JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GOVERNMENT OF MAHARASHTRA,INDIA
DEPARTMENT OF IRRIGATION

MASTER PLAN STUDY

ON

PUMPED STORAGE HYDROELECTRIC POWER DEVELOPMENT

IN

MAHARASHTRA STATE, INDIA

FINAL REPORT

APPENDIX

MARCH , 1998

ELECTRIC POWER DEVELOPMENT CO.,LTD.
PACIFIC CONSULTANTS INTERNATIONAL

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GOVERNMENT OF MAHARASHTRA,INDIA
DEPARTMENT OF IRRIGATION

MASTER PLAN STUDY

ON

PUMPED STORAGE HYDROELECTRIC POWER DEVELOPMENT

IN

MAHARASHTRA STATE, INDIA

FINAL REPORT

APPENDIX

MARCH , 1998

ELECTRIC POWER DEVELOPMENT CO.,LTD.
PACIFIC CONSULTANTS INTERNATIONAL

Appendix 1 General Description and Layout of Project Site

General Description and Layout of Project Site

The general descriptions of all the site have been here presented making a careful investigation of the upper and lower reservoir basins, the waterway layouts and the powerhouse locations including other related structures on the basis of the topographical maps of 1/50,000.

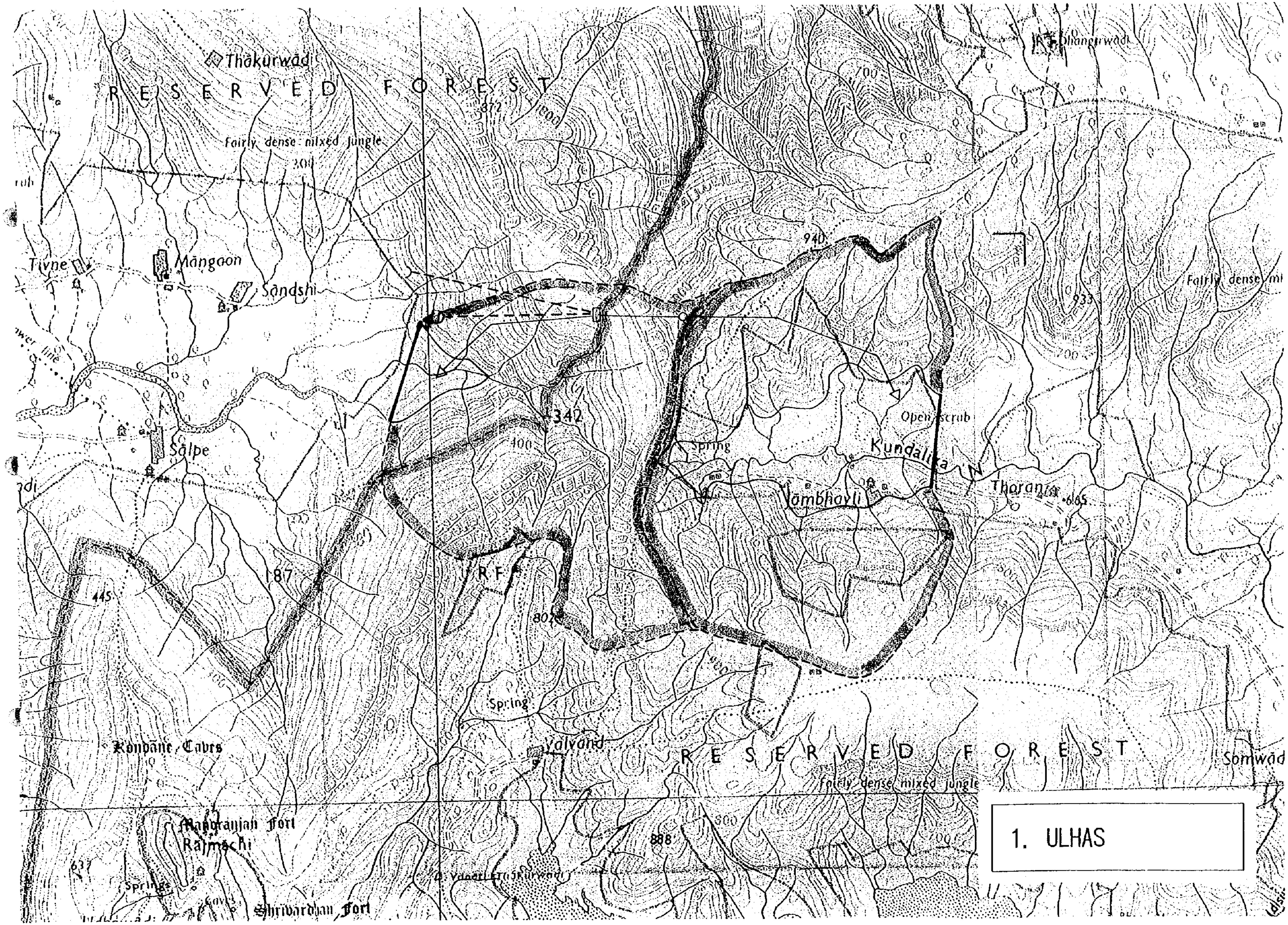
Before the completion of the general description of each project site, the most proposal layout under the technical, economical, environmental and other points view with various experiences and knowledges of the interpretation and structural layoutomg technologies on the map and the structural concepts, which have been accumulated up to the present through the many same kind of studies by the Study Team. The layouts of each site are shown in this Appendix.

The results and knowledges of the reconnaissance studies carried out at the time of the first and second serveys in India are without saying to have been thoroughly reflected to complete this general description. It is necessary however to notice that the descriptions of the sites having not been executed the reconnaissance studies may be included some misunderstanding matters especially about the natural features, though those of the sites performed the abovementioned studies are considered to be exactly presented the actual site conditions.

During this study, the aforementioned studies are carried out and the remarkable main general characteristics have been taken up and described as a form of the table for each site dividing the following items such as 'Environment conditions', 'River basin conditions', 'Location and condition of structures', 'Access road and tunnel', 'Power transmission lines' and 'General evaluation' as presented in this Appendix.

