(Field Survey: May 2007)

Ex-Post Monitoring of Completed ODA Loan Projects

Evaluator: Hajime Sonoda (Global Group 21 Japan)

Project Name: India - Teesta Canal Hydroelectric Project (I), (II) (L/A No. ID-P40, ID-P72)

Loan Outline

Loan Amount/Disbursement Amount	:	8,025 million yen/7,882 million yen (Phase 1), 6,222 million yen/6,121 million yen (Phase 2)
Loan Agreement	:	December 1986 (Phase 1), January 1991 (Phase 2)
Loan Completion	:	March 2000 (Phases 1 and 2)
Ex-Post Evaluation	:	FY 2002
Executing Agency	:	West Bengal State Electricity Distribution Co. Ltd. (WBSEDCL) (Split off from the initial executing agency, West Bengal State Electricity Board (WBSEB), on April 1, 2007)

Project Objective

The project built 67.5MW hydroelectric power stations which use the falls of the Mahananda Main Canal in West Bengal State, with the aim of stabilizing power supply in five northern districts of West Bengal State, and thereby contributing to the advancement of regional development.

Consultants: None

Contractors: Sumitomo Corporation (Japan), Telk Engineering (India), M/S Andrew Yule & Co. Ltd. (India), others

Overview of Results

Item	At time of Ex-post evaluation	At time of Ex-post monitoring
Effective-ness and Impact		Water discharge was restricted to avoid the risk of collapse of canal revetments (protective walls on the canal banks) and levee breaches, and water discharges were halted in the dry seasons since FY2003 for rehabilitation construction. This has led to water discharge shortages, and power generation has been one third of the plan over the past four years. Power generation is expected to recover after rehabilitation work is completed in 2008.
Effective-ness	(1) Performance of the project facility Hydroelectric power stations were built at three locations in West Bengal State. Three generating units (7.5MW each) were installed in each power station (total 67.5MW). They were commissioned to the executing agency consecutively from October 1997 to October 1999, and formal commercial operation began at all three power stations in November 1999. These power stations were built on the Mahananda Main Canal (MMC), and use water taken into the MMC via the Mahananda Barrage from the Teesta River and the Teesta-Mahananda Link Canal to generate power. The table below shows the performance of the project facilities by fiscal year. 310m^3/sec. to 330m^3/sec. of water flow is required for full operation, but actual water flow of the MMC is far below this level.[1] <Table 1: Performance Indicator of the Project	(1) Performance of the project facility Since FY2001, water discharge of the Mahananda Main Canal (MMC) has been only about one third of the maximum planned 330 m^3/sec., and water discharge has been halted due to canal rehabilitation for an average of nearly six months per year during the four years FY2003-FY2006. Thus, power generation has been under one third of the amount planned at the time of appraisal. Especially in 2006, water discharge was halted for a long period for MMC rehabilitation, so power generation in FY2006 was only 11% of the plan. About 150m^3/sec. of water discharge was planned for the rainy season (July to October) in FY2007, but rehabilitation construction work will also continue until September 2008, so power generation is expected be only about 100GWh. After construction ends, if large problems do not arise on the rehabilitated canal, it will be possible to increase water discharge in the rainy season to 200-220m^3/sec., and power generation is forecast to recover.

[1]The following "reasons for water shortages" were confirmed at the time of ex-post evaluation: (1) Decreased water flow function of the MMC accompanying its deterioration, (2) Lack of discharge capacity of canals and rivers on the downstream section of the MMC, (3) Accumulation of silt on the canal bed and in the power station intake area, (4) Blockages of the power station intake gate due to large volumes of floating/submerged trash, etc. (*Details and improvement measures are explained in the Sustainability column below)

Facilities by Fiscal Year (1)>

		Original Target Level**	1997-1998	1998-1999	1999-2000	2000-2001
Gross Energy Production (GWh)	PS-1	109.9	1.17	5.03	17.34	34.85
	PS-2	107.3	-	1.86	19.78	37.93
	PS-3	102.7	-	-	11.58	44.85
	Total	319.9	1.17	6.89	48.71	117.64
Peak Load (MW)	PS-1	22.5	7.7	11.0	13.2	13.4
	PS-2	22.5	-	7.5	7.6	10.8
	PS-3	22.5	-	-	11.8	13.6
Plant Load Factor (%)	PS-1	55.8	1.74	4.76	16.08	32.16
	PS-2	54.4	-	1.74	18.58	35.89
	PS-3	52.1	-	-	11.38	45.19
Water Flow in the MMC at PS-1 (m^3/s)	Avg*	194.3	45	85	95	110
	Max	332.0	50	110	120	145
	Min*	56.6	40	60	70	80

