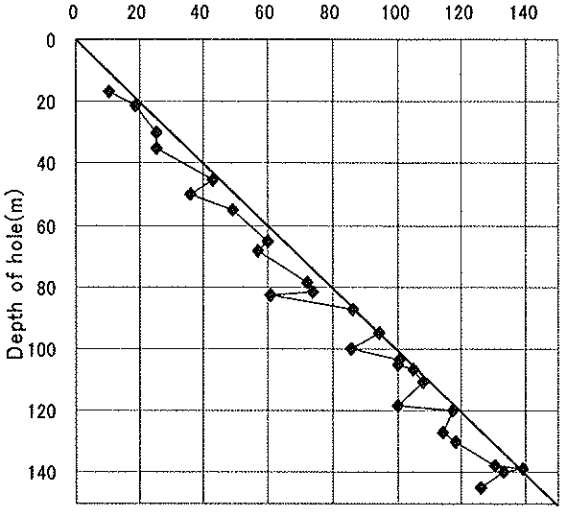
Water Level In The Hole During Drilling

B-1, B-2, B-4, B-8, B-9, B-12, BP-1, BH-1, BH-2, BH-3, BH-4, BH-5, BH-6

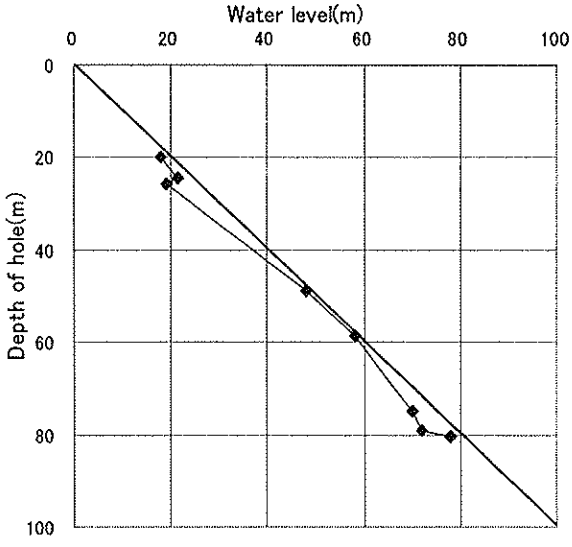
Water Level in the Hole during Drilling

(B-1, B-2, B-4, B-8)

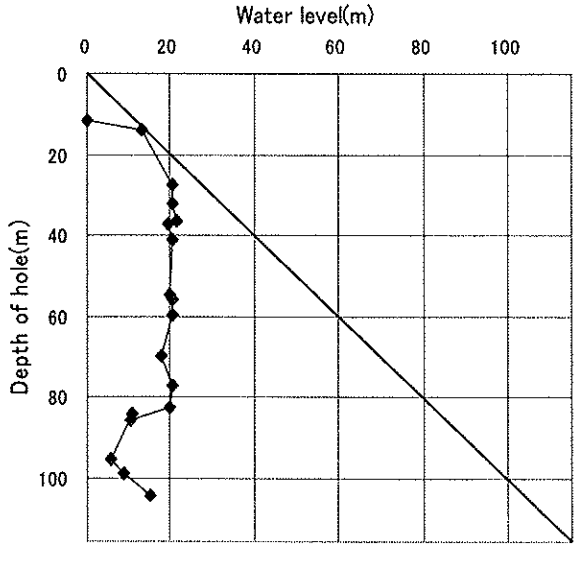
Water level during drilling B-1



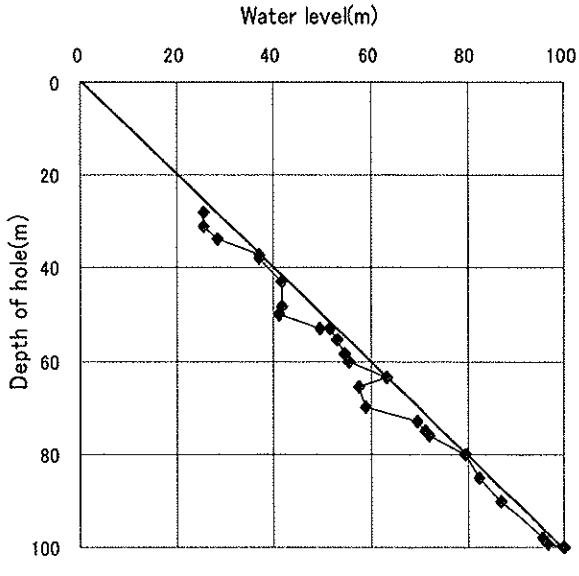
Water level during drilling B-2



Water level during drilling B-4

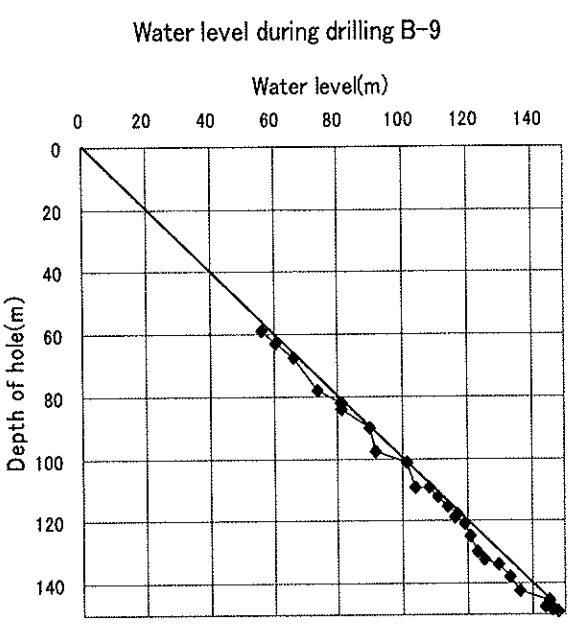


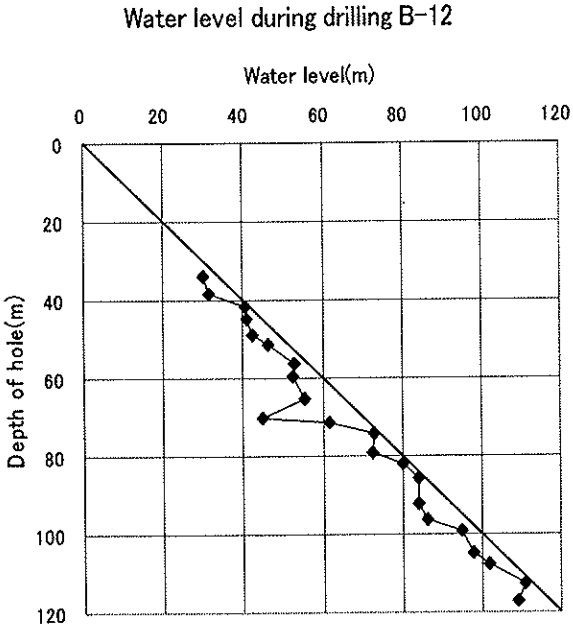
Water level during drilling B-8

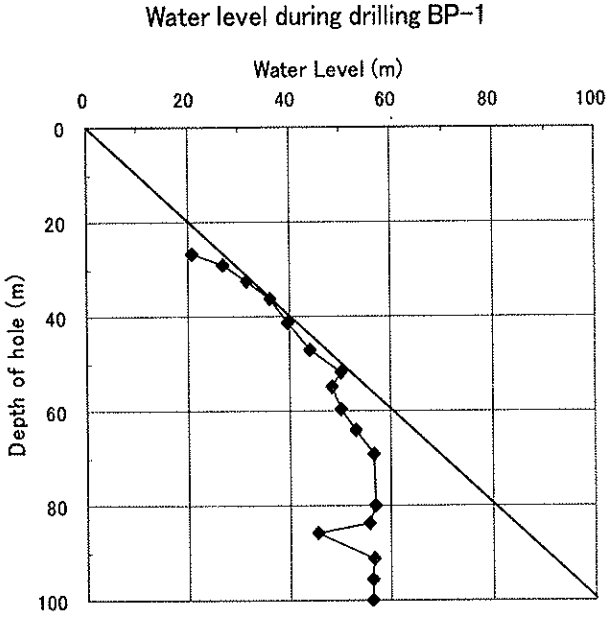


Water Level in the Hole during Drilling

(B-9, B-12, BP-1)

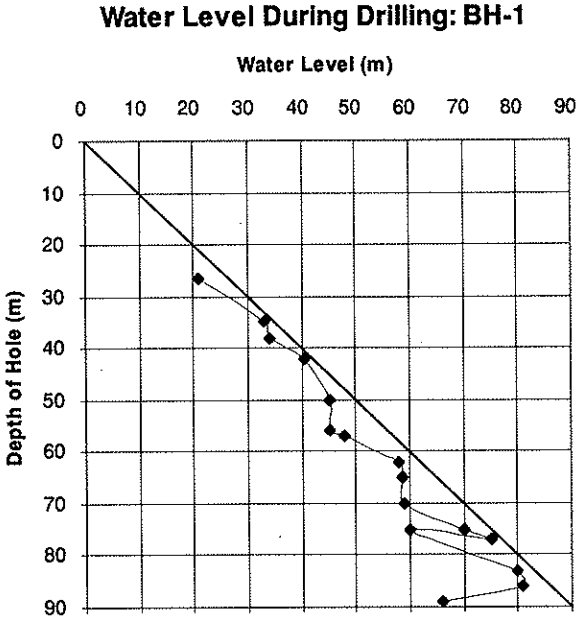


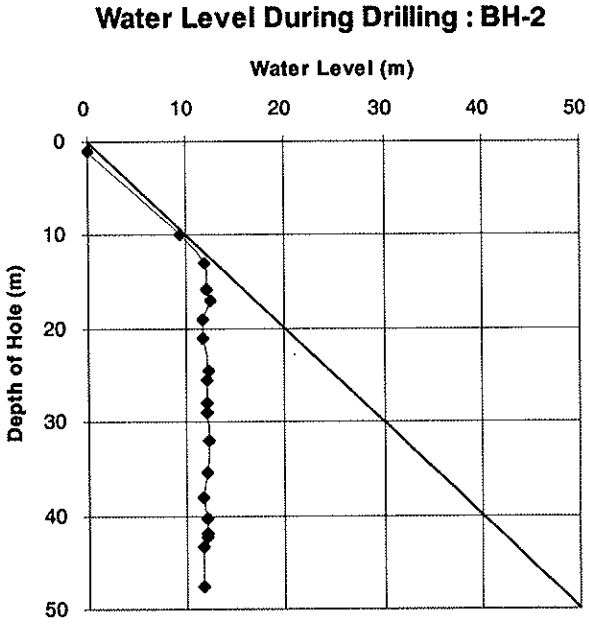


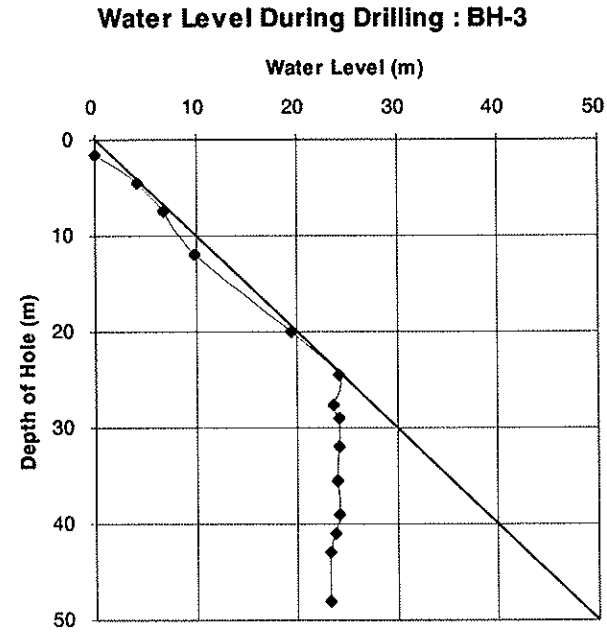


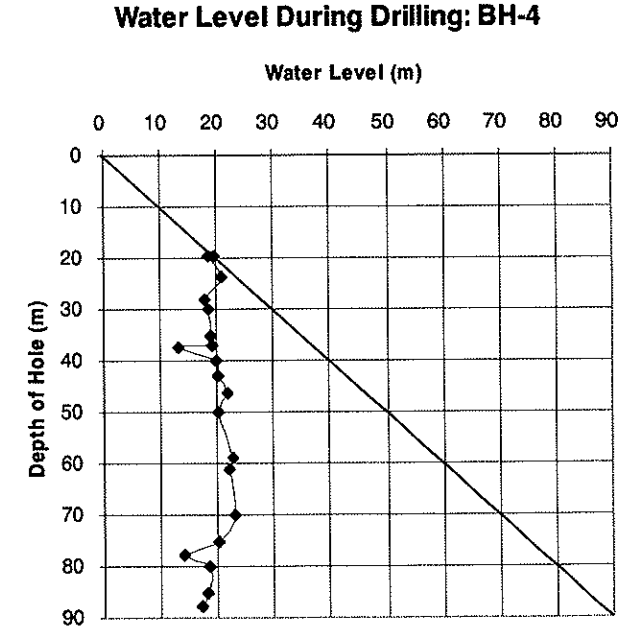
Water Level in the Hole during Drilling

(BH-1, BH-2, BH-3, BH-4)



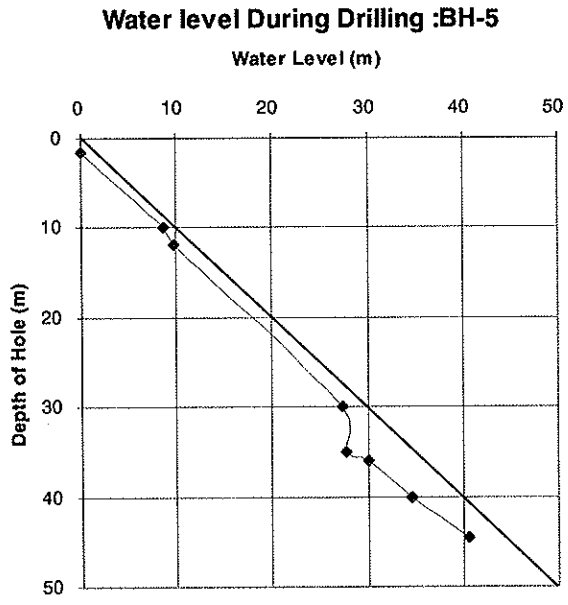


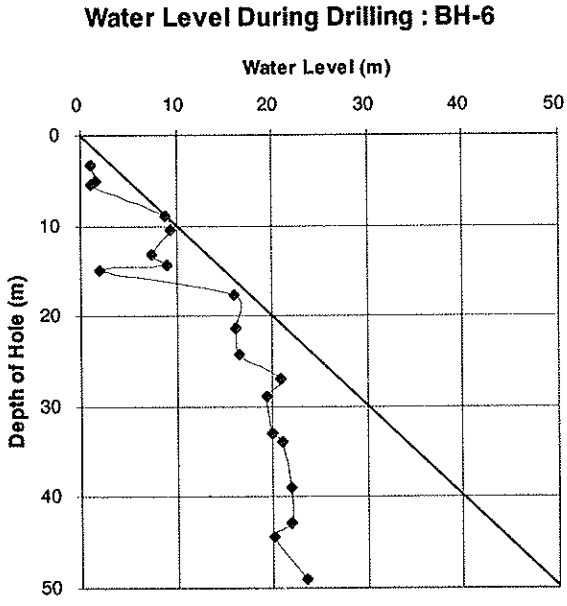




Water Level in the Hole during Drilling

(BH-5, BH-6)





CHAPTER 9 ENVIRONMENTAL IMPACT SURVEY

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Geographical Survey

Geographical Survey

Geographical Survey

1 Outline of geographical survey

In order to implement the investigations on environmental and social considerations, the topographical maps with appropriate accuracy for the planned reservoir and its vicinity is indispensable. The topographical maps that to be able to be obtaining in the study area is on a scale of 1:25,000 made based on 1:50,000 aerial photos and a contour line interval is 20 meter. The EIA of NEA was conducted with use of these maps.

In this study, two distinct regions of survey operated such as a general mapping region which include the geographic extent of the Seti and Madi River basins and a detailed region affected by dam and power station. All survey data are made, stocked and managed by Geographic information system (GIS). The overall objective of the mapping work is to prepare GIS-based digital maps and data to support this project. The survey areas and survey items, also data accuracies are shown below.

2 Methodology of geographical survey

The both scale of data were made by digitalization of existing analog maps and the satellite image analysis were arranged and stored by Geographical Information System as one data base.

This chapter describes in various datasets used for this study and also describes the methodology adopted for mapping works of GIS database, the data parameter, the definition of the coordination system, the accuracy evaluation, etc.

3 Data sources

This section shows the data source of two distinct mapping regions, the watershed study region and the river corridor detailed study region. In general, the mapping works was done using the existing analog maps. These existing data in different formats were collected, digitized, compiled and attribute data was added as for GIS data. This study also used satellite imageries to update the existing analog maps.

(1) The watershed study region

This study created the latest topographical maps of the watershed study region on a scale of 1:25,000. These maps were made based on existing 1:25,000 and 1:50,000 scale topographical maps that the Survey Department of Nepal was publishing and updated by using the ASTER satellite imagery.

The watershed study region consists of altogether 17 sheets of existing topographical maps; 13 sheets in 1:25,000 scale and 4 sheets in 1:50,000 scales. The existing topographical maps were able to use only the accuracy of 1:50,000 for the upstream part of basin. Therefore, this study made the

latest topographical map of 1:25,000 accuracy that covered the entire the basin based on the two kinds of accuracy existing topographical maps supplemented with the satellite imageries.

Table 1 shows the existing topographical maps of 1:25,000 and 1:50,000 scales used by this study.

Table 1 List of Topographical maps

NO.	Sheet Index	Scale
1	2783_04A	1:25,000
2	2783_04B	1:25,000
3	2784_01A	1:25,000
4	2784_01B	1:25,000
5	2784_02A	1:25,000
6	2884_13C	1:25,000
7	2884_13D	1:25,000
8	2884_13B	1:25,000
9	2884_13A	1:25,000
10	2883_16D	1:25,000
11	2883_16C	1:25,000
12	2883_16A	1:25,000
13	2883_16B	1:25,000
14	2884_05	1:50,000
15	2884_09	1:50,000
16	2883_12	1:50,000
17	2883_08	1:50,000

The entire of the Seti and Madi River basins were covered by three scenes of ASTER satellite imageries. These images were acquired in October 2003 and October 2004. The ASTER satellite imageries were used for making the contour line (accuracy at 20 meters intervals by which the standard of the topographical map of 1:25,000 scale), updates of the land use data, and the update work of the hazard map in the watershed study region. Especially, the ASTER satellite image bore the key role for making the contour line. Because a part of existing topographical maps that covered the upstream were a scale of 1:50,000, the contour line was 40 meter interval, the ASTER satellite imagery were making the contour line that united the watershed study region at intervals of 20 meter were done. The list of the ASTER satellite imagery used for this study is shown in Table 2.

Table 2 List of ASTER satellite imagery

Path/Row	Date	Image Format
142-116-4	5 October. 2003	EOS HDF
142-115-4	5 October. 2003	EOS HDF
142-116-6	23 October. 2004	EOS HDF

In the survey of the watershed study region was also made the geological maps based on the map concerning the land system, land capability and land utilization that LRMP (Land Resource Mapping Project, 1986) had made.

The accuracy of this base map is 1:50,000 scales. This study obtained these maps as analog paper maps then digitized and stored them as a GIS database of this study. The study area is covered in

nine sheets of maps.

Geological maps at 1:50,000 scales published by the Department of Mines and Geology (1996-99) were used for geological mapping. Only 5 sheets of geological maps covering the watershed study region are available. The existing geological maps do not cover the entire watershed study region. The list of the geological map is shown in Table 1.2.3, and the list of the soil map is shown in Table 3.

Table 3 List of Geology maps

No.	Sheet Index	Scale
1	62 P14	1:50,000
2	62 P15	1:50,000
3	62 P16	1:50,000
4	63 M13	1:50,000
5	71 D2	1:50,000
6	71 D3	1:50,000
7	71 D4	1:50,000
8	72 A1	1:50,000
9	72 A5	1:50,000

Table 4 List of Soil maps

No.	Sheet Index	Scale
1	62 P15	1:50,000
2	62 P16	1:50,000
3	63 M13	1:50,000
4	71 D4	1:50,000
5	71 A1	1:50,000

(2) The river corridor detailed study region

QuickBird high resolution satellite imagery was used for GIS data creation for base map and land use map for a detailed region. QuickBird is the advanced earth observatory satellites that have horizontal resolution of 60cm and enable to create maps with a contour interval of 5 meters from the satellite images. This study made DEM (Digital Elevation Model) by using the two sets of QuickBird Ortho-ready Standard Imagery which changed the sensor elevation angles and generated 5 meters interval contour lines for the river corridor detailed study reason. The details of the imagery scenes used for this study are shown in Table 5.

