

# Initial Environmental Examination

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Project Number: 41924-014

May 2015

## Nam Ngiep 1 Hydropower Project (Lao People's Democratic Republic)

### IEE Addendum: 230 kV Transmission Line Realignment (Tower 54 to Tower 86)

Prepared by Earth Systems on behalf of Nam Ngiep 1 Power Company Limited for the Asian Development Bank

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# IEE Addendum: 230 kV Transmission Line Realignment (Tower 54 to Tower 86)

**FINAL**

Prepared for



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May 2015



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# 1 INTRODUCTION

## 1.1 Background

The Nam Ngiep 1 Power Company (NNP1) is developing the Nam Ngiep 1 Hydropower Project (NN1) in central Lao PDR. The distribution of electricity from NNP1 requires the development of a 230 kV transmission line to transmit electricity from the Project to Thailand.

An Initial Environmental Examination (IEE) of this transmission line was conducted by Environmental Research Institute, Chulalongkorn University (ERIC) (2012) and updated by Environmental Resource Management (ERM) (May 2014). Since pre-feasibility (November 2002), the transmission line has undergone a number of route alignment changes including:

- EGAT Route (August 2007) – Re-routed to avoid Wat Ptabat Phansane Temple;
- Initial IEE route (February 2011) – Re-routed to avoid natural forest areas, residential areas, and area frequently used by an elephant herd; and
- IEE (January 2014) – Re-routed to avoid Houay Ngua Provincial Protected Area.

During the conduct of the IEE update (May 2014), it was identified that the alignment impacted a commercial eucalypt plantation operated by Oji Paper Company and that compensation costs would be significant. A new alignment to avoid this plantation has been developed.

NNP1 has commissioned an investigation of the potential environmental and social impacts of this re-alignment in line with ADB Safeguard Policy (2009) requirements. For other information such as the project description on 230 kV transmission line and general environmental protection measures for transmission line construction and operation, please refer the main IEE.

## 1.2 Objectives

The objectives of this investigation are to:

- Characterize physical, biological and social characteristics associated with the new alignment Right of Way (ROW);
- Assess the potential environmental and social impacts of the new alignment during construction and operations; and
- Propose any additional actions to control and mitigate the identified impacts during construction and operations.

## 1.3 Methodology

Earth Systems undertook the following activities to complete this investigation:

- Detailed desk-based analysis of the proposed re-alignment utilizing high-resolution satellite imagery (2014);
- Consultation with local government (PONRE) to gain necessary permissions and glean background information about areas along the realignment; and
- Conduct of a two (2) day field exercise to ground truth results of imagery analysis; assess vegetation and species in four (4) sample plots; use of village guides to help navigate the TL alignment and provide

detailed local knowledge; and a rapid assessment of commercial timber within each vegetation type present within the ROW.

Note: The original IEE assessed vegetation cover utilising Rapid-eye imagery (with 5 metre resolution) to determine Normalised Difference Vegetation Index (NDVI) for vegetative type and condition. NDVI is a simple graphical indicator used to assess the presence of 'live green vegetation'. This Study used higher resolution satellite imagery (0.5 metre) and visual interpretation to identify forest type and condition. Results of this analysis were then ground-truthed and updated accordingly.

## 2 DESCRIPTION OF THE PROJECT

### 2.1 Project Location

The 230 kV transmission line will extend approximately 125 km from the NN1 Dam site in Bolikhamsay Province to Nabong substation in Vientiane Capital with a right of way (ROW) of 35 metres. The scope of this investigation covers the proposed re-alignment between towers 54 and 86 (see Figure 2-1).

### 2.2 Project Design

Information on transmission line components is provided in the main IEE. A summary of information relevant to this investigation is outlined in Table 2-1 below.

**Table 2-1 Project Components of Re-alignment (Towers 54 to 86)**

<b>Design Features</b>	<b>Description</b>
Line voltage	230 kV
Line length	10.5 km
Type	50 Hz, 3 phase, double circuit line on self-supporting lattice steel structures.
Number of towers	~32
Tower height	Suspension towers: 46.78m and 46.18m; Tension towers: 46.04 (see IEE Annex A)
Right of way (Row)	35 metres (Vegetation suppressed to 3m)
Workers camps	No main workers camp – instead workers will set up temporary shelters on site);
Access roads	Access roads provided within the ROW (flat areas); External access roads (5m width) required in steeper areas.
Other ancillary infrastructure	No quarries (rock purchased from local supplier); No permanent spoil areas (spoil used as backfill and embankments at tower sites)
Stations	Not applicable



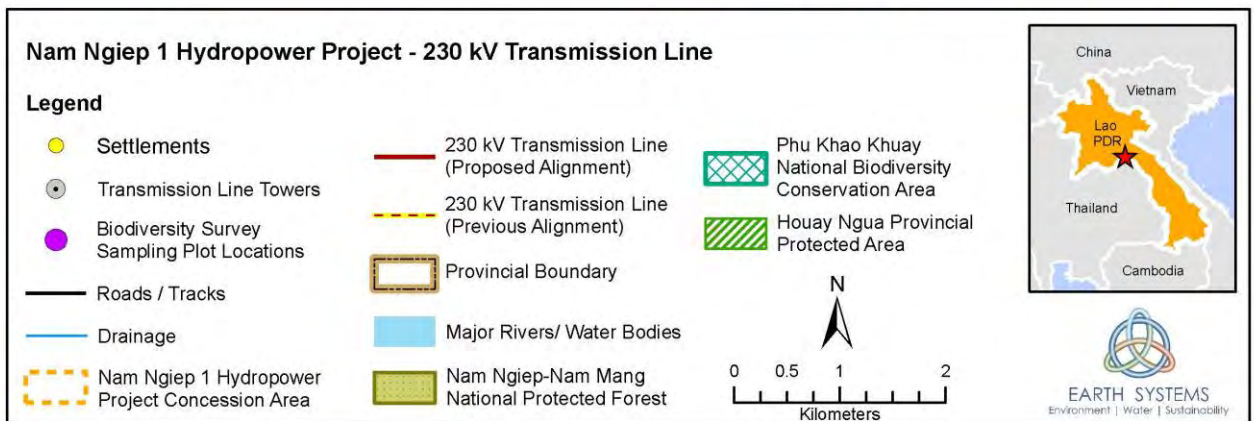
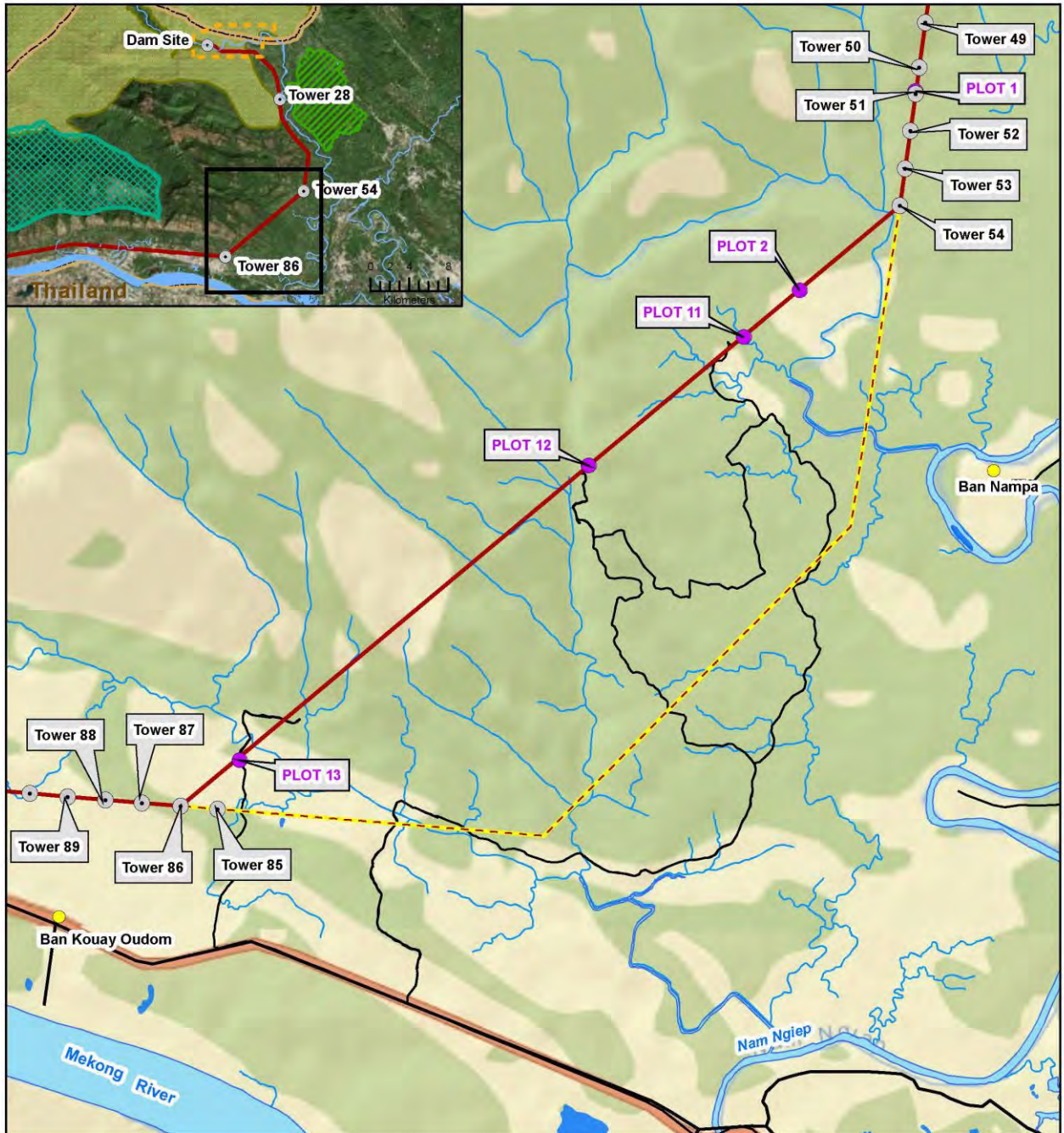


