 nos	86.396	6815
2	Ganjam	8 Nos	43.242	2800
		35 nos	129.638	9615

6. L-SECTION OF THE DAM



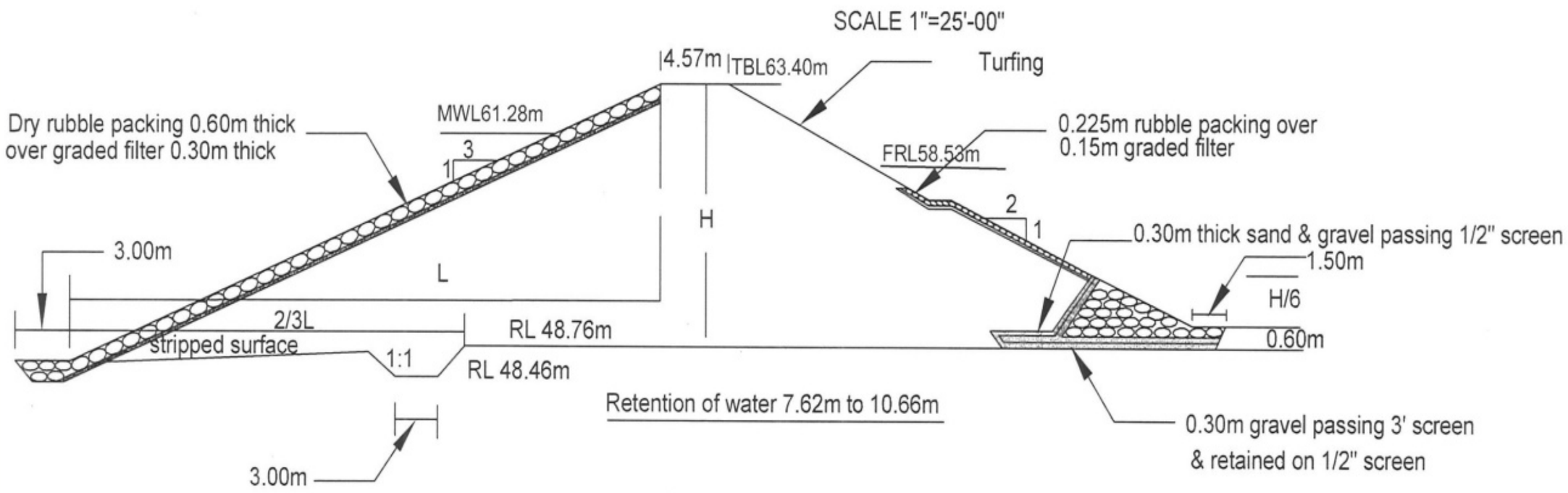
7. CROSS- SECTION OF SALIA DAM



8. CROSS- SECTION OF SALIA DAM DYKE

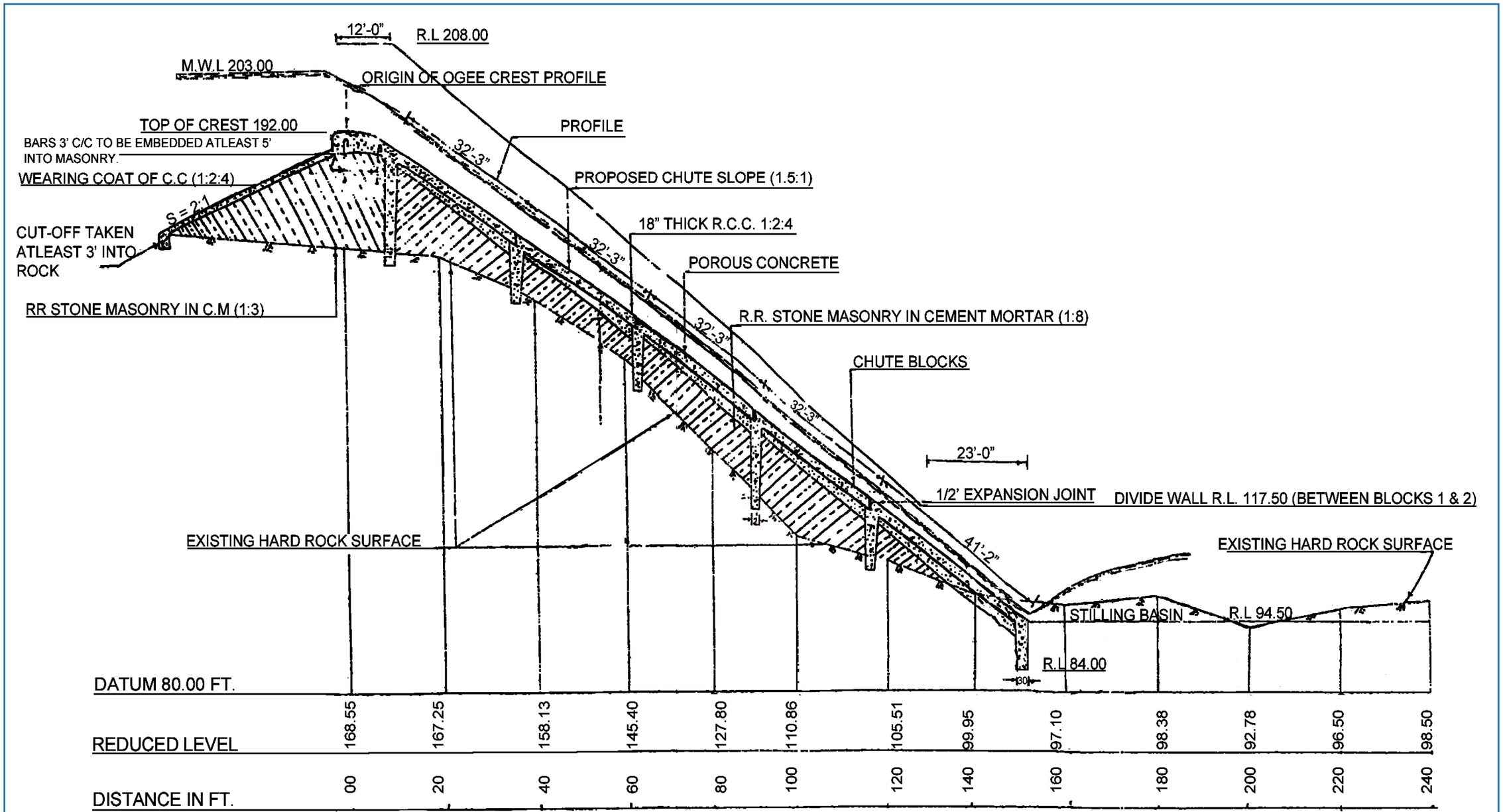
TYPICAL SECTION OF DYKE OF SALIA IRRIGATION PROJECT

SCALE 1"=25'-00"

