Initial Environmental Examination

Appendixes V-VI
March 2019

Cambodia: National Solar Park Project

National Solar Park Project
Cambodia

Hydrological Study
Preliminary Study

<u>Draft Report</u>
March 2018
By:

KEY CONSULTANTS (CAMBODIA)

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1 Introduction

1.1 Background

A new 100 MW National Solar Park Program has been launched in Cambodia with the aid of the Asian Development Bank (ADB).
The program is being set up by Electricité Du Cambodge (EDC) and will focus on delivering 100 MW of PV capacity to the Southeast Asian Country in two phases of 30 MW and 70 MW respectively.
The excellent solar irradiation of this program will help the country bring renewable, affordable and indigenously sourced power to its growing energy needs. The competitive tender is expected to drive solar power prices lower and bring access to affordable power to Cambodia's people.

1.2 Site Location

A pre-feasibility study has been prepared in August 2017 with EDC. The study explained the background to the proposed project, the technical, financial and economic analysis and the initial appraisal of environmental and social impacts.
The sites are located 70-80 km north-west of Phnom Penh, where the 1st site-5 is situated in Amleang and Prambi Mum commune, Kampong Speu Province and the Site-6 is in Kbal Tuek commune, Kampong Chhnang (see figure 1).

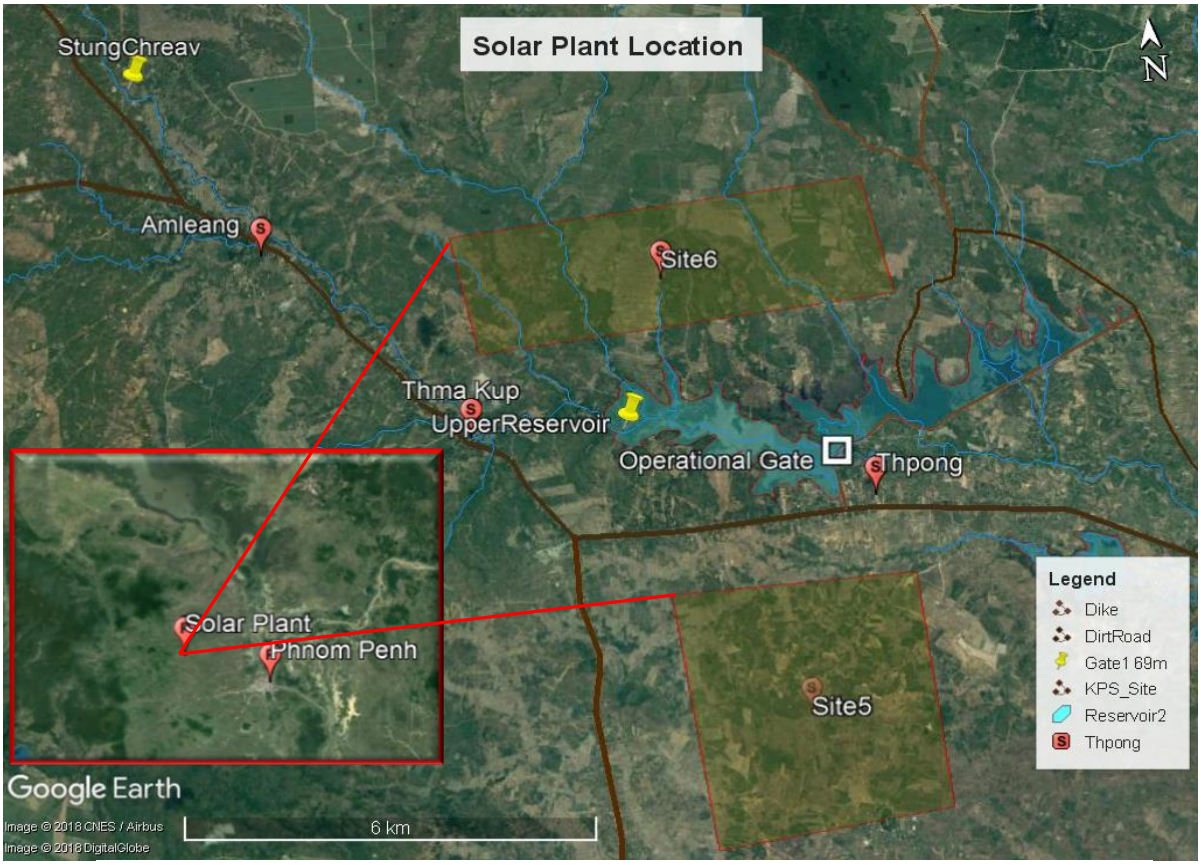


Figure 1 Proposed Project Area Location

2 Methodology

The preliminary study of hydrological has undertaken a desk analysis to identify potential of Risk that was affected and may affected by the natural dominant factors. The study has reviewed relevant documentation in order to identify the areas that require additional attention for fatal flaw analysis. Several elements were conducted to collect the data information described as the following.

2.1 Geological

A geological map is a special-purpose map made to show the geological features. The map represent by the color or symbols to indicate for example the rocks are exposed at the surface.

2.2 Climate/ Hydrological data collection

The closer climate and hydrological information will be collected for the desk study by doing some literature review and field observation. Interview the local people to get the recent and historical information regarding to rainfall and storm occurred in the area.

2.3 Drainage system and flooded level investigation

Field observation on the existing layout of the drainage system in the proposed plant site, and issues on the flood in and around the project area will be collected from the community and data recorded by agencies/institutions.

