Chapter - 4
Surveys and Investigations

4.1 General

Surveys & Investigations for the Parbati-Kalisindh-Chambal link project has been carried out in order to establish feasibility of the project. The survey & investigation works of the project has been bifurcated into two parts, viz. Topographical Survey and other Investigation works. The topographical survey has been carried out by National Water Development Agency and the various Investigation works were got carried out from different expert organizations/departments. Most of the investigation works are at the stage of completion by outside Agencies. The gist of the reports of these investigation works as received from outside Agencies will be put on web site. However, the gist of the report on construction material survey received from CSMRS, New Delhi and salient details of geological investigation extracted from the progress report submitted by the GSI, Bhopal has been incorporated in the chapter.

Topographical survey of various components of Parbati-Kalisindh-Chambal link project such as, three dams namely Patanpur, Mohanpura and Kundaliya, head works, link canal, C.D./C.M. structures, sites for pumping stations, tunnels and command area survey for all the alternatives proposed under the link has been carried out by National Water Development Agency.

The Topographical survey of seven dams and its canal systems proposed by NWDA in the upper reaches of Chambal basin has not been carried out. The feasibility of above seven proposed dams has been assessed on the basis of toposheet studies.

The special studies such as Geological investigations, Geotechnical investigations & drilling work and construction material & borrow area surveys were carried out by Geological survey of India, Bhopal and Central Soil & Materials Research Station (CSMRS), New Delhi in association with Central Water Commission, Faridabad respectively. The Socio-economic survey and environmental & ecological impact assessment studies of this project could not be carried out at the time of preparation of feasibility report. The same has been awarded to M/s. RITES Ltd., Gurgaon, Haryana during June 2005 and the studies is likely to be completed within six months.

4.2 Topographical Survey

Topographical survey has been carried out as per guidelines of National Water Development Agency formulated in 1996 and Working Group Report prepared by Ministry of Irrigation, Government of India in 1980. Details of topographical surveys carried out for different components of the project are given in the following paras:

4.2.1 G.T.S. Bench Marks

Total three numbers of GTS Bench Marks of Survey of India could be identified in the field and values of these Bench Marks have been transferred on the link

alignment for carrying out survey work and checking correctness of the topographical surveys.

4.2.2 River Surveys

The river survey at the Patanpur dam site has been carried out upto 10 km in D/s of the dam site by surveying the cross section of the river at 400 m interval upto 2 km and thereafter at interval of 1 km upto 10 km. The river survey in the upstream of the Patanpur dam site could not be taken up due to deep ponding in the river bed.

The river survey of the Mohanpura dam site has been carried out upto post dam MWL+ 3 m in the upstream and upto 10 km in the down stream of dam axis by taking levels by single leveling at 100 m interval. The cross section survey of the river has been taken at 400 m interval upto 2 km and thereafter at 1 km interval in the upstream and down stream side of the dam axis. The cross sections were extended upto pre-dam HFL + 5 m or 1000 m beyond the firm bank which ever is less. Similarly, the river survey of Kundaliya dam has also been carried out.

4.2.3 Dam axis survey

After making careful reconnaissance and preliminary studies, on toposheets, the suitable dam sites have been selected and marked on the ground. Grid survey for the Patanpur, Mohanpura and Kundaliya dam axis has been carried out for a length of 3997 m, 1900 m and 3500 m respectively. The block leveling for the dam axis has been carried out by double levelling survey at 50 m interval. The cross-section surveys along the dam axis were taken at 50 m interval by taking levels and extended upto 300 m in the upstream side and 500 m downstream side of dam axis. After carrying out the field survey, the contour plan of dam site was prepared on the appropriate scale and contours were drawn at 1 m interval to 5 m interval as per topographical condition. The same has been utilised for preparing the lay out plan, L-section along the dam axis, selection of spillway position and estimation of the cost of the project.

4.2.4 Reservoir survey

The reservoir survey of Patanpur and Mohanpura reservoirs has been carried out by Investigation Division, N.W.D.A., Gwalior during 1997 to 2000 whereas the reservoir survey of the Kundaliya reservoir has been carried out by Investigation Division, N.W.D.A., Bhopal during 1983 to 1985. Reservoir survey includes fixing of base line by chaining, compassing, ranging and double leveling at 50 m interval. The cross-sections were surveyed at 50 m to 400 m interval by taking levels at 50 m interval in case of Kundaliya dam. Whereas the cross sections were surveyed at 400 m interval upto 2 km and thereafter 1 km interval upto post dam + 5 m in the upstream side of the dam axis of Patanpur and Mohanpura dam sites.