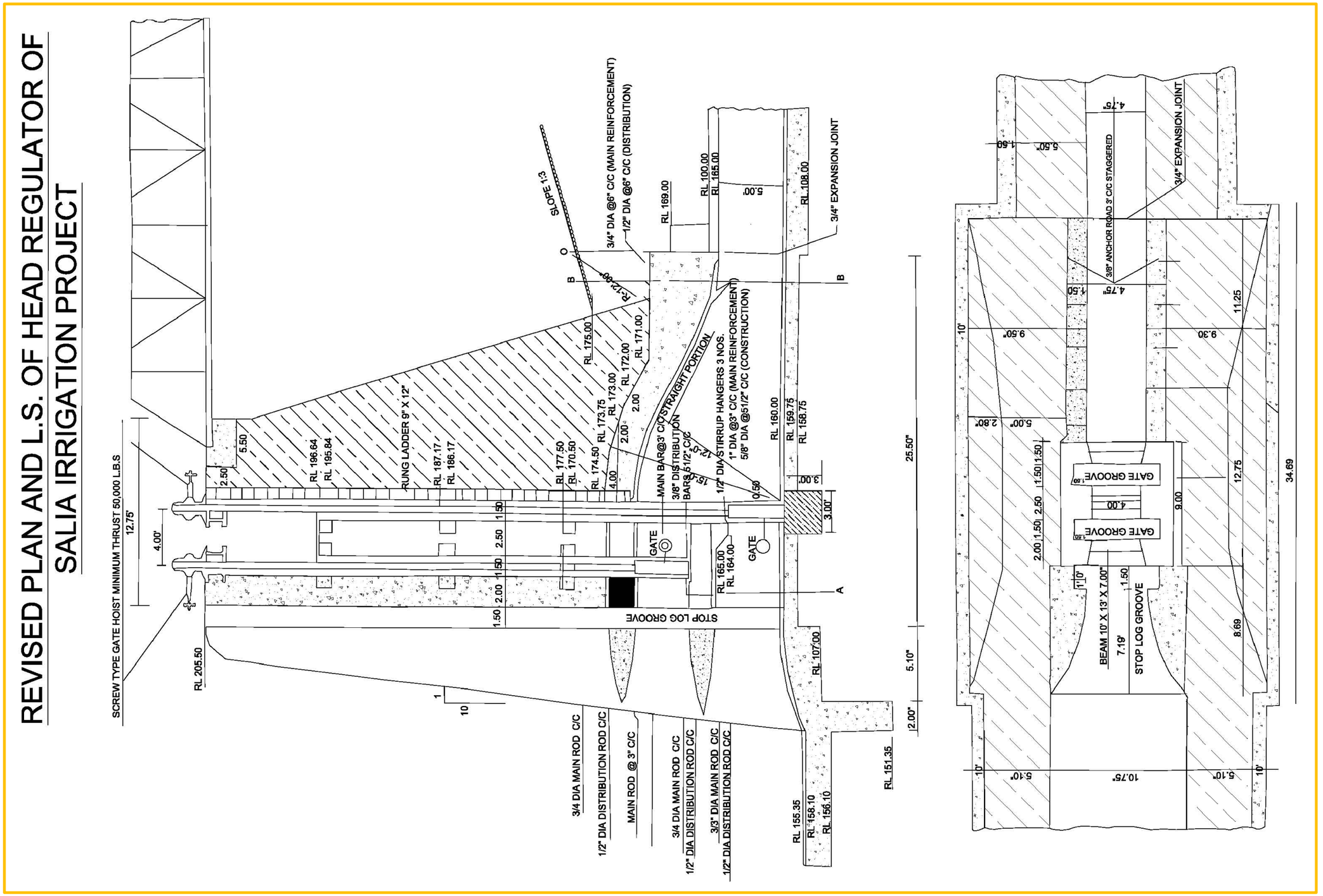


Sd/- Junior Engineer Salia Dam Section	Sd/- Asst.Engineer Salia Dam Sub-Division	Sd/- Executive Engineer Khurda Irrigation Division

9. CROSS- SECTION OF SPILLWAY OF SALIA DAM



10. CROSS SECTION OF H.R OF SUMANDAL MAIN CANAL, SALIA DAM



11. CROSS SECTION OF H.R OF BANAPUR MAIN CANAL, SALIA DAM