Table 5 List of QuickBird Satellite imagery

Scene ID	Band	Date
10100100042A6201	Pan & MSS (1,2,3,4)	April 13, 2005
10100100042F7501	Pan & MSS (1,2,3,4)	April 21, 2005

QuickBird imagery did not cover the downstream area of the dam site and portion of Damauli. To cover these areas, aerial photographs of at a scale of 1:15,000 were acquired from the Survey

Department were assumed the assistance of the topographical map making. The aerial photographs serial numbers are shown in Table 6.

Table 6 List of Aerial photographs

Photo Run	Photo Number	Year	Scale
19-16	007	1996-1997	1:15,000
19-16	008	1996-1997	1:15,000
19-16	009	1996-1997	1:15,000
19-16	010	1996-1997	1:15,000

The one of the main purpose of the river corridor detailed study region survey is to grasp the number of affected households (the number of residents) and the area of compensation for the land losses caused by this project. Therefore, to collect the cadastral maps that covered the extent of the impact area and made them into the database. The cadastral maps are collected in the Department of Survey branch of Damuri, and the numbers of collected cadastral maps are 170 sheets in total. Details of the collected cadastral maps are shown in "Appendix-1 collection cadastral map list".

Other materials collected for the river corridor detailed study region survey were survey results done by NEA in the past such as a topographical survey, a river crossing section survey, and an incidental facilities design, etc. These data was used partially of the database of this study after adjustment of the coordinate system and the confirmation of the positional accuracy.

4 Coordinate Reference System

The coordinate reference system used for mapping and GIS database for both the watershed study region (scale 1:25,000) and the river corridor detailed study region (scale 1:5,000) is the Nepalese standard coordinate reference system "Modified Universal Transverse Mercator (MUTM)" as adopted by the Survey Department. This coordinate reference system is an original coordinate system in Nepal that the Survey Department set. This coordinate system is different from an international standard coordinate system; however almost all maps officially published in Nepal like topographical map, soil map, geological map were used this coordinate system. In addition, NEA executed the topographical survey in the past based on this coordinate system. This study also was assumed to use this MUTM coordinate system for the reasons shown in the above-mentioned. The details of the coordinate reference system are shown below.

Table 7 Coordinate Reference System

Parameters	Value/Reference
Projection	Modified Universal Transverse Mercator (MUTM)
Spheroid	Everest 1830 (1937 Adjustment) Semi Major Axis: 63777276.345 metres Inverse Flattening: 300.8017
Central Meridian	84 Degree Longitude
False Coordinates at origin	500,000m at Central Meridian 0m at 0 Deg Latitude
Scale Factor	0.9999

5 GIS Data Formats

The database made by this study consists of two different types of data, the raster data set and the vector data set. The raster data set is the image data set like the satellite imagery and an analog map, and the vector data set indicates the GIS data that is called the point data, the line data, and the polygon data. The data formats used for raster datasets and images are Geo-TIFF format along with projection world file. The data formats used for GIS datasets are ESRI's shape format for all the vector datasets with associated projection and metadata files. The data form used by this study is shown as follows.

Table 8 Data format

Data Type	Data Format
Raster Data Set	GEO-TIFF Format with Projection World File
Vector Data Set	Shape Format with Projection file , associated attribute table and metadata file

The database model for topographic GIS datasets for the watershed study region is based on the "Specification for Geographic Information Service and National Topographic Database" prescribed by the Department of Survey.

However, the item of the attribute data was settled on the Department of Survey was corresponded to accuracy of 1:25,000 scales, and did not have a clear standard of the detailed scale data (accuracy 1:5,000) in Nepal, and then as a result of the conference with NEA, the item of the attribute table of the detailed study region was settled on.

The metadata for all the datasets is based on "FGDC Content Standards for Digital Geospatial Metadata" standard version "FGDC-STD-001-1998". The metadata contains the basic information related to the source and method of data creation, attribute definition, accuracy, projection parameters.

The description of datasets and structured list of data model is presented in Appendix-3.

6 Mapping Accuracy

In the river corridor detailed study region, the topographical map of accuracy 1:5,000 was newly made by using the QuickBird satellite imagery.

To obtain accuracy levels within permissible limits for all the mapping products, strict quality control are maintained at all levels of image processing and map preparation. The accuracy levels of the final product comply with the "Specification for National Urban Geographic Information Service in Nepal" by the Department of Survey.

Differential GPS (DGPS) survey was conducted in order to collect ground control points (GSP) and independent check points (ICP) for geometric correction of QuickBird Satellite Imagery.

The plannimetric (X, Y; Latitude and Longitude) error assessment is done for geometrically corrected QuickBird satellite imageries with reference to DGPS and ICPs established on the ground. Vertical error (Z) assessment for elevation is performed for DEM and contours with reference to the contours from at a scale of 1:25,000 maps as well as elevations of DGPS ground control points and check points.

DGPS survey was conducted taking a national GPS point as a reference base station. There is only one national control point in the Seti and Madi River basins numbered 28/098 which is located in Bhairenitar near Damauli. This survey was done based on a national control point, NEA control points which NEA set up in the past, and new established control points. For the population concentrated regions, Bimad Bazarl and Risin Paton which are expected the influence of the reservoir were especially deliberate the plane table survey and the leveling survey was executed.

The National GPS control point (28/098) shows in Table 9 and the list of control points used for the image geometric correction are shown in Table 10.

Table 9 Coordinate of National GPS point

Station	Easting	Northing	Elevation	Remarks
28/094	525310.56	3097449.02	367.460	GPS Point

Table 10 Coordinates of surveyed GPS points

NO	GCP	Location	Easting	Northing	Elevation
1	B001	RISINGPATAN	512553.094	3093738.789	437.911
2	BM06	PATAN	525893.785	3094178.987	339.644
3	C001	BHAISIKILI	516002.162	3093523.038	781.482
4	C002	NAYARISHING	516203.840	3089562.430	1128.028
5	C003	CHAAP	517645.554	3092756.728	712.407
6	C004	JYAMIRETHAN	519279.676	3090243.469	1155.105
7	C005	DUMRIDANDA	517334.495	3094550.108	918.630
8	C006	MOCHABRI	512320.895	3090378.447	1027.202
9	C008	BHALUKUNN	523171.003	3091650.600	888.944
10	C009	GUDUWA	509972.917	3094586.779	434.109
11	C011	PATAN	525735.526	3094477.573	339.180
12	CP06	THANING SCHOOL	519345.441	3094686.672	868.685
13	CP09	RESINGPATAN	512605.269	3093719.136	437.888
14	CP11	BELTAR	516688.118	3098147.264	511.367
15	CP12	JAGANPUR	510070.000	3098412.926	713.857
16	CP13	CHHANGPATAN	509641.341	3095654.569	457.465
17	CP14	MISHULUNG	509474.304	3092575.749	713.212
18	CP17	BHAGARGAUN	508391.233	3098923.111	470.407
19	GC10	BADHUWAPHAT	510349.447	3094211.920	432.649
20	GC11	CHHANHATIYA	513339.302	3096774.269	880.056
21	GC12	THARPU	515583.711	3098287.063	497.228
22	GC13	SISNARIPHAT	508463.330	3096746.254	448.902
23	GC14	KHAIRENITAR	509602.414	3100207.367	501.593
24	GC15	SIMLE	506288.092	3099704.571	473.681
25	GC16	BHOTECAMP	506748.574	3103476.140	487.091

NO	GCP	Location	Easting	Northing	Elevation
26	GCP3	LOKMA	525037.629	3092064.837	683.675
27	GCP7	TERSOBATO	514020.060	3092647.207	754.864
28	GCP9	BASPANI	507419.375	3092545.418	772.481
29	H015	BHIMAD	508381.284	3096171.689	436.791
30	H016	BHIMAD	508712.051	3095401.475	437.431
31	H017	BHIMAD	508720.290	3095274.469	442.185
32	H020	TWENTYEIGHT	509541.842	3094629.396	436.642
33	H-14	BHIMAD	508866.973	3095556.645	425.368
34	QR02	PATAN	525986.591	3094173.632	340.005
35	R001	RISINGPATAN	512631.467	3093475.365	436.420

The acquired control points were total 35 places. The acquired control points ware used for the satellite image geometric correction. The RMSE error obtained in X is 1.7m and in Y is 1.14m, which is within the permissible limit for 1:5,000 scale mapping.

Table 11 Measurement accuracy evaluation and image correction accuracy evaluation

Error Summary	
Systematic Errors (m)	
Dx	0.084
Dy	0.324
RMS Error (m)	
RMS X	1.735
RMS Y	1.149
Total RMSE※1	2.081

※1 RMSE(The Root Mean Square Error) square average square root error

The detail report of GPS post-processing is attached in "Appendix-2 Plannimetric error assessment report of QuickBird Satellite imagery".

Appendix-1 List of Cadastral Maps

VDC	SHEET_NO	VDC	SHEET_NO
Bhimad	1-Ga	ChhangBazar	9-Ja
	1-Gha		9-Jha
	1-Ka		9-Ka
	1-Kha		9-Nga
	1-Nga	Dhorphirdi	3-Cha
	2-Ga		3-Da
	2-Ka		3-Dha
	2-Kha		3-Ja
	3-Ga		3-Ka
	3-Ka		3-Kha
	3-Kha		3-Nga
	5-Kha		3-Nya
	6-Ga		3-Ta
	6-Ka		3-Tha
	6-Kha		6-Ka
	7-Ka		6-Kha
	7-Kha	Dulegauda	7-Ga
	8-Ga		7-Gha
	8-Ka		7-Ka
	8-Kha		7-Kha
Cha Danda Keshavtar	6-Cha		8-Ka
	7-Chha		8-Kha
	7-Ga		9-Ka
	7-Ja	Gunadi Mahendrapur	1-Ga
	7-Kha		1-Ka
	7-Nga		1-Kha
	7-Nya		2-Ga
ChhangBazar	1-Kha		2-Gha
	2-Gha		3-Ka
	2-Ka		4-Ka
	3-Ka		5-Ka
	4-Ga		7-Ka
	4-Ka		7-Kha
	4-Kha	Jamune Bhanjyang	1Ka
	4-Nga		2-Ka
	6-Ka		3-Gha
	7-Cha		4-Ga
	7-Ga		5-Nga
	7-Gha		6-Kha
	7-Ka		7-Ga
	7-Kha		7-Kha
	7-Nga	Kanhusivapur	1-Ga
	8-Ga		1-Gha
	8-Ka		1-Ka
	8-Kha		1-Kha
	8-Nga		2-Cha
	9-Cha		2-Gha
	9-Dha		2-Nga
	9-Gha		2-Ta

VDC	SHEET_NO
Kanhusivapur	2-Tha
	3-Ga
	3-Ka
	3-Kha
Dulegauda	7-Ga
	7-Gha
	7-Ka
	7-Kha
	8-Ka
	8-Kha
	9-Ka
Gunadi Mahendrapur	1-Ga
	1-Ka
	1-Kha
	2-Ga
	2-Gha
	3-Ka
	4-Ka
	5-Ka
	7-Ka
	7-Kha
Jamune Bhanjyang	1Ka
	2-Ka
	3-Gha
	4-Ga
	5-Nga
	6-Kha
	7-Ga
	7-Kha
Kanhusivapur	1-Ga
	1-Gha
	1-Ka
	1-Kha
	2-Cha
	2-Gha
	2-Nga
	2-Ta
	2-Tha
	3-Ga
	3-Ka
	3-Kha
Karlung	6-Ana
	6-Cha
	6-Da
	6-Ja
	6-Jha
	6-Ka
	6-Ta
	6-Tha
	6-Yan
Kotdarbar	1-Ana
	1-Cha

VDC	SHEET_NO
Kotdarbar	1-Chha
	1-Da
	1-Dha
	1-Ga
	1-Gha
	1-Ja
	1-Jha
	1-Kha
	1-Nga
	1-Nya
	1-Ta
	1-Taa
	1-Tha
	1-Thaa
Pharakchaur	9-Ga
	9-Gha
	9-Jha
	9-Ta
	9-Yna
Rising Ranipokhari	7-Ga
	7-Ka
	7-Kha
	8-Ga
	8-Ka
	8-Kha
	9-Cha
	9-Ga
	9-Ja
	9-Jha
	9-Ka
	9-Kha
	9-Nga
	9-Nya
SabhungBhagawti	1-Ana
	1-Cha
	1-Chha
	1-Da
	1-Dha
	1-Ga
	1-Gha
	1-Ja
	1-Ka
	1-Kha
	1-Nga
	1-Nya
Pharakchaur	9-Ga
	9-Gha
	9-Jha
	9-Ta
	9-Yna
Rising Ranipokhari	7-Ga
	7-Ka

VDC	SHEET_NO	VDC	SHEET_NO
Rising Ranipokhari	7-Ga	Uddaindhunga	1-Cha
	7-Ka		4-Cha
	7-Kha		4-Da
	8-Ga		4-Ga
	8-Ka		4-Gha
	8-Kha		4-Ka
	9-Cha		4-Kha
	9-Ga		4-Nga
	9-Ja		4-Nya
	9-Jha		5-Ga
	9-Ka		5-Ka
	9-Kha		5-Kha
	9-Nga		
	9-Nya		
SabhungBhagawti	1-Ana		
	1-Cha		
	1-Chha		
	1-Da		
	1-Dha		
	1-Ga		
	1-Gha		
	1-Ja		
	1-Ka		
	1-Kha		
	1-Nga		
	1-Nya		

Appendix-2 Plannimetric error assessment report of QuickBird Satellite imagery

GCP	LOCATION	GPS_X	GPS_Y	GPS_ELEVATION	IMAGE_X	IMAGE_Y	dX	dy	SYS_Error
B001	RISINGPATAN	512553.094	3093738.789	437.911	512553.797	3093738.615	-0.703	0.174	0.724
BM06	PATAN	525893.785	3094178.987	339.644	525894.246	3094178.787	-0.461	0.200	0.502
C001	BHAISIKILI	516002.162	3093523.038	781.482	516004.845	3093519.948	-2.683	3.090	4.093
C002	NAYARISHING	516203.840	3089562.430	1128.028	516204.210	3089562.101	-0.370	0.329	0.495
C003	CHAAP	517645.554	3092756.728	712.407	517646.181	3092756.997	-0.627	-0.269	0.682
C004	JYAMIRETHAN	519279.676	3090243.469	1155.105	519279.800	3090243.005	-0.124	0.464	0.480
C005	DUMRIDANDA	517334.495	3094550.108	918.630	517334.529	3094549.976	-0.034	0.132	0.136
C006	MOCHABRI	512320.895	3090378.447	1027.202	512321.879	3090379.072	-0.984	-0.625	1.166
C008	BHALUKUNN	523171.003	3091650.600	888.944	523168.698	3091651.144	2.305	-0.544	2.369
C009	GUDUWA	509972.917	3094586.779	434.109	509972.855	3094587.458	0.062	-0.679	0.682
C011	PATAN	525735.526	3094477.573	339.180	525735.931	3094478.621	-0.405	-1.048	1.123
CP06	THANING SCHOOL	519345.441	3094686.672	868.685	519345.876	3094686.548	-0.435	0.124	0.452
CP09	RESINGPATAN	512605.269	3093719.136	437.888	512605.476	3093718.964	-0.207	0.172	0.269
CP11	BELTAR	516688.118	3098147.264	511.367	516686.375	3098144.448	1.743	2.816	3.312
CP12	JAGANPUR	510070.000	3098412.926	713.857	510071.394	3098412.926	-1.394	0.000	1.394
CP13	CHHANGPATAN	509641.341	3095654.569	457.465	509637.370	3095652.999	3.971	1.570	4.270
CP14	MISHULUNG	509474.304	3092575.749	713.212	509474.227	3092575.377	0.077	0.372	0.380
CP17	BHAGARGAUN	508391.233	3098923.111	470.407	508393.707	3098923.953	-2.474	-0.842	2.614
GC10	BADHUWAPHAT	510349.447	3094211.920	432.649	510346.767	3094210.945	2.680	0.975	2.852
GC11	CHHANHATIYA	513339.302	3096774.269	880.056	513338.047	3096771.238	1.255	3.031	3.281
GC12	THARPU	515583.711	3098287.063	497.228	515583.354	3098287.216	0.357	-0.153	0.389
GC13	SISNARIPHAT	508463.330	3096746.254	448.902	508463.187	3096746.177	0.143	0.077	0.163
GC14	KHAIRENITAR	509602.414	3100207.367	501.593	509602.758	3100207.023	-0.344	0.344	0.486
GC15	SIMLE	506288.092	3099704.571	473.681	506292.185	3099703.727	-4.093	0.844	4.180
GC16	BHOTECAMP	506748.574	3103476.140	487.091	506748.574	3103476.140	0.000	0.000	0.000
GCP3	LOKMA	525037.629	3092064.837	683.675	525035.343	3092064.134	2.286	0.703	2.392
GCP7	TERSOBATO	514020.060	3092647.207	754.864	514016.169	3092645.210	3.891	1.997	4.374
GCP9	BASPANI	507419.375	3092545.418	772.481	507419.045	3092545.308	0.330	0.110	0.347

H015	BHIMAD	508381.284	3096171.689	436.791	508382.381	3096173.752	-1.097	-2.063	2.337
H016	BHIMAD	508712.051	3095401.475	437.431	508712.430	3095402.043	-0.379	-0.568	0.683
H017	BHIMAD	508720.290	3095274.469	442.185	508718.746	3095273.423	1.544	1.046	1.865
H020	TWENTYEIGHT	509541.842	3094629.396	436.642	509541.984	3094629.657	-0.142	-0.261	0.297
H-14	BHIMAD	508866.973	3095556.645	425.368	508866.968	3095557.285	0.005	-0.640	0.640
QR02	PATAN	525986.591	3094173.632	340.005	525989.525	3094174.051	-2.934	-0.419	2.964
R001	RISINGPATAN	512631.467	3093475.365	436.420	512629.301	3093474.469	2.166	0.896	2.344
						Total	2.925	11.355	

Error Summary	
Sytematic Errors (m)	
Dx	0.084
Dy	0.324
RMS Error (m)	
RMS X	1.735
RMS Y	1.149
Total RMSE	2.081

Appendix-3Data descriptions

The Seti River Watershed Study Region

Topographic (Base Map) Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Building	Building points from 1:25,000 topographical maps	Point	FCODE: Integer	Feature code
				BFU: Integer	Building functional use code
				RBF: Integer	Religious building functional use code
				BUILD_TYPE: String	Building type
				FUNCT_USE: String	Building functional use type
2	Canal	Irrigation canal from 1:25,000 topographical maps	Polyline	TYPE: String	Canal type
				FCODE: Integer	Feature code
				LENGTH: Float	Length of canal
				NAME: String	Name of canal
				DEPTH: Float	Depth of canal
3	Contours	Contours from 1:25,000 topographical maps	Polyline	FCODE: Integer	Feature code
				ELEVATION: Integer	Contour elevation
				TYPE: String	Contour type
4	River_Center	River centerline from 1:25,000 topographical maps	Polyline	FCODE: Integer	Feature code
				LENGTH: Float	Length of river
				NAME: String	Name of river
				TYPE: String	River type
5	River_Polygon	River water bodies and sand area from 1:25,000 topographical maps	Polygon	FCODE: Integer	Feature code
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				NAME: String	Name of river
				Category: String	Landcover classification
6	Glacier	Glacier polygon from 1:25,000 topographical maps	Polygon	FCODE: Integer	Feature code
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				NAME: String	Name of glacier
				Category: String	Landcover classification
7	Landcover	Landcover classification from 1:25,000 topographical maps	Polygon	FCODE: Integer	Feature code
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				Category: String	Landcover classification
8	Settlement	Location name from 1:25,000 topographical maps	Point	VIL_NAME: String	Location name
9	Spotheight	Spot Height from 1:25,000 topographical maps	Point	FCODE: Integer	Feature code
				SEL: Integer	Contour elevation
10	Stream	Stream line from 1:25,000 topographical maps	Polyline	FCODE: Integer	Feature code
				LENGTH: Float	Length of stream
				NAME: String	Name of stream
				TYPE: String	River or stream type

11	Transportation	Transportation network from 1:25,000 topographical maps	Polyline	FCODE: Integer	Feature code
				TYPE: String	Structure type
				LENGTH: Float	Length of road
12	Waterbody	Waterbody from 1:25,000 topographical maps	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				FCODE: Integer	Feature code
				NAME: String	Name of waterbody
				TYPE: String	Type of waterbody
13	Watershed_boundary	Upper Seti watershed area	Polygon	ID: Integer	Identification no
				AREA: Float	Area of polygon
				DESCPT: String	Description
14	AnnapurnaConservation	Annapurna conservation area boundary	Polygon	ID: Integer	Identification no
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				FCODE: Integer	Feature code
				NAME: String	Name of annapurna conservation area
15	District	District boundary	Polygon	ID: Integer	Identification no
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				DISTRICT: String	District name
16	National_boundary	National boundary for printing	Polyline	NATIONA_ID	Identification no
17	VDCs	VDC boundary within watershed area	Polygon	ID: Integer	Identification no
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				VDC: String	VDC name
				DISTRICT: String	District name
				ZONE: String	Zonal name
				REGION: String	Development region name
18	Ward	Ward boundary within watershed area	Polygon	ANN: String	VDC name
				W_NO: String	Ward number
				D_NAME: String	District name
19	DistrictHQ_Pokhara	District headquarter of Kaski District	Point	ID: Integer	Identification no
				HD_Quarter: String	Headquater name
				DISTRICT: String	District name
				ZONE: String	Zonal name
				DEV_REGION: String	Development region name
20	Districts_Pline	District boundary line for printing	Polyline	ID: Integer	Identification no
21	Lake	Lake and pond	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				FCODE: Integer	Feature code
				Category: String	Landcover classification
				POND_NAME: String	Name of lake and pond