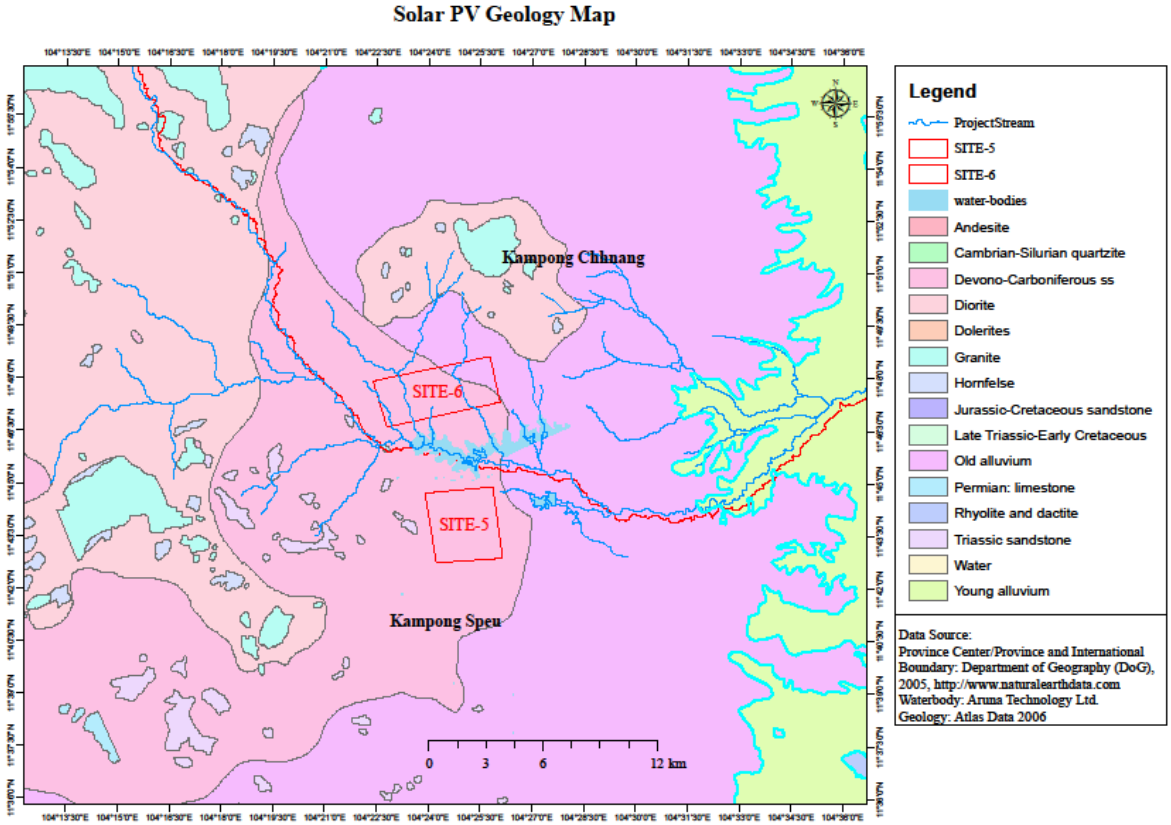
2.4 Natural Hazard

To develop the solar park, natural hazard or fatal flaw analysis is considered to convey for the preliminary study. It is done by doing literature review from the existing study by the local and international researching. Earthquake is one of the dominant hazard which is need to study for the widely plan development, in which seismicity is a method to cop the earthquake hazard. The changes of climate is an uncertainty scenario which has interconnection with the hydrological, the study is also undertaken to figure out it effects. Flood is major concerned for the development plan. The study on flood hazard is taken to account for the preliminary study for the availability of the development site area.

3 Current Situation

3.1 Geological

The site areas were mainly constituent of Devono-Carboniferouse sandstone and shale and a part of side 6 was formed by old alluvium. The figure 2 below shown the geology map for proposed sites area, where the information was conducted in 2006 by Save Cambodia's Wildlife.



*Source: Save Cambodia's Wildlife. *Atlas of Cambodia: maps on socio-economic development and environment*. Second ed. Phnom Penh, 2014. Print.*

Figure 2 Solar PV Plant geology map

3.2 Site 5

3.2.1 Site Condition

Site 5 is considered as a site among the two pre-selected sites. The site is located in the southern of Thpong commune, Amlang District, Kampong Speu Province (See figure 3). By Road N132, the site is approximately 40km from Chbarmon Town of Kampong Speu province. The administration map is seen in the figure 3 below. The site has an area above 1,300ha. The site is mainly covered by 70% of shrubland and the remaining are paddy rice and villages. The topography at the site is ranged from ±92 to ± 77m based on google earth. Access road to the site area was built with laterite material. Based on field surveying on the existing layout; borrow pits activities were found, and it is clearly seen that site 5 is covered by laterite layer. The figure 4 below presents the imagery of site 5 conditions.

