CHAPTER 5

SUMMARY

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5.1 Electric Power Condition in Angola

(1) Present Status of Electricity Supply -Demand and Future Plan

Maximum electricity supply has been increased more than 10% after termination of the civil war in 2002. In the year of 2008, installed capacity was 1,258 MW and maximum electricity supply was 4,050 GWh. The yearly electricity production, in 2008 is rapidly increased in 23% from 2007. In the future, average, average yearly electricity production from 2010 to 2016 is estimated 13%/year.

Installed capacity of Angola is 65% of OKINAWA (1,925 MW 2008) and 55% of yearly electricity production of OKINAWA (7,345 GWh, 2008).

Electric supply in Angola is almost restricted to urban areas. Rural electrification rate of villages is very low, 30.4% and more rural electrification is to be expanded. However, besides governmental electricity company of Angola, consumers have generation facilities by themselves around 900 MW to 1,200 MW and all of them are diesel generation facilities.

Types of generation facilities are 64% hydropower and 34% thermal power. Most of generation facilities are located in the north area of Angola.

DNE estimates that total investment of electric facilities of Angola from 2010 to 2025 is to be US$ 8.3 billion and recommends using the PPP scheme.

MINEA has a view that the gap of electricity supply between urban area and rural area could be resolved by utilizing the small hydropower generation, leading to avoid that the rural people rushing to the urban area. Consequently MINEA is looking for the support of financing and institutional system to deploy 10 MW class small hydropower stations for rural electrification and proceeding to apply PPP scheme.

(2) Institutions and Organizations of Electric Power Sector

MINEA and MOF have responsibility for electricity control, water supply, sanitary systems, electricity tariff and water rate including related grant provisions. MINEA develops plans and place regulations for electricity and water resource sector through internal department of DNE and DNA.

There are two public corporations in Angola. One is ENE, and the other is EDEL. ENE has the responsibility of power generation, power transmission and distribution for principal

cities in 15 states of 18 states. EDEL has the responsibility of power distribution for urban area of Luanda. Both do not have exclusive right for electric power supply in the area of responsibility.

ENE has responsibility of generation, transmission and distribution electricity for 3 major stand-alone power network systems and isolated systems in Angola. ENE was established in 1980 by integrating several entities. ENE operates hydropower plants and backbone transmission lines.

EDEL has responsibility of power supply for the capital, Luanda and its suburbs. Electric power consumption in this capital region comprises of 65% of total in the whole country. EDEL buys the electricity generated by ENE.

(3) Power Operation

Technical and commercial efficiency of the power systems both of ENE and EDEL is low and the system loss of ENE is estimated as 18 ~ 23%. The system loss of EDEL is more serious, which technical loss is estimated at 15% and commercial loss at 21%. It is explained that the reasons why the commercial loss is higher than technical loss are default of electricity charge, electricity theft, shortage of electricity meters, and inefficient charge system.

Especially, electricity charge is not collected by force and it makes the problem more serious. On the other hand, most of the technical loss is caused by the current situation that transmission and distribution line systems have to be operated at the limit of the capacity. Both of ENE and EDEL have not been able to not only repair the power systems damaged by the civil war for the long time but extend the systems to meet increasing the electricity demand.

Access rate to electricity has not been exactly comprehended because of unclear numbers of proper customers and population, but electrification rate is estimated as 30 ~ 32%. Recently, population of Luanda is rapidly expanding because of demographic shift to cities seeking for business opportunities and safety, and most of people who immigrated to Luanda live in the districts which have no city project or outer districts of Luanda.

(4) Electric Tariff

GOA sets a rate in consideration of suggestion from MINEA. In 2008, the mean electric tariff of EDEL was approximately 4 US¢/kWh (1US$ = 69 Kz) whereas the mean selling of power unit price to EDEL was approximately 11 US¢/kWh.

In addition, the electric tariff system is left unredeemed since 2004, and the following electric bill systems are applied now.

(5) Electric Power System in Angola

The maximum electric power system voltage in Angola is 400 kV and adopted for the transmission line of Cambambe Hydropower Station (180 MW). Then next voltage for the transmission line is 220 kV. However electric power system has not cover all over the Angola and there are three main areas, capital city Luanda and its suburbs, Namibe and Lunango areas, and Lucapa and Luachimo areas. There are five independent electric power systems in Angola and they are controlled by ENE.

Transmission line voltage in Angola is 400 kV, 220 kV, 110 kV and 60 kV and Distribution line voltage is 30 kV and 15 kV.

Rural electrification is mainly managed by ENE but recently new management body for rural electrification is considered by the Government and it is not clear which management body is applied to the rural electrification.

Ongoing and future projects in power sector are as follows;

- Construct power stations of 7,000 MW output equivalent to 6 times increase of existing power output.
- Install of the transmission networks of 2,607 km at 400 kV level and 2,010 km at 220 kV level.
- Secure power output of 180 MW in total by construction of small hydropower stations at 46 places.
- Install 2,350 km of ingathering distribution network for Luanda area and newly construct substations at 37 places as well as 1,300 pieces of distribution poles

5.2 The Feasibility Study Candidate Sites

MINEA has planned the hydropower development in internal regions where electrification undeveloped. The selected sites were following 5 sites of Bie and Huambo Provinces.

a. Cutato site of Bie (Andulo)
b. Luvolo site of Bie (Chicala)
c. Cunene site of Huambo (socopomo)
d. Põe site of Huambo (Cuima)
e. Cuima site of Huambo (Cuima)

The issues of the first screening for selecting feasibility study in the implementation policy are followings.

1. Rural electrification contributes to the correction of regional differential.

2. The site is not under construction or bidding
3. Output power is over 500 kW
4. There is no dangerousness of land mines.
5. The site is not in National Park or Protective Zone.

Only 2 sites (Cutato site, 1.6 MW and Luvolo site, 0.7 MW) of the FS Candidate Site, could satisfy the No.3 issue of the implementation policy.
The 5 sites evaluation of other 4 issues is same. In fact the all 5 sites could satisfy the other 4 issues. That is that all candidate sites are necessary to be electrified, not under construction or bidding, no dangerousness of land mines (this intelligence is gotten from hearing from the residences) and not in National Park or Protective Zone.

The second screening of the implementation policy is targeting nature-social environment, data of hydrology, construction cost, water right and beneficial efficient.

Access road to Luvolo site is very bad. If it needs road repair and pavement for construction (transportation of materials, turbines and generators), it costs a large amount of money. And, it is dangerous at transportation in rainy season. Furthermore adjustment of water utilization will become more important in future because people are using water for agriculture.

So Luvolo site was rejected as the FS site because of above reasons.

Cutato site is good at geography, geology and access compared to Luvolo site. Installed capacity of Cutato site is 1.6 MW (it is planned initially by using minimum river discharge) which is the biggest capacity in the candidate sites. The demand place of Cutato site is Andulo which population is about 300 thousands, so it appears the all generating energy can be easily consumed.
So Cutato site was selected in second screening as the FS site because its site is good site that its power plant generates the most energy in the candidate sites and has much demand place where its energy is easily consumed.

Because of above reasons, Cutato site was only selected to be the FS site in MINUTES OF MEETING of September 20, 2010 between DNEL and JICA Study Team, which title is ”FINAL DISCUSSION BETWEEN NATIONAL DIRECTION OF ELECTRIFICATION”, After that, same conclusion was made after the first and second screenings at JICA HQ in Tokyo on October 1.

5.3 Feasibility Study Site

(1) Characteristics of Project Site

The project site is located at the gently sloped hill area at around EL. 1,400 m. The Cutato river diverts at the just upstream of the project site, and joins at the downstream through the wide sandbar. The project site is selected at the right river course of the two.

Projected site of Cutato River site is located in the Cutato River which is the tributary of the Cuanza River (147,000 km^2). The catchment area of the projected site is 9,400 km^2. Most part of the catchment is located on the highland which is higher than EL. 1,500 m with an exception of the projected powerhouse site from EL. 1,250 to 1,500 m (refer to Fig.3.2-4, Fig. 3.2-5). This projected site is located in the relatively wet region in Angola with annual rainfall of more than 1,250 mm/yr.

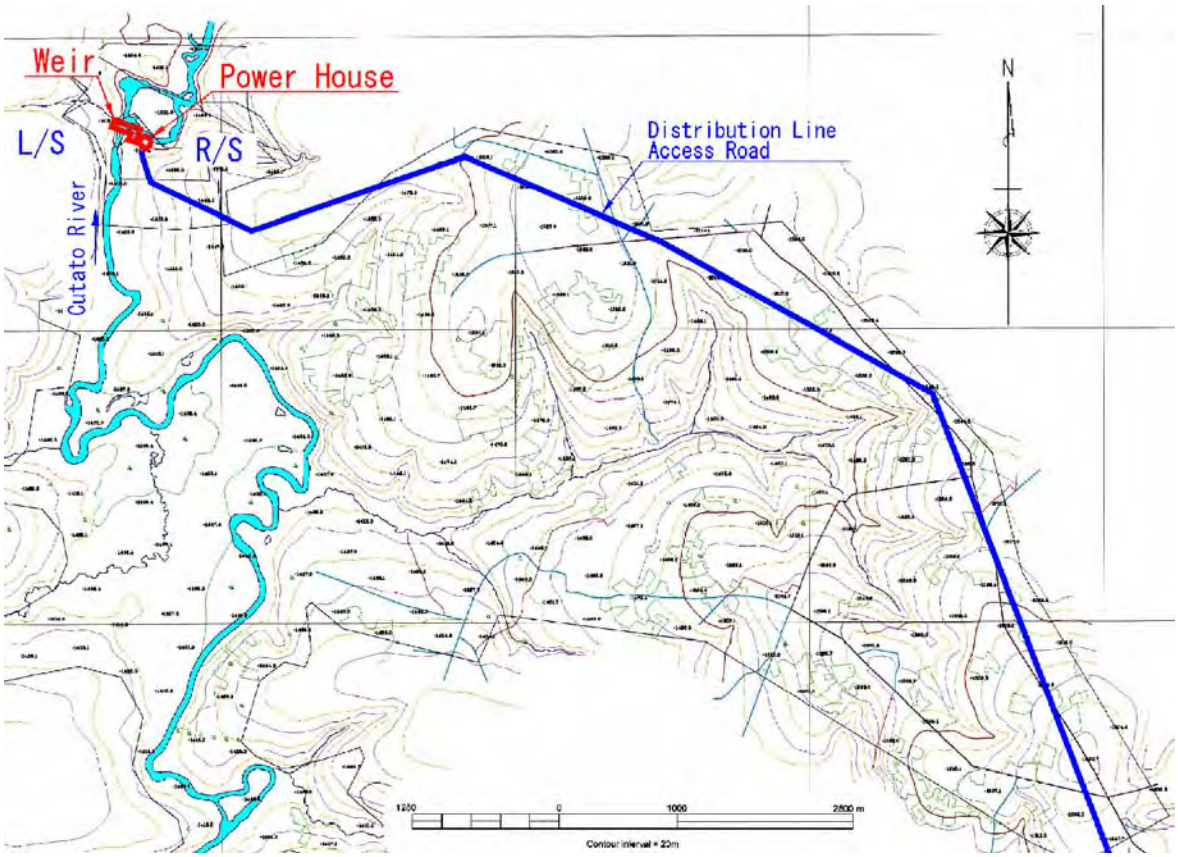
The coolest period is May to August when almost no rain falls. Heavy rain falls in the main rainy season October to April. Both Bie province and Huambo province included in the projected river basin feature almost same climate with averaging nearly 1,500 mm of rain.

Discharge duration curve at the Cambambe site of the Cuanza river flow data shows the specific discharge ($m^3/s/100\ km^2$) of 1.06, 0.51, 0.30 and 0.22 with each 25% flow (95-day flow), 50% flow (183-day flow), 75 % flow (274-day flow) and 95 % flow (346-day flow).

(2) Plan of Power Generation and Distribution

Cutato Powerhouse location was decided to be the right bank of the right branch (Cutato river has a branch at downstream of the weir). Because above location is superior to other location from many viewpoints of, for example, distribution line , access road, temporary facilities site and easiness of operation, maintenance and construction.

Optimum weir height and optimum maximum discharge were checked up in various height and discharge cases and selected out of the cases, which cost-benefit ratio (B/C) is the biggest number. The result is that weir height is 4 m, maximum discharge is 50 m^3/s.



Location of Powerhouse

(3) Outline Design of the Project

1) Civil facilities

River has a branch at the downstream of the weir and there is the intake (width: 21 m, height: 18 m, length: 14.5 m) at right tributary. From here, the maximum discharge (50 m^3/s) is taken to the powerhouse, generates maximum power about 3 MW and goes out to the river again from the outlet (width: 21 m, height: 15 m, length: 2 m).

In addition to above river area, the project needs access road (along the distribution line, it's about 5m wide and 28 km long) from Chicumbi to the site, and temporary facility ground (area is about 7,000 m^2 including disposal area of waste soil) near the power station.

2) Electro-mechanical facilities

As for electro-mechanical facilities, the S-type Tubular type was selected for the water turbine type judging from the river discharge and gross head of the Cutato River site.

The number of the turbine and generator was selected 2 units (1,500 kW × 2) with consideration for fluctuation of river discharge and redundancy of equipments in case of

maintenance and troubles.

A substation is to be installed near the power station to increase voltage of output voltage of the generator to the power transmission line voltage

3) Transmission and Distribution facilities

Transmission and distribution lines are to be installed from the Cutato River site to the city of Andulo. Distribution lines are planned to be 46 km with distributing Chicumbi village in consideration of strong request from GOA. In this plan, 30 kV high-voltage power distribution line is to be required as distribution line equipments.

5.4 Construction Plan and Schedule

Basic condition of construction plan and schedule is to intend early construction work starting and early operation beginning. Because term of electrical mechanical works is the longest term, so other term of civil works and distribution line works are planned in term of electrical mechanical works.
Access road and distribution route works in civil works are gone ahead as soon as possible after commencement of main works.

Main works consist of civil works, electrical mechanical and distribution line works.
The term of electrical mechanical works which design, examine, adjust and instruct operation are 2 years and becomes critical path of total works considering term of other works.

5.5 Project Implementation Plan

The commencement of main works is June 1st 2014 if each term of proceeding procedure are following and the time of loan agreement is at the end of November 2011. The procedure of getting CDM credit can be proceeded in parallel.

a) Consultant selection..... 5 months
b) Detailed design ..... 9 months
Preparation of tender documents, JICA approval ..... 4 months
Tender period..... 3 months
Tender evaluation, JICA approval ..... 6 months
Contract negotiation, JICA approval, L/C open etc..... 3 months
Total..... 30 months

5.6 Project Cost

The construction cost is built up by estimation of each work, such as (a) Land-mine investigation and removal, (b) Civil work including metal work, (c) Electro-mechanical work, and (d) Associated transmission and distribution line. Land-mine investigation & removal and civil work are estimated 26 Million JPY and 1,351 Million JPY respectively. And electro-mechanical and associated distribution line are estimated 1,411 Million JPY and 642 Million JPY. Therefore, the base cost for the construction cost is resulted in 3,430 Million JPY.

The project cost including the above base cost, the contingencies of 639 Million JPY, consultant service fee and owner's administration cost of 346 Million JPY becomes 4,416 Million JPY.

The construction cost seems to be expensive in comparison with the project scale. The reasons why the construction cost is costly are due to the specific condition of Angola and the site as below:

a) High price escalation rate exceeding 10 % per annum (increase of price contingency)
b) Far expensive recovery costs for construction machines and cost for material in comparison with those in Japan
c) Execution of land-mining investigation and removal
d) Adoption of S-type tubular turbine costing higher in comparison with other types of turbines due to low effective head and great volume of power intake discharge.

5.7 Economic and Financial Analysis

The project can be evaluated as bellow in terms of economic and financial analysis.

(a) Even in consideration of CER revenue, the project is deemed to be financially infeasible. On the other hand, the project's EIRR of 13.3 % is deemed to be economically feasible due to the recent soaring of the crude oil price (FOB) in the world.