1: General Description of the ULHAS Project Site

1. Environment conditions	(1) Upper reservoir		The submerged area involves 67 ha of forecst including 10ha of reserved forest
	(2) Lower reservoir		The submerged area involves 26 ha of reserved forest
2. River basin conditions	(1) Upper reservoir	(1) River basin	Due to its location at most upstream end of the river basin and the relatively gentle slopes of the river banks on both sides, it is assumed that the bed rock which has talus of rock waste has weathered and eroded in many areas.
		(2) Submerged dwellings	On the evidence of a 1/50,000 scale topographical map it appears that some isolated dwellings are present in the area. As this topographical map is old, it is likely that the number of dwellings existing in the site area may have increased.
		(3) River bed condition	The river bed has a wide and flat topography so that a low dam is adequate to provide a large reservoir capacity. Yet, it is considered that rock waste and sand carried by the river flow have settled to form deposits of considerable depth.
		(4) Circum-reservoir terrain	Since both banks have a steep gradient in the parts close to and above the high water level, and since, furthermore, the main river branch off into various streams at right angles it may be inferred as probable that the land surface in the reservoir is subject to sliding as a result of rock debris into the river and due to changes of the reservoir water level.
	(2) Lower reservoir	(1) River basin	The river basin as a whole presents a steep mountainous topography and at the most upstream end, the basin terminates in a abrupt cliff. This suggests that the surface of the terrain is covered with a fresh rock bed.
		(2) Submerged dwellings	In view of the steep precipitous nature of the relief, it is clear from the evidence of the 1/50,000 scale topographic map that there are no dwellings in this area.
		(3) River bed condition	A reservoir is being built at the transition location in which the steep precipitous water course abruptly changes to a river course with a gentle gradient. It is supposed that rock debris have deposited here to form a talus of considerable depth.
		(4) Circum-reservoir terrain	Above the high water level of the reservoir, the banks on both sides form a steep relief so that it may be reasonable to assume the possibility of the reservoir capacity being reduced by rock falling from the sides with variations of the reservoir water level.
	(3) Changes in river basin		The river basin changes at about 800m above the sea level, and this site is consisted of the river diversion plan.
3. Location and condition of structures	(1) Upper reservoir dam	(1) Dam site status	The dam site is located in a position at which the river is wide and has a flat relief. It is assumed that the river bed at this point is covered with deposits of rock debris of considerable depth especially both river banks.
		(2) Dam	The dam site presents a flat relief so that despite the large length of the dam it is possible to secure an adequate reservoir capacity although the dam has a low height.
	(2) Lower reservoir dam	(1) Dam site status	As the dam site corresponds to the location at which the steep gradient of river suddenly changes to a gentle slope, it has possibility that there are deposits of rock debris at this site.
		(2) Dam	As the dam site is located at the pivot of alluvial fan in which the river steep gradient suddenly changes to a gentle slope, the dam length is long but the height is low enough to secure the sufficient reservoir capacity.
	(3) Waterway route	(1) Geographical profile	While the natural relief offers a relatively advantageous profile for the water way route from the upper reservoir to the watershed peak. From this peak at which the river is diverted to the lower reservoir, the elevation suddenly drops, so that the topographic feature of this site is not favorable for the layout of the water course and powerhouse.
		(2) Layout	In view of the river diversion project, the flat distance of the water course reaches approximately 4km.
	(4) Intake and outlet		The ordinary horizontal type of intake and outlet structures is adopted for both the upper and lower reservoirs.
	(5) Surge tank		As both the headrace and tailrace tunnels have considerable length, it will be necessary to build surge tanks at the both sides.
	(6) Powerhouse		The longitudinal section of the waterway has an unfavorable profile so that the layout is not advantageous in topographic viewpoint with the need to locate to powerhouse approximately 1.5km from the outlet.
4. Access road and tunnel	(1) Upper and lower reservoirs		The plan is to construct a new road to the upper reservoir branching off from the existing road at Valvand over a distance of some 10km and to the lower reservoir over a distance of some 5km from the existing road at Salpe.
	(2) Access tunnel to powerhouse		For reasons due to the waterway system layout, the powerhouse is located at a remote distance from the lower reservoir so that a relatively long access tunnel is provided to reach the powerhouse.
	(3) Cable tunnel		Similarly to this long access tunnel to the powerhouse, it will be necessary to have a comparatively long cable tunnel.
5. Power transmission lines			To construct the 400kV one circuit,double conductors, 56 km from Ulhas PPS to Kalwa S/S along the 220kV one circuit transmission line between Chinchwad S/S and Kalwa S/S through Apta S/S.
6. General evaluation			The overall evaluation shows that the project has poor economic efficiency for two main reasons. One is that due to the limited storage capacity of the lower reservoir, the power generation has small output, and the other is that the both waterways are too long. There are also a number of hamlets in the project area which also has extensive areas of submerged forest and agricultural land.