Figure 2-1 Project location

## 3 DESCRIPTION OF THE ENVIRONMENT

### 3.1 Physical Components

The proposed re-alignment is located within 4 km of the original line (see Figure 2-1) and therefore the physical landscape and features of the area are similar to those described in the main IEE. Desk based analysis (assessment of satellite imagery and topographic mapping) and ground truthing of the re-alignment has highlighted the following physical components of the area.

#### 3.1.1 Topography

The topography of the re-alignment consists of lowland floodplains at approximately 166 meters above sea level (masl) at the northern end and with hilly terrain dissected by stream valleys toward the southern half of the re-aligned area, with elevation rising to approximately 350 masl. (see Figure 3-1). A number of perennial and ephemeral streams (see Section 3.1.3) will be traversed by the transmission line, the most significant of which is Nam Pa immediately south of Tower 54.

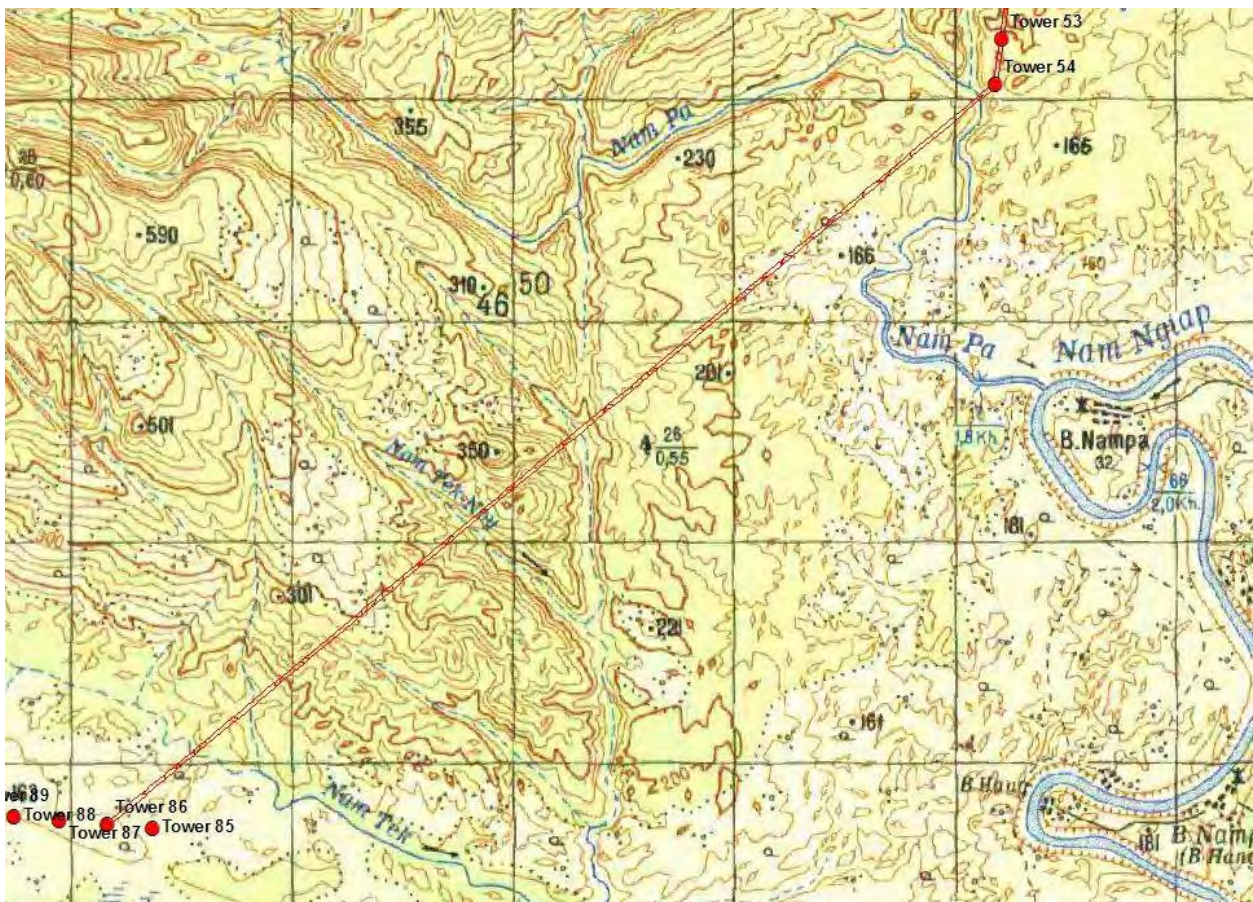


Figure 3-1 Topography of the proposed re-alignment

#### 3.1.2 Soils and Erosion

Information on soil characteristics in the re-alignment area was obtained from the National Agriculture and Forestry Institute (NAFRI). Acrisol soils dominate the re-alignment area. Acrisols form on old landscapes in humid tropical climates. The age, mineralogy, and extensive leaching of these soils generally lead to poor fertility and elevated aluminium concentrations. Acrisols in Lao PDR tend to be highly dispersive and

therefore easily eroded. Evidence of soil erosion in the area was observed, particularly in areas where vegetation has been disturbed by logging, swidden agriculture and agro-forestry.