(b) The reason the project becomes financially not attractive seems to be caused by its expensive construction cost and low power tariff of 4 US cent/kWh against the average generation cost of 11 US cent/kWh of ENE.

(c) Based on the economic analysis, the project is worth of implementation in terms of rural electrification because about 6,000 households in Andulo City become able to newly

access to electricity. The implementation of the project will support the national target that the half of population in Angola becomes able to access to electricity by the year 2015.

5.8 Environmental Impact Assessment

EFL of 1998 is most fundamental to execute the environmental policy. Concrete framework of the regulation is incomplete to apply the Law. In the EFL of 1998, article 17 states that implementation of EIA is mandatory against construction of hydropower at the capacity more than 1 MW and transmission line at the capacity more than 230 kV.

In this study initial environmental impact survey was undertaken. All the candidate sites are type of run-of-river and little difference in terms of environmental impact among sites. Cutato site is expected to be developed more capacity than the other sites. To mitigate the impact, Cutato site will require a gated-spillway to control the reservoir water level not to increase the water level at floods.

The initial environmental impact examination was undertaken for Cutato site. All the village residents near the site showed agreement of the construction in the field interview. The involuntary resettlement is not estimated to happen due to the reservoir formation. The land inundated which doesn't include cultivated land will be state own and no target of compensation.

It is expected that negative impact on eco-system is small, but further investigation must be implemented in EIA. Especially, confirmation of habitat situations of hippopotamuses at the site is required, in consideration of information by the inhabitants.

EIA was carried out from June 2011 to October 2010.

As a result, significant impacts are water pollution, soil pollution and groundwater contamination caused by chemical pollutants, oil, and fuel from materials and vehicles. Through guidance to contractors and workers in terms of disposal of materials, maintenance of vehicles and so on will be able to mitigate these negative impacts.

Migratory fishes and hippopotamus were identified. Impacts on these aquatic and semi-aquatic fauna will cause by the weir. Flap gates settled on the weir reduce raising the flood water level and complete interruption of water flow. The footprint of hippopotamus was identified near the dam site, but fortunately the environment around the dam site, whose water flow is fast and riverbank consists of rock, is not suitable for habitat of hippopotamus.

Therefore it is assumed that hippopotamus use around the dam site as not ecological niche but moving path to feeding ground. From above, it is estimated that impacts on migratory fishes and hippopotamuses are small. As mitigation for these impacts on aquatic fauna and semi-aquatic fauna, installation of fish passage and monitoring of usage of PPP and hippopotamuses population around the site are recommended.

Residences and farming lands were not confirmed in the submerged area. Therefore there isn't target of compensation. However it is necessary to avoid cemeteries and woods along access road and transmission line at detailed design phase.

From the above, the negative impact on natural environment and ecosystem is not significant. Moreover implement of mitigation measures is able to avoid and reduce it. It is assessed that the positive impact on socio-economic in good cause of supply to thousands residents is more significant than the negative one.

CHAPTER 6

FUTURE SURVEY

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Following surveys are necessary and recommended for detailed design of this project.

6.1 Hydrology

Hydrological items checked up in this feasibility study are necessary to be reviewed more closely in detailed design stage. Reviewed additional surveys are followings.

(1) River Discharge

1) Measurement of river discharge

Gauging station, where river discharge is measured, is settled at upstream of power station in Cutato river and data of river discharge shall be stocked.

2) Observation of peak discharge

To improve the accuracy of flood discharge probability, water level at peak discharge and flood wave shape at the site shall be identified by recording water transition of average daily level but also flood level for short term.

(2) Sedimentation

1) Estimation of sedimentation

The surveys for estimation of sedimentation are necessary and data of sedimentation should be stocked.

2) Hydraulic model test

Local sedimentation shape of just upstream of weir and front of flushing gate are unknown in this survey. Hydrological model experiment is recommended at detailed design stage that can clear the local sedimentation shape and protect air entering at the intake.

6.2 Topographic Survey

Topographic maps which scale is 1/25,000, 1/5,000 and 1/2,000 are made in this feasibility study by using satellite photograph. In addition, following topographic maps shall be made with field survey for more accuracy improvement of the project in detailed design stage.

- Topographic map which includes main structures of the project covering from 300 m upstream to 300 m downstream. Its scale is 1/1,000

- Longitudinal and cross section map of the river which is from 300 m upstream to 300 m downstream. Its scale is 1/1,000.
- Topographic map along access road and distribution line (about 46 km length) from the site to Andulo, if it is necessary to survey for getting land. Its scale is 1/2,000.

6.3 Access Road Survey

Access road survey is needed in detailed design stage. It is probable that materials, equipments and heavy vehicles imported from abroad are transported from Lobito to the site. Many tracks and trailers are used in domestic transportation and they use existing pavement roads and bridges to the site. Especially existing bridges should be surveyed whether they are safe for heavy load and necessary to be repaired.

6.4 Geological Survey

It is necessary that geological and geo-technical characteristics at main structures site recommended in feasibility study should be figured out in detailed design stage. Base rock around the weir and the power house is seemed to fit in the reconnaissance. It is recommended that survey borings (1 or 2 borings, 2 or 3 m length) shall be done for figuring out the base rock characteristics, and estimation of rock category and class should be done by using boring core.

6.5 Material Survey

Sands in Cutato River and crushed stones of base rock are considered to be suitable as aggregates of concrete at feasibility study stage. It is evaluated that both materials can be concrete aggregates qualitatively and quantitatively. Aggregate tests should be done with site materials at detailed design stage, and it is necessary to check up that crushed stones can be concrete aggregates. Necessary aggregate tests are to figure out specific gravity, water absorption, stability and alkali aggregate response. Concrete strength tests should be done with actual cement and actual aggregate.

6.6 Land Mine Survey

Land mine survey must be done for targeting the project area before access road work. Field director and organization for land mine survey and demining work are confirmed at detailed design and make clear the work schedule and cost.

APPENDICES

APPENDIX 1

DRAWINGS

List of Drawings

Draw. No.	Title
C-001	Cutato Hydro Power Station Figure Basin
C-002	Cutato Hydro Power Station Overall Plan
C-003	Cutato Hydro Power Station Weir Plan
C-004	Cutato Hydro Power Station Figure Upstream Weir
C-005	Cutato Hydro Power Station Weir Standard Cross Section
C-006	Cutato Hydro Power Station Power House Plan
C-007	Cutato Hydro Power Station Vertical Section for Power House
C-008	Cutato Hydro Power Station Cross Section for Power House
C-009	Cutato Hydro Power Station Riverbed Excavation Plan
C-010	Cutato Hydro Power Station Access Road Plan
C-011	Cutato Hydro Power Station Temporary Facilities (1)
C-012	Cutato Hydro Power Station Temporary Facilities (2)
E-001	Cutato Hydro Power Station Single Line Diagram
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E-004	Cutato Hydro Power Station Cross Section for Power House
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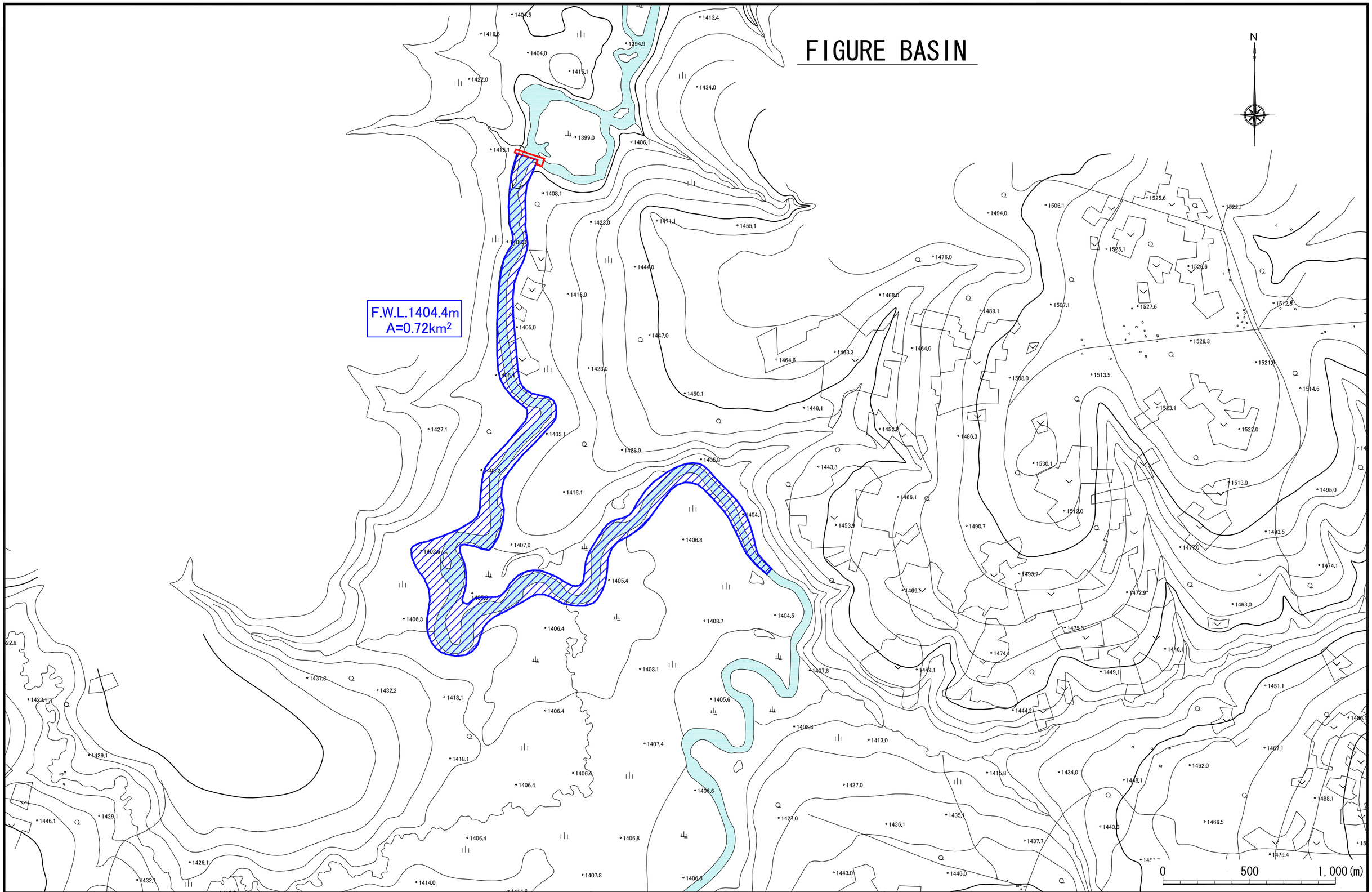
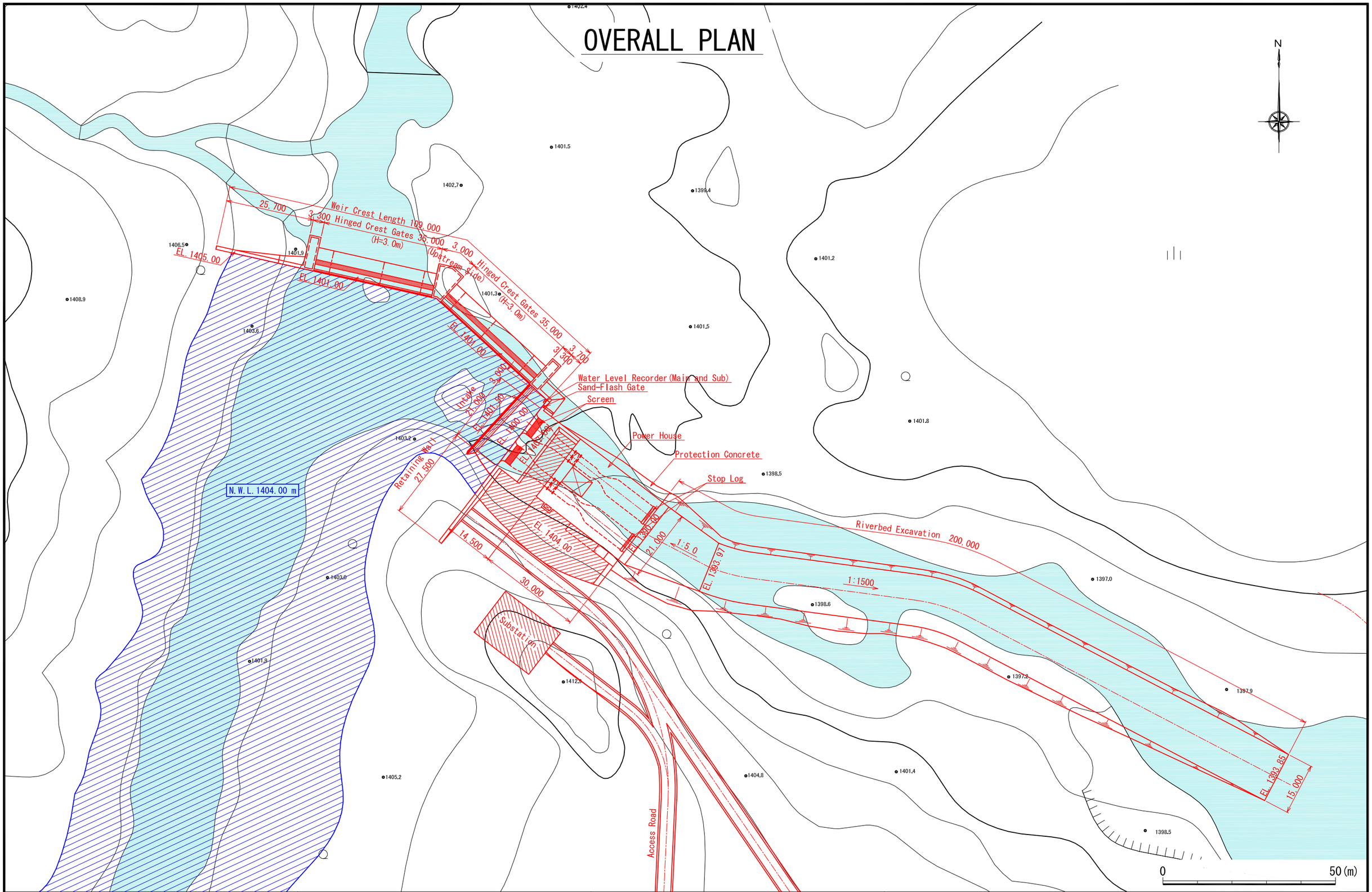
T-001	Distribution Line Route Cutato to Andulo
T-002	Single Line Diagram Distribution Line (30kV) from Cutato to Andulo
T-003	Single Line Diagram Distribution Line (400-230V) Low Voltage for Chicumbi
T-004	Sample Pole Drawing for Distribution Line Route Cutato to Andulo
T-005	Pole Drawing for Distribution Line Route Cutato to Andulo
T-006	Sample Pole Drawing for Distribution Line Route Cutato to Andulo
T-007	Pole Drawing for Distribution Line Route Cutato to Andulo

FIGURE BASIN



REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **FIGURE BASIN** **(S = 1/20,000)**	DWG No. C-001 7.Apr.2011

OVERALL PLAN



REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION OVERALL PLAN (S = 1/1,000)**	DWG No. C-002 7.Apr.2011

WEIR PLAN

N

1402.7

1399.4

1406.5

1401.9

1401.3

1401.5

1403.6

1403.2

1403.0

1398

25,700

3,300

Weir Crest Length 109,000

Hinged Crest Gates 35,000
(H=3.0m)

3,000
(Upstream Side)

Hinged Crest Gates 35,000
(H=3.0m)

3,700

3,300

10,000

9,000

6,000

1,000

EL. 1405.00

1:0.7

EL. 1401.00

J0

18,500

J1

15,000

J2

15,000

J3

12,000

J4

5,000

J5

150°

5,000

J6

12,000

EL. 1401.00

J7

15,000

90°

90°

65°

J8

1:0.7

Intake

21,000

EL. 1401.50

EL. 1400.00

EL. 1401.00

Water Level Recorder(Main and Sub)