Geological and Hazard Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Dip	Dip angles from 1:50,000 geological maps.	Point	DIP_ANGLE: String	Angle of DIP
2	Fault	Fault lines from 1:50,000 geological maps.	Polyline	LENGTH: Float	Length of line
				STRUCTURE: String	Type of fault
				IDENTIFICA: String	Identification of thrust
3	Geology	Geology polygons from 1:50,000 geological maps.	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				GEO_NAME: String	Geological name
				GEO_SYMBOL: String	Geological symbol
				GEO_MEM_NA: String	Geological member name
				GEO_MEM_SY: String	Geological member symbol
				GEO_GROUP: String	Geological group
4	Landslide	Landslide polygons from 1:50,000 geological maps	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				LANDSLIDE: String	Landslide type
5	Mineral	Mineral points from 1:50,000 geological maps	Point	MINERAL: String	Mineral type
6	Hazard	Hazard polygons from 1:50,000 geological maps	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				HAZARD_TYP: String	Hazard type
7	Rockfall	Rockfall lines from 1:50,000 geological maps	Polyline	LENGTH: Float	Length of rockfall line
				ROCK_FALL: String	Rockfall type

Soil Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Soil_LandSystem	Land form land unit polygons with dominant soil types	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of Polygon
				LYSY_NAME: String	Land System unit description
				LSYS_SBL: String	Land System unit symbol
				L_FORM: String	Land Form description
				L_UNIT: String	Land Unit description
				DOM_SOIL: String	Dominant Soil Type
				DOM_SLOPE: String	Dominant slope of land unit in degrees
				DOM_Texture: String	Texture of dominant soil type
				WAT_TABLE: String	Depth of water table
				DRAINAGE: String	Drainage pattern of land unit

Landuse Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Landuse	Land use	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of Polygon
				LANDUSE: String	Landuse type class

Imagery and Raster Datasets

SN	Dataset	Description	Data Type	Basic Attribute Field name: Type	Attribute Description
1	DEM	Digital Elevation Model at 20m pixel from topographic data and ASTER imagery	32 bit raster	Pixel Value: Float	Elevation Value
2	Slope	Slope derived from DEM at 20m pixel	32 bit raster	Pixel Value: Float	Slope in angles
3	Aspect	Aspect derived from DEM at 20m pixel	8 bit raster	Pixel Value: Unsigned Integer	Pixel class code representing the aspect
				Direction: String	Compass direction of the aspect with respect to the true north
				Angle: String	Angular range of the direction
4	ASTER_CIR	Orthorectified ASTER Color Infrared Image	8 bit raster		
5	ASTER_PNC	Orthorectified ASTER Pseudo Natural Color Image	8 bit raster		

The River Corridor Detailed Study Region

Topographic (Base Map) Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Annotation	Location name	Point	TEXTSTRING: String	Location name
2	Building	Footprints of buildings extracted from 0.6m quick bird stereo imagery	Polygon	ID: Integer	Identification no
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				FCODE: Integer	Feature code
				REMARKS: String	Remarks
3	Canal	Irrigation canal	Polyline	CANAL_ID	Identification no
				FCODE: Integer	Feature code
				LENGTH: Float	Length of canal
				NAME: String	Name of canal
4	QBContour	Contours are extracted from 0.6m quick bird imagery	Polyline	FCODE: Integer	Feature code
				ELEVATION: Integer	Contour elevation
				TYPE: String	Contour type
5	River_Center	River centerline	Polyline	FCODE: Integer	Feature code
				LENGTH: Float	Length of river
				NAME: String	Name of river
6	River_Polygon	River water bodies and sand area	Polygon	FCODE: Integer	Feature code
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				NAME: String	Name of river
				LANDCOVER: String	Landcover classification
7	Road_Edge	Road edges for printing purpose	Polyline	FCODE: Integer	Feature code
				TYPE: String	Road classification
				SURF_TYPE: String	Pavement type
8	Road_Network	Road network centerline	Polyline	FCODE: Integer	Feature code
				LENGTH: Float	Length of Road
				TYPE: String	Road classification
				SURF_TYPE: String	Pavement type
9	Spotheight	Spot Height	Point	FCODE: Integer	Feature code
				ELEVATION: Integer	Contour elevation
10	Stream	Stream line	Polyline	FCODE: Integer	Feature code
				LENGTH: Float	Length of stream
				RIVER_ID: Integer	Identification no
				NAME: String	Name of stream
				TYPE: String	River or stream type
11	Structure	Bridge structure	Polyline	FCODE: Integer	Feature code
				TYPE: String	Structure type
				HEAD: Float	Structure head
				LENGTH: Float	Length of structure
				NAME: String	Name of structure

12	River_Corridor	Upper Seti (Damauli) Storage Hydroelectric Project River Corridor area	Polygon	AREA: Float	Area of polygon
				RIVERCO_ID: Integer	Identification no
13	Parbat_syangja_tanahu_VDC	VDC boundary within watershed boundary of UpperSeti(Damauli) Storage Hydroelectric Project	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				AAN: String	VDC name
				D_NAME: String	District name
14	Ward	Ward boundary within watershed boundary of UpperSeti(Damauli) Storage Hydroelectric Project	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				AAN: String	VDC name
				D_NAME: String	District name
				W_NO: Integer	Ward no
15	Major Annotations	Major Location name for printing purpose	Point	VIL_NAME: String	Location name
16	Parbat_syangja_tanahu_vdc_Pline	VDC boundary within watershed boundary for printing purpose	Polyline	ID: Integer	Identification no
17	Sheet_plan_5000	Sheet plan in 1:5,000 scale for printing purpose	Polygon	SHEET_NO: Integer	Sheet plan number
18	WARD_PolyLine	Ward boundary within watershed boundary for printing purpose	Polyline	ID: Integer	Identification no

Cadastral Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Parcel	Parcel polygons are delineated from 1:1200 and 1:2400 uncontrolled parcel sheets	Polygon	AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				PARCEL_ID: Integer	Parcel number
				PAR_TYPE: String	Parcel type
				SHEET_NO: Integer	Sheet number
				VDC: String	VDC name

Landuse Database

SN	Dataset	Description	Topology	Basic Attribute Field name: Type	Attribute Description
1	Landuse	Landuse polygons are delineated from 0.6m quick bird satellite imagery within river corridor Area.	Polygon	OBJECTID: Integer	Identification no
				AREA: Float	Area of polygon
				PERIMETER: Float	Perimeter of polygon
				FCODE: Integer	Feature code
				LANDCOVER: String	Landcover classification
				LANDUSE: String	Landuse classification
				COMMU_FORE: String	Community forest name
				DOMNT_SPEC: String	Dominant Species of tree
				OWNERSHIP: String	Ownership
				SPECIES_NA: String	Species name

Imagery and Raster Datasets

SN	Dataset	Description	Data Type	Basic Attribute Field name: Type	Attribute Description
1	DEM	Digital Elevation Model at 5m pixel from Quickbird and field survey	32 bit raster	Pixel Value: Float	Elevation Value
2	Slope	Slope derived from DEM at 5m pixel	32 bit raster	Pixel Value: Float	Slope in angles
3	Aspect	Aspect derived from DEM at 5m pixel	8 bit raster	Pixel Value: Unsigned Integer	Pixel class code representing the aspect
				Direction: String	Compass direction of the aspect with respect to the true north
				Angle: String	Angular range of the direction
4	QBOrtho_PAN_Tile	Orthorectified Quickbird 0.6m Panchromatic image tiles	8 bit raster		
5	QBOrtho_MSS_Tile	Orthorectified Quickbird 2.4m MSS image tiles	8 bit raster		
6	Aerial_Ortho_damauli	Orthorectified aerial photographs for Damauli and area	8 bit raster		

CHAPTER 10 OPTIMIZATION OF DEVELOPMENT PLAN

CHAPTER 10 OPTIMIZATION OF DEVELOPMENT

Details of Alternatives in 10.2

- Option I
- Option II
- Option IIIa
- Option IIIb
- Option IV

Details of Alternatives in 10.4

Details of Alternatives in 10.5

Details of Alternatives in 10.2

Option I

Basic Parameters	OP1- 395					
Waterway Length						
Headrace Tunnel	m	0				
Penstock	m	186.31	12.51	83.3	72.2	18.3
Tailrace Tunnel	m	0				
	m	186.31				
Sedimentation Level	EL.m	386.2				

Specification

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	58.3	63.2	68	72.9	77.7	82.6	87.4	92.3	97.1	102
FSL	EL.m	395	395	395	395	395	395	395	395	395	395
MOL	EL.m	393.6	393.8	394	394.2	394.6	394.8	NG	NG	NG	NG
TWL	EL.m	307.3	307.5	307.6	307.7	307.8	307.9				
Loss	m	1	1	1	1	1	1				
Effective Head	m	86.7	86.5	86.4	86.3	86.2	86.1				
Pmax	MW	45	49	52	56	60	63				
Primary Energy	GWh	95.22	102.82	109.72	117.20	124.11	130.52				
Pfirm	MW	40.35	43.77	46.60	48.77	46.71	46.13				
Benefit	1000USD	27,830	30,112	32,100	33,986	34,509	35,393				
Cost	1000USD	30,090	30,377	31,338	31,605	31,868	32,080				
B/C		0.92	0.99	1.02	1.08	1.08	1.10				

Civil & Hydromechanical Work Quantity

(1) Dam											
Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	21.7	22.6	23.5	24.3	25.1	25.9	26.6	27.3	28	28.7
Dam Height (Hd)	m	107									
Crest Length (L)	m	194.9	195.8	196.7	197.5	198.3	199.1	199.8	200.5	201.2	201.9
Coefficient for Ex	Y=A*X^B										
	A	22700									
	B	0.5115									
Coefficient for Conc	Y=C*X^D										
	C	0.0157									
	D	1.1514									

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	3,675,314	3,683,985	3,692,637	3,700,311	3,707,970	3,715,614	3,722,290	3,728,955	3,735,609	3,742,251
Concrete	m3	320,372	322,076	323,781	325,297	326,815	328,334	329,663	330,993	332,324	333,656
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake		included in Dam									
Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	393.6	393.8	394	394.2	394.6	394.8	395	395.2	395.4	395.6
Waterway Diameter	m	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4	4.1	4.2
Available Height	m	1.4	1.2	1	0.8	0.4	0.2	0	- 0.2	- 0.4	- 0.6

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	446	624	756	863	942	1,019	1,087	1,147	1,200	1,248
Concrete	m3	192	290	367	432	481	530	574	613	648	680
Reinforce Bar	t	8	12	15	17	19	21	23	25	26	27
Intake Gate	t	124	135	146	157	168	179	189	200	211	222
Intake Screen	t	69	75	81	87	93	99	105	111	117	124

(3) Power Tunnel											
Tunnel Inner Diameter	m	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4	4.1	4.2
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks		
Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	2.3828608	2.480978	2.573468	2.664576	2.750901	2.836315	2.917562	2.998232	3.075205	3.151842
tm	mm	8.5409766	8.794779	9.040032	9.280928	9.508198	9.732446	38.07128	39.06864	40.02029	40.9678

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	215	231	246	261	276	292	1,174	1,238	1,301	1,365

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	4.6	4.8	5	5.1	5.3	5.5	5.6	5.8	5.9	6.1
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace Included in Dam

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel											
Tunnel Length	m	0									

Item	Unit	FSL=395									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=395									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	66,156	66,312	66,467	66,606	66,743	66,881	67,001	67,121	67,241	67,361
Concrete	41,648	41,870	42,091	42,289	42,486	42,683	42,856	43,029	43,202	43,375
Others	21,561	21,636	21,712	21,779	21,846	21,913	21,971	22,030	22,089	22,147
(2)Intake										
Excavation	8	12	14	16	18	19	21	22	23	24
Concrete	23	35	44	52	58	64	69	74	78	82
Reinforce Bar	6	10	12	14	16	18	19	20	22	23
Others	9	14	18	21	23	25	27	29	31	32
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	6,773	6,797	6,821	6,841	6,862	6,883	6,901	6,919	6,937	6,955
Total	142,238	142,738	143,233	143,671	144,105	144,539	144,918	145,297	145,674	146,051

Hydro- mechanical Works

1,000USD

Item	FSL=395									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	817	888	957	1,029	1,101	1,173	1,244	1,316	1,388	1,461
Screen	454	493	532	571	612	652	691	731	771	812
(3)Penstock	817	876	934	993	1,050	1,109	4,461	4,704	4,942	5,185
(4)Tailrace										
Gate										
(5)Others	2,793	2,827	2,860	2,894	2,928	2,962	3,655	3,726	3,796	3,867
Total	16,759	16,961	17,161	17,365	17,569	17,773	21,928	22,355	22,774	23,202

Project Cost Summary

1,000USD

Item	FSL=395									
	1	2	3	4	5	6				
1. Preparation & Compensation	2,845	2,855	2,865	2,873	2,882	2,891				
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	24,370	24,370	24,370	24,370	24,370	24,370				
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053				
(2) Dam	129,365	129,818	130,271	130,673	131,075	131,477				
(3) Intake	47	70	88	103	114	126				
(4) Power Tunnel	0	0	0	0	0	0				
(5) Penstock	0	0	0	0	0	0				
(6) Power House	0	0	0	0	0	0				
(7) Tailrace Tunnel	0	0	0	0	0	0				
(8) Tailrace	0	0	0	0	0	0				
(9) Others	6,773	6,797	6,821	6,841	6,862	6,883				
4. Hydro- Mechanical Works										
(1) Gate & Screen	2,630	2,652	2,673	2,696	2,718	2,741				
(2) Penstocks	163	175	187	199	210	222				
5. Electro- Mechanical Works	23,057	24,426	25,424	26,725	27,996	28,934				
6. Transmission Line	5,298	5,298	10,170	10,170	10,170	10,170				
Direct Cost	200,601	202,513	208,921	210,702	212,451	213,866				
7. Administration Fee	30,090	30,377	31,338	31,605	31,868	32,080				
8. Contingency	20,060	20,251	20,892	21,070	21,245	21,387				
9. Interest During Construction	50,150	50,628	52,230	52,676	53,113	53,466				
Total	300,902	303,770	313,382	316,054	318,676	320,798				

Basic Parameters	OP1- 405					
Waterway Length						
Headrace Tunnel	m	0				
Penstock	m	186.31	12.51	83.3	72.2	18.3
Tailrace Tunnel	m	0				
	m	186.31				
Sedimentation Level	EL.m	386.2				

Specification

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	75	79.8	84.6	89.4	94.2	99	103.7	108.5	113.3	118.12
FSL	EL.m	405	405	405	405	405	405	405	405	405	405
MOL	EL.m	394.4	394.6	394.8	395	395.2	395.4	395.6	395.8	396	396.2
TWL	EL.m	307.7	307.9	308	308.1	308.2	308.3	308.4	308.5	308.6	308.7
Loss	m	1	1	1	1	1	1	1	1	1	1
Effective Head	m	96.3	96.1	96	95.9	95.8	95.7	95.6	95.5	95.4	95.3
Pmax	MW	64	68	72	76	81	85	88	92	96	100
Primary Energy	GWh	130.48	138.18	145.83	153.23	160.56	167.34	173.32	179.38	184.87	190.24
Pfirm	MW	50.52	53.78	57.12	58.58	61.87	62.73	58.47	55.31	48.85	43.03
Benefit	1000USD	36,704	38,954	41,219	42,879	45,077	46,454	46,163	46,216	45,184	44,324
Cost	1000USD	34,608	34,873	35,132	35,378	35,661	35,899	36,095	36,319	36,551	36,771
B/C		1.06	1.12	1.17	1.21	1.26	1.29	1.28	1.27	1.24	1.21

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	24.6	25.4	26.2	26.9	27.6	28.3	29	29.6	30.3	30.9
Dam Height (Hd)	m	117									
Crest Length (L)	m	197.8	198.6	199.4	200.1	200.8	201.5	202.2	202.8	203.5	204.1
Coefficient for Ex	Y=A*X^B										
	A	22700									
	B	0.5115									
Coefficient for Conc	Y=C*X^D										
	C	0.0157									
	D	1.1514									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	3,876,347	3,884,359	3,892,354	3,899,337	3,906,309	3,913,268	3,920,216	3,926,162	3,933,088	3,939,015
Concrete	m3	400,307	402,172	404,037	405,671	407,305	408,941	410,577	411,980	413,618	415,022
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake		included in Dam									
Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	394.4	394.6	394.8	395	395.2	395.4	395.6	395.8	396	396.2
Waterway Diameter	m	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5
Available Height	m	10.6	10.4	10.2	10	9.8	9.6	9.4	9.2	9	8.8

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	784	1,105	1,348	1,551	1,728	1,886	2,030	2,162	2,284	2,399
Concrete	m3	384	585	748	889	1,015	1,130	1,237	1,337	1,431	1,519
Reinforce Bar	t	15	23	30	36	41	45	49	53	57	61
Intake Gate	t	181	193	204	216	227	238	249	261	272	283
Intake Screen	t	101	107	113	120	126	132	139	145	151	157

(3) Power Tunnel											
Tunnel Inner Diameter	m	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks		
Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	2.7026824	2.787827	2.870447	2.950755	3.028934	3.105146	3.177999	3.250718	3.321845	3.391768
tm	mm	10.230992	10.47285	10.71496	10.94955	11.17719	11.39838	11.60893	11.81863	12.02307	12.22343

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	292	309	325	341	358	374	390	406	422	438

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	5.2	5.4	5.5	5.7	5.9	6	6.1	6.3	6.4	6.6
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace Included in Dam

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel

Tunnel Length	m	0									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=405									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	69,774	69,918	70,062	70,188	70,314	70,439	70,564	70,671	70,796	70,902
Concrete	52,040	52,282	52,525	52,737	52,950	53,162	53,375	53,557	53,770	53,953
Others	24,363	24,440	24,517	24,585	24,653	24,720	24,788	24,846	24,913	24,971
(2)Intake										
Excavation	15	21	26	29	33	36	39	41	43	46
Concrete	46	70	90	107	122	136	148	160	172	182
Reinforce Bar	13	19	25	30	34	38	41	44	47	50
Others	18	28	35	41	47	52	57	61	66	70
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	7,616	7,642	7,667	7,689	7,710	7,732	7,753	7,772	7,793	7,811
Total	159,938	160,474	161,000	161,459	161,914	162,367	162,818	163,206	163,653	164,038

Hydro- mechanical Works 1,000USD

Item	FSL=405									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	1,191	1,266	1,341	1,416	1,491	1,566	1,639	1,713	1,788	1,862
Screen	662	703	745	787	828	870	911	952	993	1,035
(3)Penstock	1,110	1,172	1,235	1,297	1,360	1,421	1,482	1,543	1,604	1,665
(4)Tailrace										
Gate										
(5)Others	2,968	3,004	3,040	3,076	3,111	3,147	3,182	3,217	3,252	3,288
Total	17,809	18,024	18,239	18,454	18,668	18,882	19,090	19,303	19,515	19,727

Project Cost Summary 1,000USD

Item	FSL=405									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,199	3,209	3,220	3,229	3,238	3,247	3,256	3,264	3,273	3,281
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	26,280	26,280	26,280	26,280	26,280	26,280	26,280	26,280	26,280	26,280
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	146,177	146,641	147,105	147,510	147,916	148,321	148,727	149,074	149,479	149,826
(3) Intake	92	138	175	207	235	261	285	307	328	348
(4) Power Tunnel	0	0	0	0	0	0	0	0	0	0
(5) Penstock	0	0	0	0	0	0	0	0	0	0
(6) Power House	0	0	0	0	0	0	0	0	0	0
(7) Tailrace Tunnel	0	0	0	0	0	0	0	0	0	0
(8) Tailrace	0	0	0	0	0	0	0	0	0	0
(9) Others	7,616	7,642	7,667	7,689	7,710	7,732	7,753	7,772	7,793	7,811
4. Hydro- Mechanical Works										
(1) Gate & Screen	2,746	2,769	2,793	2,816	2,839	2,863	2,885	2,909	2,932	2,955
(2) Penstocks	222	234	247	259	272	284	296	309	321	333
5. Electro- Mechanical Works	28,167	29,351	30,504	31,637	33,024	34,116	34,928	35,993	37,044	38,081
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	230,722	232,488	234,213	235,850	237,738	239,327	240,634	242,130	243,672	245,138
7. Administration Fee	34,608	34,873	35,132	35,378	35,661	35,899	36,095	36,319	36,551	36,771
8. Contingency	23,072	23,249	23,421	23,585	23,774	23,933	24,063	24,213	24,367	24,514
9. Interest During Construction	57,680	58,122	58,553	58,963	59,434	59,832	60,158	60,532	60,918	61,284
Total	346,083	348,732	351,320	353,775	356,606	358,991	360,950	363,195	365,508	367,707