**Plate 3-1 Highly disturbed area with sandy soils susceptible to soil erosion in ROW near plot 12**

### 3.1.3 Hydrology

The proposed re-alignment traverses a number of perennial and ephemeral waterways in the area (see Figure 2-1). Four Perennial streams have been identified:

- Nampa (a first order perennial tributary to the Nam Ngiep River)
- Houay Khamkhaep;
- Houay Hinlan; and
- Houay Nam Tek.

### 3.1.4 Surface and Ground Water quality

No additional water quality monitoring was conducted for this assessment. On-going water quality monitoring for the construction phase of the NN1 Project indicates that surface water in tributary streams tends to be of high quality for the majority of measured parameters.

Surface water in the catchment has been found to be near neutral pH (ranging from slightly acidic to slightly alkaline), with low electrical conductivity, high concentrations of dissolved oxygen, and very low concentrations of dissolved metals. Total metal concentrations of iron are often elevated, with low concentrations of dissolved iron.

Tributaries of the Nam Ngiep tend to have moderate to high concentrations of pathogens, generally measured as Total coliform, faecal coliform, and E. Coli.

Streams traversing vegetated areas tend to have low levels of Total Suspended Solids / Turbidity, though sediment loading is a significant issue downstream of areas cleared of vegetation or where earthworks have been recently conducted.

## 3.2 Biological Components

### 3.2.1 Protected Areas and Forests

The transmission line ROW section does not intersect any international, national or locally protected areas.

### 3.2.2 Vegetation/Habitat Types

#### ***Previously Identified Land Cover Types***

Natural and modified land cover types occurring in the vicinity of the whole alignment (including the southern section not assessed in the current report) identified in the previous IEE (ERM, May 2014) are as follows:

*Natural Habitat* types-

- Deciduous forest (DF)
- Evergreen forest (EF)
- Bamboo (B)
- Scrub, Heath (SR)
- Swamp (SW)

Modified Habitat types-

- Agriculture Plantation (AP)
- Old fallow land (OFL)
- Young fallow land (YFL)
- Rice paddy (RP)
- Slash and burn (SB)

#### ***Field Survey Results***

Field surveys were conducted along the Realignment between the 8<sup>th</sup> and 10<sup>th</sup> of April 2015 by environmental scientists and a biodiversity specialist from Earth Systems, a local village guide and representatives of NNP1. Surveys consisted of observations transect walks and plot sampling in order to ground truth previous analysis of satellite imagery.

Three native vegetative communities types were identified:

- Upper mixed deciduous (UMD) forest;
- Dry dipterocarp (DD) forest; and
- Grassland / savannah.

In addition, degraded vegetative communities likely provide habitat for native flora and fauna. *Modified habitats* encountered included:

- Old fallow – left to regenerate > 8 years; and
- Young fallow – left to regenerate < 8 years.

*Natural Habitat*, as defined by the *ADB Safeguard Policy Statement (2009)* refers to “Land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area’s primary ecological functions.”

The field survey results indicated that, in the survey area, all forest types present along the proposed alignment were significantly altered by human activity (e.g. selective logging) and other disturbance (e.g. fragmentation, weeds and altered fire regimes), and should therefore be considered as *Modified Habitat*. The only *Natural Habitat* types (i.e. with lesser levels of disturbance), that was identified was Grassland / savannah.

Descriptions of each land cover type identified in the field are provided below.

### Upper Mixed Deciduous Forest

Upper Mixed Deciduous Forest dominates in a small stand between reference points 65 and 68 (see Figure 3-3). This forest type is considered fragmented / isolated within a broader landscape dominated fallow (see below). Deciduous tree species represent more than 50% of the stand. Average canopy cover in this forest stand was approximately 25%, above the threshold for Un-Stocked Forest or Degraded Forest, as per Lao PDR nomenclature (GOL, 2007). Dominant canopy species identified included *Bombax anceps*, *Cratoxylum formosum ssp. pruniflorum* and *Terminalia elliptica*. Bamboo species were commonly dominant in the mid-canopy and understorey, with *Oxytenanthera albociliata* and *O. parvifolia* common in lower layers (see Table 3-1). Upper Mixed Deciduous Forest is the most species-rich habitat type in the proposed transmission line re-alignment ROW. The invasive weed species *Chromolaena odorata* was generally common in the understorey. Other evidence of disturbance observed within the UMD patches included selective logging and fire disturbance, particularly around the boundaries. While significantly disturbed, UMD forest was the most species rich habitat type in the proposed ROW.

**Table 3-1 Upper mixed deciduous (UMD) forest most common species within the three structural layers in the proposed ROW**

Structural Component/Layer	Scientific Name	
<b>Canopy</b> Height >4 m Average 25% cover	<i>Bombax anceps</i>	<i>Hopea ferrea</i>
	<i>Cratoxylum formosum ssp. pruniflorum</i>	<i>Irvingia malayana</i>
	<i>Crypteronia paniculata</i>	<i>Lagerstroemia sp.</i>
	<i>Diospyros sp.</i>	<i>Lithocarpus sp.</i>
	<i>Dipterocarpus turbinatus</i>	<i>Memecylon edule</i>
	<i>Ficus altissima</i>	<i>Ormosia pinnata</i>
	<i>Glochidion sphaerogynum</i>	<i>Schima wallichii</i>
	<i>Grewia paniculata</i>	<i>Terminalia elliptica</i>
<b>Mid-storey:</b> Height 1 m - 4 m Average 10% cover	<i>Alangium kurzii</i>	<i>Oxytenanthera albociliata</i>
	<i>Aporosa cascarillioides</i>	<i>Oxytenanthera parvifolia</i>
	<i>Croton eluteria</i>	<i>Rinorea bussei</i>
	<i>Eurycoma longifolia</i>	<i>Streblus asper</i>
	<i>Gonocaryum lobbianum</i>	<i>Trema orientalis</i>
	<i>Grewia paniculata</i>	<i>Uvaria macrophylla</i>
	<i>Millettia pulchra</i>	
<b>Understorey:</b> Height 0 m - 1 m 10% cover	<i>Ardisia helferiana</i>	<i>Dracaena angustifolia</i>
	<i>Aspidistra sp.</i>	<i>Drynaria quercifolia</i>
	<i>Calamus javensis</i>	<i>Forrestia griffithii</i>
	<i>Caryota mitis</i>	<i>Oxytenanthera parvifolia</i>
	<i>Catimbiun bracteatum</i>	<i>Scleria terrestris</i>
	<i>Chromolaena odorata*</i>	<i>Thysanolaena maxima</i>
	<i>Curculigo orchioides</i>	<i>Uvaria macrophylla</i>
	<i>Cyclea sp.</i>	

Key - \* Non – native and one of world's most invasive species (ISSG, 2015)

### Dry Dipterocarp Forest

A very small stand of Dry Dipterocarp Forest was identified near reference point 12 (see Figure 3-5). Dry Dipterocarp Forest is dominated by species from the Dipterocarpaceae family, for which the habitat / vegetation type is named. The canopy can be quite open, with the crown of tree species being small. Canopy cover in the proposed re-alignment ROW was very sparse (see Table 3-2). Tree height in the canopy typically ranges from 8 to 25 m, though in such degraded forest, tree height did not exceed 10 m. The most common dipterocarp in this forest type was *Dipterocarpus obtusifolius*, with other species including *Aporosa villosa* and *Lagerstroemia macrocarpa* scattered throughout. The understory is covered by herbaceous plants and occasional climbers, with the invasive weed *Imperata cylindrica* also common. Similar to the UMD Forest, other evidence of disturbance observed within the Dry Dipterocarp Forest included selective logging and fire disturbance.