Sand-Flash Gate

Screen

Power House

N.W.L. 1404.00 m

Retaining Wall

27,500

EL. 1404.00

EL. 1390.00

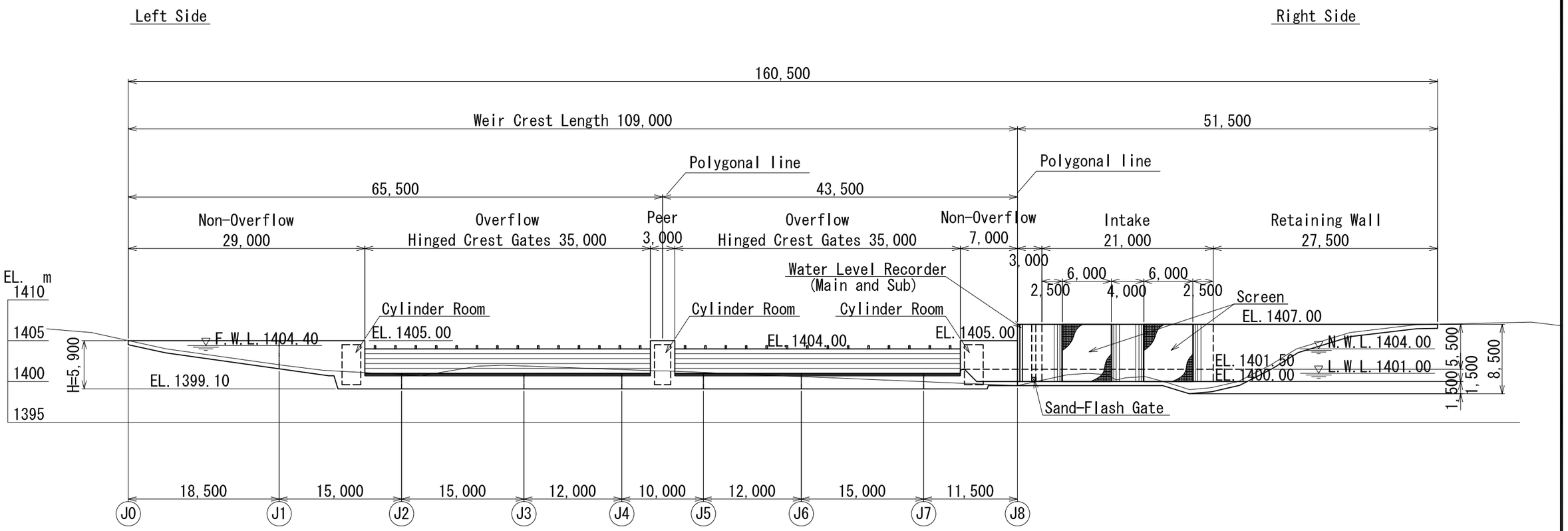
1:5.0

1393.97

0 10 20(m)

REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **WEIR PLAN** **(S = 1/500)**	DWG No. C-003 7.Apr.2011

FIGURE UPSTREAM WEIR

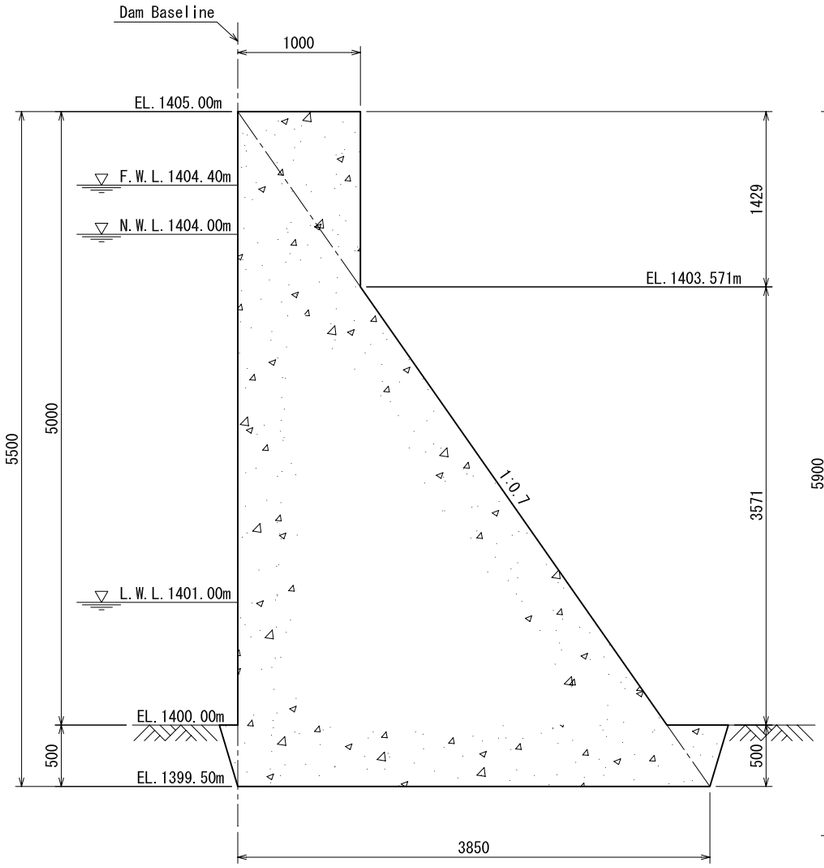


0 10 20 (m)

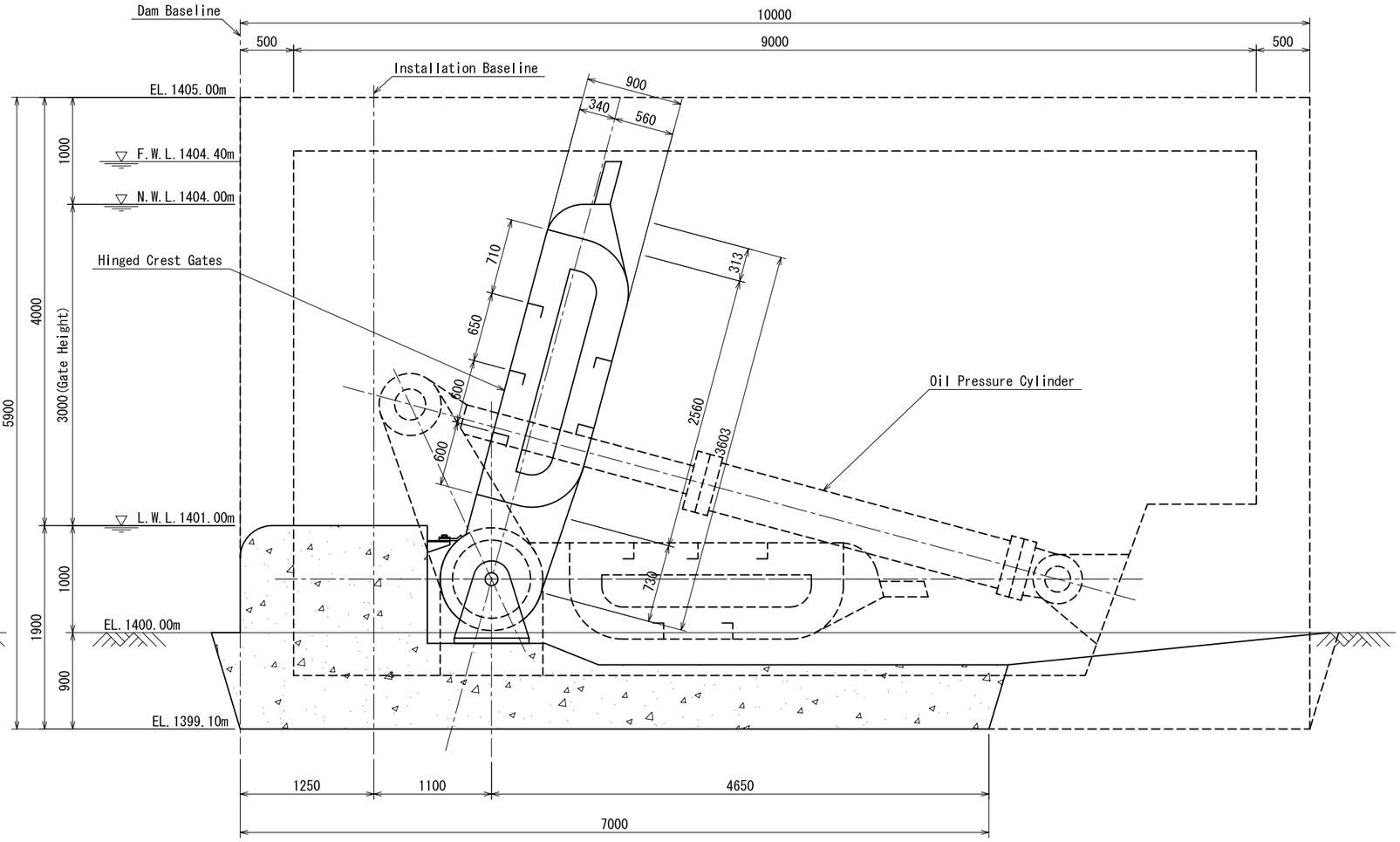
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **FIGURE UPSTREAM WEIR** **(S = 1/500)**	DWG No. C-004 7.Apr.2011

WEIR STANDARD CROSS SECTION

NON-OVERFLOW SECTION



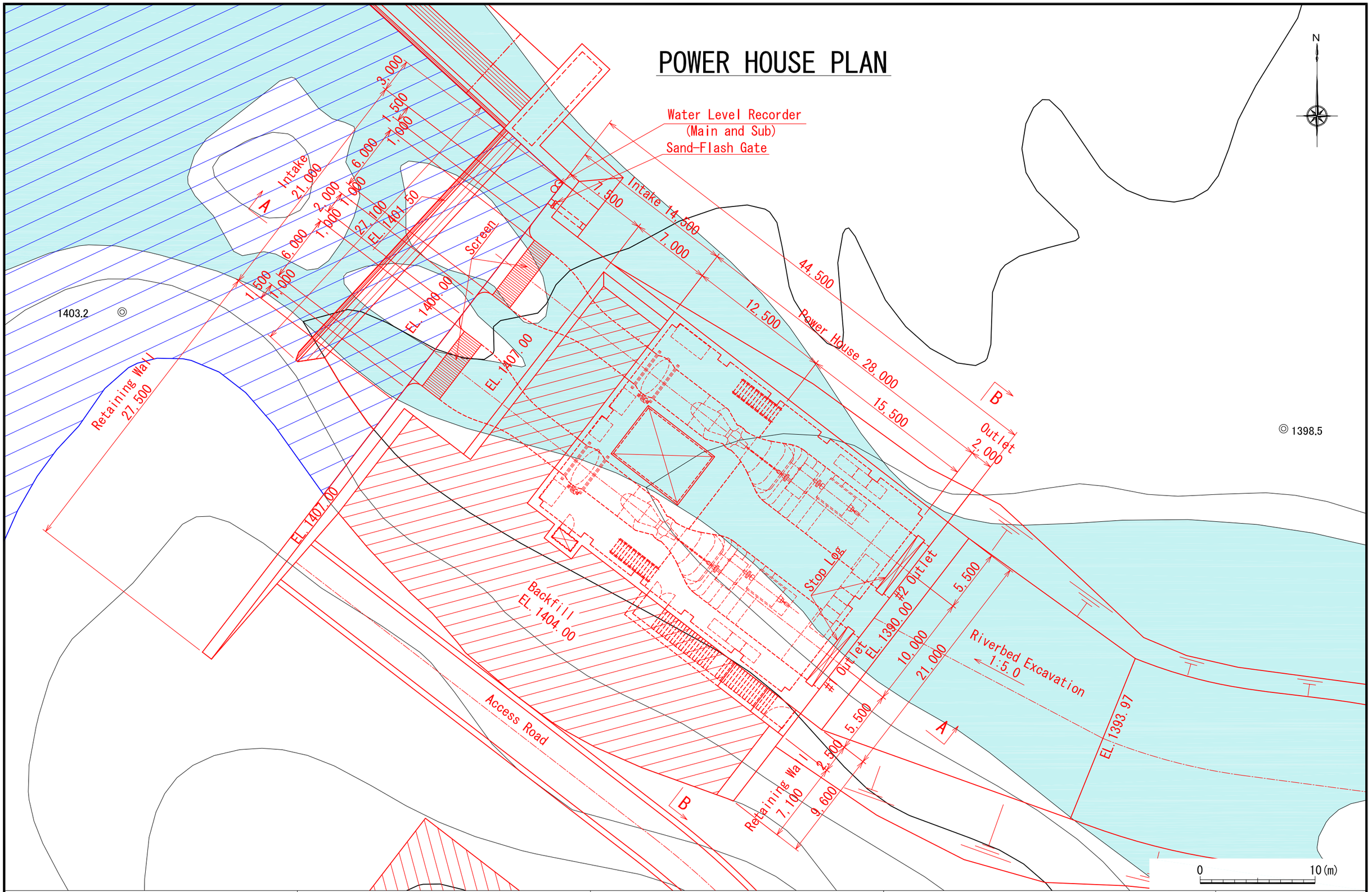
OVERFLOW SECTION and CYLINDER ROOM



0 3 (m)

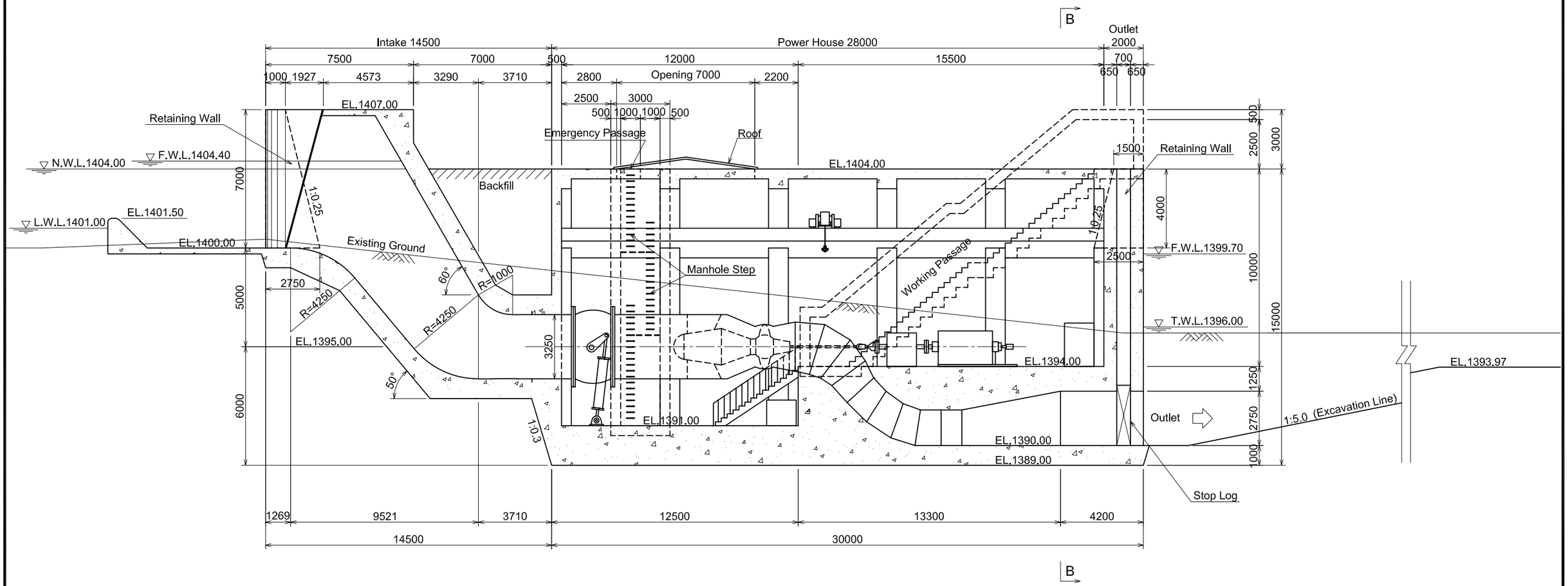
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA / NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **WEIR STANDARD CROSS SECTION** **(S = 1/50)**	DWG No. C-005 7.Apr.2011