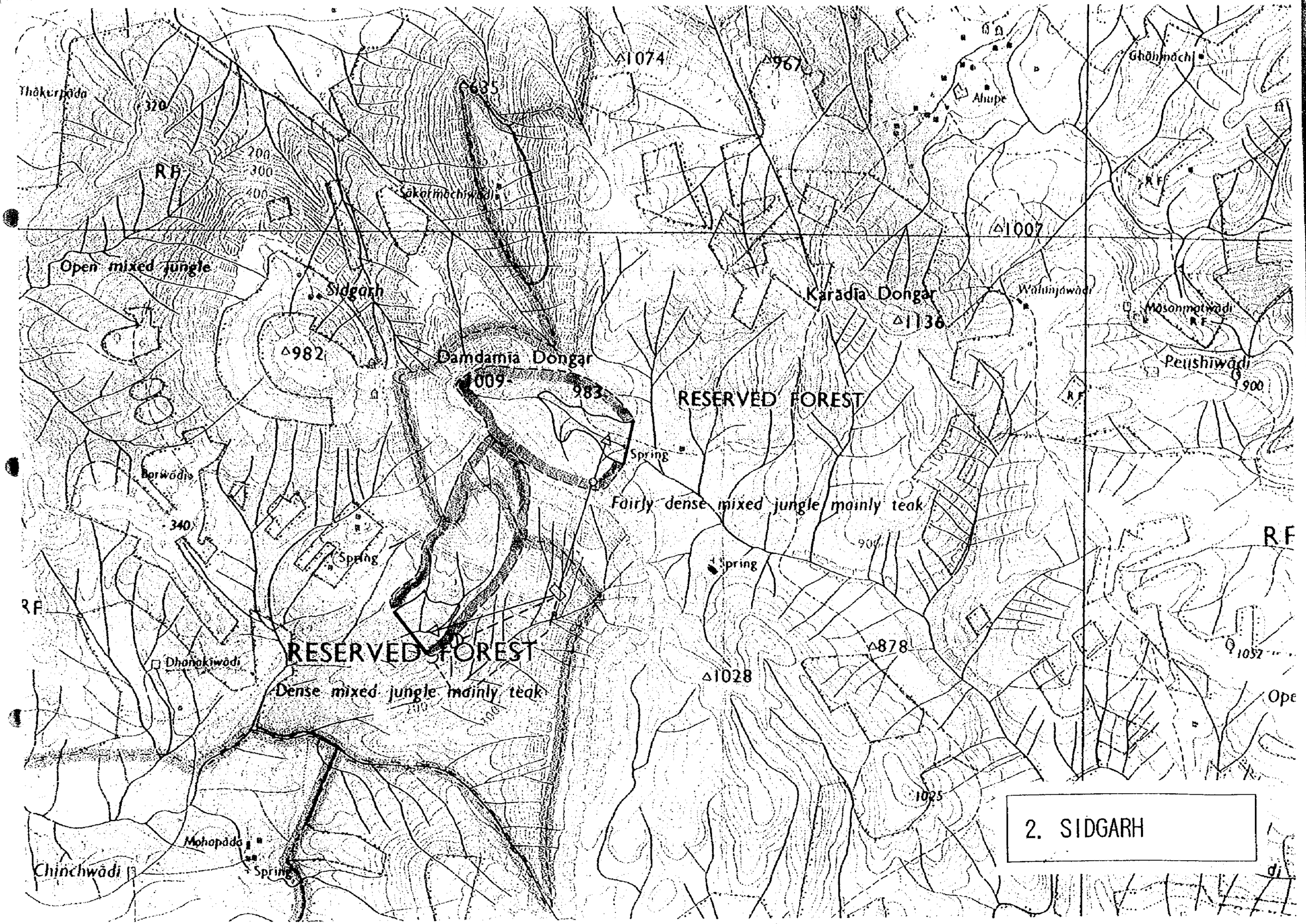


Thakurwadi
RESERVED FOREST
Fairly dense mixed jungle
Tivne
Mangaon
Sandshi
Salpe
940
933
1342
Open scrub
Kundalika N
Spring
Tambhayli
Thorania
187
445
807
Spring
Valvand
Kondane Caves
RESERVED FOREST
Fairly dense mixed jungle
Somwadi
Manoranjan Fort
Rajmachi
888
Springs
Shrivardhan Fort

1. ULHAS

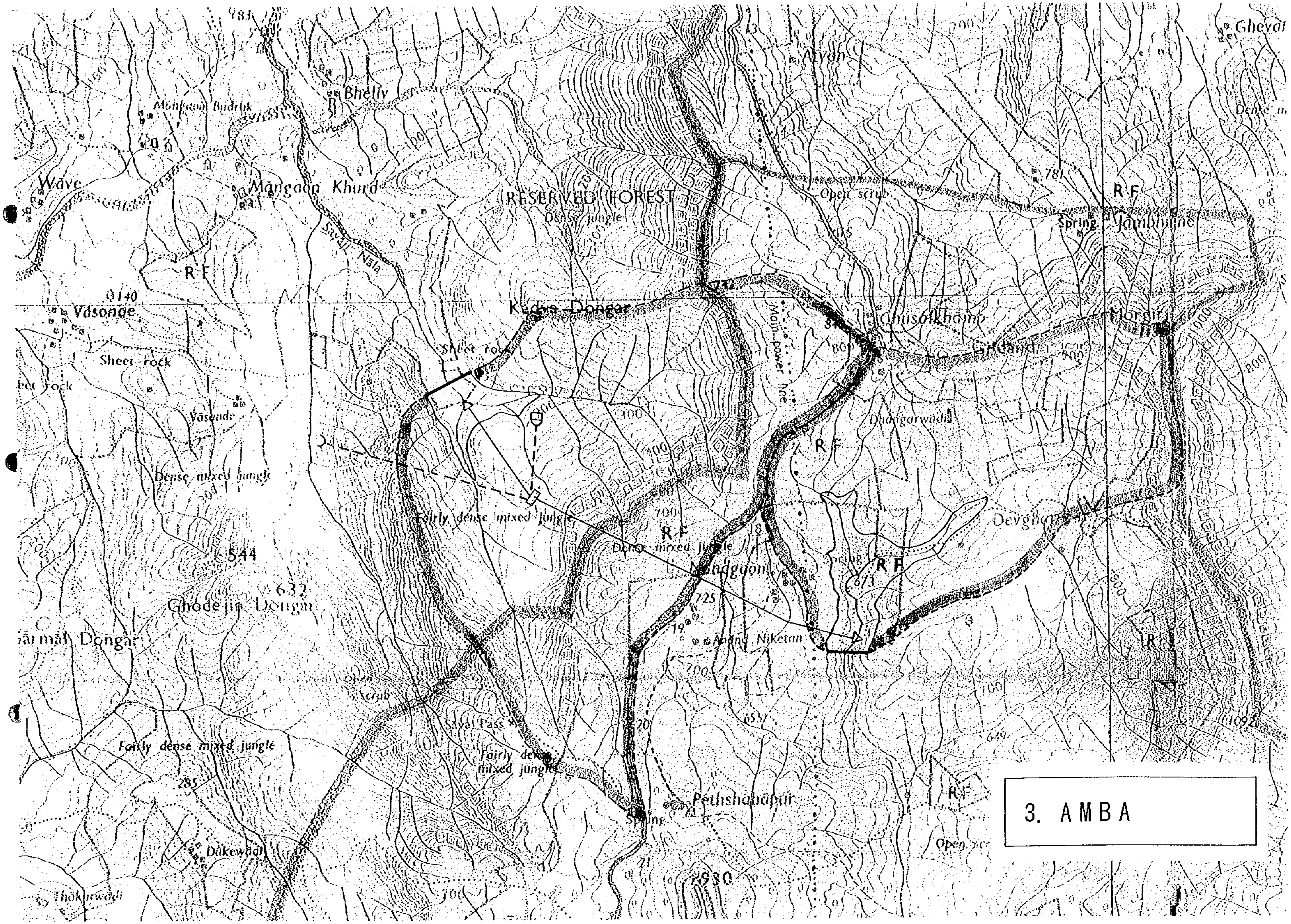
2: General Description of the SIDGARH Project Site