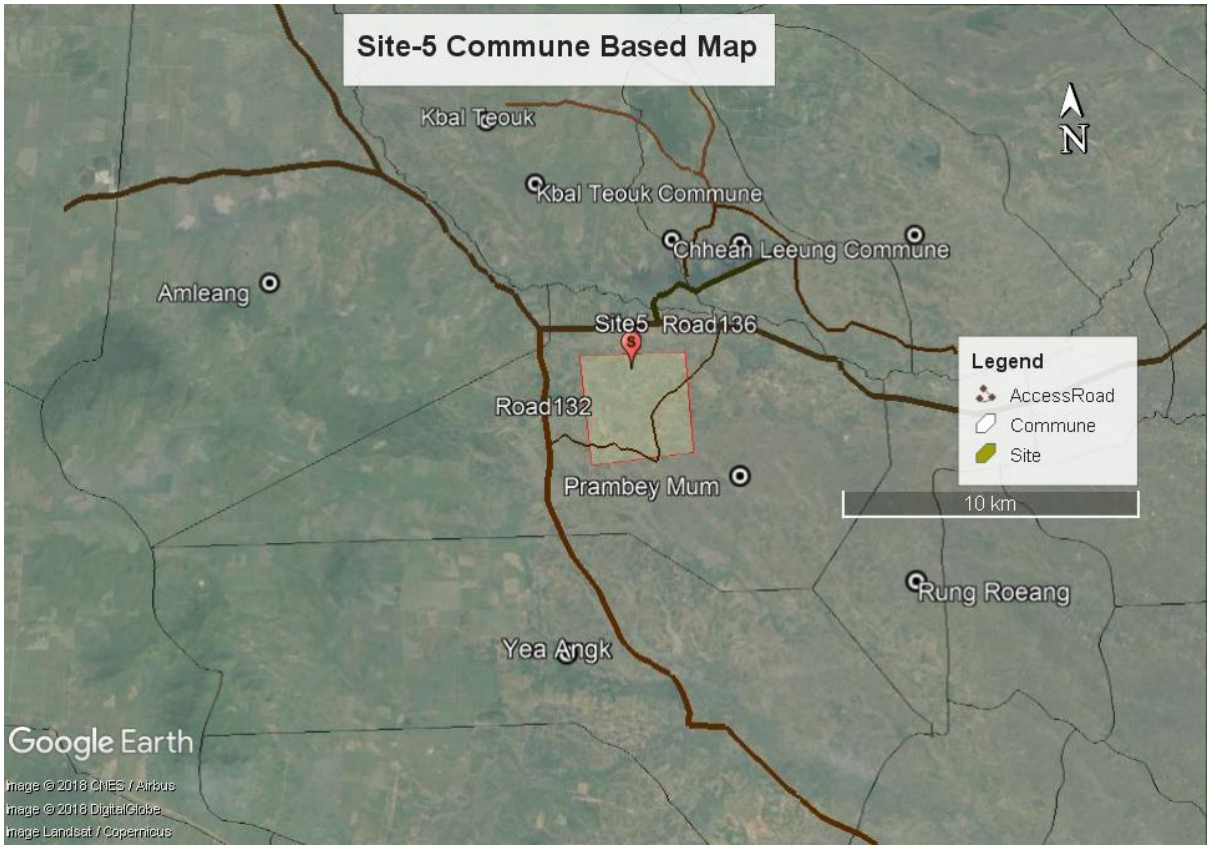


Figure 3 Administration Map for Site 5

Note:

1. Site Name: Site5
2. Province: Kampong Speu
3. E:0436452, N:1294697
4. Zone:48N
5. Elevation (msl): ±92 to ± 77m

Figure 4 Pictorials Condition of Site 5

3.2.2 Hydrological/ Drainage Status

Based on the site observation, the natural stream at the site area was not found during site visiting. It was clearly seen that the drainage is in poor condition and small capacity where it was built along the laterite access road. The figure 5 below displays out the hydrological and drainage system for site 5.

Figure 5 Pictorial of Hydrological and Drainage system for Site 5

A stream drains out the water from the site basin which is located out of the setup boundary of the study area (see figure 6). It connects to a reservoir at the lower part of the site by a drainage

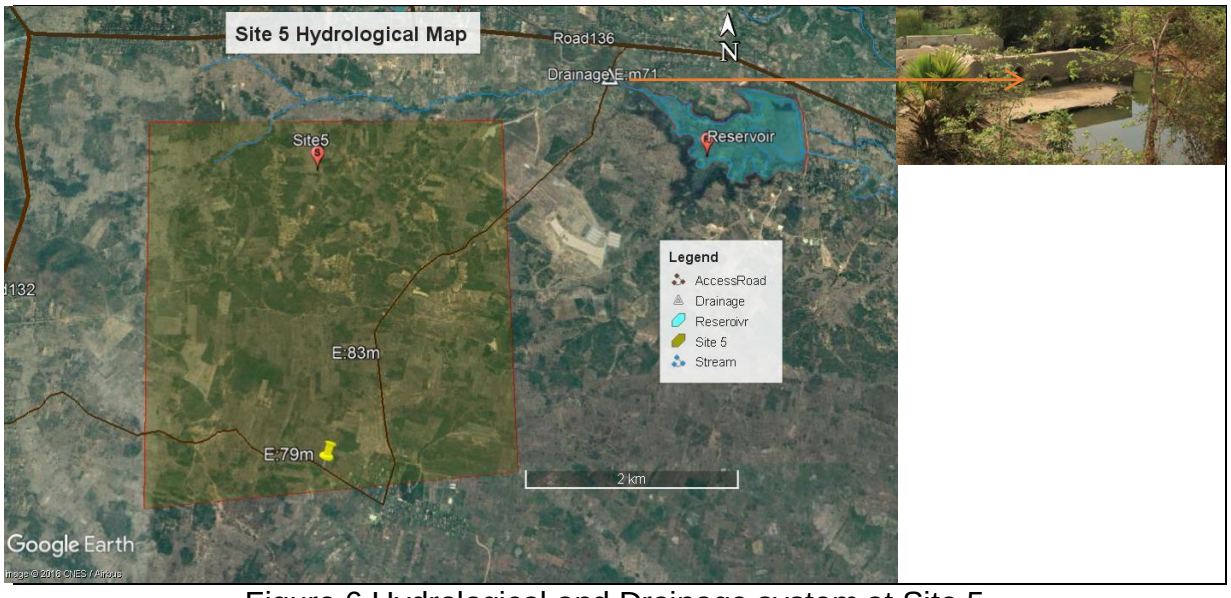


Figure 6 Hydrological and Drainage system at Site 5

3.3 Site 6

3.3.1 Site Condition

Site 6 is contemplated as another option site for the solar power voltaic plant, where it is situated at the high topography. The topography of the site is ranged from ±100m to ±80m based on google earth. It is based in major part of Kbal Teouk commune, Teuk Phos district and another part is in Chhean Laeung commune, Sameakki Mean Chey District, Kampong Chhnang Province. The administration boundary is clarified in the figure 7 below. The site is situated northward to the Site 5 about 6km. It is roughly estimated by field surveying and observing on google earth imagery; that the site is covered by 70 % of open area and 20% by shrubland and water body. The figure 8 below shown the condition map of site 6.