POWER HOUSE PLAN



REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **POWER HOUSE PLAN** **(S = 1/300)**	DWG No. C-006 7.Apr.2011

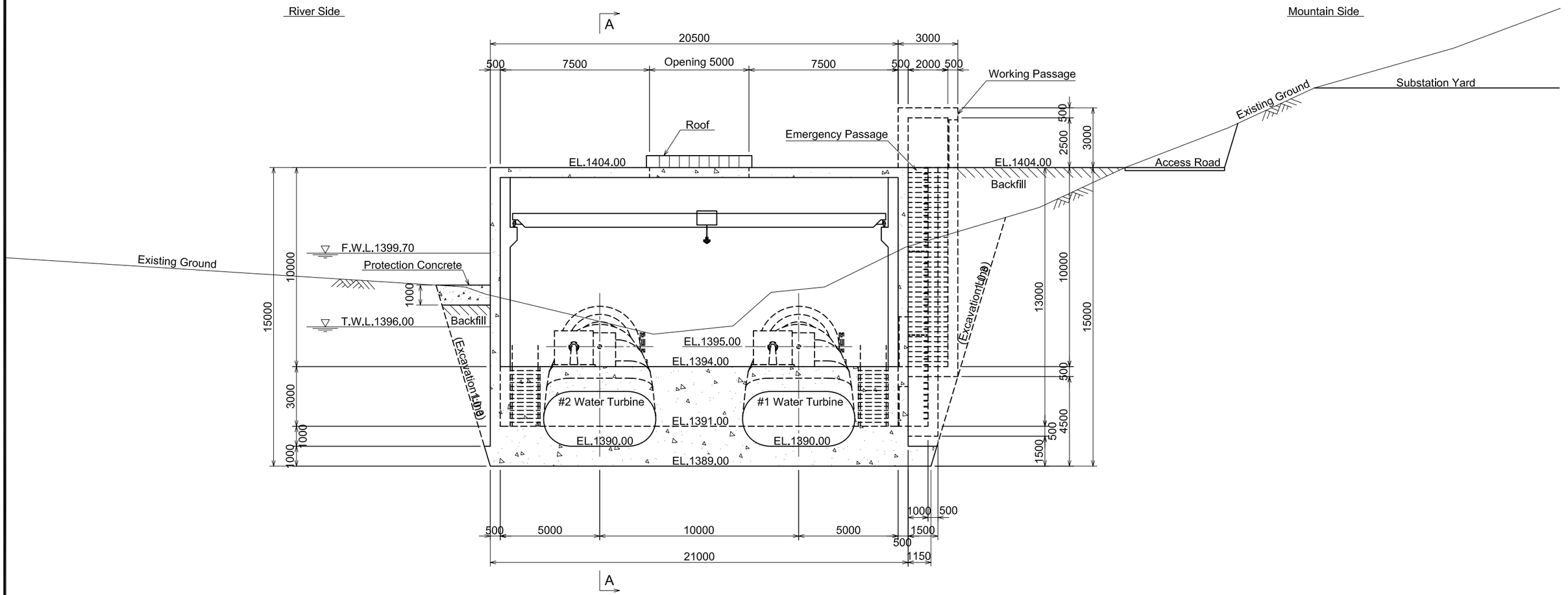
VERTICAL SECTION FOR POWER HOUSE
(A - A)



0 5 10(m)

REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **VERTICAL SECTION FOR POWER HOUSE** **(S = 1/200)**	DWG No. C-007 7.Apr.2011

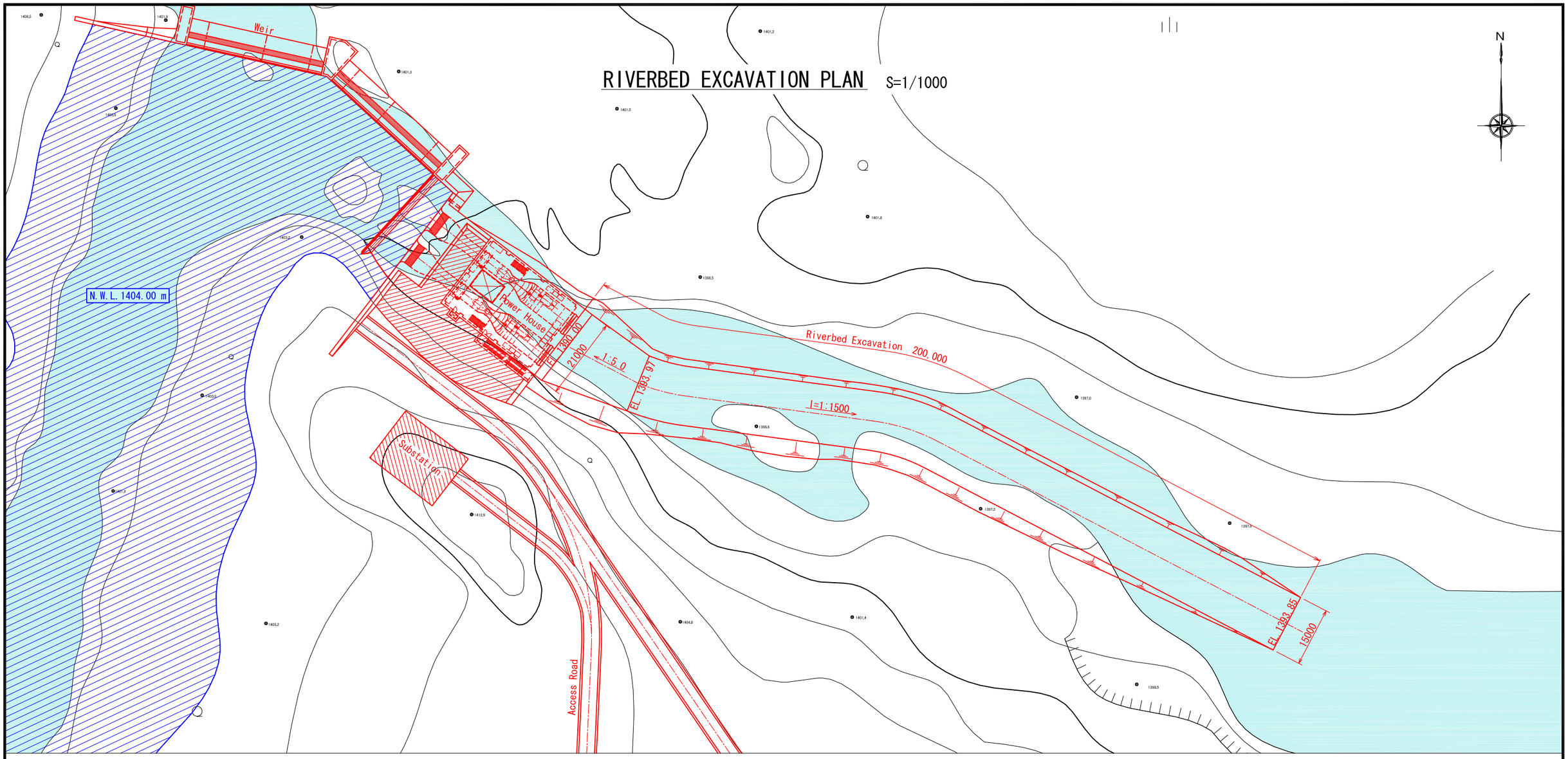
CROSS SECTION FOR POWER HOUSE
(B - B)



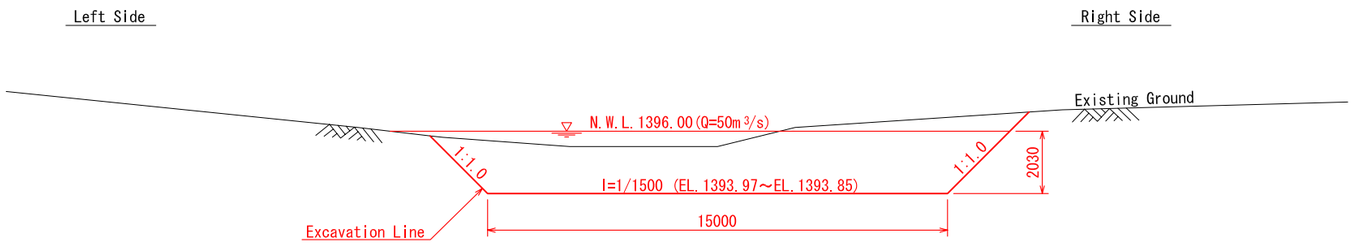
0 5 10(m)

REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **CROSS SECTION fOR POWER HOUSE** **(S = 1/200)**	DWG No. C-008 7.Apr.2011

RIVERBED EXCAVATION PLAN S=1/1000



CROSS SECTION FOR RIVERBED EXCAVATION S=1/200



0 S=1/1000 50(m)

0 S=1/200 10(m)

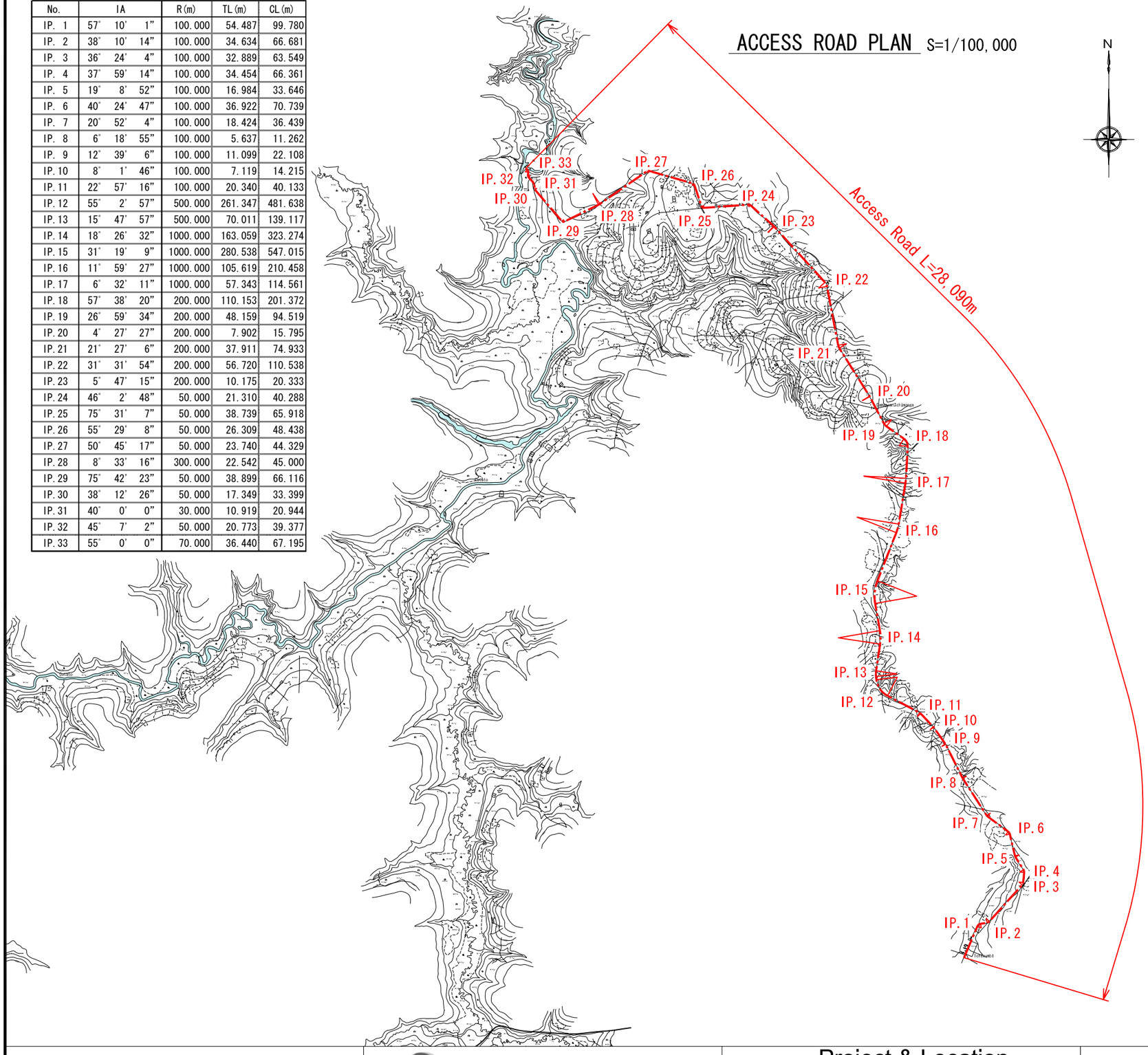
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION RIVERBED EXCAVATION PLAN (S = 1/1000 ,1/200)**

DWG No.
C-009
7.Apr.2011

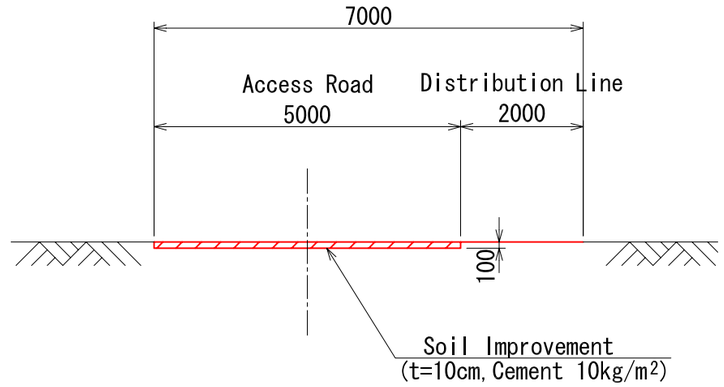
Specifications of IP

No.	IA	R(m)	TL(m)	CL(m)
IP. 1	57° 10' 1"	100.000	54.487	99.780
IP. 2	38° 10' 14"	100.000	34.634	66.681
IP. 3	36° 24' 4"	100.000	32.889	63.549
IP. 4	37° 59' 14"	100.000	34.454	66.361
IP. 5	19° 8' 52"	100.000	16.984	33.646
IP. 6	40° 24' 47"	100.000	36.922	70.739
IP. 7	20° 52' 4"	100.000	18.424	36.439
IP. 8	6° 18' 55"	100.000	5.637	11.262
IP. 9	12° 39' 6"	100.000	11.099	22.108
IP.10	8° 1' 46"	100.000	7.119	14.215
IP.11	22° 57' 16"	100.000	20.340	40.133
IP.12	55° 2' 57"	500.000	261.347	481.638
IP.13	15° 47' 57"	500.000	70.011	139.117
IP.14	18° 26' 32"	1000.000	163.059	323.274
IP.15	31° 19' 9"	1000.000	280.538	547.015
IP.16	11° 59' 27"	1000.000	105.619	210.458
IP.17	6° 32' 11"	1000.000	57.343	114.561
IP.18	57° 38' 20"	200.000	110.153	201.372
IP.19	26° 59' 34"	200.000	48.159	94.519
IP.20	4° 27' 27"	200.000	7.902	15.795
IP.21	21° 27' 6"	200.000	37.911	74.933
IP.22	31° 31' 54"	200.000	56.720	110.538
IP.23	5° 47' 15"	200.000	10.175	20.333
IP.24	46° 2' 48"	50.000	21.310	40.288
IP.25	75° 31' 7"	50.000	38.739	65.918
IP.26	55° 29' 8"	50.000	26.309	48.438
IP.27	50° 45' 17"	50.000	23.740	44.329
IP.28	8° 33' 16"	300.000	22.542	45.000
IP.29	75° 42' 23"	50.000	38.899	66.116
IP.30	38° 12' 26"	50.000	17.349	33.399
IP.31	40° 0' 0"	30.000	10.919	20.944
IP.32	45° 7' 2"	50.000	20.773	39.377
IP.33	55° 0' 0"	70.000	36.440	67.195