1. Environment conditions	(1) Upper reservoir		The submerged area involves 20 ha of reserved forest
	(2) Lower reservoir		The submerged area involves 14 ha of reserved roest
2. River basin conditions	(1) Upper reservoir	(1) River basin	The lie of this small river basin is generally a gently slope and consists of a single river.
		(2) Submerged dwellings	On the evidence of the 1/50,000 scale topographical map, it is not found that there is no submerged dwelling in the basin area.
		(3) Dam site status	The river basin consists of a gentle slope and the single river in it also slopes at a gentle gradient. The river bed is believed to be covered with rock debris and/or sand depositions.
		(4) Circum-reservoir terrain	Since the terrain surrounding the reservoir is also inclined at a gentle gradient, it is supposed that the surface is covered with deposits of rock debris. As a result, it is not possible to exclude the possibility of these rock debris depositions falling apart or sliding with the variations of the reservoir water level.
	(2) Lower reservoir	(1) River basin	The upstream parts have two steps steptopography dipped at a steep gradient. The reservoir is a gently sloping bank on the right side and a left bank with a somewhat steep gradient. With only one river as the main river and a small number of streams branching off from it, the basin extends over a small area.
		(2) Submerged dwellings	The evidence of the 1/50,000 scale topographic map indicates that there is no submerged dwelling in this area.
		(3) River bed condition	As the river has a rapid flow up to the vicinity of the reservoir, it is assumed that the base rock of the river bed is exposed in the upstream part. Near the reservoir, however, the bed dips at a gentle slope so that rock debris are considered likely to have settled there.
		(4) Circum-reservoir terrain	As the bank on the right side of the reservoir has a gentle gradient, rock debris may have settled here at considerable depth giving rise to the possibility of land slides. In contrast, the left bank dips at a steep gradient so that it seems reasonable to assume that it is stable although the rock bed may have weathered to some extent.
	(3) Changes in river basin		The river forms a watershed peak with steep overhanging cliffs on the south side and a gentle incline on the east side so that this site is consisted of the river diversion project.
3. Location and condition of structures	(1) Upper reservoir dam	(1) Dam site status	As the river dips at a generally gentle incline, it may be assumed that deposits of rock debris may be deposited in the vicinity of the reservoir.
		(2) Dam	The dam site is somewhat long and for topographical reasons it will be difficult to raise the water level of the reservoir further on both banks.
	(2) Lower reservoir dam	(1) Dam site status	In the upper reaches, the river has a rapid flow and it may thus be inferred that there are deposits of rock debris carried by this flow.
		(2) Dam	The dam site dips at a gentle slope on the right bank so that it will be difficult to raise the dam above its present height. The left bank, however, slopes at a steep gradient , presenting no structural problem.
	(3) Waterway route	(1) Geographical profile	The topography abruptly changes to a low elevation at a distance of approximately 1km from the upper reservoir, thereby imposing a physical limitation on the routing of the waterway system.
		(2) Layout	The waterway has a relatively short length of only about 2.5km. The conditions of the waterway system therefore leave no other possibility but to locate the powerhouse at a mid-way of the waterway system.
	(4) Intake and outlet		The plans foresee the use of ordinary structures for the intake and outlet.
	(5) Surge tank		In view of the short length of the waterway it will not be necessary to provide a surge tank.
	(6) Powerhouse		The physical limitations of the waterway system make it inevitable to locate the powerhouse at the mid-way of the waterway.
4. Access road and tunnel	(1) Upper and lower reservoirs		It will be necessary to construct a new road to the upper reservoir about 25km from Dhanakiwadi and two new roads to the lower reservoir, that is, one of some 15km length and the other of some 50km length.
	(2) Access tunnel to powerhouse		In view of the physical limitations for the location of the powerhouse, it will be necessary to excavate a long access tunnel.
	(3) Cable tunnel		The plan is to lead the cable tunnel to the switchyard installed on the left bank using an inclined tunnel.
5. Power transmission lines			To construct the 400kV one circuit, double conductors, 50 km from Sidgarh PPS to Pagdhe S/S along the planning of 400kV double circuits transmission line between Nagothane S/S and Padghe S/S.
6. General evaluation			Although the waterway is short and has the advantage of a relatively large head, the water storage capacity of both the upper and lower reservoirs is subject to physical limitations associated with the topographical features of the terrain. The evaluation thus leads to the conclusion that this site entails a small power output capacity and an inferior economic efficiency. The project site with the diversion of the river flow also includes areas under special protection with the presence of sanctuaries at both the upper and lower reservoirs.


Thakurpada
320
RF
200
300
400
Sakarmachiwadi
△1074
△967
△635
Ghonmachi
Ahupe
RF
△1007
Open mixed jungle
Sidgarh
Karadia Dongar
△1136
Walunjawadi
Mosanmatwadi
RF
△982
Damdamia Dongar
1009
983
RESERVED FOREST
Peilshiwadi
900
Spring
Borwadis
Fairly dense mixed jungle mainly teak
340
Spring
RF
Spring
RF
Dhanakiwadi
△878
△1028
1052
RESERVED FOREST
Dense mixed jungle mainly teak
200
300
1025
Mohopada
Chinchwadi
Spring
2. SIDGARH