Source: WBSEB

<Table 3: Performance Indicator of the Project Facilities by Fiscal Year (2)>

		01/02	02/03	03/04	04/05	05/06	06/07
Gross Energy Production (GWh)	PS-1	52.8	50.0	28.1	32.8	31.4	9.5
	PS-2	54.2	57.7	32.4	37.8	36.7	12.9
	PS-3	62.1	56.5	32.5	36.6	33.2	12.1
	Total	169.1	164.1	93.0	107.2	101.3	34.5
Peak Load (MW)	PS-1	12.0	9.7	9.5	11.4	8.5	8.4
	PS-2	13.8	12.0	10.7	13.1	10.0	10.3
	PS-3	13.6	10.5	10.6	12.4	9.4	10.4
Plant Load Factor (%)	PS-1	48.05	45.46	25.54	29.85	28.59	8.68
	PS-2	50.49	53.75	30.23	35.20	34.16	11.98
	PS-3	60.54	53.02	31.71	35.65	32.34	11.74
Average water discharge* (m^3/sec.)		140	110	110	130	90	90
Annual period discharge halted		1 mo.	1 mo.	5 mo.	3 mo.	5 1/2 mo.	9 mo.

Source: WBSEDCL

* Average water discharge is the average annual water discharge in the MMC water intake barrage, excluding periods when water discharge is halted.

The power stations of this project solely rely on water discharge of the MMC, but water discharge is determined by the Irrigation and Waterways Department, which is implementing the Teesta Barrage Project. Although this department receives requests from the power stations to increase water discharge, it has restricted water discharge for the following reasons. (A detailed explanation of the current situation and future outlook is given in the section on Sustainability)

(i) Collapse of MMC revetments: Water flow is restricted due to fears of revetment damage and collapse.
(ii) Rehabilitation construction on MMC: Water discharge is halted for long periods for fundamental rehabilitation construction.
(iii) Insufficient discharged capacity in the lower reaches: Lack of capacity downstream due to incomplete irrigation canals.

		Furthermore, to manually remove floating/submerged matter (including household garbage) from the water intake of the power station conducting canal, water inflows to the power stations are reduced every few hours, and when there is a lot of floating/submerged matter, power generation must be halted to remove such matter. There is a lot of floating/submerged matter in the rainy season. During this season, about 30% of power generation is lost at Power Station No.1, which is the first to receive water. Similar but lesser problems also occur at Power Stations No. 2 and No. 3. This was not foreseen at the time of this project's planning. It is thought that the population in the canal's surroundings has increased, leading to increased garbage being thrown in the canal. To prevent losses, WBSEDCL is investigating introduction of equipment to efficiently remove garbage, and plans to contract a consultant for installation of suitable equipment to perform a detailed investigation.
Impact	(1) Social and economic impacts (northern regions of state) (i) Contribution to improvement of the power supply/demand balance Power shortages in northern regions of the state were very severe until the time the project was finished. Thus, industries which strongly rely on electricity and general households are troubled by repeated load sheddings and unplanned power blackouts. In the future, power stations built by this project are expected to contribute to improvements in the power situation of the northern regions.	(1) Social and economic impacts (i) Contribution to improvement of the power supply/demand balance West Bengal State had nearly a 10% power shortage in the early 1990s. Power shortages exceeded 20% during peak hours, with several daily power totaling up to 10 hours in the state capital Kolkata. Since FY1998, power demand has shown rapid 9% annual growth, but power shortages have been relieved by increasing power generation capacity and facility utilization rates, and by decreasing electrical transmission and distribution losses, etc. (Table 4). There is still a small shortage of supply during peak hours, and load sheddings are also required, but blackouts in Kolkata city are at most once or twice per week, at most about 30 minutes each time. Also, as a result of progress in improvements of the electricity transmission network, the power situation in the north of the state has greatly improved, and differences with the southern areas of the state (including Kolkata) have almost

been eliminated.

<Table 4: Power Supply/Demand Trends in West Bengal State>

	98/99	01/02	02/03	03/04	04/05	05/06
Power demand (GWh)	16,319	20,670	20,551	22,091	23,115	24,936
Power supply (GWh)	16,778	20,575	20,249	21,608	22,789	24,509
Shortage (%)	-2.80	0.50	1.50	2.20	1.60	1.70
Power demand in peak hours (MW)	2,981	3,614	3,752	3,836	4,117	4,743
Power supply in peak hours (MW)	2,808	3,414	3,418	3,652	3,965	4,599
Shortage (%)	5.8	5.5	8.9	4.8	3.7	3.0

Source: Power Sector Profile, Eastern Region 2006, Ministry of Power, Gov. of India

The greatest amount of annual power generated by this project up until now was 169GWh in FY2001. This was only 0.8% of power demand in West Bengal State that year. Thus this project made a slight contribution to improvement of the power supply/demand balance.