ACCESS ROAD PLAN S=1/100,000



CROSS SECTION FOR ACCESS ROAD S=1/100

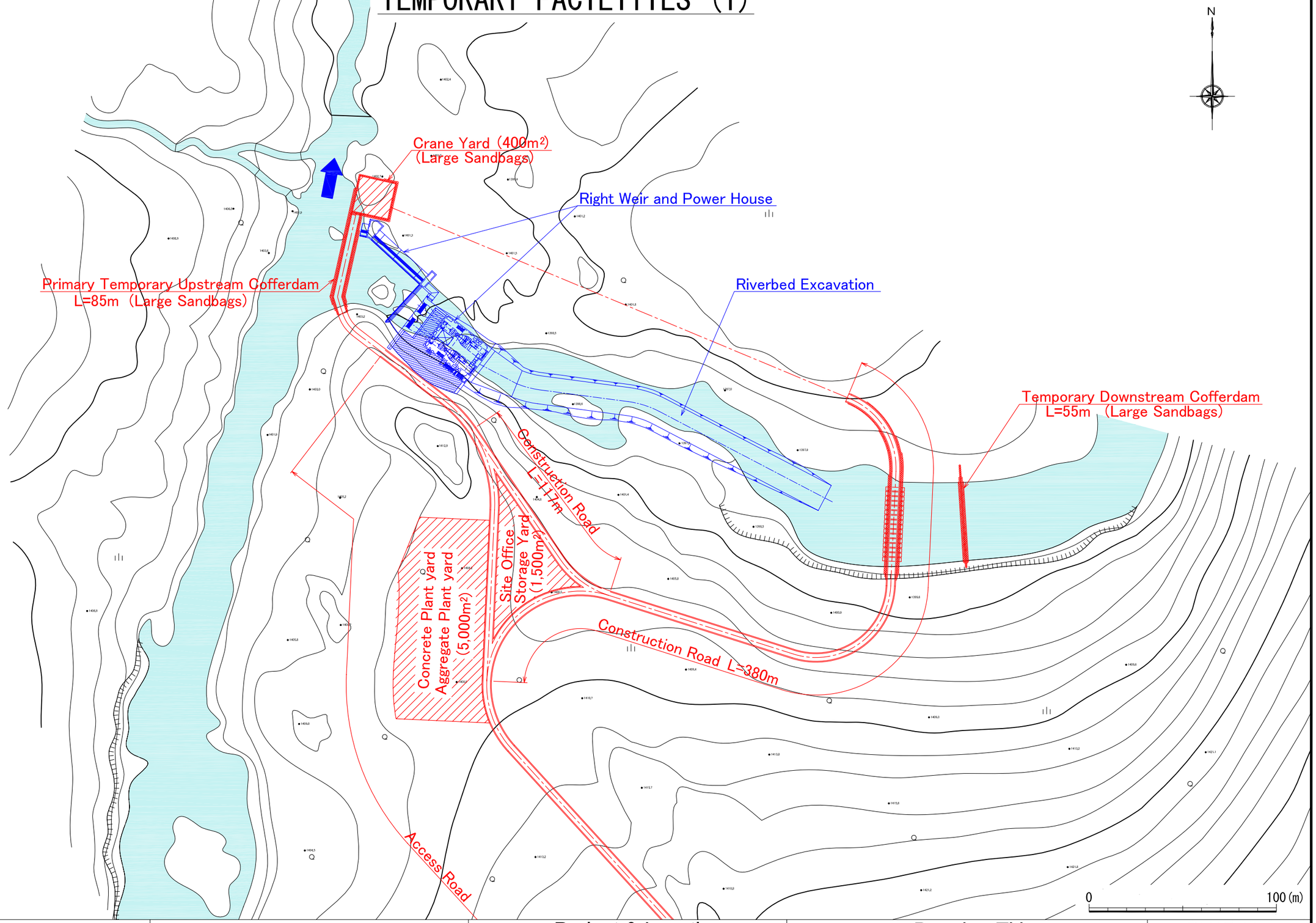


0 S=1/100,000 5,000(m)

0 S=1/100 5(m)

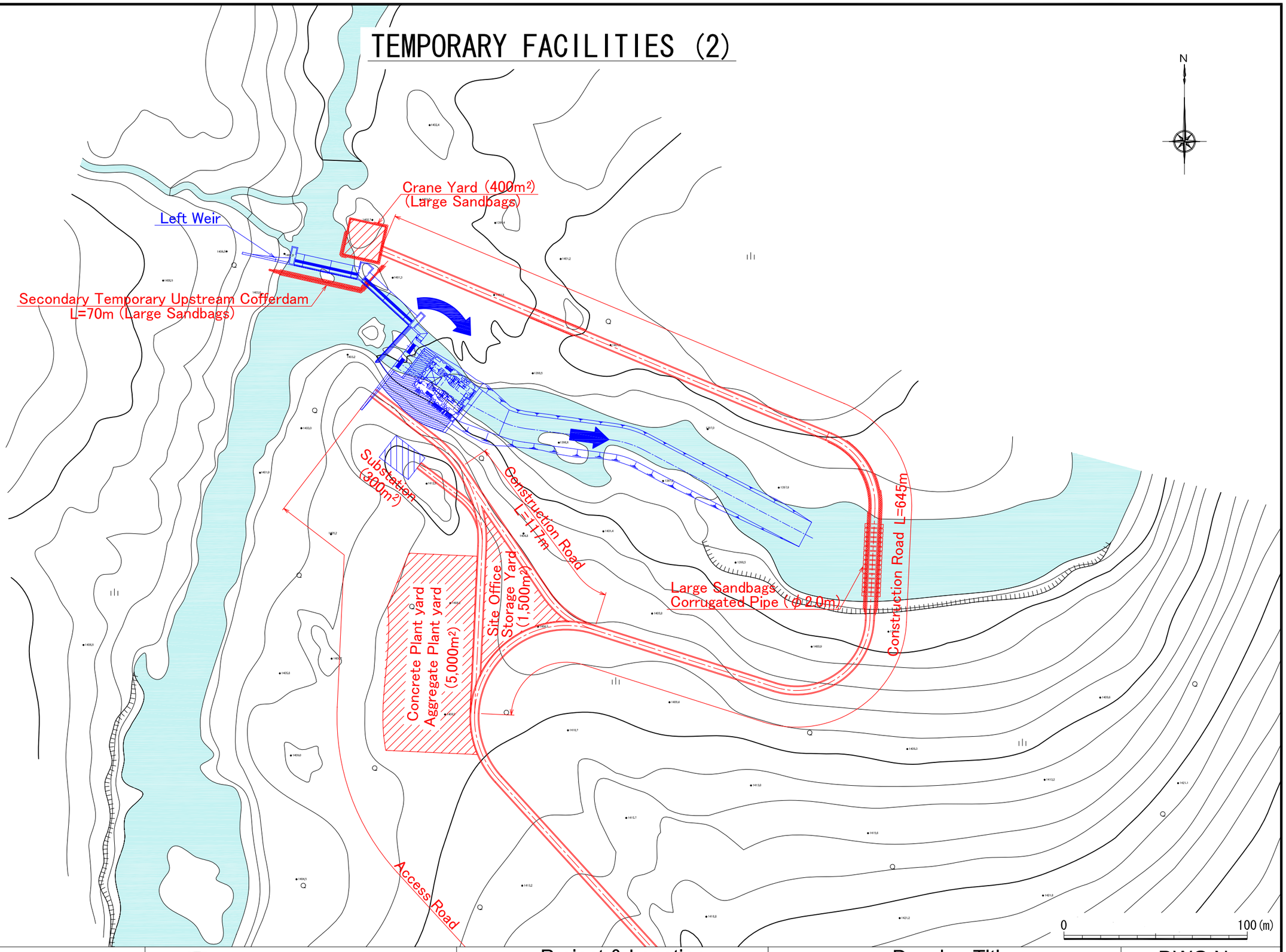
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION ACCESS ROAD PLAN (S = 1/100,000 ,1/100)**	DWG No. C-010 7.Apr.2011

TEMPORARY FACILITIES (1)

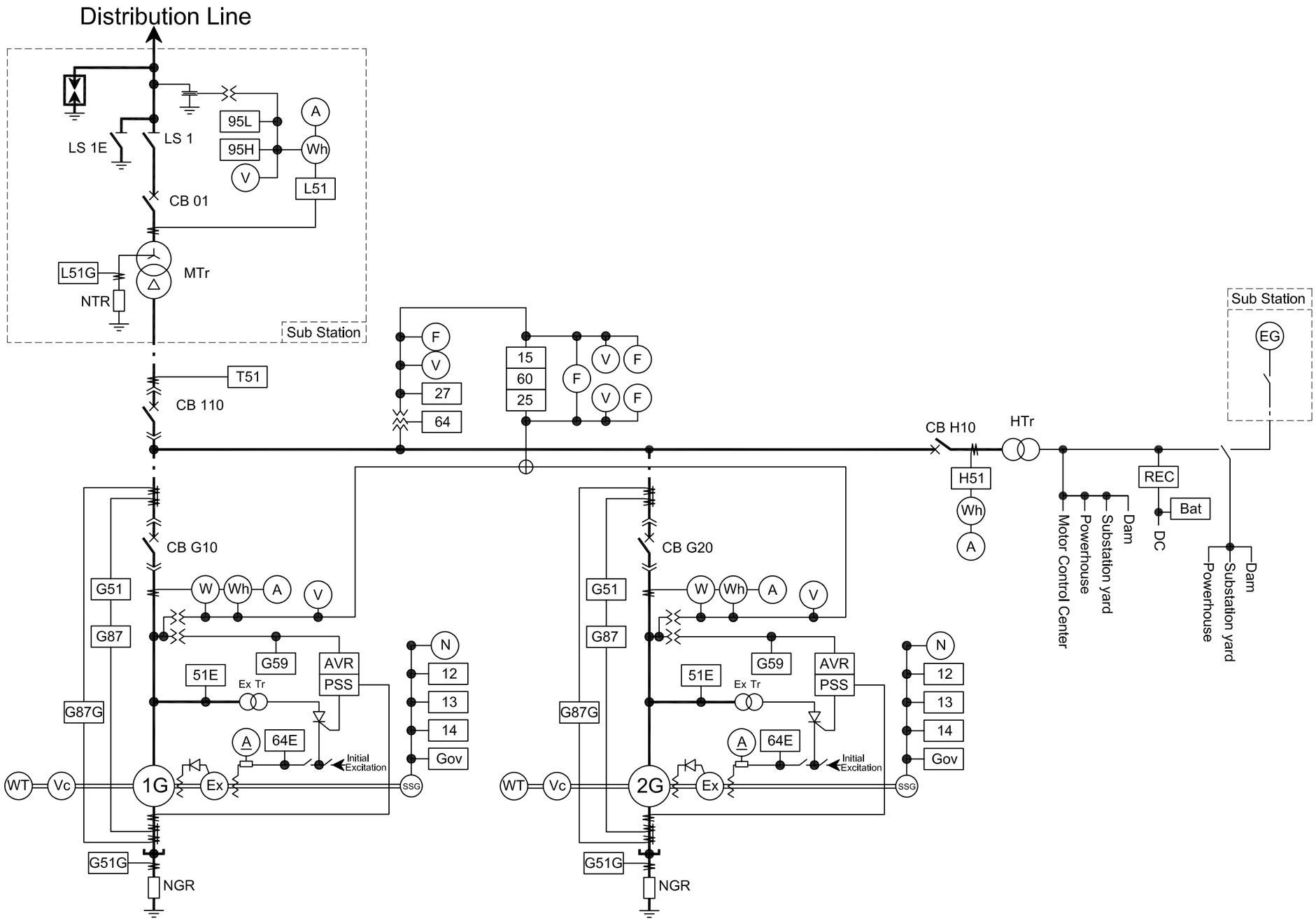


REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **TEMPORARY FACILITIES (1)** **(S = 1/2,000)**	DWG No. C-011 7.Apr.2011

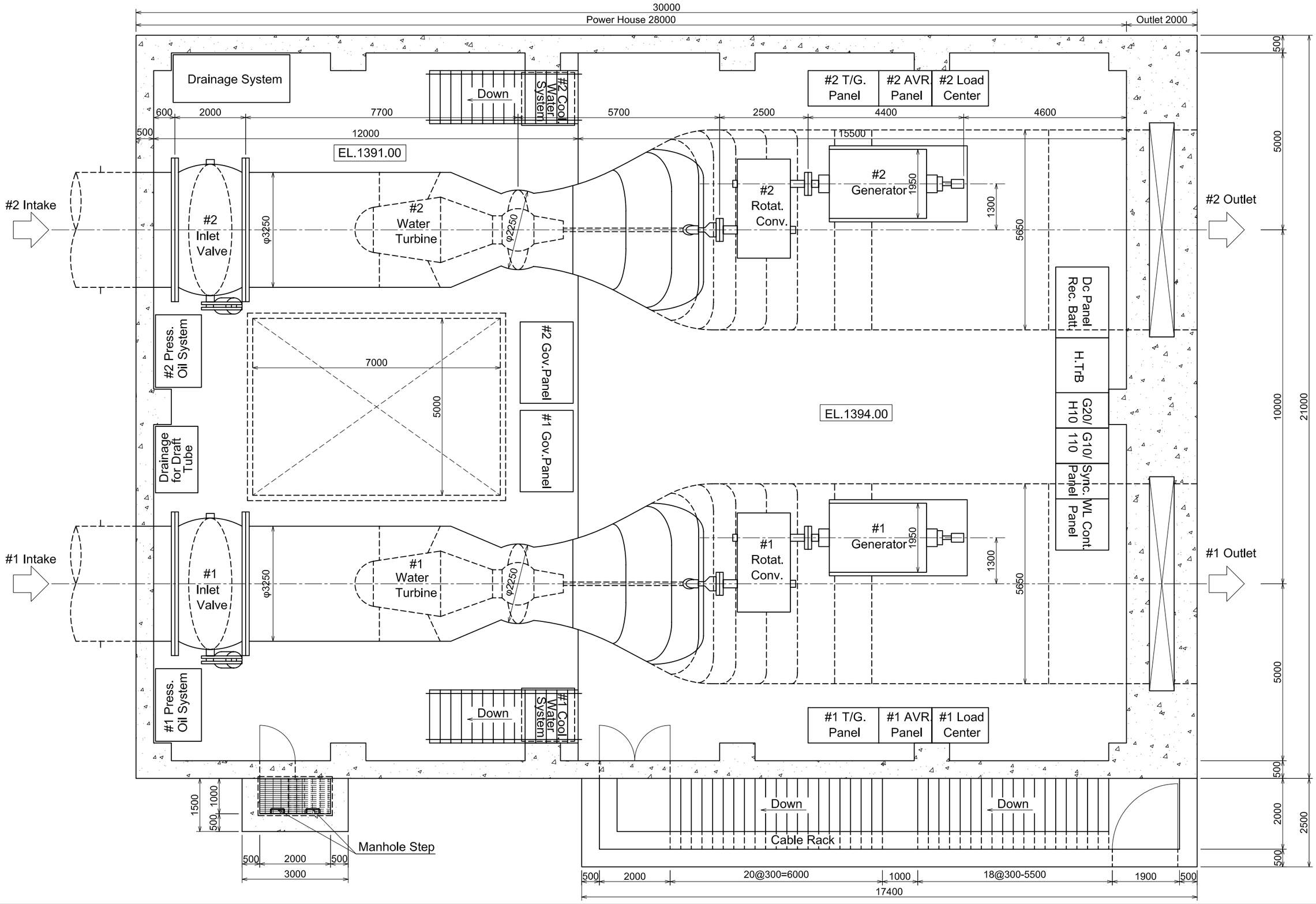
TEMPORARY FACILITIES (2)



REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **TEMPORARY FACILITIES (2)** **(S = 1/2,000)**	DWG No. C-012 7.Apr.2011