3: General Description of the AMBA Project Site

1.Environment conditions	(1) Upper reservoir		The submerged area involves 42 ha of forest including 20 ha of reserved forest as well as 5 ha of agricultural land.
	(2) Lower reservoir		The submerged area involves 20 ha of reserved forest and 3 ha of agricultural land.
2. River basin conditions	(1) Upper reservoir	(1) River basin	On the east side, this river basin consists of precipitous cliffs rising 900m above sea level. These steep slopes gradually ease and give way to gentler slopes. On the west side, however, the topographic elevation of the terrain generally drops in the direction toward the reservoir, dipping at a moderate gradient from the plateau at 700m elevation toward the reservoir.
		(2) Submerged dwellings	On the evidence of the 1/50,000 scale topographical map it appears that there are some small villages and hamlets spread around the reservoir area but there is no submerged dwelling in the reservoir itself.
		(3) River bed condition	The river divides into two branches near the back water of the reservoir. As the river dips at a gentle gradient it is supposed to be covered with rock debris.
		(4) Circum-reservoir terrain	Since the terrain surrounding the reservoir is inclined at a gentle gradient, it is estimated that the surface has a sedimentation layer of significant depth and that the rock bed has been subject to extensive weathering.
	(2) Lower reservoir	(1) River basin	On the east of the dam, the terrain forms a plateau of some 700m elevation skirted by perpendicular precipes that gradually ease to give way to more gentle dips towards the reservoir.
		(2) Submerged dwellings	The evidence of the 1/50,000 scale topographic map indicates that there is no submerged dwelling in the reservoir.
		(3) River bed condition	The river divides into two branches at the immediate upstream of the dam site, and the bed shows a progressive increase in dip gradient, rising through percipitous cliffs to a highland plateau. Topographical evidence suggests that there is few deposits of rock debris in the branches of the river.
		(4) Circum-reservoir terrain	The terrain around the reservoirs dips at steep gradients while the topography in the reservoirs shows a broad flat relief.
	(3) Changes in river basin		The plateau of some 700m elevation forms a natural watershed for diverting the river flow. On the east side, the slopes dip at a gentle gradient towards the upper reservoir and on the west side the terrain drops from the plateau through precipitous overhanging cliffs to gentler slopes extending toward the lower reservoir.
3. Location and condition of structures	(1) Upper reservoir dam	(1) . Dam site status	As the river bed has a broad flat topography, it may be assumed that sedimentation materials may have deposited or weathered rock layers developed.
		(2) Dam	In view of the estimated progressive formation of sedimentation or weather strata, difficulties may be anticipated in the construction work on the dam foundation and the banks on both sides.
	(2) Lower reservoir dam	(1) Dam site status	The dam site is positioned in the broad river location immediately downstream of the confluence of the two rivers. In the rainy season, the river bed is likely to be subject to the deposits of progressive rock debris and the development of a weathered rock layer.
		(2) Dam	The river bed of the dam is supposed to have a deep deposits of rock debris, with progressive weathering of the foundation rock bed. This may therefore give rise to difficulties in the foundation construction work. Since, furthermore, the banks slope at a steep gradient on both sides it may be assumed that fresh bed rock is exposed.
	(3) Waterway route	(1) Geographical profile	The vertical profile of the waterway shows a favorable relief for the construction of the waterway system. Yet the considerable length of approximately 4km of the waterway is a definite disadvantage.
		(2) Layout	As the upper reservoir has a flat topography, the headrace tunnel has a thin overburden so that inclined tunnel is installed downstream of the intake. The tailrace tunnel is planned to have a length of approximately 2km and the location of the powerhouse is layouted as close to the downstream as possible.
	(4) Intake and outlet		To deepen the over burden of headrace tunnel the intake structure is adopted as a sloped type. For the outlet, however, an ordinary horizontal type structure is applied.
	(5) Surge tank		In view of the considerable length of the headrace, the project provides for the structure of a surge tank to control the water pressure at the upstream part of the penstock. The outlet, however, needs no surge tank as this tailrace is short.
	(6) Powerhouse		In view of the natural topography, the waterway route is selected so that the powerhouse is to be located as close to the outlet as possible.
4. Access road and tunnel	(1) Upper and lower reservoirs		A road is already in existence in the vicinity of the upper reservoir and it will be necessary to construct an approximately 8km long access road to the upper reservoir. To reach the lower reservoir, an approximately 10km long road will need to be newly constructed as far Kalamb.
	(2) Access tunnel to powerhouse		The access tunnel to the powerhouse from the lower reservoir dam is planned.
	(3) Cable tunnel		The plan is to lead the cable tunnel to the switchyard using a inclined type.
5. Power transmission lines			To construct the 400kV one circuit, double conductors, 83 km from Amba PPS to Kalwa S/S along the 200kV double circuits transmission line between Koyna S/S and Kalwa S/S through Apta S/S.
6. General evaluation			Even though the dam on the lower reservoir may be raised it will still have a poor water storage efficiency. Consequently, the lower reservoir has a limited water storage capacity. Economic efficiency suffers as a result of the considerable length of the waterway. While it is not the project of the diversion of the river flow, the fact is that the upper reservoir contains a stretch of submerged forest covering an area of 60ha.


Bheliv
Māngaon Khurd
Wave
RESERVED FOREST
Dense jungle
Savāli Nala
R F
Vdsonde
Kedva Dongar
Sheet rock
Vāsande
Dense mixed jungle
Fairly dense mixed jungle
Dense mixed jungle
Ghusolkhāmb
Main power line
Dhangarwādi
Spring
Devghar
Mandgaon
Ānand Niketan
Ghodejin Dongar
Sarmāl Dongar
Open scrub
Savāl Pass
Fairly dense mixed jungle
Pethshahāpur
Spring
Dākewādi
Thākurwādi
Open scrub
Open scrub
Ghevāl
544
632
673
725
285
781
1092