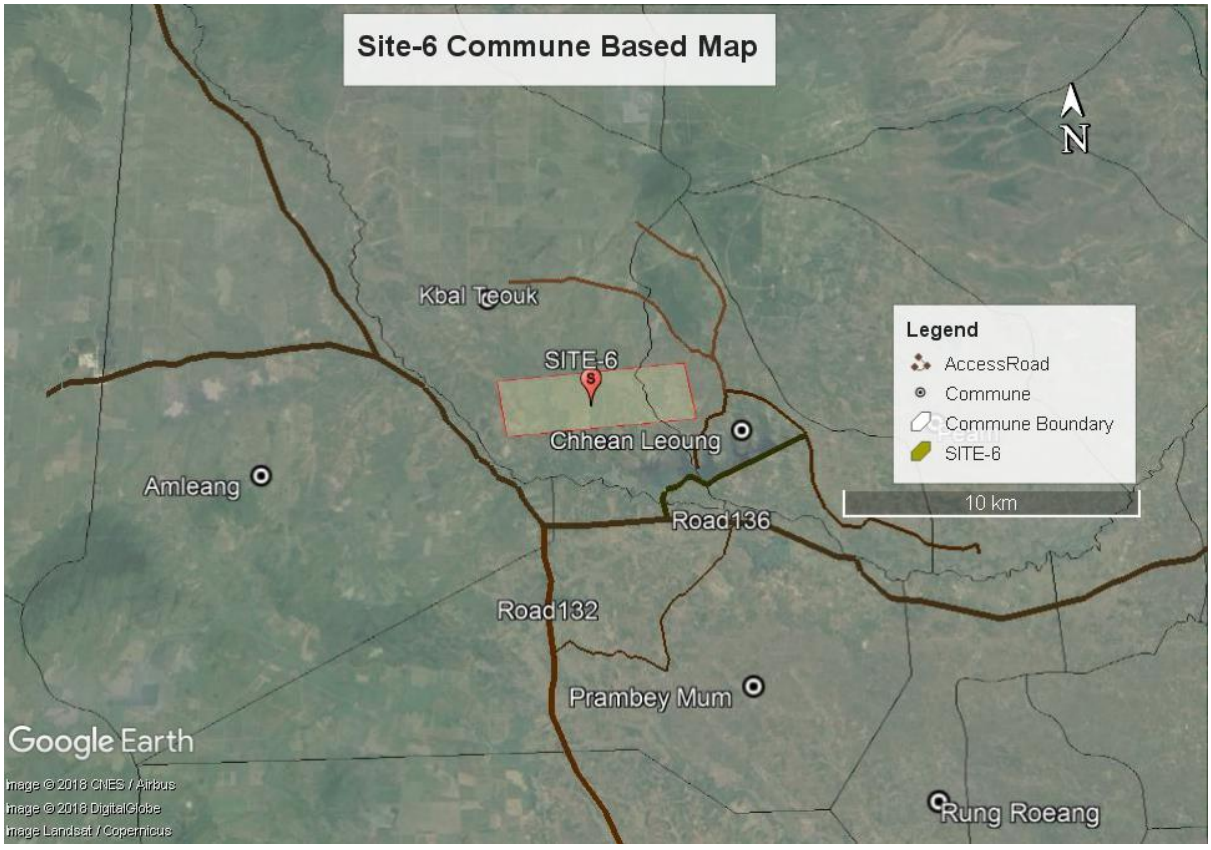


Figure 7 Administration Map for Site 6

Note:

1. Site Name: Site6
2. Province: Kampong Chhnang
3. E: 0434830, N:1303261
4. Zone:48N Zone
5. Elevation: 83m

Figure 8 Pictorial Condition of Site 6

3.3.2 Hydrological/ Drainage Status

The site is located in high elevation, the topography is varied from 100m to 80m above the mean sea level. The figure 9 below shown the contour line generated by Google Earth and ArcGIS. It is clearly seen that the northern part of the site is situated in the high topography where the water flows downward to the reservoir namely Anlung Chrey reservoir. The reservoir plays role important to support for the irrigation in the nearby area. It gathers interflow from 3 main streams, in which the major inflow is come from Stung Chreav stretched from Aural Mountain. Two main streams flow across the site area and connect to the reservoir (see figure 10).
The reservoir has the area of 479km^2, it allowed to construct hydropower with the capacity of 170 kW (see figure 11). It was noted by water level mark on the water level guage that the water level stored in the reservoir was not reached to the NHWL of 69.5m (see figure12).