However, power demand in West Bengal State is forecast to grow by 7.1% per year over the next 10 years, with peak demand growing 5.2% per year. Continual expansion of power generation capacity is required to maintain stable power supply. Thus there are expectations that the amount of power generated by this project's power stations will recover, thereby making a certain contribution to the state's supply of stable power.

Furthermore, this project is connected to the national grid, so power from these power stations can also be delivered beyond the state's northern areas to the entire state, and even other adjoining states. Therefore, there is no need to limit to the northern state the contributions of this project to improvements in the power supply/demand balance.

	(ii) Contribution to promoting the rural electrification The average rural electrification ratio in West Bengal State was 77.3% as of the end of March 2000, lower than the national average of 86.3% on the same period. With a view to promoting rural electrification within the state, the West Bengal Rural Energy Development Corporation Limited (WBREDC) was set up in November 1999 as part of the power sector's restructuring efforts in the state. By the end of 31st March 2002, the company aims to achieve an 85% rural electrification ratio. (2) Environmental impact There are no reports of negative impacts on the environment by the power stations. (environmental monitoring system is not installed)	(ii) Contribution to promoting the rural electrification In West Bengal State, the village electrification ratio rose from 79% at the end of FY2000, to 91% at the end of FY2006. Electrification of all villages is planned to be completed in FY2008 (the national village electrification ratio was 80% in December 2005). At the end of FY2006, the state's rural household electrification ratio was 32%. Also, per capita power consumption was 414kWh in FY2004, about 2/3 of the national average. Village electrification ratio (end FY2006) W. Bengal State 90.7% Northern W. Bengal 90.8% Rural household electrification ratio (end FY2006) W. Bengal State 32.1% Northern W. Bengal 23.9% As described above, this project supplies less than 1% of power demand in West Bengal State, so it contributes very little to rural electrification when viewed from the aspect of the amount of power. On the other hand, transformer facilities (33kV) are installed at each of the three power stations of this project, and power generated by these power stations and national grid power is delivered to the surrounding villages directly or via other transformer facilities (currently five locations, which can be increased as necessary). In this way, even when this project is not generating electricity, it is functioning as transformer facilities, and supports part of the electrification of surrounding villages. (2) Environmental impact No undesired impacts on the environment were seen. In contrast, removal of floating/submerged garbage from the canal during power generation is thought to contribute to conservation of the downstream environment. Environmental monitoring is not being done.

Sustain-ability		There is proper maintenance of the power stations, and there are no problems with the technical aspect, organizational structure, or financial aspects of West Bengal State Electricity Distribution Co. Ltd., which performs operations and maintenance. In particular, its financial situation has dramatically improved since the time of the ex-post evaluation. After the end of canal rehabilitation in fall next year, it is expected that about 2/3 of planned water discharge can be obtained in the rainy season, but it is unclear how much water discharge can be secured in the dry season.
	(1) Technical aspect: In each power station, there is an organization of four operation groups formed from five people each (one assistant engineer, two operators, two assistants) which works in three shifts to operated each facility. A support organization is also established with 9 to 10 employees of subcontractors, under the direction of the maintenance engineer. There are no special problems with technical levels.	(1) Technical aspect: Each power station is operated by three shifts of four person groups (one junior engineer, one operator, two assistants). Compared to at the time of the ex-post evaluation, one person was eliminated, but the maintenance staff organization is almost the same as at the time of the ex-post evaluation. No problems were seen in technical levels. In FY2002, the Supervisory Control and Data Acquisition System (SCADA) was introduced in Power Station No.1, with the aim of more efficient power station operation. SCADA uses a PC console to enable monitoring in real time of the operating situation of the power generation, transmission, and all power generation operations can be handled at the PC. In FY2006, SCADA was also introduced into Power Stations No. 2 and No. 3, and incorporated into the same system. Power generation has halted due to canal rehabilitation, so trial operations have not yet been carried out, but this is expected to enable more efficient operations.
	(2) Organizational structure: Operation and maintenance of the power stations is performed by the West Bengal State Electricity Board	(2) Organizational structure: As part of power sector reform aiming at sustainable improvements in commercial efficiency and service, in April 2007 the West Bengal