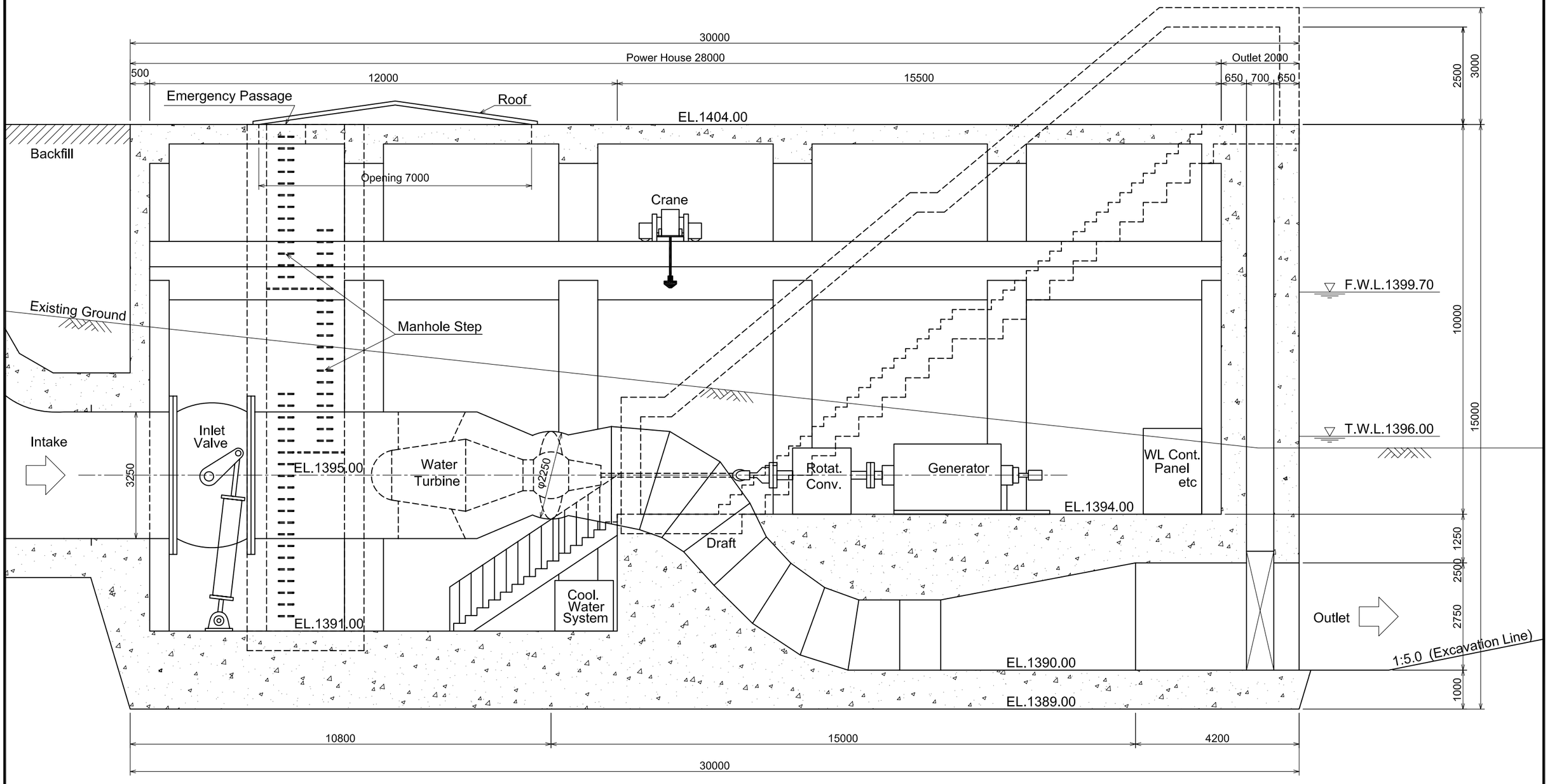


REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION SINGLE LINE DIAGRAM**	DWG No. E-001 7.Apr.2011

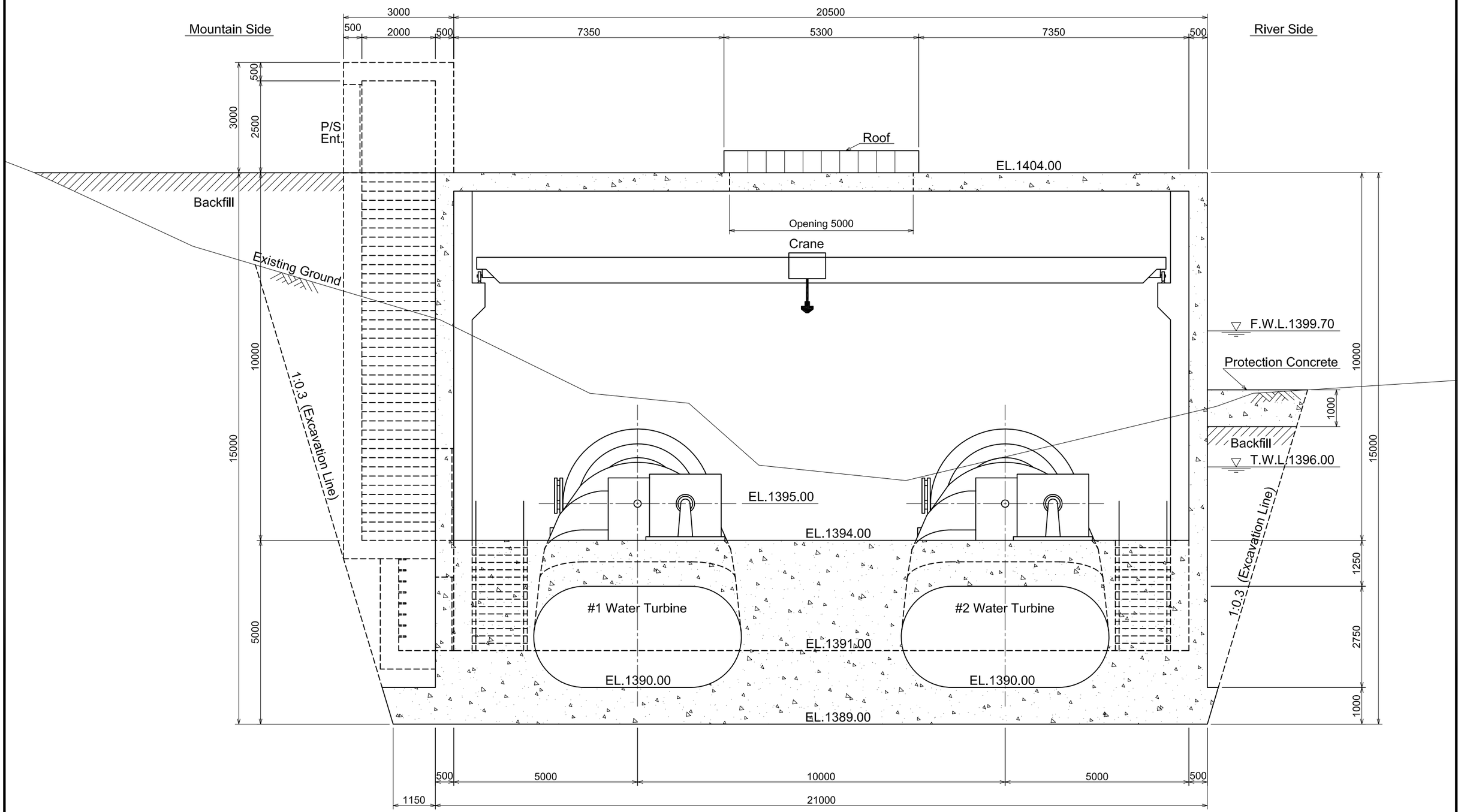


REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION POWER HOUSE LAYOUT (S = 1/100)**

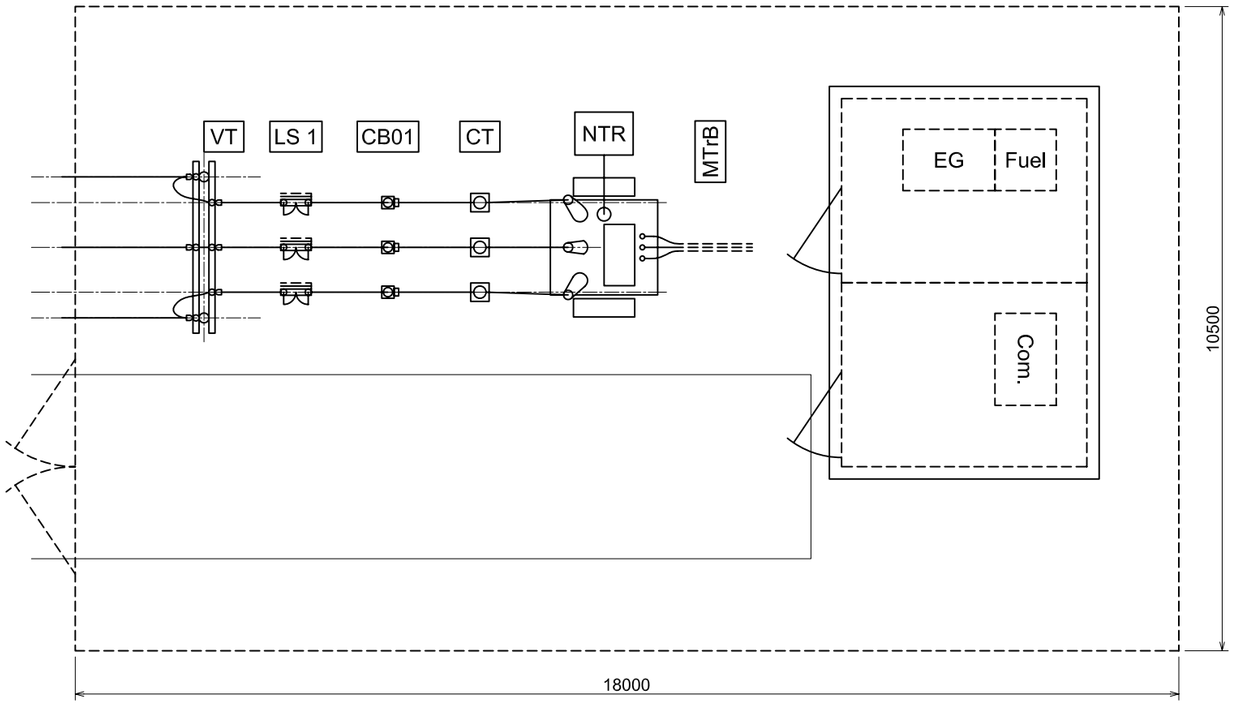
DWG No.
E-002
7.Apr.2011

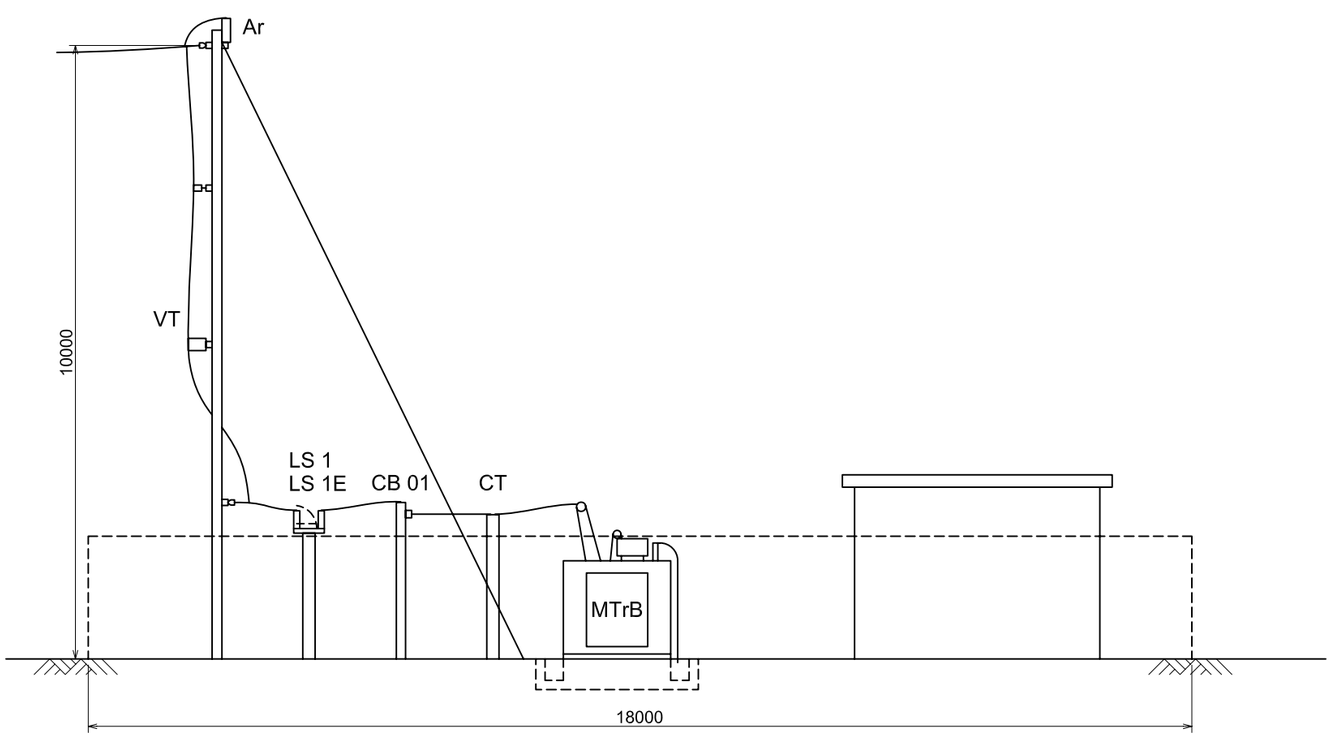


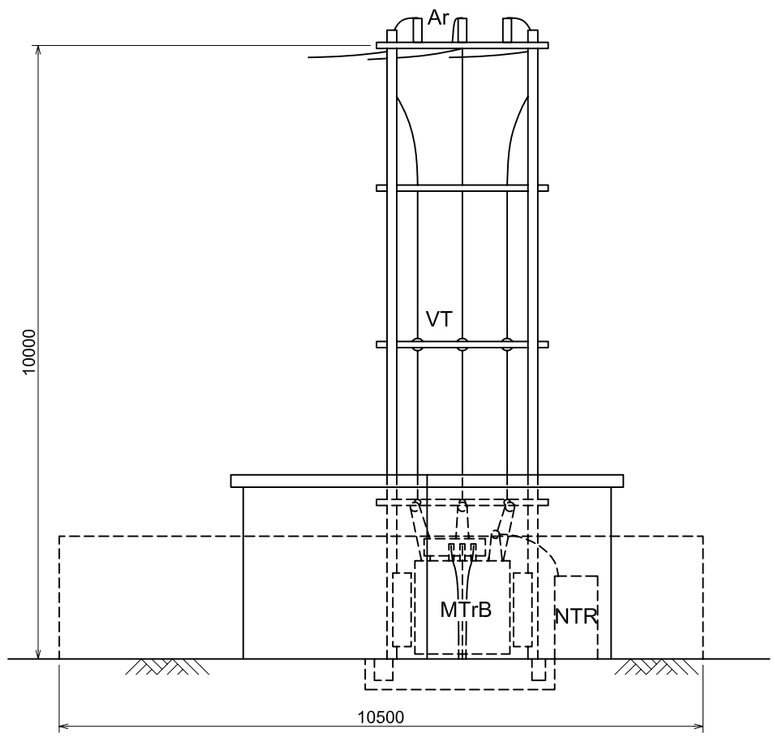
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **VERTICAL SECTION FOR POWER HOUSE** **(S = 1/100)**	DWG No. E-003 7.Apr.2011



REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION** **CROSS SECTION fOR POWER HOUSE** **(S = 1/100)**	DWG No. E-004 7.Apr.2011