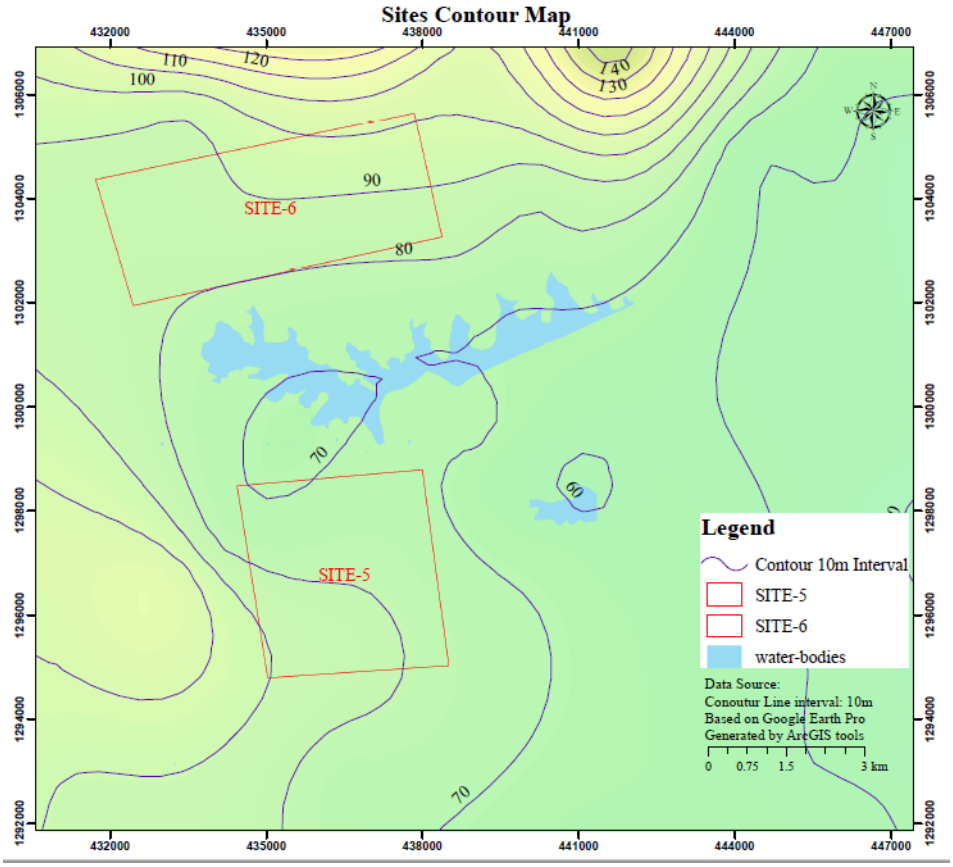


Figure 9 Sites Contour map

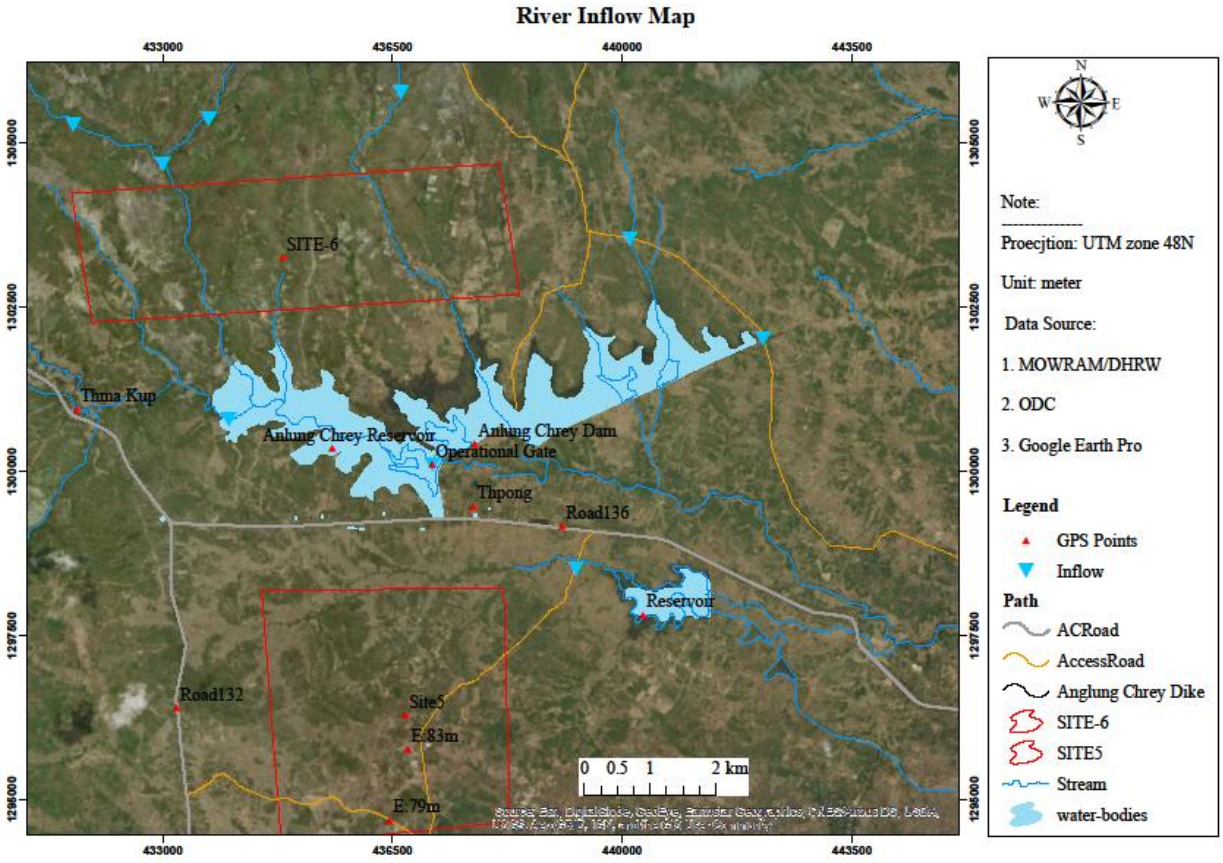


Figure 10 River inflow map

Figure 11 Anlung Chrey Power Plant

Figure 12 NHWL at the dike

3.4 Natural Hazard/Fatal flaw analysis

Cambodia has rich water sources in Mekong and Tonle Sap Lake. The lower Mekong, the Bassac, the upper Mekong and the Tonle Sap River, which flows from the Tonle Sap Lake, are the four main rivers, which meet at the Chatomouk Junction in Phnom Penh.

In Cambodia, 65% of the total number recorded of disasters occurred in 1980-2011 were related to flood followed by drought (22%). It was noted that 75% of the disaster experienced were “water related hazard” (flood 65% and storm 13%). Similarly, flood affected 62% of the total number of people followed by drought (37%). However, all death caused by disaster were due to “water related hazard” (flood and storm), though most of the estimated damage cost were due to flood (87%) and drought (13%). Flood, storm, and drought are the major disasters in Cambodia.

Flood and cyclones are predominant hazards to cause disaster in Cambodia. The record of cyclone event was smaller than the flood occurrence.

3.4.1 Flood Risk

According to National Committee for Disaster Management (NCDM), the major flooding events affecting a significant population occur every five years or so (in 1961, 1966, 1978, 1984, 1991, 1996, 2000, 2001 and 2002). One of the worst floods in the country's history occurred in the year 2000.

There are two major flood types in Cambodia, Firstly is Mekong flood; where the major flood was occurred in the Mekong by the cumulative rainfall in the upper catchments throughout the rainy season causes a slow but steady rise in water levels lasting for several days. Mekong river floods are common occurrences in the provinces of Stung Treng, Kratie, Kampong Cham, Prey Veng, Svay Rieng, Kandal, and Takeo.

Secondly, flash floods was occurred by the repeated heavy rainfall in mountainous areas, which flows to streams and tributaries of the Mekong River branch of river often flash floods These floods are swift and last only for a few days but often cause severe damage to crops and infrastructure especially in tributaries around the Tonle Sap Lake. Some part of Kampong Speu and Kampong Chhnang were affected by Flash floods among other provinces.