Basic Parameters	OP1-410					
Waterway Length						
Headrace Tunnel	m	0				
Penstock	m	186.31	12.51	83.3	72.2	18.3
Tailrace Tunnel	m	0				
	m	186.31				
Sedimentation Level	EL.m	386.2				

Specification

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	83.3	87.8	92.4	96.9	101.5	106	110.6	115.1	119.7	124.2
FSL	EL.m	410	410	410	410	410	410	410	410	410	410
MOL	EL.m	394.8	395	395.2	395.4	395.6	395.8	396	396.2	396.2	396.4
TWL	EL.m	307.9	308.1	308.2	308.3	308.4	308.5	308.6	308.7	308.8	308.8
Loss	m	1	1	1	1	1	1	1	1	1	1
Effective Head	m	101.1	100.9	100.8	100.7	100.6	100.5	100.4	100.3	100.2	100.2
Pmax	MW	75	79	83	87	91	95	99	103	107	111
Primary Energy	GWh	149.17	156.46	163.80	170.90	177.77	184.21	190.38	195.95	201.23	206.32
Pfirm	MW	55.52	58.55	61.50	62.18	65.28	68.33	70.02	59.48	53.80	50.67
Benefit	1000USD	41,291	43,403	45,501	46,877	48,942	50,920	52,446	50,203	49,370	49,271
Cost	1000USD	36,759	37,009	37,253	37,484	37,722	37,948	38,171	38,392	38,611	38,825
B/C		1.12	1.17	1.22	1.25	1.30	1.34	1.37	1.31	1.28	1.27

Civil & Hydromechanical Work Quantity

(1) Dam											
Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	26	26.7	27.4	28	28.7	29.3	29.9	30.5	31.1	31.7
Dam Height (Hd)	m	122									
Crest Length (L)	m	199.2	199.9	200.6	201.2	201.9	202.5	203.1	203.7	204.3	204.9
Coefficient for Ex	Y=A*X^B										
A		22700									
B		0.5115									
Coefficient for Conc	Y=C*X^D										
C		0.0157									
D		1.1514									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	3,974,527	3,981,664	3,988,790	3,994,888	4,001,991	4,008,070	4,014,140	4,020,202	4,026,254	4,032,298
Concrete	m3	444,397	446,195	447,995	449,538	451,339	452,884	454,429	455,975	457,522	459,070
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake		included in Dam									
Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	394.8	395	395.2	395.4	395.6	395.8	396	396.2	396.2	396.4
Waterway Diameter	m	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	4.5	4.6
Available Height	m	15.2	15	14.8	14.6	14.4	14.2	14	13.8	13.8	13.6

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	907	1,279	1,562	1,799	2,006	2,192	2,361	2,517	2,670	2,806
Concrete	m3	459	701	896	1,066	1,219	1,359	1,490	1,612	1,733	1,843
Reinforce Bar	t	18	28	36	43	49	54	60	64	69	74
Intake Gate	t	208	219	230	241	253	264	275	286	298	309
Intake Screen	t	116	122	128	134	140	147	153	159	165	171

(3) Power Tunnel											
Tunnel Inner Diameter	m	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	4.5	4.6
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks		
Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	2.8483076	2.924231	2.999856	3.072036	3.144108	3.213049	3.282025	3.348128	3.414377	3.477965
tm	mm	11.102422	11.32675	11.55856	11.77894	11.99851	12.2077	12.41656	12.61588	12.81524	13.01666

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	334	350	366	382	399	415	431	446	462	478

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	5.5	5.7	5.8	5.9	6.1	6.2	6.3	6.5	6.6	6.7
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace Included in Dam

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel

Tunnel Length	m	0									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=410									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	71,541	71,670	71,798	71,908	72,036	72,145	72,255	72,364	72,473	72,581
Concrete	57,772	58,005	58,239	58,440	58,674	58,875	59,076	59,277	59,478	59,679
Others	25,863	25,935	26,008	26,070	26,142	26,204	26,266	26,328	26,390	26,452
(2)Intake										
Excavation	17	24	30	34	38	42	45	48	51	53
Concrete	55	84	108	128	146	163	179	193	208	221
Reinforce Bar	15	23	30	35	40	45	49	54	58	61
Others	22	33	42	49	56	62	68	74	79	84
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	8,067	8,091	8,115	8,136	8,159	8,179	8,200	8,219	8,239	8,259
Total	169,405	169,919	170,422	170,853	171,345	171,769	172,190	172,609	173,028	173,444

Hydro- mechanical Works

1,000USD

Item	FSL=410									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	1,366	1,439	1,514	1,587	1,661	1,734	1,808	1,880	1,955	2,028
Screen	759	800	841	881	923	963	1,004	1,045	1,086	1,126
(3)Penstock	1,270	1,330	1,392	1,453	1,515	1,575	1,636	1,696	1,757	1,818
(4)Tailrace										
Gate										
(5)Others	3,055	3,089	3,125	3,160	3,195	3,230	3,265	3,300	3,335	3,370
Total	18,328	18,536	18,750	18,959	19,171	19,379	19,591	19,798	20,011	20,219

Project Cost Summary

1,000USD

Item	FSL=410									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,388	3,398	3,408	3,417	3,427	3,435	3,444	3,452	3,461	3,469
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	28,230	28,230	28,230	28,230	28,230	28,230	28,230	28,230	28,230	28,230
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	155,176	155,610	156,045	156,417	156,852	157,224	157,596	157,969	158,341	158,712
(3) Intake	109	165	209	247	281	312	341	368	395	419
(4) Power Tunnel	0	0	0	0	0	0	0	0	0	0
(5) Penstock	0	0	0	0	0	0	0	0	0	0
(6) Power House	0	0	0	0	0	0	0	0	0	0
(7) Tailrace Tunnel	0	0	0	0	0	0	0	0	0	0
(8) Tailrace	0	0	0	0	0	0	0	0	0	0
(9) Others	8,067	8,091	8,115	8,136	8,159	8,179	8,200	8,219	8,239	8,259
4. Hydro- Mechanical Works										
(1) Gate & Screen	2,801	2,823	2,846	2,869	2,892	2,915	2,938	2,960	2,984	3,006
(2) Penstocks	254	266	278	291	303	315	327	339	351	364
5. Electro- Mechanical Works	30,810	31,919	33,001	34,066	35,116	36,151	37,174	38,183	39,180	40,152
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	245,057	246,726	248,356	249,896	251,483	252,985	254,472	255,944	257,403	258,835
7. Administration Fee	36,759	37,009	37,253	37,484	37,722	37,948	38,171	38,392	38,611	38,825
8. Contingency	24,506	24,673	24,836	24,990	25,148	25,299	25,447	25,594	25,740	25,883
9. Interest During Construction	61,264	61,681	62,089	62,474	62,871	63,246	63,618	63,986	64,351	64,709
Total	367,586	370,089	372,534	374,843	377,224	379,478	381,708	383,915	386,105	388,252

Basic Parameters	OP1- 420					
Waterway Length						
Headrace Tunnel	m	0				
Penstock	m	186.31	12.51	83.3	72.2	18.3
Tailrace Tunnel	m	0				
	m	186.31				
Sedimentation Level	EL.m	386.2				

Specification

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	101.88	106.7	111.6	116.5	121.3	126.2	131	135.9	140.7	145.6
FSL	EL.m	420	420	420	420	420	420	420	420	420	420
MOL	EL.m	395.6	395.8	396	396.2	396.4	396.6	396.6	396.8	397	397.2
TWL	EL.m	308.4	308.5	308.6	308.7	308.8	308.9	309	309.1	309.2	309.3
Loss	m	1	1	1	1	1	1	1	1	1	1
Effective Head	m	110.6	110.5	110.4	110.3	110.2	110.1	110	109.9	109.8	109.7
Pmax	MW	101	105	110	115	119	124	129	133	138	143
Primary Energy	GWh	191.20	198.96	206.78	214.14	220.52	226.96	232.71	238.28	243.63	248.25
Pfirm	MW	64.55	65.66	68.81	71.98	75.11	78.31	74.55	61.16	59.49	54.96
Benefit	1000USD	50,940	52,554	54,791	56,957	58,950	60,974	60,795	57,696	58,079	57,482
Cost	1000USD	41,834	42,076	42,350	42,609	42,830	43,094	43,345	43,560	43,806	44,039
B/C		1.22	1.25	1.29	1.34	1.38	1.41	1.40	1.32	1.33	1.31

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	28.7	29.4	30.1	30.7	31.3	32	32.6	33.2	33.8	34.3
Dam Height (Hd)	m	132									
Crest Length (L)	m	201.9	202.6	203.3	203.9	204.5	205.2	205.8	206.4	207	207.5
Coefficient for Ex	Y=A*X^B										
A		22700									
B		0.5115									
Coefficient for Conc	Y=C*X^D										
C		0.0157									
D		1.1514									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,166,551	4,173,933	4,181,304	4,187,611	4,193,909	4,201,246	4,207,525	4,213,795	4,220,056	4,225,267
Concrete	m3	541,117	543,278	545,440	547,294	549,148	551,313	553,170	555,027	556,885	558,434
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake included in Dam

Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	395.6	395.8	396	396.2	396.4	396.6	396.6	396.8	397	397.2
Waterway Diameter	m	4.2	4.3	4.4	4.5	4.6	4.7	4.7	4.8	4.9	5
Available Height	m	24.4	24.2	24	23.8	23.6	23.4	23.4	23.2	23	22.8

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	1,112	1,570	1,920	2,213	2,470	2,701	2,917	3,113	3,296	3,468
Concrete	m3	590	902	1,155	1,376	1,575	1,758	1,933	2,094	2,246	2,391
Reinforce Bar	t	24	36	46	55	63	70	77	84	90	96
Intake Gate	t	266	279	291	304	316	329	342	354	367	379
Intake Screen	t	148	155	162	169	176	183	190	197	204	211

(3) Power Tunnel

Tunnel Inner Diameter	m	4.2	4.3	4.4	4.5	4.6	4.7	4.7	4.8	4.9	5
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks

Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	3.1499877	3.22364	3.296829	3.368429	3.437121	3.505856	3.571906	3.638096	3.701787	3.765694
tm	mm	13.003159	13.25034	13.49545	13.73456	13.9631	14.19137	14.40987	14.62845	14.83795	15.04779

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	433	451	470	489	507	526	544	562	580	599

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	6.1	6.2	6.4	6.5	6.6	6.8	6.9	7	7.2	7.3
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace Included in Dam

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel											
Tunnel Length	m	0									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=420									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	74,998	75,131	75,263	75,377	75,490	75,622	75,735	75,848	75,961	76,055
Concrete	70,345	70,626	70,907	71,148	71,389	71,671	71,912	72,153	72,395	72,596
Others	29,069	29,151	29,234	29,305	29,376	29,459	29,530	29,600	29,671	29,730
(2)Intake										
Excavation	21	30	36	42	47	51	55	59	63	66
Concrete	71	108	139	165	189	211	232	251	269	287
Reinforce Bar	20	30	38	46	52	58	64	70	75	79
Others	28	42	53	63	72	80	88	95	102	108
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	9,030	9,059	9,086	9,110	9,133	9,160	9,183	9,207	9,229	9,249
Total	189,634	190,230	190,811	191,309	191,802	192,366	192,853	193,337	193,818	194,223

Hydro- mechanical Works 1,000USD

Item	FSL=420									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	1,749	1,831	1,914	1,997	2,079	2,162	2,244	2,327	2,409	2,491
Screen	972	1,017	1,063	1,110	1,155	1,201	1,247	1,293	1,338	1,384
(3)Penstock	1,645	1,715	1,787	1,858	1,927	1,998	2,067	2,137	2,206	2,276
(4)Tailrace										
Gate										
(5)Others	3,249	3,288	3,328	3,369	3,408	3,448	3,487	3,527	3,566	3,606
Total	19,491	19,729	19,970	20,211	20,446	20,686	20,923	21,162	21,396	21,634

Project Cost Summary 1,000USD

Item	FSL=420									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,793	3,805	3,816	3,826	3,836	3,847	3,857	3,867	3,876	3,884
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	174,412	174,908	175,405	175,830	176,256	176,752	177,177	177,602	178,027	178,381
(3) Intake	139	210	267	316	360	401	439	475	508	540
(4) Power Tunnel	0	0	0	0	0	0	0	0	0	0
(5) Penstock	0	0	0	0	0	0	0	0	0	0
(6) Power House	0	0	0	0	0	0	0	0	0	0
(7) Tailrace Tunnel	0	0	0	0	0	0	0	0	0	0
(8) Tailrace	0	0	0	0	0	0	0	0	0	0
(9) Others	9,030	9,059	9,086	9,110	9,133	9,160	9,183	9,207	9,229	9,249
4. Hydro- Mechanical Works										
(1) Gate & Screen	2,920	2,945	2,971	2,997	3,022	3,048	3,074	3,100	3,125	3,151
(2) Penstocks	329	343	357	372	385	400	413	427	441	455
5. Electro- Mechanical Works	36,476	37,445	38,639	39,815	40,747	41,896	43,030	43,930	45,040	46,137
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	278,891	280,508	282,334	284,059	285,533	287,296	288,966	290,399	292,039	293,590
7. Administration Fee	41,834	42,076	42,350	42,609	42,830	43,094	43,345	43,560	43,806	44,039
8. Contingency	27,889	28,051	28,233	28,406	28,553	28,730	28,897	29,040	29,204	29,359
9. Interest During Construction	69,723	70,127	70,583	71,015	71,383	71,824	72,242	72,600	73,010	73,398
Total	418,336	420,762	423,501	426,088	428,299	430,944	433,449	435,599	438,059	440,385

Basic Parameters OP1- 415

Waterway Length						
Headrace Tunnel	m	0				
Penstock	m	186.31	12.51	83.3	72.2	18.3
Tailrace Tunnel	m	0				
	m	186.31				
Sedimentation Level	EL.m	386.2				

Specification

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	92.2	96.9	101.7	106.4	111.2	115.9	120.7	125.4	130.2	134.92
FSL	EL.m	415	415	415	415	415	415	415	415	415	415
MOL	EL.m	395.2	395.4	395.6	395.8	396	396.2	396.4	396.4	396.6	396.8
TWL	EL.m	308.2	308.3	308.4	308.5	308.6	308.7	308.8	308.9	309	309.1
Loss	m	1	1	1	1	1	1	1	1	1	1
Effective Head	m	105.8	105.7	105.6	105.5	105.4	105.3	105.2	105.1	105	104.9
Pmax	MW	87	91	96	100	105	109	113	118	122	126
Primary Energy	GWh	169.14	176.73	184.68	191.97	199.08	205.28	211.18	216.94	222.40	227.10
Pfirm	MW	60.81	62.65	64.24	66.91	70.09	73.21	72.09	62.61	58.08	52.05
Benefit	1000USD	46,175	47,981	49,770	51,775	53,904	55,864	56,502	54,608	54,150	53,117
Cost	1000USD	38,977	39,222	39,501	39,738	39,999	40,220	40,451	40,703	40,919	41,132
B/C		1.18	1.22	1.26	1.30	1.35	1.39	1.40	1.34	1.32	1.29

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	27.3	28	28.7	29.4	30	30.6	31.3	31.9	32.5	33.1
Dam Height (Hd)	m	127									
Crest Length (L)	m	200.5	201.2	201.9	202.6	203.2	203.8	204.5	205.1	205.7	206.3
Coefficient for Ex	Y=A*X^B										
A		22700									
B		0.5115									
Coefficient for Conc	Y=C*X^D										
C		0.0157									
D		1.1514									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,070,549	4,077,812	4,085,062	4,092,301	4,098,495	4,104,681	4,111,886	4,118,053	4,124,210	4,130,359
Concrete	m3	491,126	493,101	495,077	497,054	498,749	500,445	502,425	504,123	505,821	507,520
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake included in Dam

Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	395.2	395.4	395.6	395.8	396	396.2	396.4	396.4	396.6	396.8
Waterway Diameter	m	4	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8
Available Height	m	19.8	19.6	19.4	19.2	19	18.8	18.6	18.6	18.4	18.2

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	1,015	1,432	1,750	2,017	2,250	2,459	2,651	2,834	2,999	3,155
Concrete	m3	527	806	1,031	1,227	1,404	1,567	1,718	1,865	2,000	2,128
Reinforce Bar	t	21	32	41	49	56	63	69	75	80	85
Intake Gate	t	236	248	260	272	284	296	308	320	332	344
Intake Screen	t	131	138	144	151	158	164	171	178	185	191

(3) Power Tunnel

Tunnel Inner Diameter	m	4	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks

Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	2.9966074	3.072036	3.147204	3.219105	3.290916	3.359743	3.428609	3.494726	3.560983	3.624954
tm	mm	12.017179	12.25971	12.5009	12.73073	12.9598	13.1785	13.3969	13.60574	13.81463	14.01553

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	381	398	416	433	451	468	485	502	520	537

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8	6.9	7
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace	Included in Dam										
Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel											
Tunnel Length	m	0									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=415									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	73,270	73,401	73,531	73,661	73,773	73,884	74,014	74,125	74,236	74,346
Concrete	63,846	64,103	64,360	64,617	64,837	65,058	65,315	65,536	65,757	65,978
Others	27,423	27,501	27,578	27,656	27,722	27,788	27,866	27,932	27,999	28,065
(2)Intake										
Excavation	19	27	33	38	43	47	50	54	57	60
Concrete	63	97	124	147	168	188	206	224	240	255
Reinforce Bar	18	27	34	41	47	52	57	62	66	71
Others	25	38	48	57	64	72	78	85	91	96
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	8,536	8,562	8,588	8,614	8,635	8,657	8,682	8,704	8,725	8,746
Total	179,254	179,808	180,349	180,884	181,343	181,799	182,322	182,774	183,223	183,671

Hydro- mechanical Works

1,000USD

Item	FSL=415									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	1,551	1,629	1,709	1,787	1,867	1,945	2,024	2,103	2,183	2,261
Screen	861	905	949	993	1,037	1,080	1,125	1,168	1,213	1,256
(3)Penstock	1,446	1,512	1,580	1,646	1,713	1,778	1,845	1,909	1,975	2,040
(4)Tailrace										
Gate										
(5)Others	3,147	3,185	3,223	3,261	3,299	3,336	3,374	3,412	3,450	3,487
Total	18,883	19,109	19,339	19,564	19,793	20,017	20,245	20,470	20,698	20,921

Project Cost Summary

1,000USD

Item	FSL=415									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,585	3,596	3,607	3,618	3,627	3,636	3,646	3,655	3,664	3,673
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	30,180	30,180	30,180	30,180	30,180	30,180	30,180	30,180	30,180	30,180
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	164,540	165,005	165,469	165,934	166,332	166,731	167,195	167,593	167,991	168,389
(3) Intake	125	188	239	283	322	358	392	424	454	482
(4) Power Tunnel	0	0	0	0	0	0	0	0	0	0
(5) Penstock	0	0	0	0	0	0	0	0	0	0
(6) Power House	0	0	0	0	0	0	0	0	0	0
(7) Tailrace Tunnel	0	0	0	0	0	0	0	0	0	0
(8) Tailrace	0	0	0	0	0	0	0	0	0	0
(9) Others	8,536	8,562	8,588	8,614	8,635	8,657	8,682	8,704	8,725	8,746
4. Hydro- Mechanical Works										
(1) Gate & Screen	2,858	2,882	2,907	2,931	2,956	2,981	3,005	3,030	3,055	3,079
(2) Penstocks	289	302	316	329	343	356	369	382	395	408
5. Electro- Mechanical Works	33,509	34,541	35,808	36,810	38,041	39,015	39,979	41,165	42,105	43,036
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	259,844	261,479	263,337	264,921	266,659	268,136	269,671	271,355	272,791	274,216
7. Administration Fee	38,977	39,222	39,501	39,738	39,999	40,220	40,451	40,703	40,919	41,132
8. Contingency	25,984	26,148	26,334	26,492	26,666	26,814	26,967	27,136	27,279	27,422
9. Interest During Construction	64,961	65,370	65,834	66,230	66,665	67,034	67,418	67,839	68,198	68,554
Total	389,766	392,219	395,006	397,382	399,989	402,204	404,506	407,033	409,187	411,324

Basic Parameters	OP1- 425										
Waterway Length											
Headrace Tunnel	m	0									
Penstock	m	186.31	12.51	83.3	72.2	18.3					
Tailrace Tunnel	m	0									
	m	186.31									
Sedimentation Level	EL.m	386.2									