	(WBSEB).	State Electricity Board (WBSEB) was split into West Bengal State Electricity Distribution Co. Ltd. (WBSEDCL) and West Bengal State Electricity Transmission Co. Ltd. (WBSETCL). WBSEDCL has the former hydroelectric power business of WBSEB, and performs operation and maintenance. (In 1998, the state government drafted a power sector reform plan, and in 2001 it concluded a memorandum with the central government and formulated an action plan, and is moving forward with reforms such as splitting the WBSEB organization, rationalizing rates, securing transparency of the rate structure, and reducing losses from electrical transmission and distribution, while receiving financial assistance from the central government)
	(3) Financial status: The West Bengal State Electricity Board is expected to achieve at least a 3% rate of return, and WBSEB was achieving this rate of return up until FY1997-98, thanks to relief measures such as subsidies from the state government. But since FY1998, ordinary income suddenly worsened, and even with subsidies from the state government, its rate of return became negative (-102%). Also, electricity rates were raised under the guidance of the West Bengal Electricity Regulatory Commission, which played a role in improving the financial situation, but its rate of return was still negative in FY1999-2000, and one can say that there are great concerns about its financial situation. (*Clear causes and reasons for the worsened financial situation were not noted in the ex-post evaluation report)	(3) Financial status: According to a survey by the Ministry of Power "State Power Sector Performance Ratings" (June 2006), the efforts noted at the time of the ex-post evaluation bore fruit, and WBSEB's finances improved due to power sales to other states, reduced electricity transmission and distribution losses, higher rate of recovery for power charges, etc., in addition to large results from reform of the electricity distribution division. Since FY2001, subsidies from the state government also became unnecessary. In FY2003, operating income became positive, and in FY2005, its commercial profit (operating income – depreciation – interest payments) reached 810 million rupees for the first time in its 51-year history (the negative profit after tax that fiscal year shown in the table below resulted from its recording 3.36 billion rupees out of its accumulated losses as expenditures that fiscal year). Further, by splitting the company into WBSEDCL and WBSETCL, accounting is also split up, beginning in FY2007, and there are discussions on whether the state government will at this time cancel part of the debt owed by it to the former WBSEB.

<Table 2: WBSEB Profit & Loss (1)> (unit: million rupees)

	1995-96	1996-97	1997-98	1998-99	1999-00
A. Revenues	13,737	14,829	18,851	18,925	23,381
Revenue from Sales of Power	13,579	14,552	18,416	18,625	21,334
Other revenue	158	277	436	300	2,047
B. Expenditures	14,382	17,102	20,493	27,967	33,669
Purchase of Power	9,022	10,335	13,991	17,164	17,474
Cost of Sales	4,738	6,162	6,935	8,047	9,033
Net Prior Periods Credit	-1,483	-1,538	-3,073	-212	3,971
Depreciation & Interest	2,010	3,624	4,202	5,253	5,931
Less: Expense Capitalized	0	-1,561	-1,640	-2,350	-2,835
Others	96	25	78	65	95
Net Income After Tax	-645	-2,273	-1,642	-9,042	-10,288
Subsidy & Grants	817	2,455	1,843	1,864	4,440
Surplus/(Deficit)	172	183	201	-7,178	-5,848

Source: WBSEB

Reform measures including the following are being undertaken in order to improve the financial situation of WESEB: (1) Energy audit on receivables, which is undertaken to identify and reduce transmission and distribution losses in order to attain a level of 20% for FY2004-05, (2) Organizational system on regional lines of the electricity distribution division of WESEB in order to produce profits, (3) Boosting of revenue collection management to reduce receivables

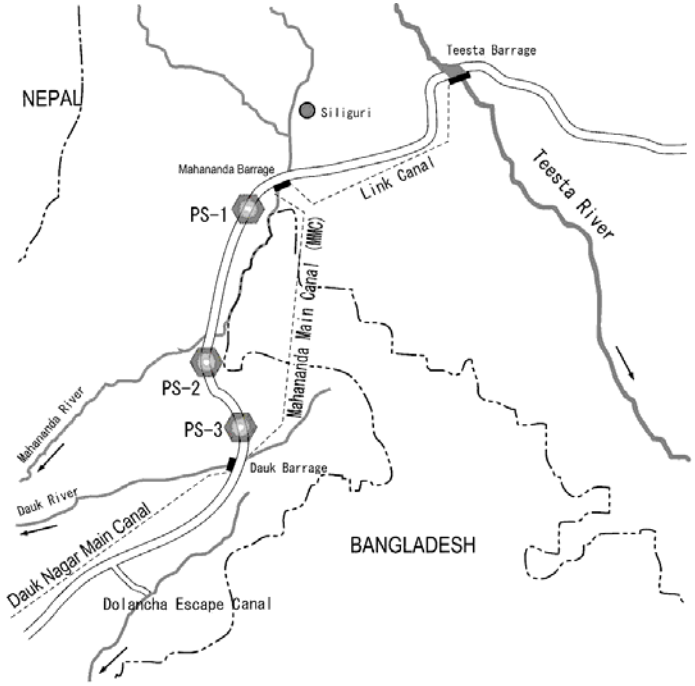
<Table 5: WBSEB Profit & Loss (2)> (unit: million rupees)

	00/01	01/02	02/03	03/04	04/05	05/06
Revenues (Power Sales + Other)	23,029	24,100	27,119	42,798	44,243	52,720
Power Purchases + Fuel Expense	19,755	23,586	23,641	33,340	32,509	38,785
Personnel Expense + Management Expense	4,244	4,060	4,186	4,276	6,698	7,540
Operating Income (EBDIT)	-2,521	-5,067	-2,321	3,000	5,036	6,395
Depreciation	1,864	1,808	1,974	2,435	3,005	3,522
Profit After Tax	-8,881	-17,129	-9,153	-3,050	-2,851	-2,568
Subsidies & Grants	2,154	2,391	0	0	0	0