Due to the significant level of disturbance of this vegetation type observed in the field, it is considered that in the surveyed area this vegetation type should be considered as *Modified Habitat*.

**Table 3-2 Disturbed / degraded Dry Dipterocarp (DD) forest most common species within the three structural layers in the proposed ROW**

Structural Component/Layer	Scientific Name	
Canopy Height >4 m Average 2% cover	<i>Aporosa villosa</i>	<i>Irvingia malayana</i>
	<i>Careya arborea</i>	<i>Lagerstroemia macrocarpa</i>
	<i>Dipterocarpus obtusifolius</i>	<i>Glochidion eriocarpum</i>
Mid-storey: Height 1 m - 4 m Average 20% cover	<i>Aporosa ficifolia</i>	<i>Hymenocardia punctata</i>
	<i>Aporosa villosa</i>	<i>Peltophorum dasyrrhachis</i>
	<i>Catunaregam tomentose</i>	<i>Phyllanthus emblica</i>
Understorey: Height 0 m - 1 m Average 10% cover	<i>Ardisia helferiana</i>	<i>Streptocaulon griffithii</i>
	<i>Ardisia crispa</i>	<i>Tetracera scandens</i>
	<i>Imperata cylindrica</i> *	<i>Uvaria macrophylla</i>
	<i>Scleria terrestris</i>	

Key - \* One of world's worst invasive species (ISSG, 2015)

### Grassland/Savannah

Grassland (or savannah) are defined by a dominance of naturally occurring grass species (e.g. Poaceae family) on land nearly devoid of trees. Scattered shrubs / young trees were found in some Grassland areas, in the early phases of forming a distinct shrub layer or mid-storey, indicating that some of this Grassland will likely transition to forested communities if left undisturbed.

### Old Fallow

Old fallow is comprised of secondary regrowth with tree canopies of < 20%, where native and non-native plants have established for at least 8 years following significant disturbance. The forest may retain structural and floristic similarities to the above categories, but is not classified as a recognised forest type due to the absence of a dominant tree layer. Although old fallow forest has been highly modified, it retains many native species and provides habitat for wildlife. Old fallow was particularly species-rich, with many similar species to upper mixed deciduous forest (see Table 3-3)

**Table 3-3 Old fallow land most common species within the three structural layers in the proposed ROW**

Structural Component/Layer	Scientific Name	
Canopy	<i>Aporosa ficifolia</i>	<i>Lagerstroemia sp.</i>

Structural Component/Layer	Scientific Name	
Height >4 m Average 15% cover	<i>Cratoxylum formosum pruniflorum</i>	<i>Ormosia pinnata</i>
	<i>Crypteronia paniculata</i>	<i>Peltophorum dasyrrhachis</i>
	<i>Glochidion sphaerogynum</i>	<i>Sapium discolor</i>
	<i>Gonocaryum lobbianum</i>	<i>Schima wallichii</i>
	<i>Grewia paniculata</i>	<i>Vitex tripinnata</i>
	<i>Irvingia malayana</i>	
Mid-storey: Height 1 m - 4 m Average 25% cover	<i>Alangium kurzii</i>	<i>Hymenocardia punctata</i>
	<i>Aporosa ficifolia</i>	<i>Oxytenanthera albociliata</i>
	<i>Cephalostachyum virgatum</i>	<i>Oxytenanthera parvifolia</i>
	<i>Croton eluteria</i>	<i>Peltophorum dasyrrhachis</i>
	<i>Gonocaryum lobbianum</i>	<i>Pterospermum semisagittatum</i>
	<i>Grewia paniculata</i>	
Understorey: Height 0 m - 1 m Average 5% cover	<i>Alpinia galanga</i>	<i>Dracaena angustifolia</i>
	<i>Ancistrocladus tectorius</i>	<i>Forrestia griffithii</i>
	<i>Ardisia helferiana</i>	<i>Lygodium flexuosum</i>
	<i>Catimbium bracteatum</i>	<i>Rinorea bussei</i>
	<i>Curculigo orchiodes</i>	<i>Scleria terrestris</i>
	<i>Cyclea barbata</i>	<i>Thysanolaena maxima</i>
	<i>Dioscorea triphylla</i>	<i>Uvaria macrophylla</i>
Most Common Weed (native and non-native) Species	<i>Cratoxylum formosum pruniflorum</i>	<i>Peltophorum dasyrrhachis</i>
	<i>Oxytenanthera albociliata</i>	<i>Scleria terrestris</i>

### Young Fallow

Young fallow was defined by land that has been recently cleared of vegetation (<8 years), with native and non-native pioneer species rapidly establishing. As with Old Fallow, the nature forest structure is regenerating, but the dominance of native tree species is too low to identify the natural forest type. Though highly modified, Young Fallow likely provides moderate habitat quality for native terrestrial species and was found to be relatively species-rich (see Table 3-4).

**Table 3-4 Young fallow land most common species within the three structural layers in the proposed ROW**

Structural Component/Layer	Scientific Name	
Canopy Height >4 m Average <1% cover	<i>Aporosa ficifolia</i>	<i>Grewia paniculata</i>
	<i>Cratoxylum formosum pruniflorum</i>	<i>Lagerstroemia sp.</i>
	<i>Crypteronia paniculata</i>	<i>Ormosia pinnata</i>
	<i>Glochidion sphaerogynum</i>	<i>Schima wallichii</i>
Mid-storey: Height 1 m - 4 m Average 45% cover	<i>Alangium kurzii</i>	<i>Gonocaryum lobbianum</i>
	<i>Aporosa ficifolia</i>	<i>Mallotus barbatus</i>
	<i>Casearia grewiifolia</i>	<i>Oxytenanthera albociliata</i>

Structural Component/Layer	Scientific Name	
	<i>Cephalostachyum virgatum</i>	<i>Trema orientalis</i>
	<i>Croton eluteria</i>	
Understorey: Height 0 m - 1 m Average 10% cover	<i>Caryota mitis</i>	<i>Lygodium flexuosum</i>
	<i>Catimbium bracteatum</i>	<i>Mallotus thorelii</i>
	<i>Chromolaena odorata*</i>	<i>Sauropus androgynus</i>
	<i>Curculigo orchioides</i>	<i>Scleria terrestris</i>
	<i>Cyclea barbata</i>	<i>Thysanolaena maxima</i>
	<i>Dracaena angustifolia</i>	

Key - \* One of world's worst invasive species (ISSG, 2015)



Plate 3-2 Old Fallow in plot 11



Plate 3-3 Young Fallow near plot 13

### Updated Definition of Deciduous Forest

Based on the results of the field survey, it is recommended that the definition of the Deciduous forest (DF) identified in the IEE (ERM, May 2014) (or 'Mixed Deciduous forest' as it is identified in this Study) is updated to account for the level of disturbance.

Previous desktop assessments of the alignment identified Deciduous forest (DF) as *Natural Habitat*. The description of Deciduous forest (DF) in the IEE (ERM, May 2014) is:

*“Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest”.*

The above definition of is consistent with the results of the current survey, however it is recommended that Deciduous Forest / Mixed Deciduous forest be distinguished as either *low disturbance (Natural Habitat)* or moderate/high disturbance (*Modified Habitat*) as per the following table.