Specification

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	112.5	117.4	122.2	127.1	131.9	136.8	141.6	146.5	151.3	156.2
FSL	EL.m	425	425	425	425	425	425	425	425	425	425
MOL	EL.m	396	396.2	396.4	396.6	396.8	397	397	397.2	397.4	397.6
TWL	EL.m	308.6	308.7	308.8	308.9	309	309.1	309.2	309.3	309.4	309.5
Loss	m	1	1	1	1	1	1	1	1	1	1
Effective Head	m	115.4	115.3	115.2	115.1	115	114.9	114.8	114.7	114.6	114.5
Pmax	MW	116	121	126	131	135	140	145	150	155	160
Primary Energy	GWh	215.25	223.05	230.19	237.29	243.19	249.21	254.71	260.22	265.33	269.14
Pfirm	MW	68.05	71.00	74.06	77.20	80.29	78.34	73.67	59.80	59.33	52.70
Benefit	1000USD	55,961	58,134	60,232	62,346	64,248	64,656	64,163	60,911	61,614	60,253
Cost	1000USD	44,779	45,041	45,311	45,565	45,784	46,034	46,281	46,514	46,756	46,997
B/C		1.25	1.29	1.33	1.37	1.40	1.40	1.39	1.31	1.32	1.28

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	30.2	30.8	31.5	32.1	32.7	33.3	33.9	34.4	35	35.6
Dam Height (Hd)	m	137									
Crest Length (L)	m	203.4	204	204.7	205.3	205.9	206.5	207.1	207.6	208.2	208.8
Coefficient for Ex	Y=A*X^B										
A		22700									
B		0.5115									
Coefficient for Conc	Y=C*X^D										
C		0.0157									
D		1.1514									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,262,653	4,269,080	4,276,566	4,282,973	4,289,371	4,295,760	4,302,140	4,307,450	4,313,813	4,320,167
Concrete	m3	594,532	596,552	598,909	600,931	602,953	604,977	607,001	608,689	610,715	612,742
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake		included in Dam									
Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	396	396.2	396.4	396.6	396.8	397	397	397.2	397.4	397.6
Waterway Diameter	m	4.4	4.5	4.6	4.7	4.8	4.9	4.9	5	5.1	5.2
Available Height	m	29	28.8	28.6	28.4	28.2	28	28	27.8	27.6	27.4

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	1,202	1,698	2,076	2,394	2,672	2,923	3,157	3,370	3,568	3,756
Concrete	m3	649	993	1,272	1,515	1,735	1,937	2,130	2,307	2,476	2,637
Reinforce Bar	t	26	40	51	61	69	77	85	92	99	105
Intake Gate	t	299	312	325	338	350	363	376	389	401	414
Intake Screen	t	166	173	180	188	195	202	209	216	223	230

(3) Power Tunnel											
Tunnel Inner Diameter	m	4.4	4.5	4.6	4.7	4.8	4.9	4.9	5	5.1	5.2
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks

Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	3.3100964	3.381415	3.449848	3.518335	3.584155	3.650122	3.713608	3.777315	3.838697	3.900362
tm	mm	14.059741	14.30899	14.54731	14.78538	15.01335	15.24144	15.46012	15.67921	15.88948	16.10039

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	492	511	530	550	569	588	607	626	645	664

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	6.4	6.5	6.7	6.8	6.9	7.1	7.2	7.3	7.4	7.5
Concerete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace Included in Dam

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel

Tunnel Length	m	0

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=425									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	76,728	76,843	76,978	77,094	77,209	77,324	77,439	77,534	77,649	77,763
Concrete	77,289	77,552	77,858	78,121	78,384	78,647	78,910	79,130	79,393	79,656
Others	30,803	30,879	30,967	31,043	31,119	31,194	31,270	31,333	31,408	31,484
(2)Intake										
Excavation	23	32	39	45	51	56	60	64	68	71
Concrete	78	119	153	182	208	232	256	277	297	316
Reinforce Bar	22	33	42	50	58	64	71	77	82	88
Others	31	46	59	69	79	88	97	104	112	119
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	9,551	9,578	9,607	9,633	9,658	9,683	9,708	9,729	9,753	9,778
Total	200,577	201,135	201,757	202,290	202,818	203,341	203,862	204,300	204,815	205,328

Hydro- mechanical Works 1,000USD

Item	FSL=425									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	1,965	2,050	2,133	2,217	2,300	2,385	2,469	2,553	2,636	2,721
Screen	1,091	1,139	1,185	1,232	1,278	1,325	1,372	1,419	1,464	1,511
(3)Penstock	1,869	1,943	2,015	2,089	2,161	2,234	2,306	2,378	2,449	2,522
(4)Tailrace										
Gate										
(5)Others	3,361	3,402	3,442	3,483	3,523	3,564	3,605	3,646	3,686	3,726
Total	20,163	20,411	20,653	20,899	21,140	21,386	21,628	21,873	22,113	22,358

Project Cost Summary 1,000USD

Item	FSL=425									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	4,012	4,023	4,035	4,046	4,056	4,067	4,077	4,086	4,096	4,107
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	40,960	40,960	40,960	40,960	40,960	40,960	40,960	40,960	40,960	40,960
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	184,820	185,274	185,804	186,257	186,711	187,165	187,618	187,996	188,450	188,903
(3) Intake	153	230	293	347	396	440	483	522	559	594
(4) Power Tunnel	0	0	0	0	0	0	0	0	0	0
(5) Penstock	0	0	0	0	0	0	0	0	0	0
(6) Power House	0	0	0	0	0	0	0	0	0	0
(7) Tailrace Tunnel	0	0	0	0	0	0	0	0	0	0
(8) Tailrace	0	0	0	0	0	0	0	0	0	0
(9) Others	9,551	9,578	9,607	9,633	9,658	9,683	9,708	9,729	9,753	9,778
4. Hydro- Mechanical Works										
(1) Gate & Screen	2,987	3,013	3,039	3,065	3,091	3,118	3,144	3,170	3,196	3,222
(2) Penstocks	374	389	403	418	432	447	461	476	490	504
5. Electro- Mechanical Works	39,446	40,586	41,710	42,821	43,703	44,790	45,866	46,930	47,983	49,025
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	298,525	300,275	302,074	303,770	305,230	306,892	308,539	310,091	311,709	313,316
7. Administration Fee	44,779	45,041	45,311	45,565	45,784	46,034	46,281	46,514	46,756	46,997
8. Contingency	29,853	30,028	30,207	30,377	30,523	30,689	30,854	31,009	31,171	31,332
9. Interest During Construction	74,631	75,069	75,518	75,942	76,307	76,723	77,135	77,523	77,927	78,329
Total	447,788	450,413	453,111	455,655	457,845	460,338	462,809	465,136	467,564	469,974

Basic Parameters	OP1- 435					
Waterway Length						
Headrace Tunnel	m	0				
Penstock	m	186.31	12.51	83.3	72.2	18.3
Tailrace Tunnel	m	0				
	m	186.31				
Sedimentation Level	EL.m	386.2				

Specification

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	134.2	139.1	144	149	153.9	158.8	163.7	168.7	173.6	178.5
FSL	EL.m	435	435	435	435	435	435	435	435	435	435
MOL	EL.m	396.8	397	397.2	397.4	397.4	397.6	397.8	398	398.2	398.2
TWL	EL.m	309.1	309.1	309.2	309.3	309.4	309.5	309.6	309.7	309.8	309.9
Loss	m	1	1	1	1	1	1	1	1	1	1
Effective Head	m	124.9	124.9	124.8	124.7	124.6	124.5	124.4	124.3	124.2	124.1
Pmax	MW	150	155	160	166	171	176	182	187	192	198
Primary Energy	GWh	265.74	273.31	279.93	286.34	291.74	296.79	301.71	305.86	309.10	312.30
Pfirm	MW	78.12	81.26	84.31	87.43	83.37	72.85	69.28	66.56	57.04	54.75
Benefit	1000USD	67,320	69,512	71,520	73,515	73,188	70,865	70,606	70,475	68,153	67,995
Cost	1000USD	52,451	52,706	52,958	53,224	53,471	53,715	53,973	54,214	54,440	54,692
B/C		1.28	1.32	1.35	1.38	1.37	1.32	1.31	1.30	1.25	1.24

Civil & Hydromechanical Work Quantity

(1) Dam											
Design Flood	m3/s	8,306									
Dam Basis EL.	m	293									
Non- overflow Width	m	80.2									
Spillway Width	m	77									
Sand Drain Width	m	16									
Intake Width	m	33	33.6	34.2	34.7	35.3	35.9	36.4	37	37.5	38
Dam Height (Hd)	m	147									
Crest Length (L)	m	206.2	206.8	207.4	207.9	208.5	209.1	209.6	210.2	210.7	211.2
Coefficient for Ex	Y=A*X^B										
	A	22700									
	B	0.5115									
Coefficient for Conc	Y=C*X^D										
	C	0.0157									
	D	1.1514									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,450,075	4,456,694	4,463,303	4,468,803	4,475,396	4,481,978	4,487,457	4,494,023	4,499,488	4,504,946
Concrete	m3	710,346	712,726	715,108	717,093	719,477	721,861	723,849	726,235	728,225	730,215
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake		included in Dam									
Number	-	2									
Design Velocity	m3/s	3.7									
MOL	EL.m	396.8	397	397.2	397.4	397.4	397.6	397.8	398	398.2	398.2
Waterway Diameter	m	4.8	4.9	5	5.1	5.1	5.2	5.3	5.4	5.5	5.5
Available Height	m	38.2	38	37.8	37.6	37.6	37.4	37.2	37	36.8	36.8

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	1,364	1,927	2,357	2,719	3,039	3,326	3,588	3,831	4,059	4,278
Concrete	m3	759	1,160	1,487	1,772	2,033	2,270	2,493	2,702	2,901	3,095
Reinforce Bar	t	30	46	59	71	81	91	100	108	116	124
Intake Gate	t	367	380	393	407	420	434	447	460	474	487
Intake Screen	t	204	211	219	226	234	241	248	256	263	271

(3) Power Tunnel											
Tunnel Inner Diameter	m	4.8	4.9	5	5.1	5.1	5.2	5.3	5.4	5.5	5.5
Concrete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(4) Penstocks		
Design Velocity 1	m/s	3.7
Penstock Length 1	m	12.51
Design Velocity 2	m/s	5.35
Penstock Length 2	m	83.3
Design Velocity 3	m/s	7.27

Penstock Length 3	m	72.2									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.3									
Mean Velocity	m/s	6.5365916									
Dm	m	3.6152692	3.680679	3.744947	3.809408	3.87154	3.932689	3.992903	4.053423	4.111869	4.169495
tm	mm	16.246583	16.50434	16.74588	16.98777	17.22011	17.44819	17.67222	17.89708	18.11343	18.3262

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3										
Lining Concrete	m3										
Reinforce Bar	t										
Penstock	t	621	642	663	684	705	725	746	767	787	807

(5) Powerhouse	included in dam										
A	m2	0	0	0	0	0	0	0	0	0	0
d	m	0									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	0	0	0	0	0	0	0	0	0	0
Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(6) Tailrace Tunnel											
Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	7	7.1	7.2	7.4	7.5	7.6	7.7	7.8	7.9	8.1
Concrete Thickness	m	0.6									
Tunnel Length	m	0									
Number	-	1									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

(7) Tailrace Included in Dam

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3										
Concrete	m3										
Reinforce Bar	t										

(8) P/H Access Tunnel

Tunnel Length	m	0									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	0	0	0	0	0	0	0	0	0	0
Lining Concrete	m3	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	t	0	0	0	0	0	0	0	0	0	0

Civil Work Cost 1,000USD

Item	FSL=435									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment (NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	80,101	80,220	80,339	80,438	80,557	80,676	80,774	80,892	80,991	81,089
Concrete	92,345	92,654	92,964	93,222	93,532	93,842	94,100	94,411	94,669	94,928
Others	34,489	34,575	34,661	34,732	34,818	34,904	34,975	35,061	35,132	35,203
(2)Intake										
Excavation	26	37	45	52	58	63	68	73	77	81
Concrete	91	139	178	213	244	272	299	324	348	371
Reinforce Bar	25	39	49	59	67	75	83	90	96	103
Others	36	54	68	81	92	103	113	122	130	139
(3)Power Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(4)Penstock										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(5)Power House										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0

Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(6)Tailrace Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(7)Tailrace										
Excavation	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(8)P/H Access Tunnel										
Tunnel Excavation	0	0	0	0	0	0	0	0	0	0
Lining Concrete	0	0	0	0	0	0	0	0	0	0
Reinforce Bar	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0
(9)Miscellaneous Works	10,658	10,689	10,718	10,742	10,771	10,799	10,823	10,851	10,875	10,898
Total	223,825	224,459	225,076	225,592	226,192	226,787	227,288	227,876	228,372	228,866

Hydro- mechanical Works

1,000USD

Item	FSL=435									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	2,410	2,498	2,585	2,674	2,762	2,849	2,936	3,025	3,112	3,200
Screen	1,339	1,388	1,436	1,486	1,534	1,583	1,631	1,681	1,729	1,778
(3)Penstock	2,359	2,439	2,518	2,599	2,677	2,756	2,834	2,913	2,991	3,068
(4)Tailrace										
Gate										
(5)Others	3,597	3,640	3,683	3,727	3,770	3,813	3,856	3,899	3,942	3,985
Total	21,583	21,843	22,101	22,363	22,622	22,878	23,135	23,396	23,652	23,909

Project Cost Summary

1,000USD

Item	FSL=435									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	4,476	4,489	4,502	4,512	4,524	4,536	4,546	4,558	4,567	4,577
(1) Access Road										
(2) Compensation										
(3) Others										
2. Environmental Mitigation	61,990	61,990	61,990	61,990	61,990	61,990	61,990	61,990	61,990	61,990
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	206,936	207,450	207,964	208,393	208,907	209,421	209,850	210,364	210,792	211,220
(3) Intake	178	268	341	404	461	514	563	608	652	694
(4) Power Tunnel	0	0	0	0	0	0	0	0	0	0
(5) Penstock	0	0	0	0	0	0	0	0	0	0
(6) Power House	0	0	0	0	0	0	0	0	0	0
(7) Tailrace Tunnel	0	0	0	0	0	0	0	0	0	0
(8) Tailrace	0	0	0	0	0	0	0	0	0	0
(9) Others	10,658	10,689	10,718	10,742	10,771	10,799	10,823	10,851	10,875	10,898
4. Hydro- Mechanical Works										
(1) Gate & Screen	3,125	3,153	3,180	3,207	3,235	3,262	3,289	3,317	3,344	3,371
(2) Penstocks	472	488	504	520	535	551	567	583	598	614
5. Electro- Mechanical Works	45,613	46,623	47,635	48,834	49,825	50,807	51,971	52,935	53,891	55,024
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	349,671	351,372	353,056	354,825	356,471	358,103	359,821	361,428	362,931	364,612
7. Administration Fee	52,451	52,706	52,958	53,224	53,471	53,715	53,973	54,214	54,440	54,692
8. Contingency	34,967	35,137	35,306	35,482	35,647	35,810	35,982	36,143	36,293	36,461
9. Interest During Construction	87,418	87,843	88,264	88,706	89,118	89,526	89,955	90,357	90,733	91,153
Total	524,507	527,058	529,583	532,237	534,707	537,154	539,731	542,141	544,397	546,918

Option II

Basic Parameters OP2- 405

Waterway Length		
Headrace Tunnel	m	56.4
Penstock	m	176.2
Tailrace Tunnel	m	106
Sedimentation Level	m	386.2

Specification

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	65.4	70.2	75	79.8	84.6	89.3	94.1	98.9	103.7	108.5
FSL	EL.m	405	405	405	405	405	405	405	405	405	405
MOL	EL.m	397	397.4	397.6	398	398.2	398.6	399	399.2	399.4	399.8
TWL	EL.m	307.6	307.6	307.7	307.7	307.7	307.8	307.8	307.8	307.8	307.9
Loss	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Effective Head	m	96.2	96.2	96.1	96.1	96.1	96	96	96	96	95.9
Pmax	MW	56	60	64	68	73	76	81	85	89	93
Primary Energy	GWh	115.44	123.60	131.56	139.56	147.49	154.17	161.42	168.04	174.27	180.10
Pfirm	MW	45.75	49.40	52.87	56.16	58.73	59.65	54.38	49.71	44.19	43.62
Benefit	1000USD	34,541	37,108	39,584	42,014	44,214	45,693	45,413	45,200	44,661	45,539
Cost	1000USD	33,069	33,373	33,657	33,952	34,268	34,512	34,836	35,097	35,355	35,630
B/C		1.04	1.11	1.18	1.24	1.29	1.32	1.30	1.29	1.26	1.28

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood		m3/s	8,306
Dam Basis EL.		m	293
Non- overflow Width		m	80.2
Spillway Width		m	77
Sand Drain Width		m	16
Intake Width		m	0
Dam Height (Hd)		m	117
Crest Length (L)		m	173.2
Coefficient for Ex	Y=A*X^B		
	A		32335
	B		0.4384
Coefficient for Conc	Y=C*X^D		
	C		0.0015
	D		1.3058

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	2,498,877	2,498,877	2,498,877	2,498,877	2,498,877	2,498,877	2,498,877	2,498,877	2,498,877	2,498,877
Concrete	m3	316,564	316,564	316,564	316,564	316,564	316,564	316,564	316,564	316,564	316,564
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake

Number	-	1									
Design Velocity	m3/s	3.5									
MOL	EL.m	397	397.4	397.6	398	398.2	398.6	399	399.2	399.4	399.8
Waterway Diameter	m	4.9	5.1	5.2	5.4	5.5	5.7	5.9	6	6.1	6.3
Available Height	m	8	7.6	7.4	7	6.8	6.4	6	5.8	5.6	5.2

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,795	4,930	5,075	5,193	5,326	5,427	5,525	5,640	5,751	5,832
Concrete	m3	3,562	3,685	3,819	3,929	4,052	4,147	4,239	4,348	4,453	4,531
Reinforce Bar	t	142	147	153	157	162	166	170	174	178	181
Intake Gate	t	78	84	89	95	101	106	112	117	123	128
Intake Screen	t	43	47	50	53	56	59	62	65	68	71

(3) Power Tunnel

Tunnel Inner Diameter	m	4.9	5.1	5.2	5.4	5.5	5.7	5.9	6	6.1	6.3
Concerete Thickness	m	0.6									
Tunnel Length	m	56.4									
Number	-	1									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	1,679	1,791	1,848	1,965	2,025	2,148	2,274	2,339	2,404	2,538
Lining Concrete	m3	615	639	650	674	685	709	733	744	756	780
Reinforce Bar	t	25	26	26	27	27	28	29	30	30	31

(3') Srevice Adit

Tunnel Length	m	1148									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	34,174	36,451	37,618	40,006	41,227	43,725	46,297	47,610	48,942	51,660

(4) Penstocks

Design Velocity 1	m/s	3.5									
Penstock Length 1	m	5									
Design Velocity 2	m/s	4.47									
Penstock Length 2	m	117.1									
Design Velocity 3	m/s	6.08									
Penstock Length 3	m	36									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.1									
Mean Velocity	m/s	5.542609									
Dm	m	3.876027	4.015748	4.150769	4.281534	4.408421	4.529222	4.649355	4.766461	4.880758	4.992439
tm	mm	13.81653	14.24249	14.64113	15.03937	15.4258	15.77953	16.14501	16.50129	16.84902	17.17317

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	3,566	3,765	3,962	4,158	4,353	4,542	4,735	4,926	5,117	5,307
Lining Concrete	m3	1,487	1,533	1,578	1,621	1,663	1,704	1,743	1,782	1,820	1,857
Reinforce Bar	t	18	18	19	19	20	20	21	21	22	22
Penstock	t	295	315	335	355	375	394	414	433	453	472

(5) Powerhouse Undergroundtype

A	m2	741.1007	767.8156	793.3566	818.3503	842.6029	865.3919	888.3455	910.7207	932.5593	953.5667
d	m	30									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	48,913	50,676	52,362	54,011	55,612	57,116	58,631	60,108	61,549	62,935
Concrete	m3	11,117	11,517	11,900	12,275	12,639	12,981	13,325	13,661	13,988	14,304
Reinforce Bar	t	44	46	48	49	51	52	53	55	56	57

(6) Tailrace Tunnel

Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	4.9	5.1	5.2	5.4	5.5	5.7	5.9	6	6.1	6.3
Concerete Thickness	m	0.6									
Tunnel Length	m	106									
Number	-	1									

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	3,155	3,366	3,473	3,694	3,807	4,037	4,275	4,396	4,519	4,770
Lining Concrete	m3	1,157	1,200	1,222	1,266	1,288	1,332	1,377	1,399	1,421	1,466
Reinforce Bar	t	46	48	49	51	52	53	55	56	57	59

(7) Tailrace

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,494	4,739	4,938	5,179	5,373	5,610	5,848	6,037	6,225	6,460
Concrete	m3	1,301	1,404	1,489	1,594	1,680	1,786	1,895	1,984	2,072	2,185
Reinforce Bar	t	21	22	22	23	24	25	26	26	27	28

(8) P/H Access Tunnel

Tunnel Length m 1663

Item	Unit	FSL=405									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835
Lining Concrete	m3	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630
Reinforce Bar	t	499	499	499	499	499	499	499	499	499	499