Source: WBSEB Annual Report

	outstanding. (4) Maintenance situation of the project facilities Overhauls of the facilities are performed with the cooperation of a local company which supplied the equipment. A maintenance organization was built to carry out tasks including maintenance of facilities based on the frequency and methods specified in manuals distributed by the contractor. During the field survey of the ex-post evaluation, a mechanical problem arose in Unit 5 of Power Station No. 2, and its operation was halted for two months. It was confirmed that a similar problem arose during the commissioning test of Unit 6. (5) Operation and maintenance situation of irrigation canals Maintenance of irrigation canals has the following problems, and it is pointed out that they are preventing achievement of results from this project. (i) Deterioration of Mahananda Main Canal (MMC) Since water began flowing in this canal, many problems are arising, such as repeated collapse of concrete revetment walls. The Irrigation and Waterways Department takes urgent measures each time at the place that a problem occurs, but it is not resolving the fundamental problems.	(4) Maintenance situation of the project facilities The maintenance situation and maintenance organization are unchanged from the time of the ex-post evaluation, and no large problems were seen. The turbine governor problem at Power Station No. 2 which was reported at the time of the ex-post evaluation was resolved by exchanging parts. After that, there have been no serious failures in the generator facilities, with almost no halts in generation due to mechanical failure. Imported spare parts purchased through this project still remain, but new purchases of some types are required, so a list was made and quotes are being requested from suppliers. Further, WBSEDCL is doing proper maintenance including removing sedimentation from canals pertaining to the power stations which were built by this project (conducting canals, discharge canals, escape canals), and the facilities are in good condition.[i] (5) Operation and maintenance situation of irrigation canals <Water discharge to the MMC> The Teesta Barrage Project influences the success or failure of this hydroelectric project. The Barrage project began in FY1975 as a project of the state Irrigation and Waterways Department. The initial plan was to build the Teesta High Dam on the Teesta River, and also build the Teesta Barrage downstream, then provide irrigation via branch canals connecting to the Teesta Mahananda Link Canal (Teesta River left bank: west side), and to the Teesta Jaldhaka Main Canal (right bank: east side). Later, in order to utilize the water discharged into the Mahananda River which flows downstream, the Mahananda Barrage, Mahananda Main Canal (MMC), Dauk Barrage, Dauk Nagar Main Canal (DNMC), etc. were added to the plan, together with the conception of generation of power of canal electric generation (this

	(ii) Insufficient discharged capacity in the lower reaches of the Mahananda Main Canal (MMC) The power stations require 310-330m^3/sec. of water flow to operate at full capacity, but the Dauk River does not have more than a maximum discharge capacity of 205m^3/sec.. This has a serious impact on utilization of the power stations. (iii) Deposition of silt on the bed of the Mahananda Main Canal (MMC) 1.0-1.5m of silt has accumulated on the canal bed, which is reducing the canal's discharge capacity. As described in (ii) above, the canal's actual water flow is small, so silt carried there keeps accumulating, and not much flows downstream. (iv) Stack of floating/submerged trash at the intake gate The inflow of large volume of floating/submerged trash (mainly vegetation) washed into the Mahananda Main Canal (MMC) blocks the grate on the power station's water intake, promotes settlement and accumulation of silt, and obstructs water flow into the power station.	project) which uses the falls of the MMC. With completion of the MMC and its connecting branch canals and downstream irrigation facilities (Dauk Barrage, Dauk Nagar Main Canal, and branch canals connecting to them), this project generates power by using the potential energy available at Fall Structure in the MMC. The Teesta Irrigation Project is East India's largest irrigation project, with a final planned irrigation area reaching 920,000ha. But there have been long delays in its execution, and construction in progress covers only about 150,000ha. One can consider that at the time of appraisal of this project (1986), the Teesta Barrage and Teesta Mahananda Link Canal were already completed, but the Mahananda Barrage, MMC, and Dauk Barrage were under construction (water flowed later, in 1995), the DNMC was being planned or was under construction (it is still incomplete)[ii]. Moreover, the dam plan for the Teesta River was passed over in the early 1990s due to issues including inability to resolve the sedimentation problems. The direct causes of inability to obtain water discharge volume required for this project's power generation are: the fact that the construction of the Teesta Irrigation Project did not progress as planned, and the insufficient quality and maintenance of the canals which were built. Various issues were in the background of these problems, such as inadequate project planning and operation management, budget shortages, the area's remoteness, site acquisition problems, and various local problems.[iii] The specific reasons for restricting the volume of water discharge of the MMC and efforts on this issue by the Irrigation and Waterways Department are as follows. (i) Collapse of MMC revetments In the 5.5km from Mahananda Barrage to Power Station No.1 and for several kilometers further downstream, small concrete



panels and waterproof sheets are used as canal revetments, but almost all of these revetments have collapsed before reaching even half of the 30-year lives they were designed for. Also, 2km to 3km upstream from Power Station No. 2, levees breached in both 1999 and 2005. There is also deterioration of concrete panels, plant growth in joints, etc. in other canal sections, and if these other sections are left as is, places remain where it is feared that the problems will progress until these revetments also collapse.