The above survey data has been utilised for preparing submergence area plan in the scale of 1:5000 and drawing contours at 1 m to 5 m interval as per the topographical conditions. On the basis of above submergence area plan, the reservoir storage capacities and affected population have been assessed and adopted in the studies. While carrying out these surveys, it has been experienced that the cross-sections

taken at such large interval were not able to cover all the important features of the areas.

4.2.5 Survey for Plant & Colony area

The suitable site for plant and colony areas at Patanpur dam has been identified and proposed to be located on left bank of the river near village Parasana in Rajgarh district. For Mohanpura dam site, the plant & colony area site has been proposed to be located on the right bank of the river near village Mohanpura. For Kundaliya dam, the plant is proposed to be located on left bank of river near village Kundaliya in Rajgarh district and the colony area is proposed near village Limoda in district Rajgarh. For pumping station, these sites can be located near Akheri village in district Jhalawar. Colony area is proposed near town Biaora, district Rajgarh for link canal between Patanpur to Mohanpura reach, near town Khilichipur, distt. Rajgarh for Mohanpura to Kundaliya reach, at Bhawani Mandi in Jhalawar district for Kundaliya to RPS reach and near Garot of Shajapur district for Kundaliya to Gandhisagar reach. The private land is proposed to be acquired to construct the above colonies. Detailed survey has not been carried out for Plant and Colony areas at this stage. The same has been proposed to be carried out at the time of the preparation of detailed project report of the scheme.

4.2.6 Survey of the canal alignment and canal structures

Strip survey of 400 m width (200 m on either side of centre line of link canal) along the link canal for the reach from Patanpur reservoir to Mohanpura reservoir/dam for length of 55.37 km and Mohanpura reservoir to Kundaliya reservoir /dam for initial length of 10 km and thereafter the strip survey has been extended to 1000 m width (500 m on either side of the centre line of the link canal) upto the destination reservoirs for the three alternatives described in earlier chapters.

The link alignment was first transferred on ground from toposheets with the help of chaining, compassing, ranging and theodolite. The link alignment survey has been carried out by double leveling survey along the link canal at 50 m interval and cross section survey was conducted at 400 m interval by taking levels at each 50 m interval with the help of single leveling. The survey data has been utilised for preparing the strip contour plan and longitudinal (L) section in the scale of 1:5000 H and 1:200 V and the contours has been drawn at 1 m to 5 m interval as per topographical condition. The grid survey of various CD/CM structures proposed along the link canal has been carried out upto 300 m to 500 m either side of the link canal. The survey of cross-sections of the drains at proposed structures has been done upto 150 m beyond firm bank by single levelling at 50 m interval. Similarly, the grid survey at the road/railway crossing has also been carried out. These surveys have been utilised for preparation of the contour plan of the drains, L-section of the drains and X-section of the rivers at proposed sites with 1 m to 5 m contour interval as per topographical condition.

4.2.7 Survey of Pumping Station sites

The pumping station is proposed to be installed in case of linking to Gandhisagar alternative (b)-I and alternative (b)-II. In alternative (b)-I, the three pumping stations

including sump well and 1.55 km pipeline are to be installed along the link canal and in case of alternative (b)-II, one pumping station, sump well and 3.2 km long pipeline has to be installed. Separate strip contour survey for these sites has not been carried out as these sites had already been covered in the surveyed strip of the link canal.

4.2.8 Tunnel survey

Five tunnels have been proposed along the link canal in case of linking to Rana Pratap Sagar (RPS) in alternative (a), four tunnels in case of linking to Gandhisagar in alternative (b)-II and three tunnels in case of linking to Gandhisagar in alternative (b)-I. The 1st tunnel of 6.6 km length has been proposed in the reach of Patanpur to Mohanpura dam. The 2nd & 3rd tunnels of 1.29 km & 3.10 km length respectively have been proposed between Mohanpura to Kundaliya reach. These 3 tunnels between above two reaches are a part of three alternatives described above. A tunnel of 3.60 km length proposed between the link from Kundaliya reservoir to Ahu barrage is falling under alternative (a) & alternative (b)-II only. Another tunnel of 5.96 km length is also proposed at the end of link canal in case of linking to RPS under alternative (a). Separate strip contour survey has not been conducted for the above tunnel areas as the strip contour survey carried out for the link canal covers the areas of proposed tunnels.