The figure 13 below illustrates (a) the maximum flood extent in 2000 by Mekong flood; and (b) maximum flash flood event in 2001. The image clearly indicates that the site areas (SITE-5 & SITE-6) represented in red circle were out of the flood boundary in the worst flood event in 2000 and 2011.

(a) Maximum flood extent in Year 2000 (b) Maximum flood extent in 2001
Source: Mekong River Commission (MRC)

Figure 13 Cambodia Flood extent in 2000 and 2001

From the 13 figure above, it is clearly noted that the propose site areas were not affected by the severed flood event. Where the most flooded area were occurred in lower land area i.e. lower Mekong basin and surround the Tonlé Sap Lake.
The flood were reached to the upstream of the reservoir illustrated in red circle below (433999E, 1300808N, 48N), reported by the residential. The flood occurred by the accumulated flow stored in the reservoir by the hydro power operation. There were no servered strom affected the site area from the neigborhood country.

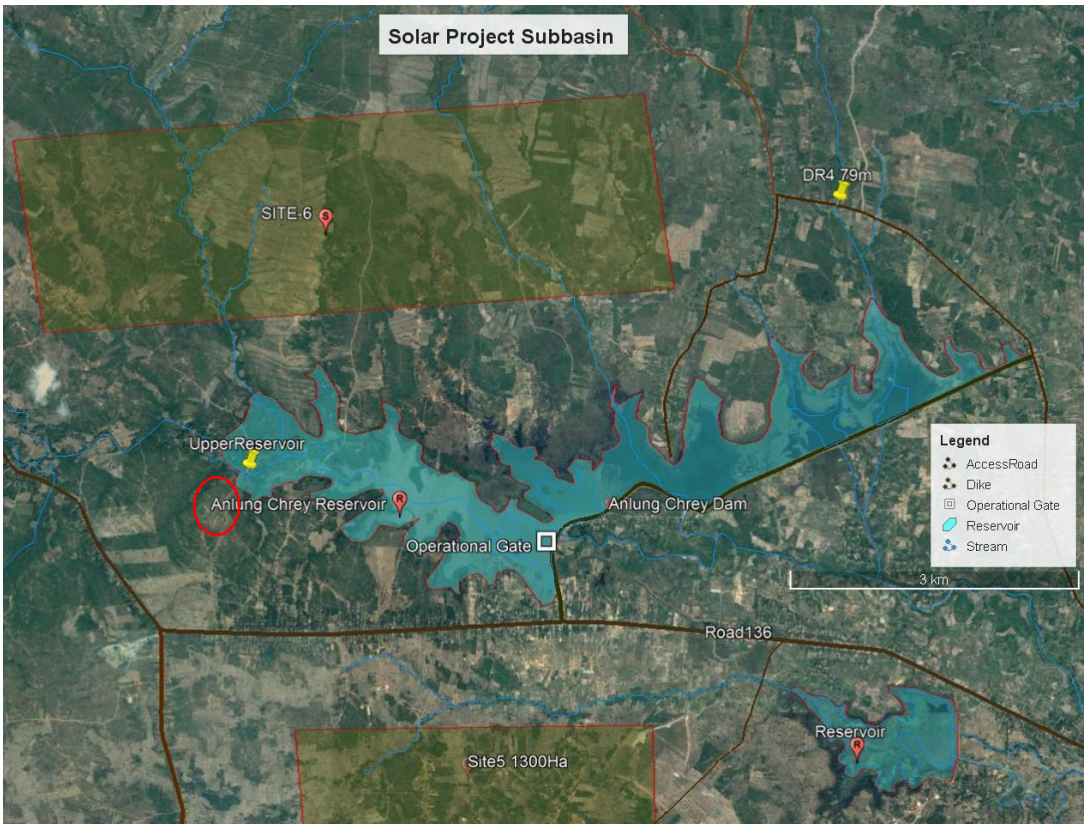
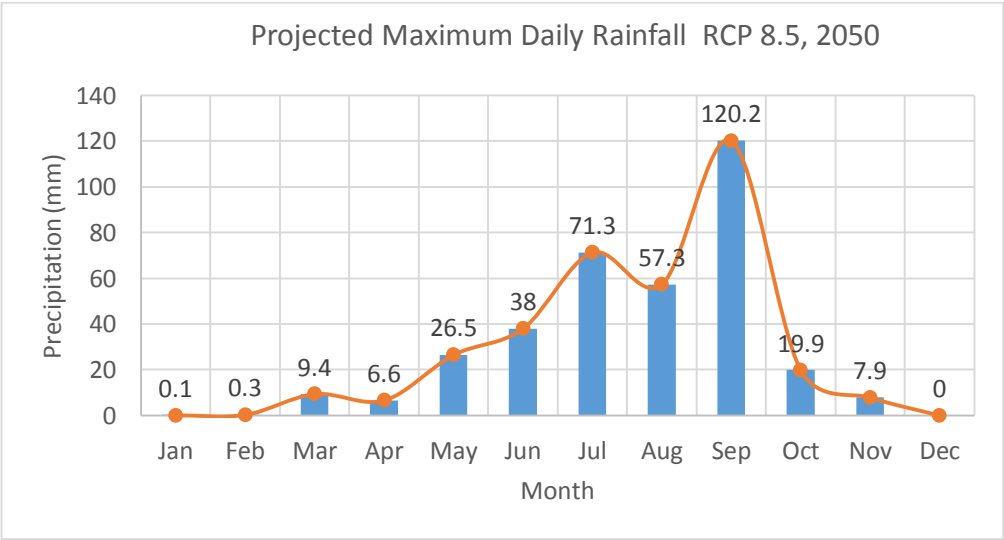


Figure 14 Solar Project Subbasin

3.4.2 Climate Change Impacts

According to the JICA Report's studied on Natural Disaster Risk Assessment in 2015, the temperature in Cambodia may increase by up to 1.35 ºC -2.50 ºC in 2100. Annual rainfall may increase between by 3.0 to 3.5 percent from current conditions. The lower land areas seem to be more likely to be affected by climate change than the highland areas by 2100. In the year of 2050, the maximum daily rainfall would be 120 mm given by the RCP 8.5 High Emission. The value has slightly changed by 10mm from the present rainfall (see figure 15).