If a large volume of water is discharged, damage and decay of levees will progress, with increasing danger of eventual breach. This is why the Irrigation and Waterways Department is careful regarding increases in water discharge volume, with discharge restricted to about one third of the MMC's 345m^3/sec. maximum designed discharge volume for almost all the time until today.

On many sections of the MMC until Power Station No. 2, in filling zones where the canal bed is higher than the surrounding elevation, levees are made of piled earth, which furthermore has a sandy composition, so there is a need for sufficiently strong levees and revetments. Based on the experiences described above, the Irrigation and Waterways Department is improving the width of levees and revetment structures in rehabilitation construction work currently being done. After rehabilitation construction work is finished, it is first necessary to confirm performance of the revetments, while slowly increasing water discharge volume over one to two months.

It is thought that the quality of construction work is also a problem due to various reasons such as construction management, competence of contractors, and improper construction materials. The insufficient maintenance budget is also a serious problem. Insufficient work is being done to remove plant growth from concrete panel joints (revetments will

		eventually be damaged if left as is), remove sedimentation from the canal bed, repair and replace deteriorated concrete panels, etc. An annual budget of about 10 million rupees is allocated to the Teesta Irrigation Project, which is less than one tenth of the required amount. Thus facilities are maintained by securing budgets each year under the categories of repairs, rehabilitation, etc. (ii) Rehabilitation construction work on MMC After the ex-post evaluation field survey in September 2001, based on a proposal from JBIC in December 2001, a conference was held under the Hon'ble Chief Minister, West Bengal with the Power Department Minister, Home Department Minister, Irrigation and Waterways Department Minister, and Teesta Irrigation Project Chief Engineer. It was confirmed that: (1) Regarding the necessity of rehabilitation of the MMC, WBSEB and Irrigation and Waterways Department would perform a joint inspection by January 2002, (2) The Irrigation and Waterways Department would accelerate discharge canal construction in order to secure discharge capacity (described below), (3) These measures aim to enable an initial discharge of $220m^3$/sec., with $330m^3$/sec. in the long term. Moreover, due to another proposal from JBIC, a similar conference was also held the following year in September 2002, under the West Bengal State Chief Secretary. It was then confirmed that the Irrigation and Waterways Department would accelerate construction and rehabilitation of drainage canals. As a result, rehabilitation work on levees has been carried out every year since 2003, with continued suspensions of water discharge for long periods.

		June-July 2003 — Rehabilitation construction work upstream from Power Station No.1 December 2003 – June 2004 — (same as above) December 2004 — (same as above) April-June 2005 — Rehabilitation work after levee breach February-July 2006 — Rehabilitation work between Power Stations No.1 & No. 2 November 2006-June 2007 (plan) — (same as above) November 2007-September 2008 (plan) — (same as above) These construction projects are not emergency measures. These are for fundamental rehabilitation work, and are originally required in 2020-2025 when the canal's age exceeds the 30 years of useful life it was designed for. Due to budget restrictions, restrictions on construction work (securing sites along the canal required for work), etc., the Irrigation and Waterways Department has no choice but to proceed with work on different canal sections in succession each year, and discharge from the MMC is halted each time. Rehabilitation construction work has been scheduled to avoid the rainy season, when large amounts of water flow in the rivers. Thus a certain amount of water discharge and power generation have been possible in the rainy season, but the water discharge stoppages, which stretch over several months, are resulting in great losses of power generation from this project. All rehabilitation work on the MMC is expected to be completed by September 2008. Rehabilitation is still required in some remaining locations of its downstream sections (Dauk Nagar Main Canal), and rehabilitation construction work may be done after FY2009. In that case however, it is thought that discharge into the MMC will not be completely stopped because a certain amount of water discharge into the Dauk River would