Civil Work Cost 1,000USD

Item	FSL=405									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	44,980	44,980	44,980	44,980	44,980	44,980	44,980	44,980	44,980	44,980
Concrete	41,153	41,153	41,153	41,153	41,153	41,153	41,153	41,153	41,153	41,153
Others	17,227	17,227	17,227	17,227	17,227	17,227	17,227	17,227	17,227	17,227
(2)Intake										
Excavation	91	94	96	99	101	103	105	107	109	111
Concrete	427	442	458	471	486	498	509	522	534	544
Reinforce Bar	118	122	127	130	135	138	141	144	148	150
Others	159	165	170	175	180	185	189	193	198	201
(3)Power Tunnel										
Tunnel Excavation	118	125	129	138	142	150	159	164	168	178
Lining Concrete	86	89	91	94	96	99	103	104	106	109
Reinforce Bar	22	22	23	24	24	25	26	26	27	27
Others	34	36	36	38	39	41	43	44	45	47
(3')Service Adit										
Tunnel Excavation	2,392	2,552	2,633	2,800	2,886	3,061	3,241	3,333	3,426	3,616

(4)Penstock										
Tunnel Excavation	499	527	555	582	609	636	663	690	716	743
Lining Concrete	208	215	221	227	233	238	244	250	255	260
Reinforce Bar	17	17	18	18	19	19	20	20	21	21
Others	145	152	159	166	172	179	185	192	198	205
(5)Power House										
Excavation	2,935	3,041	3,142	3,241	3,337	3,427	3,518	3,606	3,693	3,776
Concrete	2,112	2,188	2,261	2,332	2,401	2,466	2,532	2,596	2,658	2,718
Reinforce Bar	39	41	42	43	44	46	47	48	49	50
Others	2,543	2,635	2,722	2,808	2,891	2,970	3,048	3,125	3,200	3,272
(6)Tailrace Tunnel										
Tunnel Excavation	237	252	261	277	286	303	321	330	339	358
Lining Concrete	220	228	232	241	245	253	262	266	270	278
Reinforce Bar	41	42	43	45	45	47	48	49	50	52
Others	149	157	161	169	173	181	189	193	198	206
(7)Tailrace										
Excavation	54	57	59	62	64	67	70	72	75	78
Concrete	169	183	194	207	218	232	246	258	269	284
Reinforce Bar	17	18	18	19	20	21	21	22	23	23
Others	60	64	68	72	76	80	84	88	92	96
(8)P/H Access Tunnel										
Tunnel Excavation	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237
Lining Concrete	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162
Reinforce Bar	439	439	439	439	439	439	439	439	439	439
Others	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
(9)Miscellaneous Works	6,586	6,614	6,637	6,665	6,687	6,714	6,742	6,763	6,784	6,811
Total	138,296	138,895	139,375	139,962	140,429	140,997	141,573	142,024	142,469	143,033

Hydro- mechanical Works

1,000USD

Item	FSL=405									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	514	551	588	624	661	697	733	769	806	842
Screen	285	306	326	347	367	387	407	427	448	468
(3)Penstock	1,121	1,198	1,273	1,348	1,424	1,497	1,572	1,647	1,722	1,795
(4)Tailrace										
Gate	514	551	588	624	661	697	733	769	806	842
(5)Others	2,862	2,896	2,930	2,964	2,998	3,031	3,064	3,098	3,132	3,165
Total	17,174	17,379	17,582	17,785	17,989	18,185	18,386	18,589	18,791	18,988

Project Cost Summary

1,000USD

Item	FSL=405									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	2,766	2,778	2,787	2,799	2,809	2,820	2,831	2,840	2,849	2,861
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	26,280	26,280	26,280	26,280	26,280	26,280	26,280	26,280	26,280	26,280
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	103,360	103,360	103,360	103,360	103,360	103,360	103,360	103,360	103,360	103,360
(3) Intake	796	823	852	876	902	923	943	967	989	1,006
(4) Power Tunnel	2,651	2,824	2,913	3,094	3,187	3,377	3,571	3,671	3,772	3,978
(5) Penstock	869	911	952	993	1,033	1,073	1,112	1,151	1,190	1,229
(6) Power House	7,629	7,904	8,167	8,424	8,674	8,909	9,145	9,375	9,600	9,816
(7) Tailrace Tunnel	646	680	696	731	748	784	820	838	857	894
(8) Tailrace	300	322	339	361	378	400	422	440	458	481
(9)P/S Access Tunnel	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405
(10) Others	6,586	6,614	6,637	6,665	6,687	6,714	6,742	6,763	6,784	6,811
4. Hydro- Mechanical Works	17,174	17,379	17,582	17,785	17,989	18,185	18,386	18,589	18,791	18,988
5. Electro- Mechanical Works	25,773	26,988	28,187	29,351	30,776	31,626	33,001	34,081	35,144	36,203
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	220,458	222,490	224,381	226,348	228,452	230,077	232,241	233,983	235,702	237,535
7. Administration Fee	33,069	33,373	33,657	33,952	34,268	34,512	34,836	35,097	35,355	35,630
8. Preliminary Cost	22,046	22,249	22,438	22,635	22,845	23,008	23,224	23,398	23,570	23,754
9. Interest During Construction	55,115	55,622	56,095	56,587	57,113	57,519	58,060	58,496	58,926	59,384
Total	330,687	333,735	336,571	339,521	342,678	345,116	348,362	350,975	353,553	356,303

Basic Parameters OP2- 410

Waterway Length		
Headrace Tunnel	m	56.4
Penstock	m	176.2
Tailrace Tunnel	m	106
Sedimentation Level	m	386.2

Specification

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	73.7	78.2	82.8	87.3	91.9	96.4	101	105.5	110.1	114.6
FSL	EL.m	410	410	410	410	410	410	410	410	410	410
MOL	EL.m	397.6	397.8	398.2	398.4	398.8	399	399.4	399.6	399.8	400.2
TWL	EL.m	307.7	307.7	307.7	307.8	307.8	307.8	307.8	307.9	307.9	307.9
Loss	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Effective Head	m	101.1	101.1	101.1	101	101	101	101	100.9	100.9	100.9
Pmax	MW	66	71	75	79	83	87	91	95	99	103
Primary Energy	GWh	133.90	142.01	150.02	157.39	164.94	171.94	178.92	185.12	191.13	196.56
Pfirm	MW	51.18	54.46	58.00	60.04	62.75	66.04	66.12	58.78	55.81	49.10
Benefit	1000USD	39,497	41,943	44,450	46,390	48,564	50,814	52,094	51,003	51,191	50,150
Cost	1000USD	35,090	35,404	35,689	35,953	36,232	36,487	36,760	37,011	37,259	37,523
B/C		1.13	1.18	1.25	1.29	1.34	1.39	1.42	1.38	1.37	1.34

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood		m3/s	8,306
Dam Basis EL.		m	293
Non- overflow Width		m	80.2
Spillway Width		m	77
Sand Drain Width		m	16
Intake Width		m	0
Dam Height (Hd)		m	122
Crest Length (L)		m	173.2
Coefficient for Ex	Y=A*X^B		
	A		32335
	B		0.4384
Coefficient for Conc	Y=C*X^D		
	C		0.0015
	D		1.3058

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	2,545,144	2,545,144	2,545,144	2,545,144	2,545,144	2,545,144	2,545,144	2,545,144	2,545,144	2,545,144
Concrete	m3	353,122	353,122	353,122	353,122	353,122	353,122	353,122	353,122	353,122	353,122
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake

Number	-	1									
Design Velocity	m3/s	3.5									
MOL	EL.m	397.6	397.8	398.2	398.4	398.8	399	399.4	399.6	399.8	400.2
Waterway Diameter	m	5.2	5.3	5.5	5.6	5.8	5.9	6.1	6.2	6.3	6.5
Available Height	m	12.4	12.2	11.8	11.6	11.2	11	10.6	10.4	10.2	9.8

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	5,946	6,108	6,249	6,398	6,526	6,664	6,781	6,909	7,037	7,136
Concrete	m3	4,640	4,796	4,932	5,077	5,203	5,338	5,454	5,581	5,708	5,807
Reinforce Bar	t	186	192	197	203	208	214	218	223	228	232
Intake Gate	t	91	97	102	108	113	119	124	130	135	141
Intake Screen	t	51	54	57	60	63	66	69	72	75	78

(3) Power Tunnel

Tunnel Inner Diameter	m	5.2	5.3	5.5	5.6	5.8	5.9	6.1	6.2	6.3	6.5
Concerete Thickness	m	0.6									
Tunnel Length	m	56.4									
Number	-	1									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	1,848	1,906	2,025	2,086	2,211	2,274	2,404	2,471	2,538	2,675
Lining Concrete	m3	650	662	685	697	721	733	756	768	780	804
Reinforce Bar	t	26	26	27	28	29	29	30	31	31	32

(3') Srevice Adit

Tunnel Length	m	1148

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	37,618	38,802	41,227	42,467	45,002	46,297	48,942	50,292	51,660	54,452

(4) Penstocks

Design Velocity 1	m/s	3.5									
Penstock Length 1	m	5									
Design Velocity 2	m/s	4.47									
Penstock Length 2	m	117.1									
Design Velocity 3	m/s	6.08									
Penstock Length 3	m	36									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.1									
Mean Velocity	m/s	5.542609									
Dm	m	4.114638	4.238394	4.361271	4.478216	4.594684	4.705832	4.8168	4.922936	5.029115	5.130861
tm	mm	15.17503	15.57129	15.96475	16.32519	16.69775	17.0533	17.40827	17.73237	18.07169	18.39685

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	3,909	4,093	4,280	4,462	4,647	4,827	5,010	5,188	5,370	5,547
Lining Concrete	m3	1,566	1,607	1,648	1,687	1,725	1,762	1,799	1,834	1,870	1,903
Reinforce Bar	t	19	19	20	20	21	21	22	22	22	23
Penstock	t	344	364	384	403	423	442	462	481	501	520

(5) Powerhouse Undergroundtype

A	m2	799.8603	823.9176	847.8042	870.2504	892.8837	914.483	936.0473	956.3568	976.9838	996.7495
d	m	30									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	52,791	54,379	55,955	57,437	58,930	60,356	61,779	63,120	64,481	65,785
Concrete	m3	11,998	12,359	12,717	13,054	13,393	13,717	14,041	14,345	14,655	14,951
Reinforce Bar	t	48	49	51	52	54	55	56	57	59	60

(6) Tailrace Tunnel

Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	5.2	5.3	5.5	5.6	5.8	5.9	6.1	6.2	6.3	6.5
Concerete Thickness	m	0.6									
Tunnel Length	m	106									
Number	-	1									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	3,473	3,583	3,807	3,921	4,155	4,275	4,519	4,644	4,770	5,028
Lining Concrete	m3	1,222	1,244	1,288	1,310	1,355	1,377	1,421	1,443	1,466	1,510
Reinforce Bar	t	49	50	52	52	54	55	57	58	59	60

(7) Tailrace

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	4,897	5,084	5,318	5,502	5,735	5,916	6,147	6,326	6,506	6,732
Concrete	m3	1,471	1,552	1,655	1,737	1,843	1,927	2,035	2,120	2,207	2,317
Reinforce Bar	t	22	23	24	24	25	26	27	28	28	29

(8) P/H Access Tunnel

Tunnel Length	m	1663									

Item	Unit	FSL=410									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835
Lining Concrete	m3	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630
Reinforce Bar	t	499	499	499	499	499	499	499	499	499	499

Civil Work Cost 1,000USD

Item	FSL=410									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	45,813	45,813	45,813	45,813	45,813	45,813	45,813	45,813	45,813	45,813
Concrete	45,906	45,906	45,906	45,906	45,906	45,906	45,906	45,906	45,906	45,906
Others	18,344	18,344	18,344	18,344	18,344	18,344	18,344	18,344	18,344	18,344
(2)Intake										
Excavation	113	116	119	122	124	127	129	131	134	136
Concrete	557	575	592	609	624	641	654	670	685	697
Reinforce Bar	154	159	164	169	173	177	181	185	190	193
Others	206	213	219	225	230	236	241	247	252	256
(3)Power Tunnel										
Tunnel Excavation	129	133	142	146	155	159	168	173	178	187
Lining Concrete	91	93	96	98	101	103	106	108	109	113
Reinforce Bar	23	23	24	25	25	26	27	27	27	28
Others	36	37	39	40	42	43	45	46	47	49
(3')Service Adit										
Tunnel Excavation	2,633	2,716	2,886	2,973	3,150	3,241	3,426	3,520	3,616	3,812

(4)Penstock										
Tunnel Excavation	547	573	599	625	651	676	701	726	752	777
Lining Concrete	219	225	231	236	242	247	252	257	262	266
Reinforce Bar	18	18	19	19	20	20	21	21	21	22
Others	157	163	170	176	182	189	195	201	207	213
(5)Power House										
Excavation	3,167	3,263	3,357	3,446	3,536	3,621	3,707	3,787	3,869	3,947
Concrete	2,280	2,348	2,416	2,480	2,545	2,606	2,668	2,726	2,784	2,841
Reinforce Bar	42	44	45	46	47	48	49	50	52	53
Others	2,745	2,827	2,909	2,986	3,064	3,138	3,212	3,282	3,352	3,420
(6)Tailrace Tunnel										
Tunnel Excavation	261	269	286	294	312	321	339	348	358	377
Lining Concrete	232	236	245	249	257	262	270	274	278	287
Reinforce Bar	43	44	45	46	48	48	50	51	52	53
Others	161	165	173	177	185	189	198	202	206	215
(7)Tailrace										
Excavation	59	61	64	66	69	71	74	76	78	81
Concrete	191	202	215	226	240	250	265	276	287	301
Reinforce Bar	18	19	20	20	21	22	22	23	23	24
Others	67	70	75	78	82	86	90	94	97	102
(8)P/H Access Tunnel										
Tunnel Excavation	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237
Lining Concrete	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162
Reinforce Bar	439	439	439	439	439	439	439	439	439	439
Others	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
(9)Miscellaneous Works	6,984	7,006	7,033	7,055	7,082	7,103	7,130	7,151	7,172	7,198
Total	146,654	147,120	147,701	148,151	148,727	149,169	149,740	150,172	150,609	151,168

Hydro- mechanical Works 1,000USD

Item	FSL=410									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	599	636	672	708	744	780	817	852	889	924
Screen	333	353	373	393	414	434	454	474	494	513
(3)Penstock	1,307	1,382	1,458	1,531	1,607	1,680	1,756	1,828	1,903	1,977
(4)Tailrace										
Gate	599	636	672	708	744	780	817	852	889	924
(5)Others	2,943	2,977	3,011	3,044	3,077	3,110	3,144	3,177	3,210	3,243
Total	17,660	17,860	18,064	18,262	18,464	18,663	18,864	19,061	19,263	19,459

Project Cost Summary 1,000USD

Item	FSL=410									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	2,933	2,942	2,954	2,963	2,975	2,983	2,995	3,003	3,012	3,023
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	28,230	28,230	28,230	28,230	28,230	28,230	28,230	28,230	28,230	28,230
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	110,062	110,062	110,062	110,062	110,062	110,062	110,062	110,062	110,062	110,062
(3) Intake	1,030	1,063	1,093	1,124	1,151	1,181	1,205	1,233	1,260	1,281
(4) Power Tunnel	2,913	3,003	3,187	3,281	3,473	3,571	3,772	3,874	3,978	4,189
(5) Penstock	941	980	1,018	1,056	1,094	1,131	1,169	1,205	1,242	1,278
(6) Power House	8,234	8,482	8,727	8,959	9,192	9,414	9,636	9,845	10,057	10,261
(7) Tailrace Tunnel	696	714	748	766	802	820	857	875	894	932
(8) Tailrace	335	352	373	390	412	429	451	468	485	508
(9)P/S Access Tunnel	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405
(10) Others	6,984	7,006	7,033	7,055	7,082	7,103	7,130	7,151	7,172	7,198
4. Hydro- Mechanical Works	17,660	17,860	18,064	18,262	18,464	18,663	18,864	19,061	19,263	19,459
5. Electro- Mechanical Works	28,289	29,703	30,810	31,909	32,979	34,032	35,069	36,104	37,112	38,107
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	233,935	236,025	237,929	239,684	241,543	243,247	245,068	246,739	248,396	250,156
7. Administration Fee	35,090	35,404	35,689	35,953	36,232	36,487	36,760	37,011	37,259	37,523
8. Preliminary Cost	23,394	23,602	23,793	23,968	24,154	24,325	24,507	24,674	24,840	25,016
9. Interest During Construction	58,484	59,006	59,482	59,921	60,386	60,812	61,267	61,685	62,099	62,539
Total	350,903	354,037	356,893	359,527	362,315	364,871	367,602	370,108	372,593	375,234

Basic Parameters OP2- 415

Waterway Length		
Headrace Tunnel	m	56.4
Penstock	m	176.2
Tailrace Tunnel	m	106
Sedimentation Level	m	386.2

Specification

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	82.6	87.3	92.1	96.8	101.6	106.3	111.1	115.8	120.6	125.3
FSL	EL.m	415	415	415	415	415	415	415	415	415	415
MOL	EL.m	398.2	398.4	398.8	399	399.4	399.6	400	400.2	400.4	400.8
TWL	EL.m	307.7	307.8	307.8	307.8	307.8	307.9	307.9	307.9	307.9	308
Loss	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Effective Head	m	106.1	106	106	106	106	105.9	105.9	105.9	105.9	105.8
Pmax	MW	78	83	87	92	96	100	105	109	114	118
Primary Energy	GWh	154.52	162.73	171.05	179.12	187.02	193.85	201.13	207.22	213.60	218.79
Pfirm	MW	57.09	60.44	63.36	64.72	68.38	71.70	74.82	63.50	59.85	50.29
Benefit	1000USD	44,986	47,472	49,848	51,709	54,232	56,460	58,709	56,400	56,451	54,509
Cost	1000USD	40,361	40,666	40,946	41,241	41,515	41,766	42,072	42,317	42,597	42,859
B/C		1.11	1.17	1.22	1.25	1.31	1.35	1.40	1.33	1.33	1.27

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood		m3/s	8,306
Dam Basis EL.		m	293
Non- overflow Width		m	80.2
Spillway Width		m	77
Sand Drain Width		m	16
Intake Width		m	0
Dam Height (Hd)		m	127
Crest Length (L)		m	173.2
Coefficient for Ex	Y=A*X^B		
	A		32335
	B		0.4384
Coefficient for Conc	Y=C*X^D		
	C		0.0015
	D		1.3058

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	2,590,358	2,590,358	2,590,358	2,590,358	2,590,358	2,590,358	2,590,358	2,590,358	2,590,358	2,590,358
Concrete	m3	392,176	392,176	392,176	392,176	392,176	392,176	392,176	392,176	392,176	392,176
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake

Number	-	1									
Design Velocity	m3/s	3.5									
MOL	EL.m	398.2	398.4	398.8	399	399.4	399.6	400	400.2	400.4	400.8
Waterway Diameter	m	5.5	5.6	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8
Available Height	m	16.8	16.6	16.2	16	15.6	15.4	15	14.8	14.6	14.2

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	7,086	7,268	7,432	7,602	7,752	7,911	8,050	8,200	8,348	8,469
Concrete	m3	5,757	5,940	6,105	6,277	6,430	6,593	6,735	6,889	7,043	7,169
Reinforce Bar	t	230	238	244	251	257	264	269	276	282	287
Intake Gate	t	105	111	117	123	129	135	141	146	152	158
Intake Screen	t	58	62	65	68	72	75	78	81	85	88

(3) Power Tunnel

Tunnel Inner Diameter	m	5.5	5.6	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8
Concerete Thickness	m	0.6									
Tunnel Length	m	56.4									
Number	-	1									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	2,025	2,086	2,211	2,274	2,404	2,471	2,606	2,675	2,745	2,888
Lining Concrete	m3	685	697	721	733	756	768	792	804	816	839
Reinforce Bar	t	27	28	29	29	30	31	32	32	33	34

(3') Srevice Adit

Tunnel Length	m	1148

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	41,227	42,467	45,002	46,297	48,942	50,292	53,047	54,452	55,875	58,778

(4) Penstocks

Design Velocity 1	m/s	3.5									
Penstock Length 1	m	5									
Design Velocity 2	m/s	4.47									
Penstock Length 2	m	117.1									
Design Velocity 3	m/s	6.08									
Penstock Length 3	m	36									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.1									
Mean Velocity	m/s	5.542609									
Dm	m	4.356001	4.478216	4.599681	4.715585	4.831086	4.941565	5.051902	5.157654	5.263463	5.365046
tm	mm	16.62959	17.02603	17.43359	17.82249	18.21003	18.56526	18.93514	19.28964	19.64434	19.96808

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	4,272	4,462	4,655	4,843	5,034	5,220	5,409	5,594	5,781	5,964
Lining Concrete	m3	1,646	1,687	1,727	1,765	1,804	1,841	1,877	1,912	1,947	1,981
Reinforce Bar	t	20	20	21	21	22	22	23	23	23	24
Penstock	t	399	420	442	463	485	506	527	548	570	590