4.2.9 Command area survey

The proposed culturable command area enroute of the Parbati-Kalisindh-Chambal link project lies in the States of Madhya Pradesh and Rajasthan. Considering the large area and the time factor involved in the field surveys of the entire command, a sample command area survey of 1000 ha common to all the three alternatives has been carried out by NWDA. The block levelling survey was done on 50 m grid basis. The contour plan was prepared with an interval of 1.0 m.

4.3 Other Agencies works

4.3.1 Geological Investigations

In order to ascertain feasibility of the project, this investigation work had been awarded to the Geological Survey of India (GSI). The GSI has completed the geological investigation work of the project but the final report from GSI has not been received. However, the extract taken from the progress report submitted by GSI is briefed in the following paragraphs:

There are a number of important structures such as dam, barrage, aqueducts, tunnel etc in the proposed Parbati-Kalisindh-Chambal link project. In order to know the characteristics of the foundation strata of these important structures it is essential to carry out geological and foundation investigations. The Senior Geologist, Engineering Geology Division, GSI, Bhopal has inspected the important sites and completed the geological investigation works of the three dam sites namely Patanpur, Mohanpura and Kundaliya, two barrages across Kanthali and Ahu river, thirteen aqueducts sites and five tunnels.

The link scheme is located mainly in parts of the Malwa plateau of western M.P., which is characterized by a typical Trappean topography comprising extensive plains, low lying flat topped hills and isolated hills exhibiting mesa, bute, cuesta and various other land forms. The rivers mostly flow from South to North with dendritic to sub – dendritic pattern. The drainage density in the area is low to moderate. Vegetation is scanty.

The Kundaliya to Gandhisagar link canal area is occupied by rock masses of two chronologically different geological domains of which the lower most comprises sub-horizontal sedimentary sequences of the Vindhyan Super group unconformably overlain by thick cover of basaltic lava flows and associated intertrappeans of the Deccan trap complex. Alluvium/soil cover corresponding to the quaternary to recent period is mostly confined to the river banks and plains. Soil profile in the area ranges in thickness from 0.5 m to 6 m.

Geological/Geotechnical studies comprising geological traverses and large-scale geological mapping in and around component axis show presence of basaltic lava flows of the Deccan Trap complex. Fresh to slightly weathered, hard, massive basalt representing middle part of a flow unit is exposed at Patanpur, Mohanpura and Kundaliya dams and two barrage sites. Two prominent open, conjugate sets of sub vertical to vertical joints in addition to closed spaced column joints (cooling joints) render the rock mass blocky at the dams/barrage sites.

Regional geological information has revealed that the basaltic lava flows exposed in Kundaliya-Rana Pratap Sagar (RPS) alignment or Kundaliya-Gandhisagar alignment belong to the Mandleshwar, Kalisindh and Kankariya Pirukheri formations in an ascending order of the Malwa group of Deccan Trap complex which unconformably overlies the Suket shale formation (Khorip group) and Chittorgarh Fort, sand stone formation (Kaimur group) of the Vindhyan super group in the canal alignment area. The sets of the joints are given below:

i. N 45^0 E – S 45^0W / dipping at 70^0-90^0 towards SE or NW spacing 0.3-1.50 m and persistence upto 10-15 m.
ii. N 15^0 – 20’ E – S 15^0 –20' W/ dipping at 65 – 90^0 towards ESE or WNW, spacing 0.5 m – 1 m and persistence upto 10 – 15 m.
iii. N 50^0 W – S 50^0 E / 70 – 90^0 towards NE or SW spacing 0.2 m – 1.0 m and persistence upto 10 m
iv. NNW – SSE/ vertical, spacing 0.5 – 1.5 m and persistence 5 – 15 m.

Joints are mostly open with opening of usually 0.5 cm to 5 cm and sometimes even to 10 cm. The joint planes are rough, straight to irregular, stained and oplex clay infilled. The columns of the cooling joints are also variable in size and shape.

In addition to above, the drilling of three bore holes one in river bed and one each on either bank of river of the three dams and Ahu barrage sites, three bore holes for tunnel no. 1, two bore holes for tunnel no. 2 to 4, one bore hole for tunnel no. 5 & at deep cutting and two bore holes for each three aqueduct sites have been done by Central Water Commission. The purpose of this drilling was to confirm the bed / rock profile and sub-surface geological characteristics of structures and media of tunnels. The tunnelling media at designed CBL/FSL is required to be known essentially in

order to evaluate the percentage of different rock mass categories, weak geological features therein and also to evolve adequate support system.

4.3.2 Geotechnical investigation and borrow area surveys

The basic purpose of geotechnical investigation was to find out type of rock in the area, major joints, shear zone, faults, fracture zone and also to know some of the properties of rock through laboratory testing.