		be possible. (iii) Insufficient discharged capacity in the lower reaches Downstream water consumption for irrigation was originally included in the 330m^3/sec. maximum water discharge from the Mahananda Barrage which this project expected. Only 40% of branch canals which are to connect to MMC have been completed, and water is also not flowing in the incomplete Dauk Nagar Main Canal. Thus water discharged into the MMC is limited to about 30m^3/sec. for irrigation water consumption via the MMC, in addition to 180m^3/sec. of water which can be discharged via the Dauk River, for a total limit of about 210m^3/sec.. There are no forecasts for completion of the Dauk Nagar Main Canal, so in 2005 the Irrigation and Waterways Department completed a drainage canal which extends about 5km from the Dauk Nagar Main Canal's Dauk Barrage to the Doloncha River which is several kilometers downstream. This drainage canal can discharge 70m^3/sec.[iv], and its operation is planned to begin in FY2008, when rehabilitation construction work on the MMC finishes and a maximum water discharge of about 220m^3/sec. begins. This will enable a theoretical maximum discharge of 280m^3/sec.. However, the volume which can actually be discharged into the Dauk River is also influenced by the water volume of the Dauk River itself, and if poor conditions occur simultaneously, flooding will occur downstream. 70m^3/sec. of discharge previously created flooding downstream in the Dauk River. The Irrigation and Waterways Department gives this as a reason for being very careful regarding large increases in water discharged into the MMC.

		In this way, the Irrigation and Waterways Department has spent time working on the issues of rehabilitation of the MMC and securing outflow volume which were pointed out at the time of the ex-post evaluation. Due to results from these efforts, this department is considering discharging about 150m^3/sec. in the 2007 rainy season (July-October), and over 200m^3/sec. depending on the water volume enabled by using the Teesta Barrage after September 2008 when rehabilitation of the MMC is complete. On the other hand, WBSEDCL is expecting a maximum discharge of 220m^3/sec., based on the discussions of 2002. Completion of the Dauk Nagar Main Canal and the start of irrigation are conditions for the MMC to obtain a maximum discharge of 330m^3/sec. as initially planned. After 45km of the total 80km of this canal were built, construction was suspended for 20 years due to site acquisition problems and budget restrictions, but construction towards the 67.5km point was to be restarted this fiscal year as a national project[v]. However, there must be progress in land acquisition for new branch canal construction in order to begin irrigation use, so it is unclear when water will flow in this section and irrigation will begin.[vi] On the other hand, the following new facts and recognition regarding the possibility of restrictions on discharge were presented by the Construction Chief Engineers for the Teesta Barrage project.[vii] · The Teesta Mahananda Link Canal transports water from the Teesta Barrage to the MMC. This canal's capacity has been steadily lost due to sedimentation over many years. Sedimentation has never been removed from this canal, so according to engineers, current capacity has decreased to about 180m^3/sec., less than half of its designed capacity. However, from visual inspections in the field, these figures are rather hard to believe at first glance, so more objective verification is required.

		· Flow volume of the Teesta River has decreased, so there is a possibility that flow volume will be restricted, except for in the rainy season. However, reliability of the data shown by the Irrigation and Waterways Department is unclear, and further verification is required based on data of the Central Water Commission, etc. · By restarting irrigation development on the Teesta River's left bank which was suspended due to not obtaining environmental clearance, a maximum of about 70m^3/sec. of irrigation water will be required after two to three years. It is possible that discharge into the MMC will be reduced by this amount. · The Teesta River flows downstream into Bangladesh, and until now there has been no clear agreement with Bangladesh regarding water rights, but Bangladesh built a new barrage downstream from the Teesta Barrage, and discussions on water use rights have reopened. Depending on results of those discussions, there is a possibility that total water volume which can be taken from the Teesta Barrage will be restricted in the dry season. Considering the above items, if the rehabilitation construction work currently being done is completed as planned, one can at least expect that about 200-220m^3/sec. can be secured in the MMC during the four months of the rainy season. However, the Irrigation and Waterways Department is taking the position that discharge volume through the year depends on the amount of flow that can be used at the Teesta Barrage, and cannot necessarily provide guarantee for much exceeding discharge volume required for irrigation. Also, there are many undefined factors at the current time, so one cannot have too strong expectations that the volume of discharge into the MMC will be increased further in the future.

		<Silt accumulation on the MMC bed> The Irrigation and Waterways Department does not do silt removal work frequently, so accumulation of silt on the MMC bed is progressing further. For now, there are no plans to carry out silt removal work. This silt also accumulates in the approach canals of the power stations, but power stations continually use a method of emergency efforts by workers who use hoses which shoot in compressed air to create movement within the approach canal, thereby minimizing the accumulation. The power stations expect that this problem will be resolved if the discharge volume of the MMC increases, and are not particularly considering long term measures. Moreover, silt accumulation has not reached the point where it greatly reduces the MMC's capacity, and it passes through the turbines without problems as it is extremely fine sand, so it has not been an obstacle for generation up until now. <Stack of floating/submerged trash at the intake gate> Even large volumes of floating/submerged matter are not an obstacle for irrigation, so the Irrigation and Waterways Department is not taking particular countermeasures against floating/submerged matter. However, as mentioned above, work to remove floating/submerged matter reduces power generation by about 30% in the rainy season, and more efficient removal methods are being investigated at WBSEDCL.