Table 3-5 Descriptions of different 'Deciduous forest' land cover types

Forest Type	Description
Deciduous Forest / Mixed Deciduous Forest – low disturbance (Natural Habitat)	Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring



Forest Type	Description
	<p>above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.</p> <p>This forest type is considered 'low disturbance' when the majority of the following criteria are met:</p> <p>Tree canopy dominated by trees with greater than 30cm DBH.</p> <p>Tree canopy cover greater than 50%;</p> <p>Alien species rare (e.g. represent less than 5% of the stand);</p> <p>Level of disturbance from factors such as selective logging and fire is relatively low;</p>
Deciduous Forest / Mixed Deciduous Forest - moderate/high disturbance (Modified Habitat)	<p>Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.</p> <p>This forest type is considered 'moderate/high disturbance' when:</p> <p>Tree canopy dominated by trees with less than than 30cm DBH.</p> <p>Tree canopy cover greater than 10% but less than 50%;</p> <p>Alien species can be widespread (e.g. represent &gt; 10% of the stand);</p> <p>Level of disturbance from factors such as selective logging and fire is high.</p>

### 3.2.3 Land Use, Habitat Distribution and Quality

Upper Mixed Deciduous Forest dominates in a small stand between reference points 65 and 68 (see Figure 3-3). This forest type is considered fragmented / isolated within a broader landscape dominated fallow (see below). Deciduous tree species represent more than 50% of the stand. Average canopy cover in this forest stand was approximately 25%, above the threshold for Un-Stocked Forest or Degraded Forest, as per Lao PDR nomenclature (GOL, 2007). Dominant canopy species identified included *Bombax anceps*, *Cratoxylum formosum ssp. pruniflorum* and *Terminalia elliptica*. Bamboo species were commonly dominant in the mid-canopy and understorey, with *Oxytenanthera albociliata* and *O. parvifolia* common in lower layers (see Table 3-1). Upper Mixed Deciduous Forest is the most species-rich habitat type in the proposed transmission line re-alignment ROW. The invasive weed species *Chromolaena odorata* was generally common in the understorey. Other evidence of disturbance observed within the UMD patches included selective logging and fire disturbance, particularly around the boundaries. While significantly disturbed, UMD forest was the most species rich habitat type in the proposed ROW.

**Table 3-6 Land use and habitat types present within the proposed ROW**

Land Use/ Habitat Type	Area (ha)	Percentage Area (%)
Upper Mixed Deciduous Forest	1.25	3.41
Dry Dipterocarp Forest	0.09	0.26
Old Fallow	14.70	40.07
Young Fallow	14.82	40.41
Savannah / Grassland	2.76	7.52
Cultivated Land	0.92	2.50
Plantation/Agroforestry	1.73	4.73

<b>Land Use/ Habitat Type</b>	<b>Area (ha)</b>	<b>Percentage Area (%)</b>
Water	0.17	0.48
Road / Tracks	0.23	0.64
<b>Total area (ha)</b>	<b>36.68</b>	<b>100.00</b>

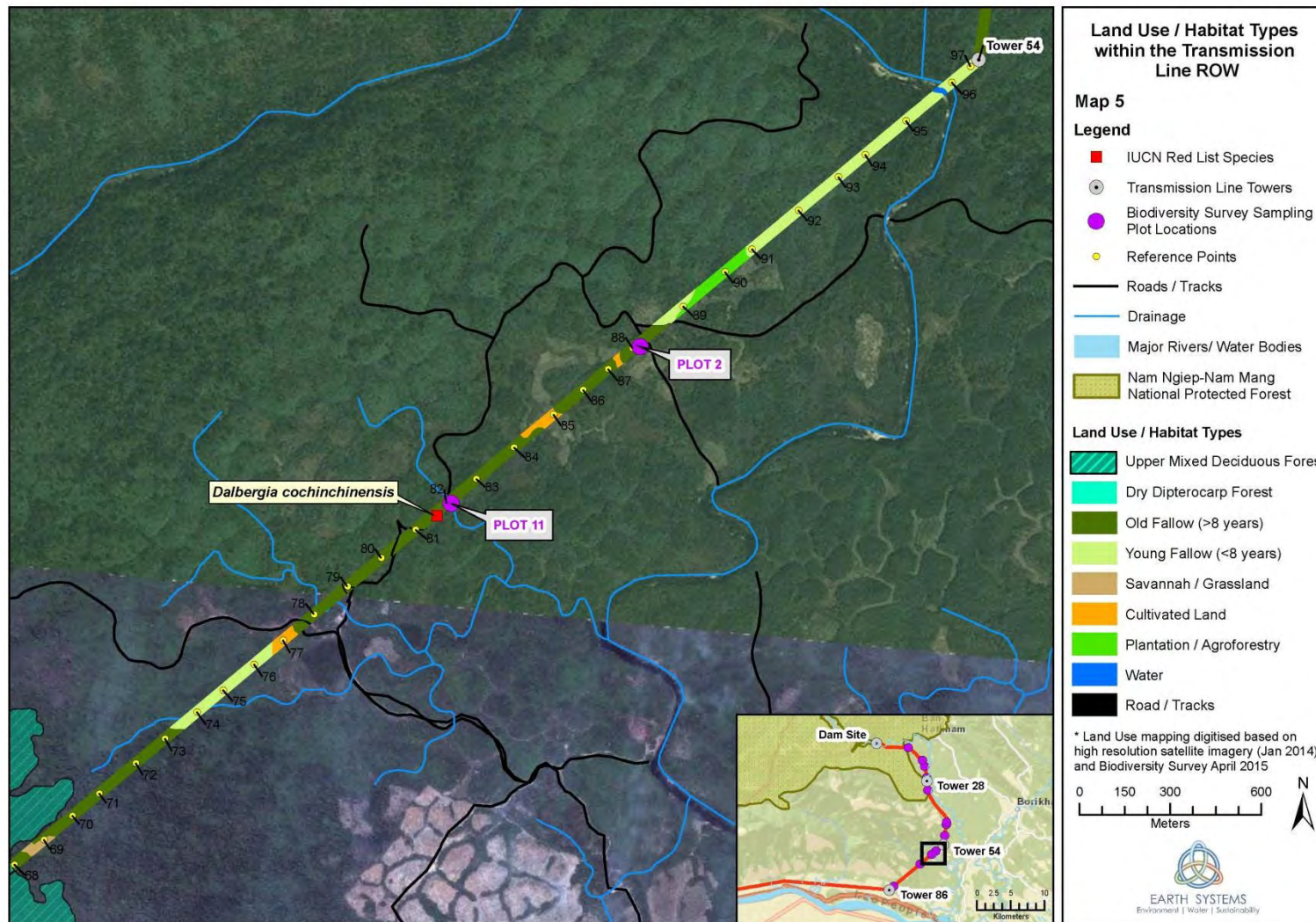


Figure 3-2 Land use and habitat types within the transmission line ROW, with mapped patches of upper mixed deciduous forest to indicate likely boundaries of threatened tree habitat