(5) Powerhouse Undergroundtype

A	m2	860.5151	884.3803	908.3679	931.2572	954.0668	975.5779	997.3609	1018.239	1039.128	1058.849
d	m	30									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	56,794	58,369	59,952	61,463	62,968	64,388	65,826	67,204	68,582	69,884
Concrete	m3	12,908	13,266	13,626	13,969	14,311	14,634	14,960	15,274	15,587	15,883
Reinforce Bar	t	52	53	55	56	57	59	60	61	62	64

(6) Tailrace Tunnel

Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	5.5	5.6	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8
Concerete Thickness	m	0.6									
Tunnel Length	m	106									
Number	-	1									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	3,807	3,921	4,155	4,275	4,519	4,644	4,898	5,028	5,159	5,427
Lining Concrete	m3	1,288	1,310	1,355	1,377	1,421	1,443	1,488	1,510	1,533	1,578
Reinforce Bar	t	52	52	54	55	57	58	60	60	61	63

(7) Tailrace

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	5,312	5,502	5,741	5,928	6,164	6,348	6,584	6,766	6,949	7,179
Concrete	m3	1,652	1,737	1,846	1,932	2,043	2,131	2,245	2,334	2,425	2,540
Reinforce Bar	t	24	24	25	26	27	28	28	29	30	31

(8) P/H Access Tunnel

Tunnel Length	m	1663									

Item	Unit	FSL=415									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835
Lining Concrete	m3	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630
Reinforce Bar	t	499	499	499	499	499	499	499	499	499	499

Civil Work Cost 1,000USD

Item	FSL=415									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	46,626	46,626	46,626	46,626	46,626	46,626	46,626	46,626	46,626	46,626
Concrete	50,983	50,983	50,983	50,983	50,983	50,983	50,983	50,983	50,983	50,983
Others	19,522	19,522	19,522	19,522	19,522	19,522	19,522	19,522	19,522	19,522
(2)Intake										
Excavation	135	138	141	144	147	150	153	156	159	161
Concrete	691	713	733	753	772	791	808	827	845	860
Reinforce Bar	191	197	203	208	213	219	224	229	234	238
Others	254	262	269	277	283	290	296	303	309	315
(3)Power Tunnel										
Tunnel Excavation	142	146	155	159	168	173	182	187	192	202
Lining Concrete	96	98	101	103	106	108	111	113	114	118
Reinforce Bar	24	25	25	26	27	27	28	28	29	30
Others	39	40	42	43	45	46	48	49	50	52
(3')Service Adit										
Tunnel Excavation	2,886	2,973	3,150	3,241	3,426	3,520	3,713	3,812	3,911	4,114

(4)Penstock										
Tunnel Excavation	598	625	652	678	705	731	757	783	809	835
Lining Concrete	230	236	242	247	253	258	263	268	273	277
Reinforce Bar	19	19	20	20	21	21	21	22	22	23
Others	169	176	183	189	196	202	208	215	221	227
(5)Power House										
Excavation	3,408	3,502	3,597	3,688	3,778	3,863	3,950	4,032	4,115	4,193
Concrete	2,452	2,520	2,589	2,654	2,719	2,780	2,842	2,902	2,962	3,018
Reinforce Bar	45	47	48	49	50	52	53	54	55	56
Others	2,953	3,035	3,117	3,196	3,274	3,348	3,422	3,494	3,566	3,633
(6)Tailrace Tunnel										
Tunnel Excavation	286	294	312	321	339	348	367	377	387	407
Lining Concrete	245	249	257	262	270	274	283	287	291	300
Reinforce Bar	45	46	48	48	50	51	52	53	54	56
Others	173	177	185	189	198	202	211	215	220	229
(7)Tailrace										
Excavation	64	66	69	71	74	76	79	81	83	86
Concrete	215	226	240	251	266	277	292	303	315	330
Reinforce Bar	20	20	21	22	22	23	24	24	25	25
Others	75	78	82	86	90	94	99	102	106	110
(8)P/H Access Tunnel										
Tunnel Excavation	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237
Lining Concrete	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162
Reinforce Bar	439	439	439	439	439	439	439	439	439	439
Others	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
(9)Miscellaneous Works	7,402	7,425	7,453	7,476	7,504	7,526	7,554	7,575	7,597	7,624
Total	155,446	155,922	156,523	156,990	157,585	158,039	158,630	159,080	159,533	160,109

Hydro- mechanical Works

1,000USD

Item	FSL=415									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	690	728	768	807	846	884	923	962	1,001	1,039
Screen	383	405	427	448	470	491	513	534	556	577
(3)Penstock	1,517	1,597	1,679	1,760	1,842	1,921	2,003	2,083	2,165	2,243
(4)Tailrace										
Gate	690	728	768	807	846	884	923	962	1,001	1,039
(5)Others	3,031	3,067	3,104	3,140	3,176	3,212	3,248	3,284	3,320	3,355
Total	18,188	18,403	18,623	18,838	19,057	19,270	19,488	19,703	19,922	20,132

Project Cost Summary

1,000USD

Item	FSL=415									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,109	3,118	3,130	3,140	3,152	3,161	3,173	3,182	3,191	3,202
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	51,040	51,040	51,040	51,040	51,040	51,040	51,040	51,040	51,040	51,040
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	117,131	117,131	117,131	117,131	117,131	117,131	117,131	117,131	117,131	117,131
(3) Intake	1,271	1,310	1,346	1,383	1,415	1,450	1,481	1,514	1,547	1,574
(4) Power Tunnel	3,187	3,281	3,473	3,571	3,772	3,874	4,083	4,189	4,297	4,516
(5) Penstock	1,017	1,056	1,096	1,134	1,173	1,211	1,250	1,287	1,325	1,362
(6) Power House	8,858	9,104	9,351	9,587	9,821	10,043	10,267	10,482	10,697	10,900
(7) Tailrace Tunnel	748	766	802	820	857	875	913	932	952	991
(8) Tailrace	373	390	412	430	452	470	493	511	529	552
(9)P/S Access Tunnel	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405
(10) Others	7,402	7,425	7,453	7,476	7,504	7,526	7,554	7,575	7,597	7,624
4. Hydro- Mechanical Works	18,188	18,403	18,623	18,838	19,057	19,270	19,488	19,703	19,922	20,132
5. Electro- Mechanical Works	31,122	32,451	33,487	34,761	35,763	36,763	37,981	38,941	40,126	41,073
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	269,074	271,104	272,973	274,938	276,766	278,443	280,482	282,116	283,980	285,726
7. Administration Fee	40,361	40,666	40,946	41,241	41,515	41,766	42,072	42,317	42,597	42,859
8. Preliminary Cost	26,907	27,110	27,297	27,494	27,677	27,844	28,048	28,212	28,398	28,573
9. Interest During Construction	67,269	67,776	68,243	68,735	69,192	69,611	70,120	70,529	70,995	71,432
Total	403,612	406,656	409,459	412,408	415,149	417,665	420,722	423,173	425,971	428,589

Basic Parameters OP2- 420

Waterway Length		
Headrace Tunnel	m	56.4
Penstock	m	176.2
Tailrace Tunnel	m	106
Sedimentation Level	m	386.2

Specification

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	92.3	97.2	102	106.9	111.7	116.6	121.4	126.3	131.1	136
FSL	EL.m	420	420	420	420	420	420	420	420	420	420
MOL	EL.m	398.8	399	399.4	399.6	400	400.2	400.4	400.8	401	401.2
TWL	EL.m	307.8	307.8	307.8	307.9	307.9	307.9	307.9	308	308	308
Loss	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Effective Head	m	111	111	111	110.9	110.9	110.9	110.9	110.8	110.8	110.8
Pmax	MW	91	96	101	106	111	115	120	125	130	134
Primary Energy	GWh	176.91	185.64	194.20	202.29	209.90	216.81	223.62	230.05	235.99	241.23
Pfirm	MW	63.27	64.62	67.06	70.43	74.08	77.59	76.99	63.99	61.94	56.71
Benefit	1000USD	50,875	52,853	55,128	57,598	60,065	62,365	63,410	60,657	61,110	60,480
Cost	1000USD	39,972	40,267	40,576	40,864	41,166	41,413	41,689	41,986	42,257	42,494
B/C		1.27	1.31	1.36	1.41	1.46	1.51	1.52	1.44	1.45	1.42

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood	m3/s	8,306
Dam Basis EL.	m	293
Non- overflow Width	m	80.2
Spillway Width	m	77
Sand Drain Width	m	16
Intake Width	m	0
Dam Height (Hd)	m	132
Crest Length (L)	m	173.2
Coefficient for Ex	Y=A*X^B	
A		32335
B		0.4384
Coefficient for Conc	Y=C*X^D	
C		0.0015
D		1.3058

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	2,634,583	2,634,583	2,634,583	2,634,583	2,634,583	2,634,583	2,634,583	2,634,583	2,634,583	2,634,583
Concrete	m3	433,788	433,788	433,788	433,788	433,788	433,788	433,788	433,788	433,788	433,788
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake

Number	-	1									
Design Velocity	m3/s	3.5									
MOL	EL.m	398.8	399	399.4	399.6	400	400.2	400.4	400.8	401	401.2
Waterway Diameter	m	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8	6.9	7
Available Height	m	21.2	21	20.6	20.4	20	19.8	19.6	19.2	19	18.8

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	8,242	8,442	8,616	8,804	8,966	9,143	9,311	9,461	9,621	9,780
Concrete	m3	6,933	7,141	7,322	7,519	7,689	7,877	8,056	8,215	8,386	8,557
Reinforce Bar	t	277	286	293	301	308	315	322	329	335	342
Intake Gate	t	120	126	132	139	145	151	157	163	169	176
Intake Screen	t	67	70	73	77	80	84	87	91	94	98

(3) Power Tunnel

Tunnel Inner Diameter	m	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8	6.9	7
Concerete Thickness	m	0.6									
Tunnel Length	m	56.4									
Number	-	1									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	2,211	2,274	2,404	2,471	2,606	2,675	2,745	2,888	2,960	3,034
Lining Concrete	m3	721	733	756	768	792	804	816	839	851	863
Reinforce Bar	t	29	29	30	31	32	32	33	34	34	35

(3') Srevice Adit

Tunnel Length	m	1148

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	45,002	46,297	48,942	50,292	53,047	54,452	55,875	58,778	60,256	61,753

(4) Penstocks

Design Velocity 1	m/s	3.5									
Penstock Length 1	m	5									
Design Velocity 2	m/s	4.47									
Penstock Length 2	m	117.1									
Design Velocity 3	m/s	6.08									
Penstock Length 3	m	36									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.1									
Mean Velocity	m/s	5.542609									
Dm	m	4.604673	4.725318	4.840587	4.955492	5.065526	5.175439	5.280892	5.386412	5.487813	5.589428
tm	mm	18.17097	18.59466	18.99946	19.38748	19.77356	20.15922	20.52922	20.88261	21.23808	21.5943

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	4,663	4,859	5,050	5,244	5,433	5,625	5,813	6,003	6,190	6,379
Lining Concrete	m3	1,729	1,769	1,807	1,845	1,882	1,918	1,953	1,988	2,022	2,056
Reinforce Bar	t	21	21	22	22	23	23	23	24	24	25
Penstock	t	461	484	507	529	552	575	597	620	642	665

(5) Powerhouse Undergroundtype

A	m2	923.4325	947.6271	970.7433	993.4882	1015.548	1037.584	1058.725	1079.555	1099.878	1120.244
d	m	30									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	60,947	62,543	64,069	65,570	67,026	68,481	69,876	71,251	72,592	73,936
Concrete	m3	13,851	14,214	14,561	14,902	15,233	15,564	15,881	16,193	16,498	16,804
Reinforce Bar	t	55	57	58	60	61	62	64	65	66	67

(6) Tailrace Tunnel

Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	5.8	5.9	6.1	6.2	6.4	6.5	6.6	6.8	6.9	7
Concerete Thickness	m	0.6									
Tunnel Length	m	106									
Number	-	1									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	4,155	4,275	4,519	4,644	4,898	5,028	5,159	5,427	5,564	5,702
Lining Concrete	m3	1,355	1,377	1,421	1,443	1,488	1,510	1,533	1,578	1,600	1,623
Reinforce Bar	t	54	55	57	58	60	60	61	63	64	65

(7) Tailrace

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	5,747	5,939	6,176	6,366	6,601	6,788	6,971	7,207	7,388	7,571
Concrete	m3	1,849	1,938	2,049	2,139	2,253	2,345	2,436	2,554	2,647	2,741
Reinforce Bar	t	25	26	27	28	29	29	30	31	31	32

(8) P/H Access Tunnel

Tunnel Length	m	1663									

Item	Unit	FSL=420									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835
Lining Concrete	m3	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630
Reinforce Bar	t	499	499	499	499	499	499	499	499	499	499

Civil Work Cost 1,000USD

Item	FSL=420									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	47,422	47,422	47,422	47,422	47,422	47,422	47,422	47,422	47,422	47,422
Concrete	56,392	56,392	56,392	56,392	56,392	56,392	56,392	56,392	56,392	56,392
Others	20,763	20,763	20,763	20,763	20,763	20,763	20,763	20,763	20,763	20,763
(2)Intake										
Excavation	157	160	164	167	170	174	177	180	183	186
Concrete	832	857	879	902	923	945	967	986	1,006	1,027
Reinforce Bar	230	237	243	250	255	262	267	273	278	284
Others	305	314	321	330	337	345	353	360	367	374
(3)Power Tunnel										
Tunnel Excavation	155	159	168	173	182	187	192	202	207	212
Lining Concrete	101	103	106	108	111	113	114	118	119	121
Reinforce Bar	25	26	27	27	28	28	29	30	30	30
Others	42	43	45	46	48	49	50	52	53	55
(3')Service Adit										
Tunnel Excavation	3,150	3,241	3,426	3,520	3,713	3,812	3,911	4,114	4,218	4,323

(4)Penstock										
Tunnel Excavation	653	680	707	734	761	787	814	840	867	893
Lining Concrete	242	248	253	258	263	269	273	278	283	288
Reinforce Bar	20	20	21	21	21	22	22	23	23	23
Others	183	190	196	203	209	216	222	228	235	241
(5)Power House										
Excavation	3,657	3,753	3,844	3,934	4,022	4,109	4,193	4,275	4,356	4,436
Concrete	2,632	2,701	2,767	2,831	2,894	2,957	3,017	3,077	3,135	3,193
Reinforce Bar	49	50	51	52	54	55	56	57	58	59
Others	3,169	3,252	3,331	3,409	3,485	3,560	3,633	3,704	3,774	3,844
(6)Tailrace Tunnel										
Tunnel Excavation	312	321	339	348	367	377	387	407	417	428
Lining Concrete	257	262	270	274	283	287	291	300	304	308
Reinforce Bar	48	48	50	51	52	53	54	56	56	57
Others	185	189	198	202	211	215	220	229	233	238
(7)Tailrace										
Excavation	69	71	74	76	79	81	84	86	89	91
Concrete	240	252	266	278	293	305	317	332	344	356
Reinforce Bar	21	22	22	23	24	24	25	26	26	27
Others	83	86	91	94	99	103	106	111	115	118
(8)P/H Access Tunnel										
Tunnel Excavation	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237
Lining Concrete	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162
Reinforce Bar	439	439	439	439	439	439	439	439	439	439
Others	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
(9)Miscellaneous Works	7,843	7,866	7,895	7,918	7,946	7,969	7,991	8,019	8,041	8,062
Total	164,694	165,185	165,790	166,268	166,867	167,340	167,801	168,398	168,853	169,311

Hydro- mechanical Works

1,000USD

Item	FSL=420									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	787	829	869	910	950	991	1,032	1,073	1,113	1,154
Screen	437	460	483	506	528	551	573	596	618	641
(3)Penstock	1,752	1,840	1,926	2,012	2,097	2,185	2,270	2,355	2,441	2,527
(4)Tailrace										
Gate	787	829	869	910	950	991	1,032	1,073	1,113	1,154
(5)Others	3,128	3,167	3,205	3,243	3,281	3,319	3,357	3,395	3,432	3,471
Total	18,769	19,002	19,228	19,458	19,684	19,915	20,142	20,369	20,595	20,825

Project Cost Summary

1,000USD

Item	FSL=420									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,294	3,304	3,316	3,325	3,337	3,347	3,356	3,368	3,377	3,386
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	124,578	124,578	124,578	124,578	124,578	124,578	124,578	124,578	124,578	124,578
(3) Intake	1,523	1,568	1,607	1,649	1,685	1,726	1,764	1,798	1,834	1,871
(4) Power Tunnel	3,473	3,571	3,772	3,874	4,083	4,189	4,297	4,516	4,628	4,741
(5) Penstock	1,097	1,138	1,177	1,216	1,255	1,293	1,331	1,370	1,407	1,445
(6) Power House	9,506	9,755	9,993	10,227	10,454	10,681	10,899	11,113	11,322	11,532
(7) Tailrace Tunnel	802	820	857	875	913	932	952	991	1,011	1,031
(8) Tailrace	413	431	454	472	495	513	531	555	574	592
(9)P/S Access Tunnel	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405
(10) Others	7,843	7,866	7,895	7,918	7,946	7,969	7,991	8,019	8,041	8,062
4. Hydro- Mechanical Works	18,769	19,002	19,228	19,458	19,684	19,915	20,142	20,369	20,595	20,825
5. Electro- Mechanical Works	33,981	35,217	36,432	37,638	38,815	39,743	40,889	42,032	43,148	44,030
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	266,478	268,448	270,505	272,429	274,443	276,084	277,927	279,907	281,712	283,292
7. Administration Fee	39,972	40,267	40,576	40,864	41,166	41,413	41,689	41,986	42,257	42,494
8. Preliminary Cost	26,648	26,845	27,050	27,243	27,444	27,608	27,793	27,991	28,171	28,329
9. Interest During Construction	66,619	67,112	67,626	68,107	68,611	69,021	69,482	69,977	70,428	70,823
Total	399,716	402,671	405,757	408,643	411,664	414,127	416,890	419,860	422,568	424,937

Basic Parameters OP2- 425

Waterway Length		
Headrace Tunnel	m	56.4
Penstock	m	176.2
Tailrace Tunnel	m	106
Sedimentation Level	m	386.2

Specification

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	102.9	107.8	112.6	117.5	122.3	127.2	132	136.9	141.7	146.6
FSL	EL.m	425	425	425	425	425	425	425	425	425	425
MOL	EL.m	399.4	399.8	400	400.2	400.6	400.8	401	401.4	401.6	401.8
TWL	EL.m	307.8	307.9	307.9	307.9	307.9	308	308	308	308	308.1
Loss	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Effective Head	m	116	115.9	115.9	115.9	115.9	115.8	115.8	115.8	115.8	115.7
Pmax	MW	106	111	116	122	126	131	136	141	146	151
Primary Energy	GWh	201.75	210.31	218.44	226.57	233.70	240.29	246.69	252.94	258.88	263.76
Pfirm	MW	67.72	69.79	73.14	76.57	80.21	83.36	76.93	62.61	62.09	57.31
Benefit	1000USD	56,685	58,849	61,320	63,815	66,193	68,327	67,545	64,362	65,275	64,716
Cost	1000USD	42,021	42,327	42,606	42,918	43,178	43,452	43,720	44,008	44,272	44,536
B/C		1.35	1.39	1.44	1.49	1.53	1.57	1.54	1.46	1.47	1.45

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood		m3/s	8,306
Dam Basis EL.		m	293
Non- overflow Width		m	80.2
Spillway Width		m	77
Sand Drain Width		m	16
Intake Width		m	0
Dam Height (Hd)		m	137
Crest Length (L)		m	173.2
Coefficient for Ex	Y=A*X^B		
	A		32335
	B		0.4384
Coefficient for Conc	Y=C*X^D		
	C		0.0015
	D		1.3058

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	2,677,877	2,677,877	2,677,877	2,677,877	2,677,877	2,677,877	2,677,877	2,677,877	2,677,877	2,677,877
Concrete	m3	478,021	478,021	478,021	478,021	478,021	478,021	478,021	478,021	478,021	478,021
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake

Number	-	1									
Design Velocity	m3/s	3.5									
MOL	EL.m	399.4	399.8	400	400.2	400.6	400.8	401	401.4	401.6	401.8
Waterway Diameter	m	6.1	6.3	6.4	6.5	6.7	6.8	6.9	7.1	7.2	7.3
Available Height	m	25.6	25.2	25	24.8	24.4	24.2	24	23.6	23.4	23.2

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	9,429	9,621	9,817	10,012	10,182	10,367	10,544	10,703	10,872	11,040
Concrete	m3	8,182	8,386	8,597	8,808	8,992	9,194	9,387	9,562	9,747	9,933
Reinforce Bar	t	327	335	344	352	360	368	375	382	390	397
Intake Gate	t	136	142	149	155	161	168	174	180	187	193
Intake Screen	t	76	79	83	86	90	93	97	100	104	107