3. AMBA

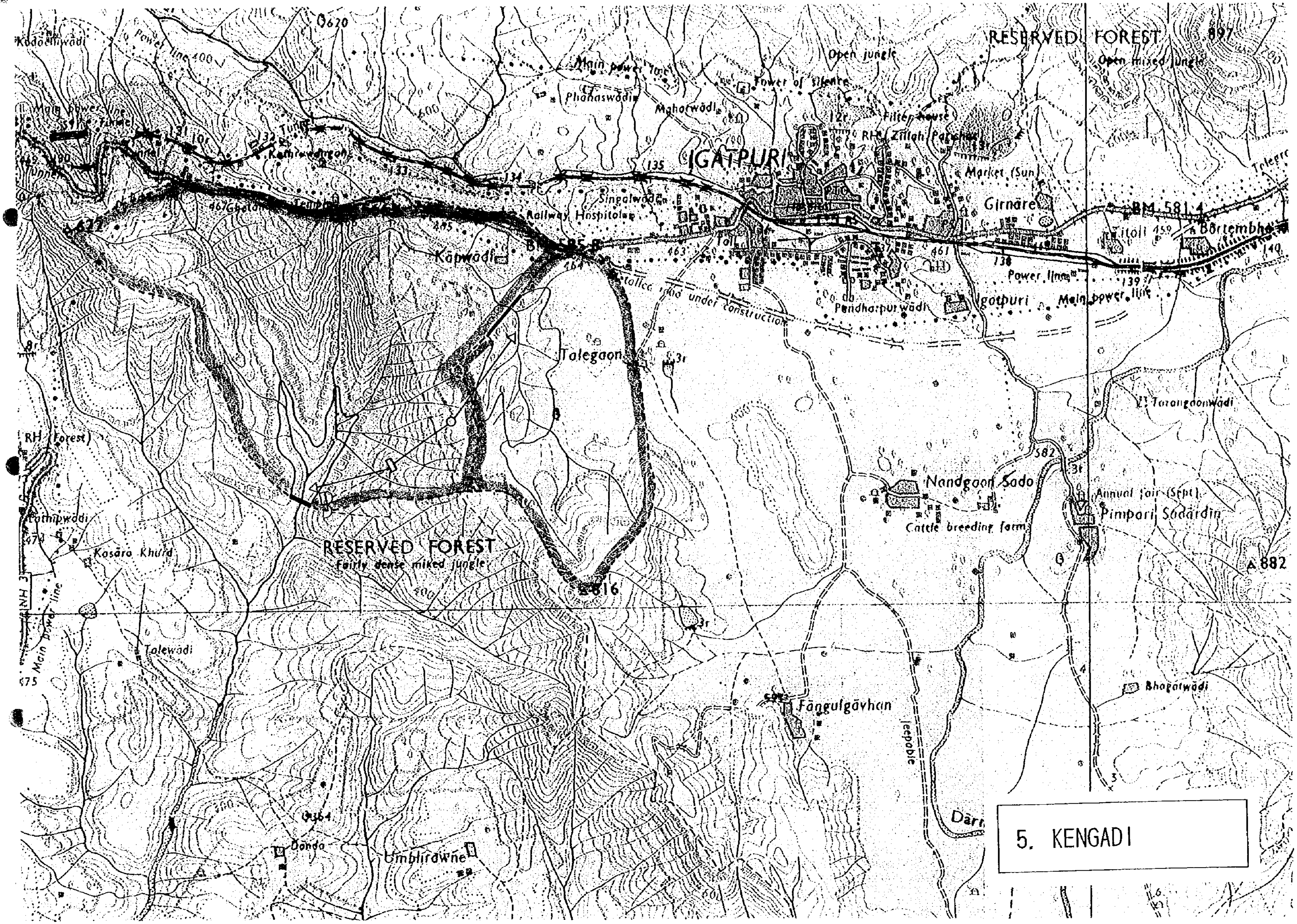
4: General Description of the PINJAL Project Site

1. Environment conditions	(1) Upper reservoir		Submerged area involves 7 ha of reserved foredst
	(2) Lower reservoir		Submerged area involves 104 ha of foredst including 3 ha of reserved forest
2. River basin conditions	(1) Upper reservoir	(1) River basin	Located at the most upstream end of the tributary of the river Debandh Nadi, the upper reservoir generally presents a gently inclined topography. The topographic relief around the reservoir is that of a flat basin.
		(2) Submerged dwellings	On the evidence of the 1/50,000 scale topographical map it appears that there is no submerged dwelling in the reservoir.
		(3) River bed condition	The river basin has a comparatively gentle gradient of dip so that it is exposed to significant weathering and erosion in its entirety. It may therefore be assumed there are substantial deposits of extensively weathered and eroded sedimentation layers in the entire river area, including the mountain streams.
		(4) Circum-reservoir terrain	Since the terrain surrounding the reservoir presents the topography of a flat basin, there is reason to fear that the soil surface in the vicinity of the reservoir may collapse or slide with the variations of water level although the available water depth is shallow. This may be a causal factor in reducing water storage capacity.
	(2) Lower reservoir	(1) River basin	Located downstream of the upper reservoir, the river basin reaches a total area of 32km^2 and is criss-crossed by a large number of streams branching off from the main river. Throughout the river basin the natural topography remain flat with gently dipping slopes.
		(2) Submerged dwellings	The evidence of the 1/50,000 scale topographic map indicates that there are a few (two or three) dwellings submerged in the reservoir. There are also a few dwellings dotted here and there around the reservoir.
		(3) River bed condition	The relief presents a gently inclined topography with evidence to suggest significant weathering and erosion of the surface. The river bed is assumed to have deposits of rock debris that have eroded and are being eroded by the flood in the rainy season.
		(4) Circum-reservoir terrain	The terrain around the reservoir dips at gentle gradient and forms a flat so that it is likely to suppose that sedimentation layers of weathered rock or rock debris from the talus. This suggests the possibility of the surrounding terrain caving in or sliding due to variations in water level thereby giving rise to a reduction in water storage capacity.
	(3) Changes in river basin		This project plan consists of a pumped-up hydroelectric power station using the upper and lower reaches of the same river. It does not therefore require any changes in the river basin.
3. Location and condition of structures	(1) Upper reservoir dam	(1) Dam site status	The bed is assumed to be generally a large width, with deep deposits layers of weathered and eroded rock carried by river at the dam site river bed. It is also conceivable that extensive weathering is taking place at the foundation rock bed.
		(2) Dam	The dam site has a flat section, with weathering progressing on both sides so that it is reasonable to anticipate certain difficulties in dealing with the foundation rock bed, including the abutment.
	(2) Lower reservoir dam	(1) Dam site status	The dam has a relatively narrow bed comparing the upper reaches and the topographical features of both banks suggests the presence of deep depsits at the river bed and both banks, with evidence to indicate that the dam foundation rock bed has also weathered to a significant depth.
		(2) Dam	The dam site adjoins a small mountain ridge on the right bank and a gentle slope on the left. It is anticipated, however, that certain problems may arise in connection with the methods required to deal with the weathered rock bed and the deposits that have formed on the river bed and on the banks.
	(3) Waterway route	(1) Geographical profile	Topographical features are generally flat, and a layout has been selected so that the waterway is routed in such a manner as to pass through the locations with a high elevation where possible, but is not favorable topography features as the route of the waterway system.
		(2) Layout	The waterway route is relatively short at only 3km and passes through a flat topography, with indications to suggests that the deeper zones have progressively weathered. The layout has been established so as to make the head of the waterway as deep as possible .
	(4) Intake and outlet		To deepen the headrace tunnel, the intake structure is adopted as a morning glory type. For the outlet, the ordinary horizontal type outlet structure is be used.
	(5) Surge tank		In view of the short length of the waterway system and given the low head, the layout has been arranged so that no surge tank is needed for water pressure control.
	(6) Powerhouse		In view of the flat topography and the layout chosen for the waterway system, the powerhouse has been located somewhere in the middle of the waterway system.
4. Access road and tunnel	(1) Upper and lower reservoirs		A road is already in existence in the vicinity of the dams of the upper and lower reservoirs so that the short roads are planned to be newly constructed as side roads to this existing one.
	(2) Access tunnel to powerhouse		The powerhouse is layouted in a location somewhere in the middle of the waterway route so that the access tunnel to the powerhouse is relatively long.
	(3) Cable tunnel		In view of the position of the switchyard, the plan has the cable tunnel connected to the transformer room.
5. Power transmission lines			To construct the 220kV double circuits (including return way), one conductor, 20km from Pingal PPS connected to Nasik-Kalwa transmission line.
6. General evaluation			Due to the existing topographical limitations , the upper and lower reservoirs have only a small storage capacity and the head is low. The inevitable result is that the power station has a small output capacity. Nor can the site be described as favoring economic efficiency. Although there is no diversion of the river flow in this project, there are village communities on the lower reservoir and a stretch of submerged forest covering an area of over 100ha is present in the reservoir.