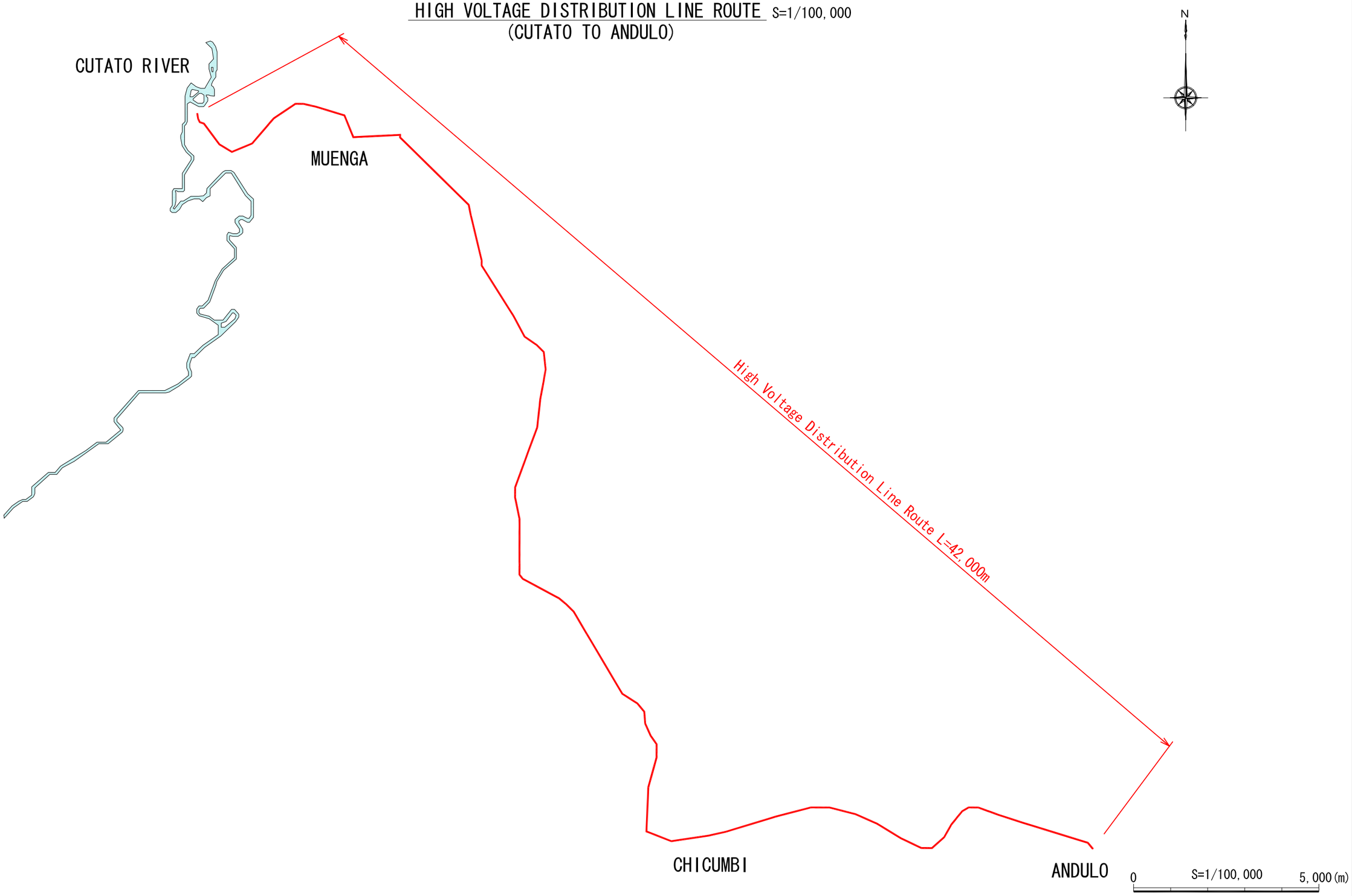




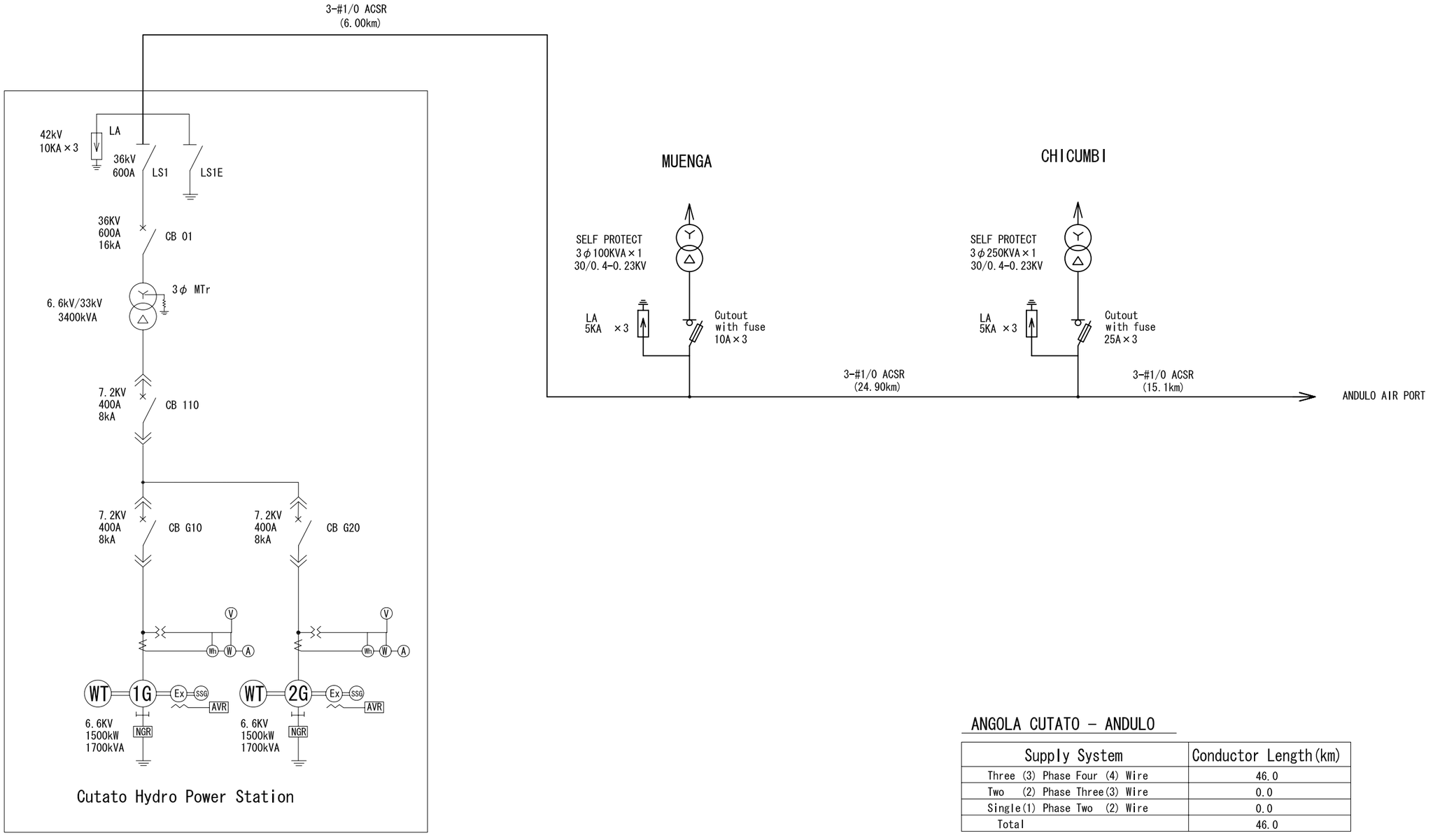


REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **CUTATO HYDRO POWER STATION SUBSTATION LAYOUT (S = 1/100)**	DWG No. E-005 7.Apr.2011

HIGH VOLTAGE DISTRIBUTION LINE ROUTE S=1/100,000
(CUTATO TO ANDULO)



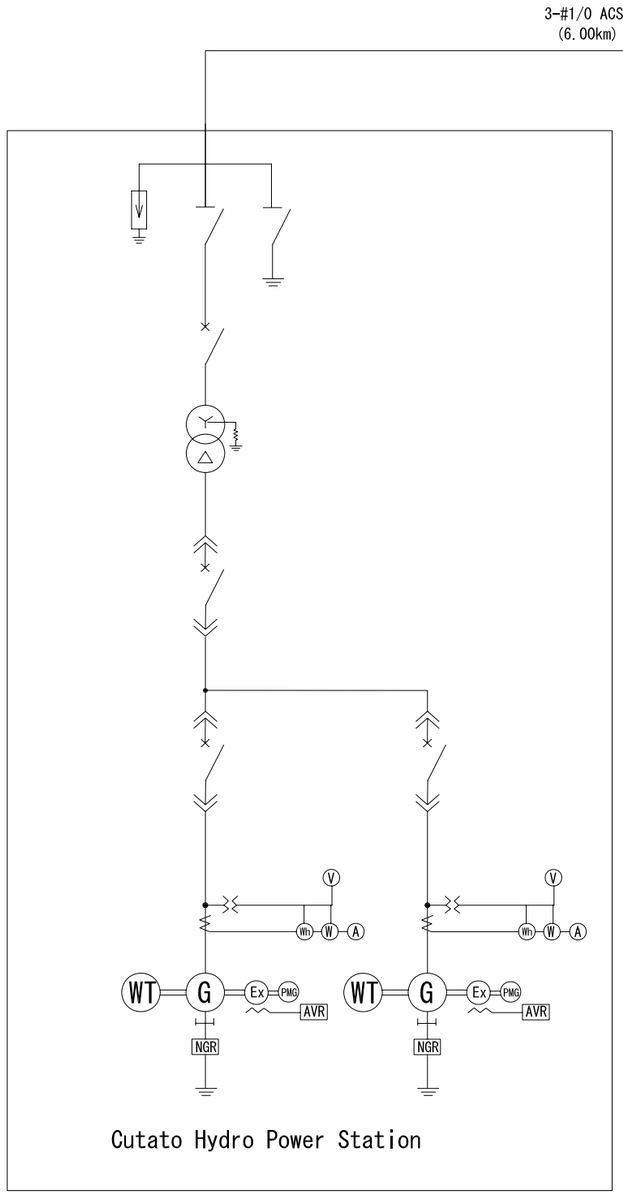
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **DISTRIBUTION LINE ROUTE CUTATO TO ANDULO (1/100,000)**	DWG No. T-001 7.Apr.2011

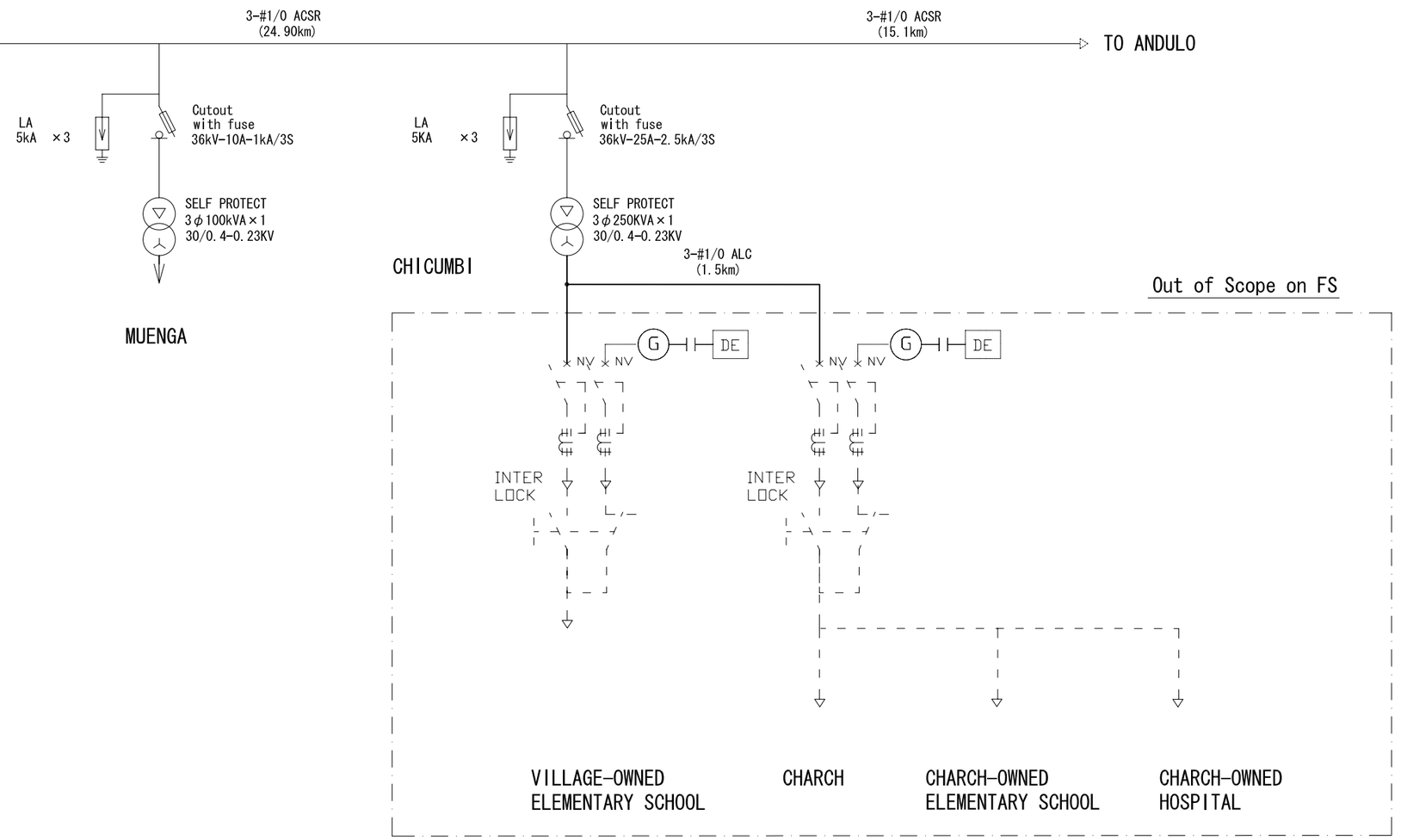


ANGOLA CUTATO – ANDULO

Supply System	Conductor Length(km)
Three (3) Phase Four (4) Wire	46.0
Two (2) Phase Three(3) Wire	0.0
Single(1) Phase Two (2) Wire	0.0
Total	46.0

REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **SINGLE LINE DIAGRAM DISTRIBUTION LINE (30kV) FROM CUTATO TO ANDULO**	DWG No. T-002 7.Apr.2011





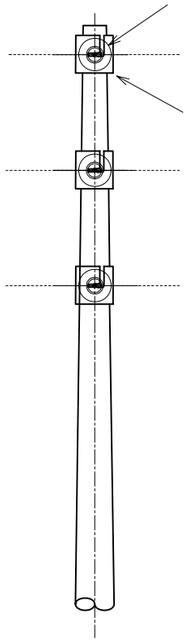
CHICUMBI

Supply System	Conductor Length(km)
Three (3) Phase Four (4) Wire	1.5
Two (2) Phase Three(3) Wire	0.0
Single(1) Phase Two (2) Wire	0.0
Total	1.5

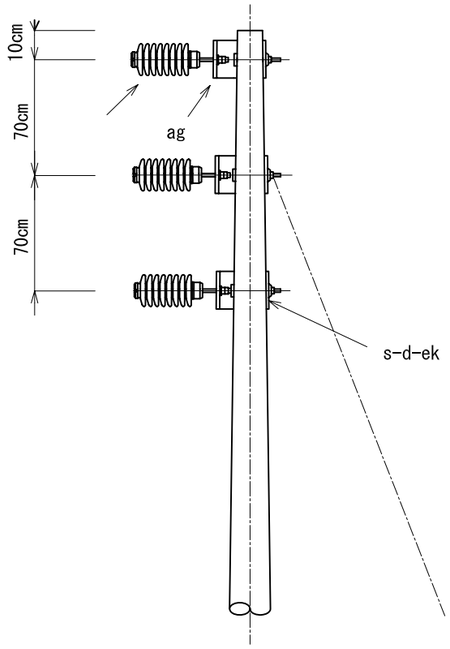
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **SINGLE LINE DIAGRAM DISTRIBUTION LINE(400-230V) LOW VOLTAGE FOR CHICUMBI**	DWG No. T-003 7.Apr.2011

POLE DRAWING (CUTATO - ANDULO)

30kV. THREE PHASE 0° TO 5° ANGLE (VERTICAL TYPE)