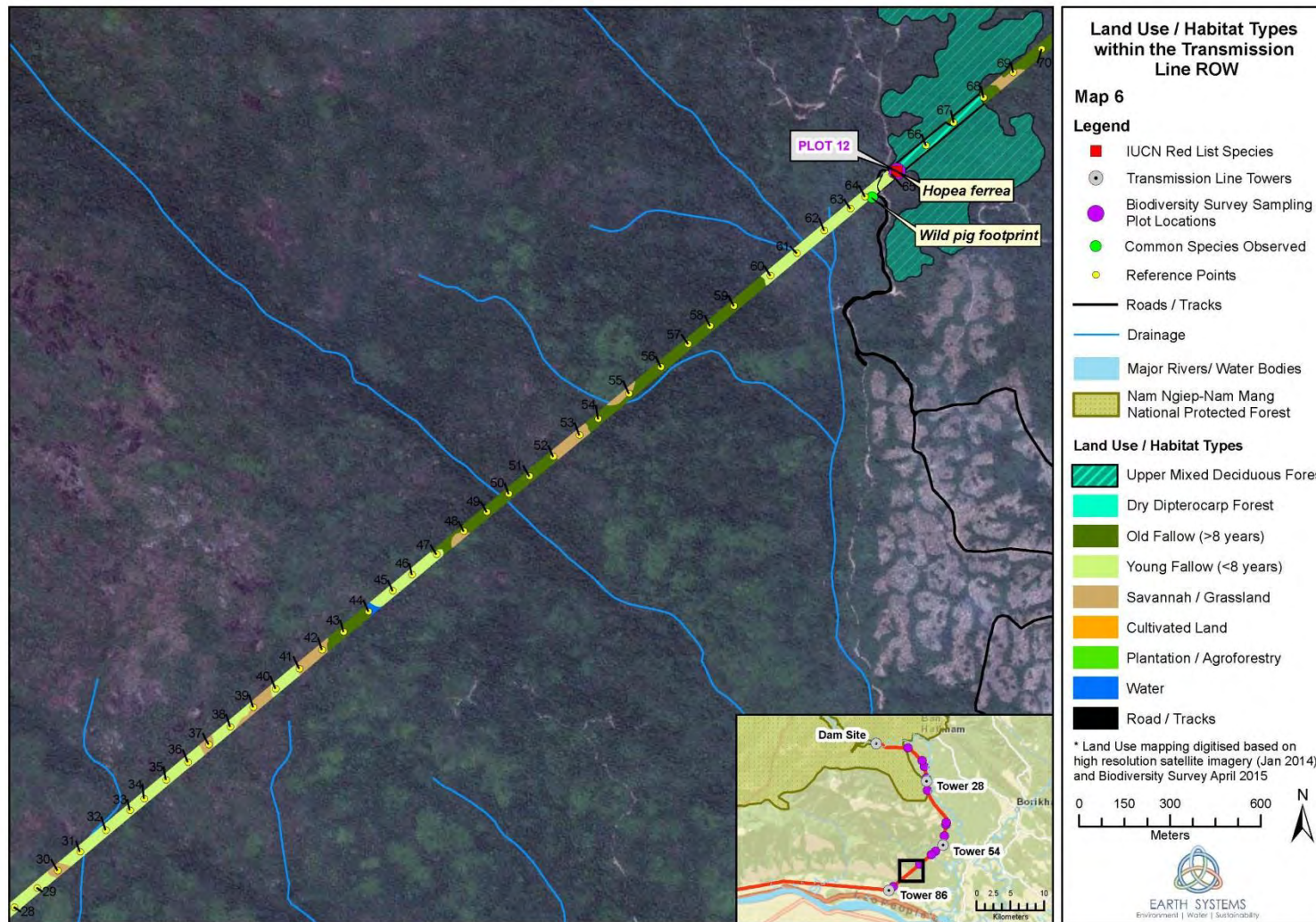


Figure 3-3 Land use and habitat types within the transmission line ROW, including location and habitat types of IUCN threatened trees, with mapped patches of upper mixed deciduous forest to indicate likely boundaries of threatened tree habitat

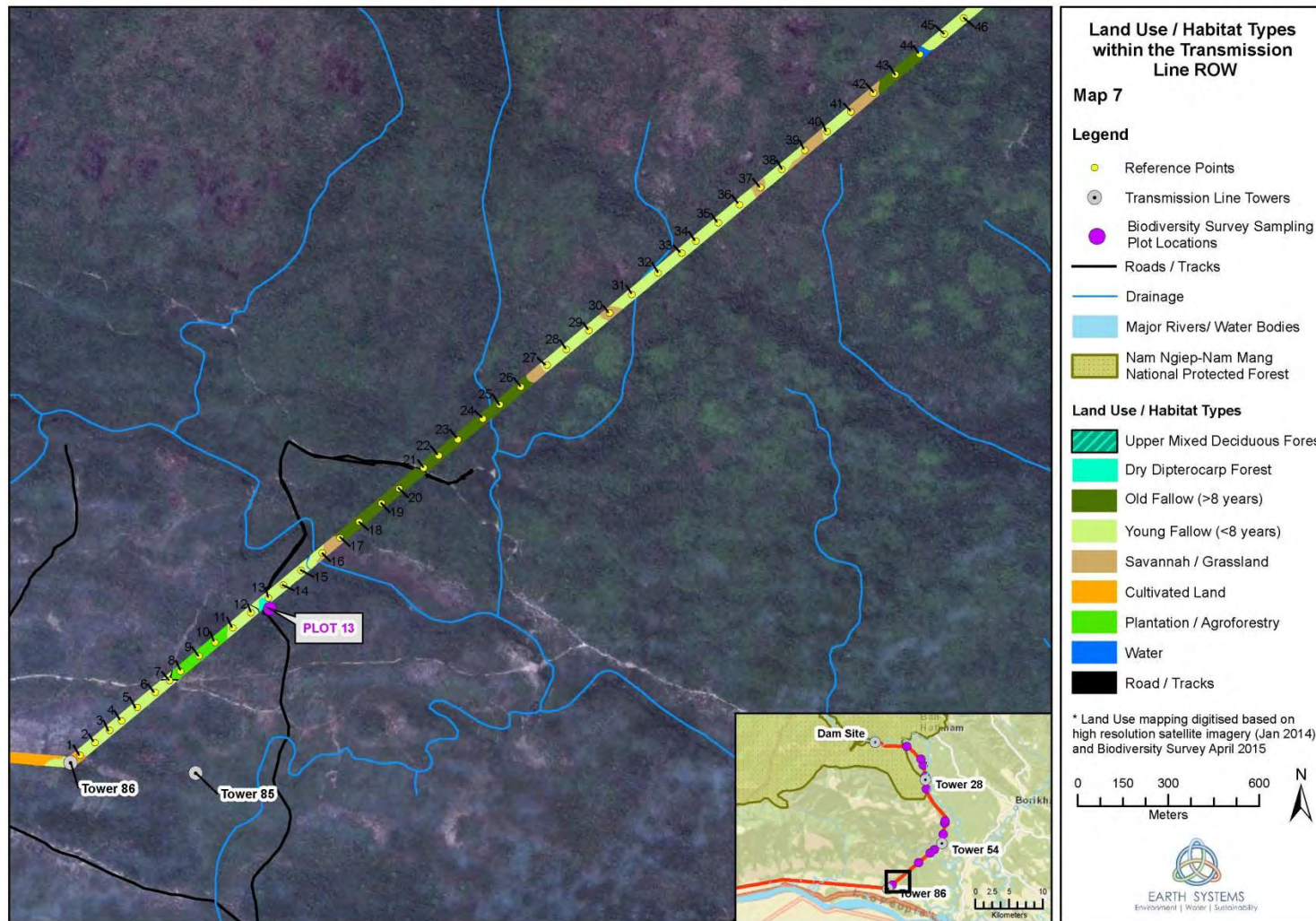


Figure 3-4 Land use and habitat types within the transmission line ROW, with mapped patches of upper mixed deciduous forest to indicate likely boundaries of threatened tree habitat

### 3.2.4 Flora

#### **Species Richness**

Most flora species identified during TL surveys are common to Laos and the greater region. Species richness was generally low or average for disturbed and predominantly regenerating habitat (Table A1). In addition, there were several non-native invasive species identified.