(3) Power Tunnel

Tunnel Inner Diameter	m	6.1	6.3	6.4	6.5	6.7	6.8	6.9	7.1	7.2	7.3
Concerete Thickness	m	0.6									
Tunnel Length	m	56.4									
Number	-	1									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	2,404	2,538	2,606	2,675	2,816	2,888	2,960	3,108	3,184	3,260
Lining Concrete	m3	756	780	792	804	827	839	851	875	887	899
Reinforce Bar	t	30	31	32	32	33	34	34	35	35	36

(3') Srevice Adit

Tunnel Length	m	1148

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	48,942	51,660	53,047	54,452	57,317	58,778	60,256	63,269	64,802	66,354

(4) Penstocks

Design Velocity 1	m/s	3.5									
Penstock Length 1	m	5									
Design Velocity 2	m/s	4.47									
Penstock Length 2	m	117.1									
Design Velocity 3	m/s	6.08									
Penstock Length 3	m	36									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.1									
Mean Velocity	m/s	5.542609									
Dm	m	4.861895	4.976309	5.085892	5.195374	5.300431	5.40557	5.506617	5.607892	5.705357	5.803165
tm	mm	19.83518	20.23932	20.64096	21.04224	21.4273	21.79574	22.16578	22.53666	22.89359	23.23361

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	5,085	5,279	5,468	5,660	5,848	6,038	6,224	6,414	6,599	6,787
Lining Concrete	m3	1,814	1,852	1,888	1,925	1,960	1,995	2,028	2,062	2,094	2,127
Reinforce Bar	t	22	22	23	23	24	24	24	25	25	26
Penstock	t	531	555	578	602	626	649	673	696	720	743

(5) Powerhouse Undergroundtype

A	m2	989.442	1012.435	1034.73	1057.004	1078.378	1099.452	1120.005	1140.603	1160.427	1179.98
d	m	30									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	65,303	66,821	68,292	69,762	71,173	72,564	73,920	75,280	76,588	77,879
Concrete	m3	14,842	15,187	15,521	15,855	16,176	16,492	16,800	17,109	17,406	17,700
Reinforce Bar	t	59	61	62	63	65	66	67	68	70	71

(6) Tailrace Tunnel

Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	6.1	6.3	6.4	6.5	6.7	6.8	6.9	7.1	7.2	7.3
Concerete Thickness	m	0.6									
Tunnel Length	m	106									
Number	-	1									

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	4,519	4,770	4,898	5,028	5,292	5,427	5,564	5,842	5,983	6,127
Lining Concrete	m3	1,421	1,466	1,488	1,510	1,555	1,578	1,600	1,645	1,668	1,690
Reinforce Bar	t	57	59	60	60	62	63	64	66	67	68

(7) Tailrace

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	6,202	6,440	6,626	6,813	7,046	7,231	7,413	7,647	7,827	8,008
Concrete	m3	2,061	2,175	2,265	2,357	2,473	2,567	2,659	2,780	2,874	2,969
Reinforce Bar	t	27	28	29	29	30	31	32	32	33	34

(8) P/H Access Tunnel

Tunnel Length m 1663

Item	Unit	FSL=425									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835
Lining Concrete	m3	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630
Reinforce Bar	t	499	499	499	499	499	499	499	499	499	499

Civil Work Cost 1,000USD

Item	FSL=425									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	48,202	48,202	48,202	48,202	48,202	48,202	48,202	48,202	48,202	48,202
Concrete	62,143	62,143	62,143	62,143	62,143	62,143	62,143	62,143	62,143	62,143
Others	22,069	22,069	22,069	22,069	22,069	22,069	22,069	22,069	22,069	22,069
(2)Intake										
Excavation	179	183	187	190	193	197	200	203	207	210
Concrete	982	1,006	1,032	1,057	1,079	1,103	1,126	1,147	1,170	1,192
Reinforce Bar	272	278	285	292	299	305	312	317	324	330
Others	358	367	376	385	393	401	410	417	425	433
(3)Power Tunnel										
Tunnel Excavation	168	178	182	187	197	202	207	218	223	228
Lining Concrete	106	109	111	113	116	118	119	123	124	126
Reinforce Bar	27	27	28	28	29	30	30	31	31	32
Others	45	47	48	49	51	52	53	56	57	58
(3')Service Adit										
Tunnel Excavation	3,426	3,616	3,713	3,812	4,012	4,114	4,218	4,429	4,536	4,645

(4)Penstock										
Tunnel Excavation	712	739	766	792	819	845	871	898	924	950
Lining Concrete	254	259	264	269	274	279	284	289	293	298
Reinforce Bar	21	21	22	22	22	23	23	24	24	24
Others	197	204	210	217	223	229	236	242	248	254
(5)Power House										
Excavation	3,918	4,009	4,098	4,186	4,270	4,354	4,435	4,517	4,595	4,673
Concrete	2,820	2,885	2,949	3,012	3,073	3,133	3,192	3,251	3,307	3,363
Reinforce Bar	52	53	55	56	57	58	59	60	61	62
Others	3,395	3,474	3,551	3,627	3,700	3,773	3,843	3,914	3,982	4,049
(6)Tailrace Tunnel										
Tunnel Excavation	339	358	367	377	397	407	417	438	449	460
Lining Concrete	270	278	283	287	295	300	304	313	317	321
Reinforce Bar	50	52	52	53	55	56	56	58	59	59
Others	198	206	211	215	224	229	233	243	247	252
(7)Tailrace										
Excavation	74	77	80	82	85	87	89	92	94	96
Concrete	268	283	295	306	322	334	346	361	374	386
Reinforce Bar	22	23	24	24	25	26	26	27	27	28
Others	91	96	99	103	108	112	115	120	124	128
(8)P/H Access Tunnel										
Tunnel Excavation	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237
Lining Concrete	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162
Reinforce Bar	439	439	439	439	439	439	439	439	439	439
Others	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
(9)Miscellaneous Works	8,306	8,335	8,358	8,381	8,410	8,432	8,454	8,483	8,505	8,526
Total	174,422	175,038	175,516	175,996	176,601	177,070	177,532	178,140	178,597	179,054

Hydro- mechanical Works

1,000USD

Item	FSL=425									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	893	935	976	1,019	1,059	1,102	1,143	1,184	1,225	1,267
Screen	496	520	542	566	589	612	635	658	681	704
(3)Penstock	2,019	2,109	2,198	2,289	2,378	2,467	2,556	2,646	2,735	2,823
(4)Tailrace										
Gate	893	935	976	1,019	1,059	1,102	1,143	1,184	1,225	1,267
(5)Others	3,236	3,275	3,314	3,354	3,393	3,432	3,471	3,510	3,549	3,588
Total	19,416	19,652	19,886	20,124	20,356	20,592	20,824	21,061	21,293	21,527

Project Cost Summary

1,000USD

Item	FSL=425									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,488	3,501	3,510	3,520	3,532	3,541	3,551	3,563	3,572	3,581
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570	35,570
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	132,413	132,413	132,413	132,413	132,413	132,413	132,413	132,413	132,413	132,413
(3) Intake	1,791	1,834	1,880	1,925	1,964	2,007	2,048	2,085	2,125	2,164
(4) Power Tunnel	3,772	3,978	4,083	4,189	4,406	4,516	4,628	4,855	4,971	5,088
(5) Penstock	1,184	1,223	1,262	1,301	1,338	1,377	1,414	1,452	1,489	1,527
(6) Power House	10,186	10,422	10,652	10,881	11,101	11,318	11,530	11,742	11,946	12,147
(7) Tailrace Tunnel	857	894	913	932	971	991	1,011	1,051	1,072	1,092
(8) Tailrace	456	479	497	516	539	558	576	600	619	638
(9)P/S Access Tunnel	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405
(10) Others	8,306	8,335	8,358	8,381	8,410	8,432	8,454	8,483	8,505	8,526
4. Hydro- Mechanical Works	19,416	19,652	19,886	20,124	20,356	20,592	20,824	21,061	21,293	21,527
5. Electro- Mechanical Works	37,077	38,247	39,389	40,739	41,626	42,734	43,817	44,887	45,943	47,002
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	280,143	282,177	284,040	286,118	287,854	289,677	291,464	293,390	295,145	296,904
7. Administration Fee	42,021	42,327	42,606	42,918	43,178	43,452	43,720	44,008	44,272	44,536
8. Preliminary Cost	28,014	28,218	28,404	28,612	28,785	28,968	29,146	29,339	29,515	29,690
9. Interest During Construction	70,036	70,544	71,010	71,529	71,964	72,419	72,866	73,347	73,786	74,226
Total	420,215	423,266	426,061	429,177	431,781	434,516	437,196	440,085	442,718	445,356

Basic Parameters OP2- 435

Waterway Length		
Headrace Tunnel	m	56.4
Penstock	m	176.2
Tailrace Tunnel	m	106
Sedimentation Level	m	386.2

Specification

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Qmax	m3/s	124.6	129.5	134.4	139.4	144.3	149.2	154.1	159.1	164	168.9
FSL	EL.m	435	435	435	435	435	435	435	435	435	435
MOL	EL.m	400.6	401	401.2	401.4	401.6	402	402.2	402.4	402.6	402.8
TWL	EL.m	308	308	308	308	308	308.1	308.1	308.1	308.1	308.1
Loss	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Effective Head	m	125.8	125.8	125.8	125.8	125.8	125.7	125.7	125.7	125.7	125.7
Pmax	MW	140	145	151	156	162	167	173	178	184	189
Primary Energy	GWh	254.59	262.84	270.84	277.99	284.96	290.87	296.81	302.14	306.49	310.72
Pfirm	MW	78.36	81.99	85.37	88.84	92.19	78.42	73.05	65.48	61.97	57.30
Benefit	1000USD	69,397	71,974	74,430	76,761	79,024	75,945	75,399	74,082	73,809	73,165
Cost	1000USD	50,325	50,613	50,908	51,171	51,461	51,741	52,026	52,281	52,561	52,811
B/C		1.38	1.42	1.46	1.50	1.54	1.47	1.45	1.42	1.40	1.39

Civil & Hydromechanical Work Quantity

(1) Dam

Design Flood		m3/s	8,306
Dam Basis EL.		m	293
Non- overflow Width		m	80.2
Spillway Width		m	77
Sand Drain Width		m	16
Intake Width		m	0
Dam Height (Hd)		m	147
Crest Length (L)		m	173.2
Coefficient for Ex	Y=A*X^B		
	A		32335
	B		0.4384
Coefficient for Conc	Y=C*X^D		
	C		0.0015
	D		1.3058

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	2,761,876	2,761,876	2,761,876	2,761,876	2,761,876	2,761,876	2,761,876	2,761,876	2,761,876	2,761,876
Concrete	m3	574,583	574,583	574,583	574,583	574,583	574,583	574,583	574,583	574,583	574,583
Gate	t	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827	1,827

(2) Intake

Number	-	1									
Design Velocity	m3/s	3.5									
MOL	EL.m	400.6	401	401.2	401.4	401.6	402	402.2	402.4	402.6	402.8
Waterway Diameter	m	6.7	6.9	7	7.1	7.2	7.4	7.5	7.6	7.7	7.8
Available Height	m	34.4	34	33.8	33.6	33.4	33	32.8	32.6	32.4	32.2

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	11,815	12,016	12,226	12,436	12,637	12,818	13,011	13,204	13,389	13,570
Concrete	m3	10,797	11,023	11,261	11,499	11,728	11,936	12,157	12,379	12,592	12,803
Reinforce Bar	t	432	441	450	460	469	477	486	495	504	512
Intake Gate	t	169	176	183	189	196	203	209	216	222	229
Intake Screen	t	94	98	101	105	109	113	116	120	124	127

(3) Power Tunnel

Tunnel Inner Diameter	m	6.7	6.9	7	7.1	7.2	7.4	7.5	7.6	7.7	7.8
Concerete Thickness	m	0.6									
Tunnel Length	m	56.4									
Number	-	1									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	2,816	2,960	3,034	3,108	3,184	3,337	3,415	3,494	3,574	3,655
Lining Concrete	m3	827	851	863	875	887	911	923	936	948	960
Reinforce Bar	t	33	34	35	35	35	36	37	37	38	38

(3') Srevice Adit

Tunnel Length	m	1148									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	57,317	60,256	61,753	63,269	64,802	67,925	69,514	71,121	72,746	74,390

(4) Penstocks

Design Velocity 1	m/s	3.5									
Penstock Length 1	m	5									
Design Velocity 2	m/s	4.47									
Penstock Length 2	m	117.1									
Design Velocity 3	m/s	6.08									
Penstock Length 3	m	36									
Design Velocity 4	m/s	8.76	2 penstocks								
Penstock Length 4	m	18.1									
Mean Velocity	m/s	5.542609									
Dm	m	5.350039	5.454222	5.556452	5.658865	5.757462	5.854399	5.949757	6.045511	6.137901	6.22892
tm	mm	23.26694	23.68108	24.08745	24.49455	24.88649	25.2535	25.63226	26.01259	26.37956	26.74108

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	5,937	6,128	6,317	6,510	6,699	6,887	7,074	7,265	7,451	7,637
Lining Concrete	m3	1,976	2,011	2,045	2,079	2,111	2,144	2,175	2,207	2,238	2,268
Reinforce Bar	t	24	24	25	25	25	26	26	26	27	27
Penstock	t	686	712	738	764	790	815	840	867	892	918

(5) Powerhouse Undergroundtype

A	m2	1118.62	1140.403	1161.778	1183.191	1203.807	1223.75	1243.683	1263.699	1283.011	1302.037
d	m	30									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	73,829	75,267	76,677	78,091	79,451	80,768	82,083	83,404	84,679	85,934
Concrete	m3	16,779	17,106	17,427	17,748	18,057	18,356	18,655	18,955	19,245	19,531
Reinforce Bar	t	67	68	70	71	72	73	75	76	77	78

(6) Tailrace Tunnel

Design Velocity	m/s	3.5									
Tunnel Inner Diameter	m	6.7	6.9	7	7.1	7.2	7.4	7.5	7.6	7.7	7.8
Concerete Thickness	m	0.6									
Tunnel Length	m	106									
Number	-	1									

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	5,292	5,564	5,702	5,842	5,983	6,272	6,419	6,567	6,717	6,869
Lining Concrete	m3	1,555	1,600	1,623	1,645	1,668	1,713	1,736	1,758	1,781	1,804
Reinforce Bar	t	62	64	65	66	67	69	69	70	71	72

(7) Tailrace

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Excavation	m3	7,110	7,345	7,529	7,714	7,895	8,128	8,308	8,490	8,668	8,846
Concrete	m3	2,505	2,624	2,719	2,815	2,910	3,033	3,130	3,228	3,325	3,423
Reinforce Bar	t	30	31	32	33	33	34	35	35	36	37

(8) P/H Access Tunnel

Tunnel Length m 1663

Item	Unit	FSL=435									
		1	2	3	4	5	6	7	8	9	10
Tunnel Excavation	m3	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835	74,835
Lining Concrete	m3	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630	16,630
Reinforce Bar	t	499	499	499	499	499	499	499	499	499	499

Civil Work Cost 1,000USD

Item	FSL=435									
	1	2	3	4	5	6	7	8	9	10
(1) Concrete Dam										
(1).1 River Treatment(NEA F/S)	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(1).2 Concrete Dam										
Excavation	49,714	49,714	49,714	49,714	49,714	49,714	49,714	49,714	49,714	49,714
Concrete	74,696	74,696	74,696	74,696	74,696	74,696	74,696	74,696	74,696	74,696
Others	24,882	24,882	24,882	24,882	24,882	24,882	24,882	24,882	24,882	24,882
(2)Intake										
Excavation	224	228	232	236	240	244	247	251	254	258
Concrete	1,296	1,323	1,351	1,380	1,407	1,432	1,459	1,485	1,511	1,536
Reinforce Bar	358	366	374	382	389	396	404	411	418	425
Others	470	479	489	499	509	518	527	537	546	555
(3)Power Tunnel										
Tunnel Excavation	197	207	212	218	223	234	239	245	250	256
Lining Concrete	116	119	121	123	124	128	129	131	133	134
Reinforce Bar	29	30	30	31	31	32	33	33	33	34
Others	51	53	55	56	57	59	60	61	62	64
(3')Service Adit										
Tunnel Excavation	4,012	4,218	4,323	4,429	4,536	4,755	4,866	4,978	5,092	5,207

(4)Penstock										
Tunnel Excavation	831	858	884	911	938	964	990	1,017	1,043	1,069
Lining Concrete	277	282	286	291	296	300	305	309	313	318
Reinforce Bar	23	23	23	24	24	24	25	25	26	26
Others	226	232	239	245	252	258	264	270	276	283
(5)Power House										
Excavation	4,430	4,516	4,601	4,685	4,767	4,846	4,925	5,004	5,081	5,156
Concrete	3,188	3,250	3,311	3,372	3,431	3,488	3,544	3,602	3,657	3,711
Reinforce Bar	59	60	61	62	64	65	66	67	68	69
Others	3,838	3,913	3,987	4,060	4,131	4,199	4,268	4,336	4,403	4,468
(6)Tailrace Tunnel										
Tunnel Excavation	397	417	428	438	449	470	481	493	504	515
Lining Concrete	295	304	308	313	317	325	330	334	338	343
Reinforce Bar	55	56	57	58	59	60	61	62	63	63
Others	224	233	238	243	247	257	262	267	271	276
(7)Tailrace										
Excavation	85	88	90	93	95	98	100	102	104	106
Concrete	326	341	353	366	378	394	407	420	432	445
Reinforce Bar	25	26	27	27	28	28	29	29	30	30
Others	109	114	118	121	125	130	134	138	142	145
(8)P/H Access Tunnel										
Tunnel Excavation	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237	5,237
Lining Concrete	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162	2,162
Reinforce Bar	439	439	439	439	439	439	439	439	439	439
Others	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
(9)Miscellaneous Works	9,295	9,324	9,347	9,371	9,393	9,423	9,445	9,468	9,490	9,512
Total	195,187	195,813	196,296	196,783	197,259	197,877	198,349	198,824	199,290	199,754

Hydro- mechanical Works

1,000USD

Item	FSL=435									
	1	2	3	4	5	6	7	8	9	10
(1)Dam & Spillway										
Gate	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878	11,878
(2)Intake										
Gate	1,113	1,157	1,200	1,244	1,288	1,331	1,374	1,418	1,461	1,505
Screen	619	643	667	691	715	739	763	788	812	836
(3)Penstock	2,607	2,705	2,803	2,903	3,000	3,096	3,193	3,293	3,390	3,488
(4)Tailrace										
Gate	1,113	1,157	1,200	1,244	1,288	1,331	1,374	1,418	1,461	1,505
(5)Others	3,466	3,508	3,549	3,592	3,634	3,675	3,716	3,759	3,801	3,842
Total	20,795	21,045	21,296	21,552	21,802	22,049	22,299	22,554	22,803	23,053

Project Cost Summary

1,000USD

Item	FSL=435									
	1	2	3	4	5	6	7	8	9	10
1. Preparation & Compensation	3,904	3,916	3,926	3,936	3,945	3,958	3,967	3,976	3,986	3,995
(1) Access Road										
(2) Conpensation										
(3) Others										
2. Environmental Mitigation	61,990	61,990	61,990	61,990	61,990	61,990	61,990	61,990	61,990	61,990
3. Civil Works										
(1) River Treatment	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053	6,053
(2) Dam	149,292	149,292	149,292	149,292	149,292	149,292	149,292	149,292	149,292	149,292
(3) Intake	2,348	2,396	2,447	2,497	2,546	2,590	2,637	2,684	2,729	2,774
(4) Power Tunnel	4,406	4,628	4,741	4,855	4,971	5,207	5,327	5,448	5,571	5,695
(5) Penstock	1,356	1,395	1,433	1,471	1,509	1,546	1,584	1,622	1,658	1,695
(6) Power House	11,515	11,740	11,960	12,180	12,392	12,598	12,803	13,009	13,208	13,403
(7) Tailrace Tunnel	971	1,011	1,031	1,051	1,072	1,113	1,134	1,155	1,176	1,198
(8) Tailrace	545	569	588	607	626	650	669	689	708	727
(9)P/S Access Tunnel	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405	9,405
(10) Others	9,295	9,324	9,347	9,371	9,393	9,423	9,445	9,468	9,490	9,512
4. Hydro- Mechanical Works	20,795	21,045	21,296	21,552	21,802	22,049	22,299	22,554	22,803	23,053
5. Electro- Mechanical Works	43,455	44,485	45,707	46,712	47,904	48,900	50,066	51,028	52,171	53,113
6. Transmission Line	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170	10,170
Direct Cost	335,500	337,419	339,384	341,142	343,071	344,943	346,840	348,542	350,410	352,075
7. Administration Fee	50,325	50,613	50,908	51,171	51,461	51,741	52,026	52,281	52,561	52,811
8. Preliminary Cost	33,550	33,742	33,938	34,114	34,307	34,494	34,684	34,854	35,041	35,208
9. Interest During Construction	83,875	84,355	84,846	85,285	85,768	86,236	86,710	87,135	87,602	88,019
Total	503,250	506,129	509,077	511,713	514,606	517,414	520,260	522,813	525,615	528,113