4. PINJAL

5: General Description of the KENGADI Project Site

1. Environment conditions	(1) Upper reservoir			Submerged area involves 245 ha of agricultural and residential land
	(2) Lower reservoir			Submerged area involves 27 ha of reserved foredst
2. River basin conditions	(1) Upper reservoir	(1) River basin		This river basin is located in the southwestern part of the town of Igatpuri. Apart from the most upstream end, the basin has a flat relief. Between the basin's highest elevation and the elevation of the dam location there is a gradient difference of approximately 200m.
		(2) Submerged dwellings		On the sole evidence of the 1/50,000 scale topographical map it appears that there is no submerged dwelling. As this topographical map is old, however, there is possibility that some submerged dwellings exist in the reservoir.
		(3) River bed condition		The slopes of upper reaches have been eaten away by erosion and the debris carried by the river flow to the lower region so that it is likely that the entire flatland area of the basin is covered with deposits. It is estimated that thick deposits may have settled also at the two side tributaries.
		(4) Circum-reservoir terrain		The surrounding terrain is also part of the plain, with a somewhat low relief along the river. Dam construction would involve the great risk that the terrain around the reservoir might slide to the reservoir side in the wake of variations in the reservoir water level.
	(2) Lower reservoir	(1) River basin		The upper reaches of the basin form precipitous cliffs, with the steep mountain ridges encircled by the mountain streams. The tributaries merge in the lower reaches of the basic where both the topographical relief and the rivers have a gentler gradient than in the upper reaches.
		(2) Submerged dwellings		Since the tributaries are rapid streams flowing on precipitous cliffs, there is no submerged dwelling in the basin.
		(3) River bed condition		It is possible to make a broad distinction between three tributaries merging immediately upstream of the dam site, with each of these tributaries forming precipitous cliffs. Around the reservoir, however, the river gradient is a gentle one, with evidence to indicate that rock debris from the upper reaches has settled there,
		(4) Circum-reservoir terrain		The terrain around the reservoir abruptly changes from gentle slopes to steep, precipitous cliffs skirting the reservoir. If these cliff have fresh bed rock there is little danger of their collapsing. Yet there is a conceivable risk of sliding in the gentler slope parts as a result of variations in water level.
	(3) Changes in river basin			The project is not the diversion of the river flow with the watershed peak consisting of a plateau running in the north-south direction.
3. Location and condition of structures	(1) Upper reservoir dam	(1) Dam site status		The upper reservoir consists of a river flowing through a plain, with only the river part being low. In the dry season, however, the river floor as well as the banks on both sides are no longer distinguishable from each other so that there is reason to assume the presence of deposits to a significant depth. The foundation rock bed is supposed to has weathered to considerable depth.
		(2) Dam		The condition of the river bed and the banks on both sides suggests that serious difficulties might be encountered in the construction of the dam.
	(2) Lower reservoir dam	(1) Dam site status		The banks on both sides rise to projecting ridges forming abrupt precipices. Deposits of rock debris are likely to exist on the river bed but there is every evidence to suggest that these layers are not deep.
		(2) Dam		The construction work of the dam planned under this project is not likely to give rise to any particular problems.
	(3) Waterway route	(1) Geographical profile		The waterway route has been selected by taking the natural relief into account. The route topography along the waterway shows a flat profile on all fronts. The terrain on the upper reservoir side, in particular, has a flat topography so that the headrace tunnel becomes thin for topographical reasons.
		(2) Layout		As the headrace has a thin over burden as a result of topographical conditions, the plan is to deepen the headrace by giving the upper reservoir a morning glory type. The waterway system takes a bent meandering shape for topographical reasons. Due to the short length of the waterway of only 2.5km, the waterway becomes simple.
	(4) Intake and outlet			A morning glory type intake is adopted to accommodate the existing topographical conditions so as to deepen the headrace tunnel.
	(5) Surge tank			In view of the short length of the waterway system, the topography permits no other alternative but to position the powerhouse somewhere in the middle of the waterway. The short length of the waterway system does have the advantage that no surge tank is required to control water pressure.
	(6) Powerhouse			In view of the topographical conditions, the layout leaves no alternative but to locate the powerhouse somewhere in the middle of the waterway system.
4. Access road and tunnel	(1) Upper and lower reservoirs			A road is already in existence in the vicinity of the upper and lower reservoirs so that the new roads are to be constructed branching from the existing road.
	(2) Access tunnel to powerhouse			The plan is to construct an access tunnel to the powerhouse from the left bank of the lower reservoir.
	(3) Cable tunnel			In view of the presence of a suitable space for the switch yard on the left bank of the lower reservoir, the cable tunnel is to construct linking the transformer room adopting the inclined tunnel.
5. Power transmission lines				To construct the 220kV double circuits (including return way), one conductor, 1km from Kangadi PPS connected to Nasik-Padghe transmission line.
6. General evaluation				The most serious problem area in this project lies in the likely need for the construction of a dam on the upper reservoir. The inability to secure adequate water storage capacity leads to a poor economic efficiency for this project. Although there is no need for the diversion of the river flow in this site, there is the drawback that 150ha of agricultural area will be submerged.