Lessons Learned, Recommenda-tions, Information Resources and Monitoring Methods (1) Follow up on lessons learned and recommenda-tions made in ex-post evaluation report or in later evaluations (2) Proposals for securing sustainability and instructions given at time of follow-up monitoring	(1) Lesson learned In hydroelectric power projects which use a canal, if the institution which implements maintenance of the canal is not the project's executing agency, it is possible that the canal's maintenance institution will also have a large impact on the project's sustainability. Thus for similar projects, at the time of planning, it is necessary to sufficiently investigate the overall framework of maintenance. (2) Recommendations (i) This project has not achieved its expected results due to various problems. Measures to resolve problems were proposed, but approvals for actual implementation were not confirmed in the ex-post evaluation field survey. Urgent implementation of these countermeasures is desirable.	(Lesson learned) At the time of appraisal, in addition to the ODA loan project, similar attention must also be paid to other projects which become conditions for determining the success or failure of the ODA loan project. (Recommendations) The West Bengal State government works to secure an appropriate maintenance budget for the Irrigation and Waterways Department to move forward with rehabilitation of the canal. WBSEDCL improves its floating/submerged matter removal methods. The India government and West Bengal State government monitor discharge volume, and take initiatives to resolve problems as necessary. (1) Lesson learned ・ If there are other projects which become conditions for determining the success or failure of the ODA loan project, especially if they are at the planning and implementation stage, attention must also be paid to these other projects in the appraisal, similar to the ODA loan project. Expertise to examine the other projects must be included in such an appraisal mission. (2) Recommendations ・ The West Bengal State government works for the Irrigation and Waterways Department to move forward with rehabilitation construction work as planned, while taking care regarding work quality. The government also works to secure an appropriate maintenance budget. WBSEDCL researches efficient removal of floating/submerged matter, and implement when found to be appropriate.

	(ii) With the exception of rehabilitation of the MMC, WBSEB should be responsible for securing funds and implementing countermeasures. Regarding rehabilitation, it is desirable that the Irrigation and Waterways Department bears its sole responsibility for implementation.	· The India government and West Bengal State government monitor progress of the canal rehabilitation and discharge volumes thereafter. If at least 200m^3/sec. of discharge cannot be secured in the rainy season, or if annual power generation does not exceed the maximum achieved in the past (about 170GWh), understand the reasons, and take appropriate initiatives to resolve problems via discussions between the WBSEDCL and the Irrigation and Waterways Department.

[i] At the time of the ex-post evaluation, the Irrigation and Waterways Department was to construct the escape canal of Power Station No. 2, but as a result of technical investigations, a conclusion was reached that this construction is not necessary, as there are multiple irrigation drainage canals downstream from Power Station No.2 and there is sufficient drainage capacity, so its construction was halted.

[ii] According to interviews with Irrigation and Waterways Department staff. Documents have not been stored from the time of the appraisal, so we were unable to confirm details of the progress, planning, etc. for irrigation projects at that time.

[iii] According to interviews with Irrigation and Waterways Department staff, major reasons that the Teesta Irrigation Project did not move forward were: (1) Due to a worsening relationship between the central government and West Bengal Stage government, the budget could not be obtained from the central government for a period of time, (2) Due to the remoteness of the area, the Chief Engineer did not want to live on site, and stayed in Kolkata (currently, the Construction Chief Engineer is not same person as the Chief Engineer, and lives on site).

[iv] However, it is has not been completed because some portions such as the gate's seals will be completed before start of operation.

[v] Regarding the plan for downstream beyond the 67.5km point, arrangements have not been made for moving to implementation.

[vi] In recent years, there have been increasing social problems surrounding site acquisition for industrial estates in West Bengal State, so residents increasingly do not want to sell land to the government, and there are strong fears that site acquisition for this project will also be a difficult process.

[vii] With a limited budget, it is not easy to constantly maintain in good condition large-scale and complex water use facilities. One can also understand that it is influenced by the external conditions of river flow volume and water use rights. However, in this survey, some engineers of the Irrigation and Waterways Department have the understanding that the main objective of discharge into the MMC is for irrigation. The Irrigation and Waterways Department has the actual authority to determine discharge volume, and some people are not necessarily focused on water discharge which exceeds the amounts for irrigation use, for the purpose of power generation. On the other hand, as the current goal of 220m^3/sec has not been achieved after such a long time, WBSEDCL authorities are increasingly discontented with the long-term halts to power generation that are made unavoidable, and have deeply seated mistrust of the Irrigation and Waterways Department. The Irrigation and Waterways Department's engineer in charge of the MMC frequently receives requests from the power stations for increased water discharge volume, but feels that the power stations do not sufficiently understand the current situation of the Teesta Barrage Project and the various conditions which restrict water discharge, and make unrealistically difficult and excessive requests.