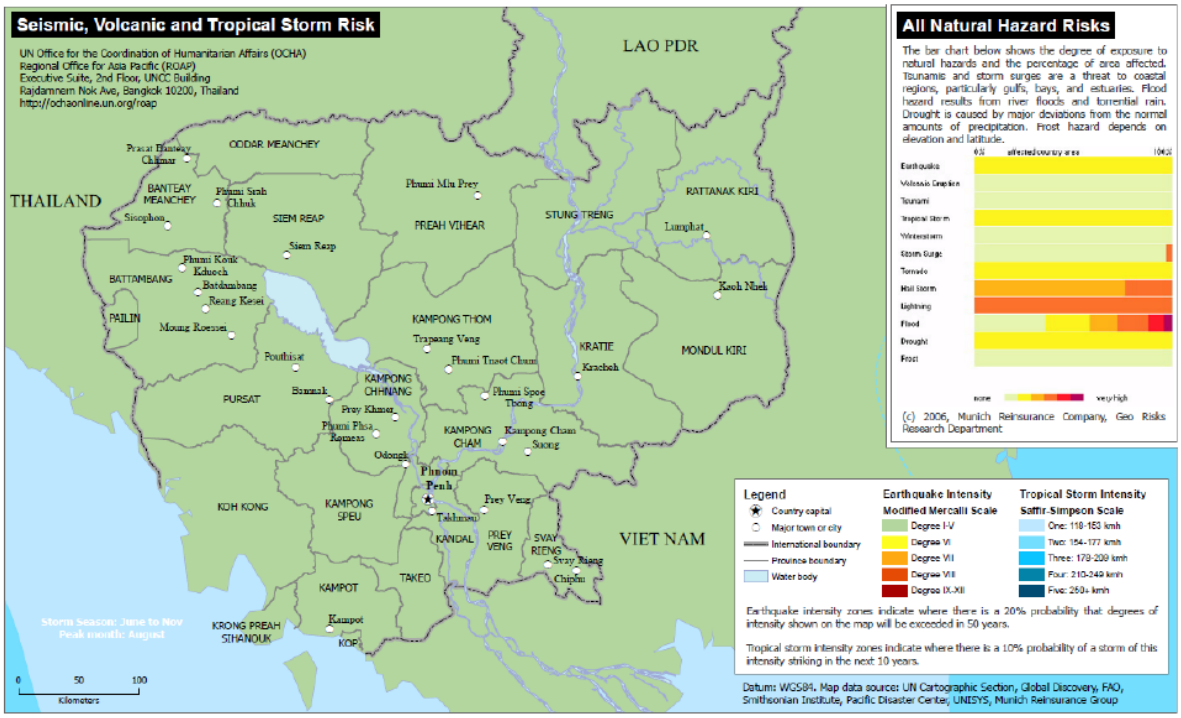


Source: NASA NEX Climate Change data

Figure 15 Projected Maximum Daily Rainfall RCP 8.5 in 2050 Year

3.4.3 Seismic Risk

There are natural hazard assessment reports for ASEAN region generated by international organizations Earthquake disasters are not common in Cambodia. There is no record of significant disaster caused by vibration of earthquakes.
The figure 16 below shows seismic and other natural hazard risks in Cambodia. The zones indicate where there is a probability of 20% that degrees of intensity shown on the map will be exceeded in 50 years. This probability figure varies with time; i.e., it is lower for shorter periods and higher for longer periods. All of Cambodia is categorized as V and below on the Modified Mercalli Scale.



Source: United Nations Office for the Coordination of Humanitarian Affairs
Figure 16 Natural Hazard Risk of Cambodia (Seismic, Volcanic and Tropical Storm Risk)

4 Conclusion

In conclusion, the study was done by desk study and field surveying. The data information was derived from the national institution and some International organization and doing questionnaires with the people during site observation. The digital elevation described in the above paragraph is taken from the Google Earth with the combination of ArcGIS.
Based on the studying above the two sites could be concluded as the following:

Description	**SITE-5**	**SITE-6**
Site Condition	70 % covered by Shrubland, -30% Paddy Rice	Open Area 70%, Shrubland 20%, other 10%
Historical Flood	No Flood Event affected the Site	No Flood Event affected the Site

Climate Change	Slightly Changes by 10mm in 2050, (RCP High Emission 8.5)	
Historical Storm	No Flood Event affected the Site	No Flood Event affected the Site
Drainage	Poor Drainage and water body	- Has drainage system from the upper part flow across the area. - Water body is available to adequate for the project during the construction
Topography	92 to 78m	100m to 80m
Seismic	Degree IV, Earthquake Intensity Modified Mercalli Scale	

It is recommended that the site-6 is suitable for the solar plant in accordance with the site condition, historical natural dominant and existing layout of area and drainage. It is also need to be adequate to have a precise elevation in order to get more detail regarding to rainfall and run-off on the subbasin of the proposed plan.

Date of Audit - May 10 2018

APPENDIX VI: ENVIRONMENTAL AUDIT OF EXISTING FACILITY (GS6)

A. Introduction

1. The National Solar Park Project for Energy Access will support Electricité du Cambodge (EDC) to construct 100 megawatt (MW) capacity solar park in Kampong Chhnang province and a transmission interconnection system to existing grid substation 6 ("GS6") located near the Phnom Penh demand center. The project will supply power to the national grid.

2. The existing 230/115/22 kV GS6 will be upgraded as per the technical specifications listed below. This environmental audit has been conducted for GS6.

B. Technical Specifications of the Upgrade

3. Technical specifications of the upgrade are as follows:

- Two new feeder bays (with Circuit Breakers, Dis-connector, Current Transformer, Voltage Transformer and Surge Arrestors)
- Protection panels (feeder protection with distance protection as main, Over current (O/C) backup, Power revers protection on two (2) transformer circuits
- Check on current transformer characteristics (for replacements if any)
- Control Scheme and SCADA upgrade
- High Voltage connection

C. Objective and Methodology of Environmental Audit

4. The objective of the audit is to determine if actions were in accordance with ADB SPS 2009 and to identify and address outstanding compliance issues. The audit will (i) asses environmental concerns of the existing facility that is currently under operation; and (ii) ensure all environmental impacts will be considered during the upgrade works of GS6 and mitigation and safeguards measures will be implemented.