RESERVED FOREST
Open mixed jungle
Open jungle
Tower of silence
Filter house
Phanaswadi
Mahorwadi
IGATPURI
Market (Sun)
Girnare
Railway Hospital
Singalwadi
Kapwadi
Titoli
Bortembha
Power line
Main power line
Pendharpurwadi
Igatpuri
Talegaon
Tarangaonwadi
RH (Forest)
Nandgaon Sado
Cattle breeding farm
Annual fair (Sept)
Pimpari Sadardin
882
816
RESERVED FOREST
Fairly dense mixed jungle
Kosaro Khurd
Talewadi
Fangulgavhan
Jeepable
Bhogarwadi
Donda
Umblirdwne

5. KENGADI

6: General Description of the KALU Project Site

1. Environment conditions	(1) Upper reservoir		Submerged area involves 54 ha of reserved foredst
	(2) Lower reservoir		Submerged area involves 15 ha of reserved foredst
2. River basin conditions	(1) Upper reservoir	(1) River basin	The rivers in this basin branch off into a number of mountain streams roughly at right angles in respect to the main river. After the most upstream reaches of the main river dip at a steep gradient from the water-shed peak at roughly 1,200m elevation, apart containing abrupt overhanging cliffs, the slopes suddenly ease to a gentle gradient before the reach down to the reservoir, with the surrounding parts of the reservoir forming a broad plain.
		(2) Submerged dwellings	On the evidence of the 1/50,000 scale topographical map it appears that there is no submerged dwelling.
		(3) River bed condition	None of the many streams gives the appearance of having been scored out, a fact probably due to the extensive forest coverage of the upstream area. Near the reservoir, the gradient is much gentler, with the part immediately surrounding the reservoir forming a plain with likely deposits.
		(4) Circum-reservoir terrain	The terrain surrounding the reservoir is a broad plain and it is supposed that both the river bed and the banks on both sides are covered with deposits.
	(2) Lower reservoir	(1) River basin	The upper reaches of the basin form watershed peak with abrupt overhanging cliffs on the south side. From the precipitous slopes at approximately 300m, the terrain dips at a much gentler gradient, with the slopes decreasing as they approach the reservoir. The parts surrounding the reservoir present an alluvial fan-shaped topography.
		(2) Submerged dwellings	Due to the steep slopes surrounding the reservoir, there is no submerged dwelling in the reservoir.
		(3) River bed condition	A number of side streams branch off from and along the main river. Yet, only the main river presents a eroded out topography. This may be due to the fact that the terrain has a steep relief and the rock bed will be fresh. In the vicinity of the reservoir, the natural relief presents an alluvial fan-shaped topography, with evidence to suggest the presence of deep deposits.
		(4) Circum-reservoir terrain	The terrain around the reservoir has a fairly steep topography. Judging from the basin as a whole, it may be concluded that the terrain around the reservoir has a fresh rock although there may be existing the deposits.
	(3) Changes in river basin		The overhanging, approximately 1,200m high cliff forms a watershed peak dividing the basin into the upper and lower reservoir reaches. The direction of flow of the rivers is in the east-north direction for the upper reservoir and the south-west direction for the lower reservoir. The pattern is thus a fairly parallel flow, with the rivers divided in opposite direction as they flow down.
3. Location and condition of structures	(1) Upper reservoir dam	(1) Dam site status	The terrain adjoining the dam site is flat and forms a broad plain, with evidence to suggest the presence of deep weathered strata and deposits. Similarly, the rock bed of the river base is assumed on topographical evidence to have progressively weathered. On the left bank, in particular, it would be appropriate to conduct a thorough survey in and around the abutment area.
		(2) Dam	The location is not suited as the dam site on account of the geological conditions prevailing here and also because the topography of the relief on the left bank of the dam site imposes limitations on the height of the dam.
	(2) Lower reservoir dam	(1) Dam site status	The terrain adjoining the dam site forms an alluvial fan-shaped topography. Nor is it supposed that the deposits have a particularly great thickness. The foundation rock will be expected to be fresh.
		(2) Dam	Since the dam site is long and the topographical conditions on either bank is steep, therefore even if the dam is raised, the reservoir will have a very poor storage capacity so that there is no reason to expect an economically favorable result from any attempt to raise the dam height.
	(3) Waterway route	(1) Geographical profile	In view of the topographical conditions, the decision has been taken to select a curved route for the waterway systems. The objective of this choice is to let the rivers feeding the upper and lower reservoirs flow parallel, yet in opposite directions to each other and also to secure a suitable overburden for the headrace.
		(2) Layout	The waterway makes effective use of the topographical relief of the basin and the layout selected for the power station is to make the headrace as long as possible in order to bring the powerhouse as close to the outlet as possible.
	(4) Intake and outlet		For both the intake and outlet, the ordinary horizontal type structures are applied.
	(5) Surge tank		As the headrace has a length of approximately 2km, it will be necessary to provide a surge tank to control the water pressure.
	(6) Powerhouse		Given the short length of the tailrace, a layout has been adopted in which the powerhouse is situated in the vicinity of the lower reservoir.
4. Access road and tunnel	(1) Upper and lower reservoirs		For access to the upper reservoir, a new approximately 3km long road is to be constructed branching from the existing road which passes through Panchnai. For access to the lower reservoir, it is proposed that the approximately 75km long road from Merdi should be repaired and a new approximately 10km road should be added.
	(2) Access tunnel to powerhouse		The access tunnel is planned as close as possible to the lower reaches so that the layout will favor a short access tunnel from the right bank of the lower reservoir.
	(3) Cable tunnel		The cable tunnel is layouted as similar to that of the access tunnel to the powerhouse.
5. Power transmission lines			To construct the 400kV double circuits (including return way), double conductors, 3km from Kalu PPS connected to Bableshwar-Kalwa transmission line.
6. General evaluation			The head is in the order of 500m and there is no mean magnitude. Yet, the fact is that both the upper and lower reservoirs have a limited storage capacity because of the limited dam heights. Consequently, the power output will also be comparatively small and the economic effectiveness of the projects is not favorable. In the upper reservoir area, there are over 100ha of forest submerged. It is also assumed that there are sanctuaries at the upper and lower reservoirs, and this project requires the diversion of the river flow.

Potaichiwadi

Open mixed jungle

Bahiroba Nala

1028

1149

Bayroba Dongar

1284

Vithal Dhar

Lavhali Koti

Panchnai

Sheet rock

Open mixed jungle

1206

Dadar Dongar

Napta Dongar

Kothal

Raksha Dhol

634 Bahiroba Matha

udholwadi

Fairly dense mixed jungle

1384

Tolan Khind

Annual fair (Mar)

Caves

Bala Qila

1422

Harishchandra Garh

453

Belpada

Volhivre

227

RESERVED FOREST

RF

RF

Fairly dense jungle

6. KALU

hind

Sadada Dhol

RF

Open scrub

Open mixed jungle 415