#### **Presence Conservation Important Species**

One globally threatened species was identified inside the ROW. *Hopea ferrea* (EN) was found in a patch of Young Fallow (Table A1, Table B1). This dipterocarp is a commercially important tree and its range and abundance has presumably declined from over-exploitation. No other globally threatened species (i.e. vulnerable, endangered and critically endangered) were identified in the ROW.

### 3.2.5 Fauna Common Species Present

There were few signs of fauna within the ROW, while wild pig/boar (*Sus scrofa*) and wild chicken (*Gallus gallus*) were common in the broader area. Other species seen while traversing the area included:

- Eastern spotted dove (*Spilopelia chinensis*);
- Changeable hawk-eagle (*Nisaetus cirrhatus*); and
- Wire-tailed swallow (*Hirundo smithii*).

These species are common and widespread. It is unlikely for many fauna species to use the more open and degraded habitat. The habitat is more likely to attract disturbance-tolerant and invasive species such as boars and chickens.

#### **Presence Conservation Important Species**

No habitat was identified which is considered likely to support endangered fauna species. Most fauna species of conservation significance are considered as unlikely or highly unlikely to occur because the habitat is too open. The majority of these species are restricted to protected or densely forested areas due to habitat loss and hunting.

The most likely species to be present include the greater coucal (*Centropus sinensis*) and Siamese fireback (*Lophura diardi*). None of these species are of global conservation importance, but are of national, regional and/or local importance.

## 3.3 Social and Cultural Components

### 3.3.1 Communities

The proposed re-alignment is located on land allocated to Ban Nam Pha and Ban Kouay Oudom. Locations of these village settlements are provided in Figure 2-1. Basic demographic information is provided in Table 3.6 below.

**Table 3-7 Project Affected Villages**

Village Name	Total Population	Female	No. Households	No. Families
Ban Nampha	1,825	620	225	300
Ban Kouay Oudom	551	258	107	107

Source: Village Records (2015)

### 3.3.2 Land and Forest Resource Use

A summary of land and forest resources within the re-alignment ROW is provided in Section 3.2.3.

According to Village guides from Ban Nam Pha and Ban Kouay Oudom indicated the boundary between the two villages is the Houay Nam Thek, located between reference points 15 and 16).

Villagers from both communities reportedly use land and forest resources in and around the proposed realignment. Activities include shifting cultivation, NTFP / TFP harvesting, hunting and the establishment of plantations (i.e. rubber and eucalypt) and rain-fed rice paddies. According to village guides, shifting cultivation has largely been abandoned in recent years due to the low productivity of the land.

Key agricultural land use features identified within the re-alignment right of way (see Figures 3-2 to 3-4) include:

- 0.92 ha of rain-fed rice paddies; and
- 1.73 ha of commercial tree plantations.

Local village chiefs consulted in this study indicated plans to expand their agriculture and forestry activities including cultivation of cassava and rubber trees within village lands that the re-alignment ROW traverses.

According to village guides, the areas in the immediate vicinity of the re-alignment have also been logged intensively by commercial operations over the last 10 years. Section 3.4 provides further information on remaining commercial timber resources in the area.

### 3.3.3 Water Resource Use

Village guides confirmed that local villagers do not currently use waterways within the re-alignment area for irrigation purposes but they do rely on these waterways for fish and other aquatic resources.

### 3.3.4 Cultural Heritage

No areas of cultural significance were identified during field exercises with village guides from Ban Nam Pha and Ban Kouay Oudom.

## 3.4 Commercial Timber Resources

A rapid assessment of commercial timber resources occurring in the re-alignment ROW was conducted. This included field surveys with the assistance of local guides to record the number and size of locally recognised<sup>1</sup> commercial trees above 10 cm diameter at breast height (DBH) in four (4) sample plots within the re-alignment ROW and nine (9) additional plots in the wider project area (see Annex B). Analysis of this information was conducted against land use and habitat data to estimate commercial timber resources within the re-alignment ROW.

Table 3-7 provides the results of this analysis. An estimated 4,762 commercial trees are present in the ROW, with the majority existing in old fallow forests. Basal area (the average area occupied by tree stems) has been calculated as 27 m<sup>2</sup> per hectare or 120.5 m<sup>2</sup> for the ROW.

**Table 3-8 Estimated Commercial Timber Resources: Re-alignment**

Forest Type	Total Area in ROW (ha)	Commercial Trees			Basal Area (m <sup>2</sup> )	
		Average # per Ha	Estimated Total # in ROW	Average DBH	Estimated Area per Ha	Estimated Area in RoW
Upper Mixed Deciduous	1.25	268.60	335.70	27.19	12.88	16.09

<sup>1</sup> Determined by national biodiversity specialist and local field guide.

Forest Type	Total Area in ROW (ha)	Commercial Trees			Basal Area (m2)	
		Average # per Ha	Estimated Total # in ROW	Average DBH	Estimated Area per Ha	Estimated Area in RoW
Dry Dipterocarp	0.09	171.43	16.17	35.62	34.24	3.23
Old Fallow	14.70	300.00	4,410.16	16.52	6.88	101.19
<b>Total</b>	16.04	-	4,762.04	39.66	27.00	120.51

Note: Average number of trees per ha and average DBH per tree calculated from 13 plots surveyed.

Table 3-8 provides information on the type and number of commercial tree species recorded in four (4) plots within the ROW of the re-alignment. A total of 23 commercial tree species were identified in the four (4) plots. Most common species include *Crypteronia paniculata*, *Largerstroemia*, *Peltophorum dasyrrhachis* and *Aporosa ficifolia*.

### 3.4.1 Upper Mixed Deciduous

As outlined in Section 3.2.3 only one small patch of UMD forest is impacted by the re-alignment ROW. Plot 12 conducted in this area identified 19 commercial trees with an. Average size (DBH) of these trees (across the wider project area) is 26.1 cm ranging from 9.6 cm up to 44.6 cm (see Annex B). Average minimum and maximum DBH are 18.4 and 29.8 respectively. Basal area per ha has been calculated at 12.88 m2 per hectare (Table 3-6)

### 3.4.2 Dry Dipterocarp

A small patch of dry dipterocarp forest was identified within the re-alignment. Plot 13 surveying conducted in this area identified 12 commercial tree species. Average size of these trees is 35.6 cm, ranging 10.5 cm to 162.6 cm (see Annex B). Average minimum and maximum DBH are 12.4 cm and 53.0 cm respectively. Basal area per ha has been calculated at 34.23 m2 per hectare (Table 3-7).

### 3.4.3 Fallow Forests

A total of 39 commercial trees were recorded in plot 11 – Old fallow. These trees are generally small with an average DBH of 16.25 cm ranging 9.5 cm to 36.3 cm (see Annex B). Average minimum and maximum DBH are 12.4 cm and 53.0 cm respectively. Basal area per ha has been calculated at 6.9 m2 per hectare (Table 3-7). Few to no commercial trees were recorded in young fallow forest plots.