5. The audit is based on: (i) review of available documents and (ii) interviews with the site engineer and substation engineer of Cambodia Transmission Limited (CTL), the facility operator.

D. Institutional Arrangements and Responsibilities

6. The existing GS6 is operated and managed by the CTL since 2013 in accordance with a 25-year agreement with EDC on Build Operate and Transfer ("BOT") contract.

7. For the upgrade of GS6, the key institutions involved in the IEE and EMP implementation will be the PMO within EDC and PIC in collaboration with CTL. PIC will collaborate with CTL for day-to-day coordination and implementation of the upgrade works in line with the EMP, contractor tender clauses, and oversight of the Engineering, Procurement,

Construction (EPC) contractor(s), other contractors[1] or third party consultants. After upgrade, the operation of existing GS6 will remain under operation and maintenance control of CTL.

E. Document Review

8. At the time of the site visit on May 10, 2018, the Safety Manual was available onsite and this was reviewed. The Initial Environmental Impact Assessment (IEIA) for the substation facility issued by the MOE was not available. Both site and substation engineers did not know the date of issue of IEIA. Requests for IEIA for the GS6 have been made, and is still pending.

F. Site Visit Observations and Interviews with CTL Staff

9. **Location.** The GS6 substation is located in Odongk district in Kampong Speu province; the land is owned by EDC and is fenced on all sides, with one main entrance gate with a security check. GS6 is situated at a distance of 500 m from Sdok Lapove village, Khsem Khsan Commune and the rest of surrounding area is open land. There are no sensitive natural habitats in and around the existing facility. r

10. **Safety.** The substation has an onsite manual on Health and Safety, including Emergency Response Plans (ERP). This is in English with no local language translation. The engineers impart training on Personal Protection Equipment (PPE), electrical safety and health to its in-house staff on monthly basis. There have been no incidents since start of operation in 2013. No community health and safety training and / or ERP have been conduced with the nearby community (Sdok village) till date.

11. **Water.** The substation utilizes groundwater for in-house use such as sanitation / kitchen viz a 1000 liters capacity tank; water is pumped to the tank once per day. The substation also pumps groundwater for fire fighting and stores it in three tanks of 2000 liters capacity each. Both site and substation engineers were not aware of any permitting requirements for groundwater abstraction.

12. **Drainage.** For rainwater runoff, the substation has an existing lined drainage (L 500 m x W 2 m x D 1 m approx.); the drain connects to an outlet at the substation periphery with final rainwater discharge to the adjacent open field. At the time of the site visit, the drain was dry.

13. **Water quality testing.** The CTL safety officer conducts water quality testing at the substation site on a semi-annual basis. The drain water is collected at the final discharge point for sampling and sent to a Ministry of Environment (MOE) registered laboratory for tests. There has no been detection for water contamination at the site since start of operation in 2013.

14. **Transformer oil.** Transformers function checks are conducted regularly; if case of any observed abnormality, filtration is conducted by an onsite filtration machine that heats the transformer oil up to 65^{o}C to remove moisture. Transformer oil / filter change is not a regular or intermittent feature at the site. CTL has an agreement with a 3rd party certified vendor called RUNSAON for collection and transport of any used / unused oil.

[1] Contractors imply - solar park and transmission interconnection infrastructure Engineering Procurement, Construction contractor and solar PV power plant contractor(s).

15. Equipment storage. CTL has warehouses for equipment storage and repairing parts. There has been no re-sale or auction so far for any equipment at the substation site.

At GS6

Existing road and rainwater runoff drainage at GS6

Area proposed for two new bays and switchgear

Area adjacent to the GS6, where the main drain discharges offsite

G. Current Operation as per ADB SPS

16. Leader Energy and CTL undertook development of the existing GS6. There was no funding by ADB. Based on interviews at the site, the MOE has issued an IEIA for the substation facility. However, the IEIA for the substation facility was not available at the time of the site visit. Request for the copy of the IEIA for the GS6 was made several times and did not yield results.

17. While the overall operation and maintenance of the substation facility seems to be in good working order, corrective actions are proposed for further compliance as listed in Item I.

H. Potential Impact and Mitigation Measures

18. Upgrade to GS6 will involve construction as per the technical specifications listed in Item B. Upgrading activities, temporary storage of and installation of equipment will take place within the fenced perimeter of the existing substation and there will be no impacts to the nearby communities.

19. During peak construction, environmental concerns will be temporary and localized and may include:

- Dust and air pollution
- Noise
- Solid waste such as construction debris
- Disturbance due to power cuts
- Disturbance due to increase in traffic to the site
- Occupational health and safety (OHS)

20. During operation, the environmental concerns are:

- Occupational health and safety (OHS)
- Community health and safety
- Groundwater abstraction
- Other hazards such as lightening, fires, and accidents.

21. Mitigation of potential impacts will be done in line with the EMP prepared for this project and enclosed as Annexure 1.

I. Conclusion and Corrective Actions

22. The upgrade of GS6 will result in temporary and localized impacts and these will be mitigated and managed via EMP prepared for the project. There are no anticipated impacts on the nearby village / communities since the upgrade activities are confined within the fenced perimeter of the existing substation.

23. PIC and CLT will ensure that upgrade activities are be in compliance with the national environmental regulations and ADB safeguards requirements as detailed in the IEE and EMP (see Annexure I).

24. Corrective Actions:

- Consult with the nearby village / communities in line with section 7 - Information, Disclosure and Participation of the IEE and details included in EMP.
- Translate the Safety Manual in the local language and make relevant sections available to the nearby village / communities
- Conduct ERP drills with the nearby village / communities on a regular basis
- Obtain a permit for groundwater abstraction from the relevant ministry in case there is none.