The dams proposed in the P-K-C link project are having composite sections viz. part of dam is concrete and remaining part earthen. For the earthen portion of the dam, deep cut reaches and along the link canal, the trial pits of varying depths were excavated by NWDA in association with CSMRS under borrow area survey to determine the depth of clay, soil etc. Samples taken from these trial pits have been sent to CSMRS, New Delhi to know the properties of the soil. To know the sub-surface geology in respect of concrete portion of dams, barrages, aqueducts and tunnel sites, drilling was carried out as per the suggestion of GSI. Drilling at 28 Nos. of drill holes at varied depths had been carried out by CWC in co-ordination with CSMRS. The samples collected from each drill hole have been logged by GSI and sent to CSMRS, New Delhi for conducting various laboratory tests.

4.3.3 Hydrological and Meteorological Investigation

There are a number of gauge and discharge (G&D) measurement sites across the rivers, maintained by CWC and Govt. of M.P., within the sub-basins of P.K.C. link project. Similarly, there are also a number of rain gauge stations in and around these sub-basins. These rain gauge stations are maintained by either IMD or the State Government. River flow and rainfall data of selected sites were collected for a number of years and use of these data was made. However, river flow data of following three sites were used for developing unit Hydrographs for the sites and estimation of design flood at various dam sites on proportionate catchment area basis.

i. Agra-Bombay (A-B) road crossing G&D site on Parbati River
ii. Aklera G&D site on Newaj River
iii. Sarangpur G&D site on Kalisindh River

However, NWDA has not established any G&D site upstream/downstream of the dam sites.

4.3.4 Construction Materials Investigation

In order to ascertain suitability of the material to use it in concrete, Central Soil & Materials Research Station, New Delhi was assigned to carry out the tests and recommendations thereon.

Investigation for the availability of the soil, rock, coarse aggregate, fine aggregate etc were done on the basis of the location map for construction materials prepared by NWDA and panchayat authority. Brief on the construction materials survey obtained from the report prepared by CSMRS for this investigation work is as follows:

4.3.4.1 Soil

For earthen dam portion and canal embankments, a number of borrow area have been identified on u/s side of dam axis and along the canal alignment during the investigation. Sixty nos. of soil samples were collected from the pits located in different borrow area with the help of augur and taken to the CSMRS laboratory at New Delhi for testing.

Soil from canal excavation is proposed for formation of embankments. Where the earth from excavation is found to be inadequate, it is proposed to borrow the depth from the nearby fields. Based on broad soil classification in command area in the vicinity of the link canal and bore hole data along the link alignment, the soil could be classified as alluvium in nature (i) black clayey soil (ii) ordinary gravel (iii) sandy silty loam (iv) yellowish brown colour which are considered to be suitable for construction of embankment in part filling and cutting reaches. Soil profile in the area varies in thickness from 0.30 m to 6.0 m

4.3.4.2 Sand / fine aggregate

In order to ascertain suitability of the material as fine aggregate in concrete, CSMRS was assigned to carry out the construction material survey after collecting the samples from the available quarry sites. Coarse as well as fine sand including gravel confirming to required specifications are available in sufficient quantities in near by rivers/streams along the canal alignment within economical leads.

4.3.4.3 Coarse aggregate

Stone for masonry and the coarse aggregate for concrete required for construction of structures are available from the proposed quarries in the river of each dam site and aqueduct site within economical leads as shown in the quarry map. Crushers can be installed near the dam sites to make coarse aggregates. Trial pits in these areas were made and rock samples were collected from these pits by CSMRS and taken to their laboratory for testing.

4.4 Socio-economic and environmental survey

As the project construction is likely to make significant environmental and economic impact in the region, it was felt necessary to carry out a detailed study to assess the likely effects on various aspects such as socio-economic and environment. Due to constraint of time, this investigation work could not be taken up at feasibility stage of the project and is proposed to be taken at the time of preparation of detailed project report.

4.5 Archaeological survey

As the alignment of canal does not affect any place of archaeological importance, hence no archaeological surveys are contemplated.

4.6 Mineral survey

There are no mineral deposits that get affected either in the canal excavation or in the command area.

4.7 Communication surveys

The command area under the link canal is well served by a network of existing roads viz. National highway, state Highway, district and village roads etc connecting almost all the villages. The National Highway No.3 and 12, western railway line connecting Maksi to Guna and Bombay to New Delhi run through the command area. There are also sufficient number of power transmission and telephone links and some more are being laid as a part of development.