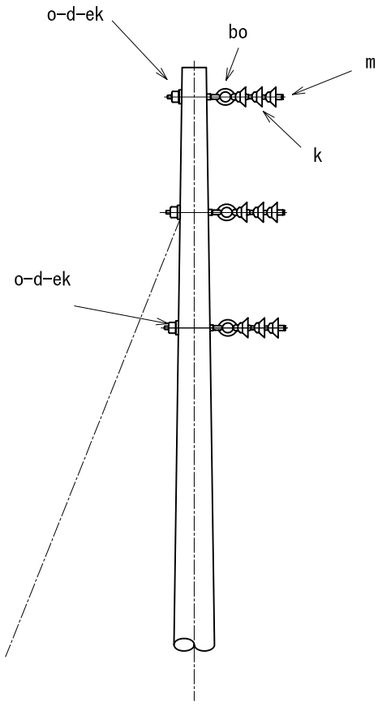
ELEVATION



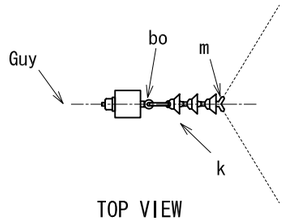
SIDE VIEW

Item	Materials
a-	Line Post Pin Type Insulator
ag-	Angle
d-	hole washer
s-	Single arm bolt
ek-	lock nut

30kV, THREE PHASE 30° TO 60° ANGLE (VERTICAL TYPE)



ELEVATION



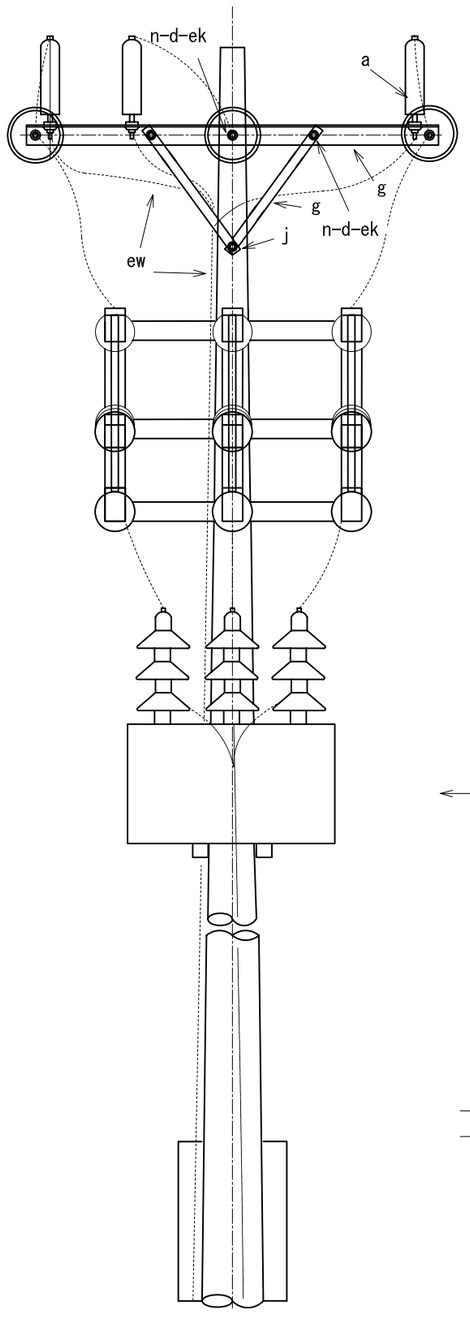
TOP VIEW

Item	Materials
d-	Hole washer
k-	Suspension insulator
o-	Eye bolt
m-	Suspension clamp
bo-	Anchor shackle
ek-	locknuts

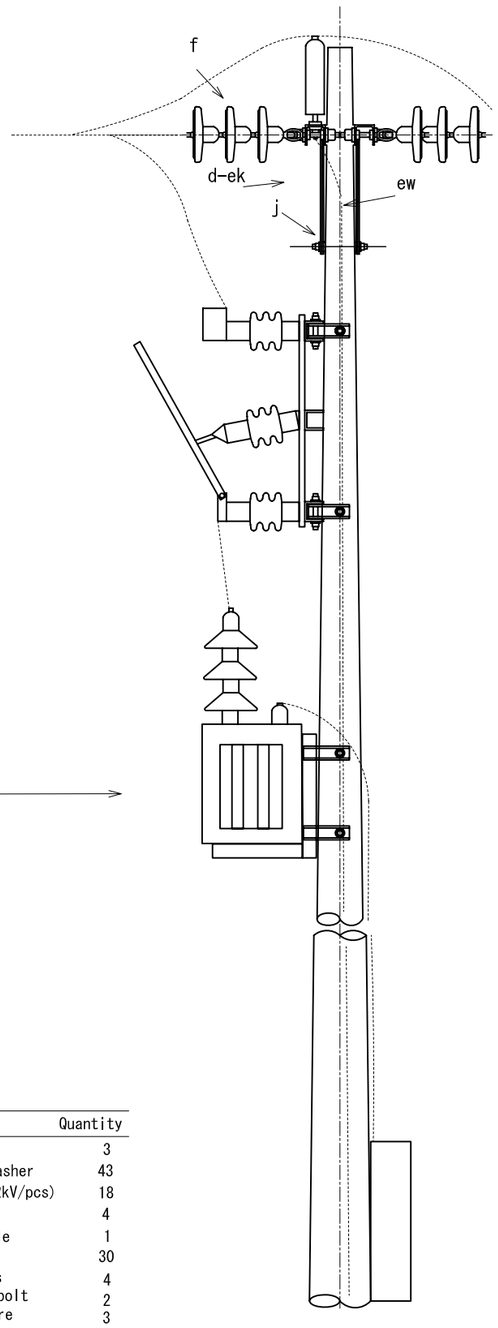
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **SAMPLE POLE DRAWING FOR DISTRIBUTION LINE ROUTE CUTATO TO ANDULO**	DWG No. T-004 7.Apr.2011

POLE TR & CUT OUT SW INSTALLATION VIEW (100kVA) FOR MUENGA

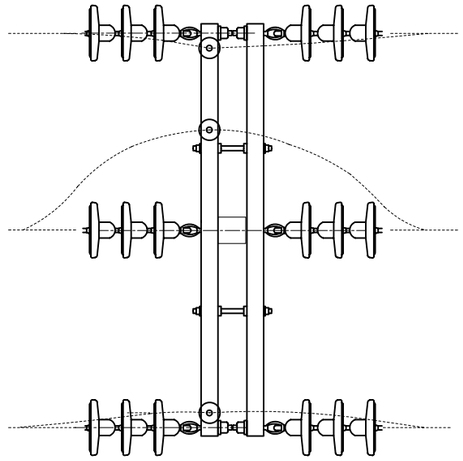
30kV. THREE PHASE



FRONT VIEW



SIDE VIEW



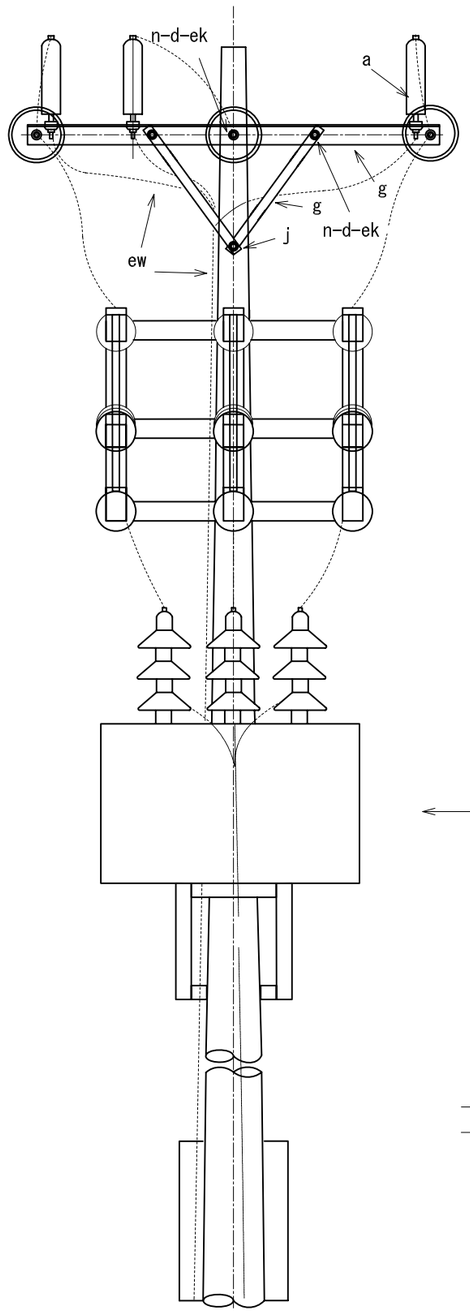
TOP VIEW

Item	Materials	Quantity
a-	Surrge Arrester	3
d-	Hole washer	43
f-	Insulator(12kV/pcs)	18
g-	Cross beam	4
cu-	Concrete pole	1
ek-	Locknuts	30
i-	Carriage bolts	4
n-	Double arm bolt	2
ew-	Grand earth wire	3
o-	Eye bolt	6
s-	Single arm bolt	10
tr-	Transformer	1

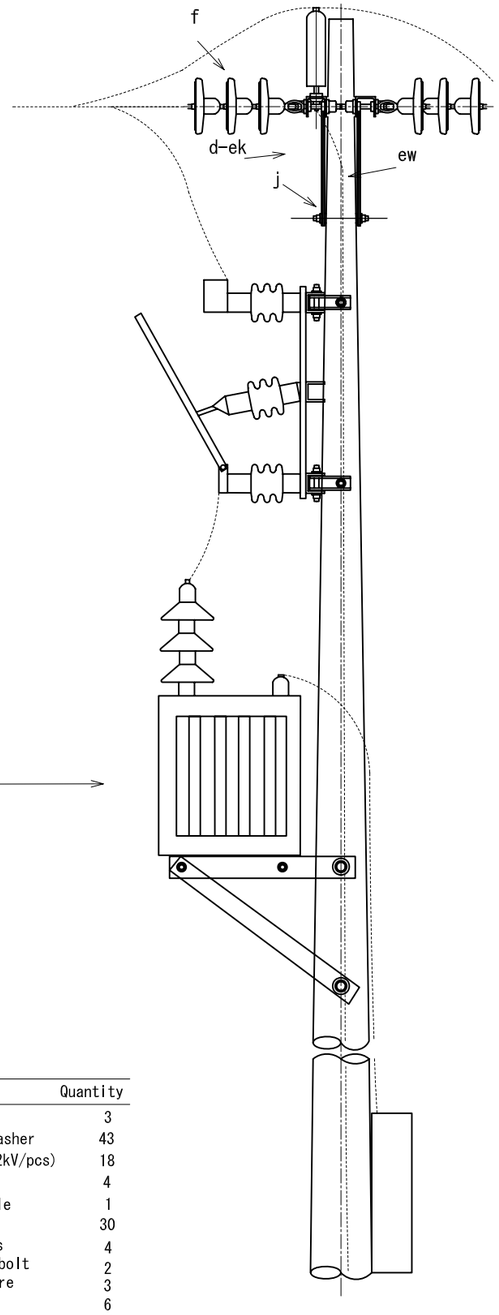
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **POLE DRAWING FOR DISTRIBUTION LINE ROUTE CUTATO TO ANDULO**	DWG No. T-005 7.Apr.2011

POLE TR & CUT OUT SW INSTALLATION VIEW (250kVA) FOR CHICUMBI

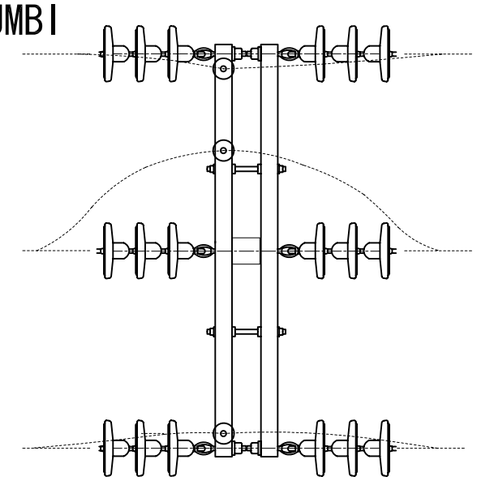
30kV. THREE PHASE,



FRONT VIEW



SIDE VIEW



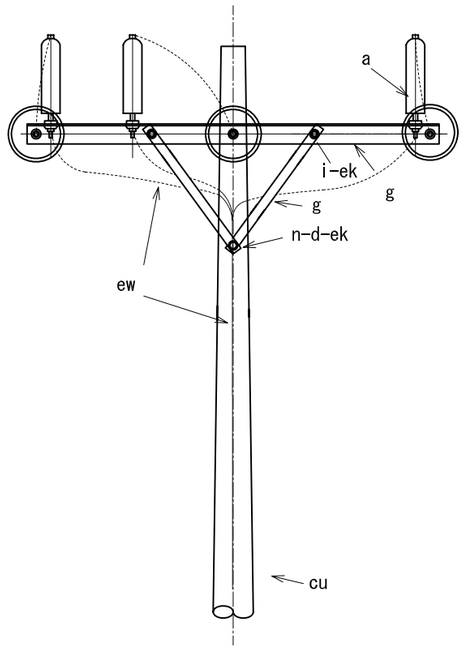
TOP VIEW

Item	Materials	Quantity
a-	Surrge Arrester	3
d-	Hole washer	43
f-	Insulator(12kV/pcs)	18
g-	Cross beam	4
cu-	Concrete pole	1
ek-	Locknuts	30
i-	Carriage bolts	4
n-	Double arm bolt	2
ew-	Grand earth wire	3
o-	Eye bolt	6
s-	Single arm bolt	10
tr-	Transformer	1

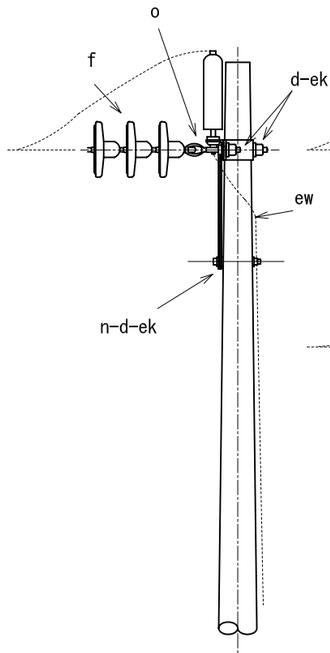
REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **SAMPLE POLE DRAWING FOR DISTRIBUTION LINE ROUTE CUTATO TO ANDULO**	DWG No. T-006 7.Apr.2011

END POLE

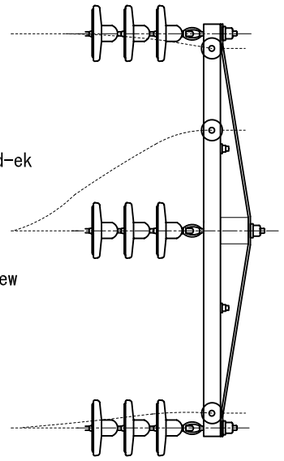
30kV. THREE PHASE 0° TO 5° ANGLE



FRONT VIEW



SIDE VIEW



TOP VIEW

Item	Materials	Quantity
a-	Surrge Arrester	3
d-	Hole washer	16
f-	Insulator(12kV/pcs)	9
g-	Cross beam	2
cu-	Concrete pole	1
ek-	Locknuts	9
i-	Carriage bolts	2
n-	Double arm bolt	0
ew-	Grand earth wire	3
o-	Eye bolt	3
s-	Single arm bolt	1

REPUBLIC OF ANGOLA MINISTRY OF ENERGY AND WATER	JICA NEWJEC	JAPAN INTERNATIONAL COOPERATION AGENCY NEWJEC Inc.	Project & Location THE PREPARATORY SURVEY ON RURAL ELECTRIFICATION DEVELOPMENT IN THE REPUBLIC OF ANGLA	Drawing Title **POLE DRAWING FOR DISTRIBUTION LINE ROUTE CUTATO TO ANDULO**	DWG No. T-007 7.Apr.2011