**Table 3-9 Commercial Tree Species Present in the ROW**

No.	Common Name (Lao)	Species	Family	Habitat / Plot #			
				UMD	D. Dip	O. Fallow	Total
				12	13	11	
1	Muad kieng	Aporosa ficifolia	Phyllanthaceae			7	7
2	Muad ngai	Aporosa villosa	Euphorbiaceae		3		3
3	Mai Wan	Bauhinia racemosa	Leguminosae/ Caesalpinioideae				0
4	Phi man	Buchanania siamensis	Anacardiaceae		2		2
5	Ka don	Careya arborea	Lecythidaceae		3		3
6	Mai tiw som	Cratoxylum formosum	Hypericaceae			2	2
7	Mai tieu deng	cratoxylum formosum var. Pruniflorum	hypericaceae			4	4
8	Mai ka arm	Crypteronia paniculata	Crypteroniaceae			11	11
9	Mai sa ngon	Derris	Leg./Papilionoideae	2			2
10	Maim nang dam	Diospyros	Ebenaceae	1			1
11	Khee mod	Glochidion sphaerogynum	Phyllanthaceae		2		2
12	mai khaen hin	Hopea ferrea	Dipterocarpaceae	6			6
13	Ka ka lau	Lagerstroemia macrocarpa	Lythraceae		2		2
14	Mai peuyay	lagerstromia	lythraceae	4		6	10
15	Mai muad ae	Memecylon edule	Melastomataceae	1			1
16	Mai khee mou	Ormosia pinnata	Leg./Papilionoideae	1			1
17	Mai saphang	peltophorum dasyrrhachis	leg / caesalp.			9	9
18	Mai phai ven	Phoebe lanceolata	Lauraceae	1			1
19	Mai leung keo	Rinoria boisseui	Violaceae	1			1
20	Mai peuy lerd	Terminalia elliptica	Combretaceae	2			2
<b>TOTAL</b>				19	12	39	70

## 4 PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

### 4.1 Consultations for Preparation of May 2014 IEE

Consultations relating to the TL alignment took place with relevant stakeholders between 2008 and 2011 as outlined in the May 2014 IEE (Table 6.1). Stakeholders have included local villagers, district, provincial and national government representatives and international financiers. The consultation activities have helped to identify potential impacts, including impacts to significant historical/ archaeological sites, such as the Wat Prabat Phonsan. The result has been a realignment of the transmission line corridor in order to minimise the potential impacts.

### 4.2 Oji Consultations

A meeting was held between NNP1 and Oji Lao Plantation Forest Co., Ltd. (OLPF) in November 2014 to discuss compensation for use of tree plantation land (managed by OLPF) for the 230kV Transmission Line of the NNP1 Project. As a result of the meeting, an optimised realignment was agreed upon and a sublease agreement was reached between the two parties to compensate OLPF for loss of land within the TL ROW.

### 4.3 Consultations for this Report

During the conduct of this assessment a meeting was held with local government officials (PONRE) to gain necessary permissions and glean background information about areas along the TL alignment. In addition, village chiefs from Ban Hatsaykham and Ban Somseun were informed about this assessment. Local guides were engaged to help navigate the TL alignment and provide detailed local knowledge to inform the study such as identification of local streams and other geographical features, history and current usage of the area along the ROW and information relating to any sites of cultural significance.

## 5 KEY FINDINGS / POTENTIAL IMPACTS AND RECOMMENDED MITIGATION MEASURES

### 5.1 Key Findings / Potential Impacts

Key findings / potential impacts include:

- The proposed re-alignment transverses the land of two villages, Ban Nam Pha and Ban Kouay Oudom, however the path of the re-alignment is relatively remote and does not affect any village settlements or permanent structures.
- The re-aligned ROW would have a minor impact on permanent agriculture:
  - » Approximately 0.92 ha of the ROW passes through rain-fed rice paddies which may be temporarily impacted during construction, with very small area of permanent land acquisition for towers (the location of which are yet to be confirmed).
  - » Approximately 1.73 ha of commercial tree plantations will be permanently impacted. One plantation near Ban Kouay Oudom and the other within Ban Nam Pha boundary.
- Land within and in close proximity to the re-alignment ROW currently has limited productive use. While swidden agriculture occurred over 5 years ago, most villagers have now abandoned this area due to the poor soil fertility. Local village chiefs consulted during this study indicated plans to expand their agriculture and forestry activities including cultivation of cassava and rubber trees.
- The proposed transmission line alignment does not pass through any areas of very high biodiversity significance such as NBCA areas or Ramsar Wetland Sites.
- *Modified habitat* dominates the habitat in the ROW, with approximately 32 ha of Old Fallow and Young Fallow to be removed for the Project.
- No areas of primary forest, or areas with minimal human disturbance occur within the realignment ROW. The forest types present were Upper mixed deciduous (UMD) forest and Dry dipterocarp (DD) forest which occur in small patches and only cover a small proportion of the alignment. In the area of the alignment these forests have been significantly disturbed by human activity (e.g. selective logging) and other factors such as weeds and should therefore be considered as *Modified Habitat*.
- Only a small proportion (2.76 ha) of the alignment is comprised of Grassland/Savanna, which has lesser levels of disturbance than other habitat types within the ROW. As these areas are nearly devoid of trees, they are not expected to be significantly disturbed by the presence of the transmission line (negligible clearance is expected to be required).
- It is unlikely that *critical habitat* exists within the ROW, although this has not been extensively assessed. A full Critical Habitat Assessment would be required to confirm the presence/absence of critical habitat but due to the low likelihood of this possibility, it is not recommended. It is also unlikely that removal of such a small amount of habitat would affect the global distribution of the Endangered plant species found to be present in the ROW.
- One globally threatened species was identified inside the ROW. *Hopea ferrea* (EN) was found in a patch of young fallow. No globally threatened fauna were observed, while domestic species were most commonly seen. Globally threatened fauna species are unlikely to utilise habitat within the ROW, and are likely primarily restricted to protected areas in the broader region.
- An estimated 4,762 commercial trees with an estimated basal area of 120.5 m<sup>2</sup> are present in primarily old fallow forest habitats within the ROW. The size of most commercial trees is relatively small with the average diameter (dbh) of trees in old fallow forest habitats of approximately 16.52 cm. The topography

of the landscape (elevations ranging from 166 to 350 masl) may lead to additional land and vegetation impacts due to the requirement of additional towers and access roads outside the ROW.

- The topography of the landscape (elevations ranging from 166 to 350 masl) may lead to additional land and vegetation impacts due to the requirement of additional towers and access roads outside the ROW.
- Soils in the area are Acrisol and are known for their high erodibility. This coupled with extensive vegetation and habitat degradation presents high risk of erosion and sediment transportation.
- Four (4) perennial and numerous ephemeral waterways are located along the re-alignment. These waterways are reportedly used by local villages for fishing and collecting other aquatic resources.

## 5.2 Recommendations

It is recommended that definition of the Deciduous forest (DF) identified in the previous IEE (ERM, May 2014) (or 'Mixed Deciduous forest' as it is identified in this Study) is updated to account for the level of disturbance in some Deciduous Forest. The following categories are recommended (with definitions are provided in Section 3.3.2):

- Deciduous forest / Mixed Deciduous forest classed as low disturbance (Natural Habitat)
- Deciduous forest / Mixed Deciduous forest classed as moderate/high disturbance (Modified Habitat)

The mitigation and management measures identified in the IEE (ERM May 2014) (Section 4 and Table 8.2) are considered applicable to the management of the potential impacts of the proposed re-alignment, and should be implemented. No other protection measures are recommended.

In addition, it is recommended that NNP1:

- Conduct further consultations with project affected people in Ban Nam Pha and Ban Kouay Oudom to confirm that the new alignment has been selected and inform them of the project schedule; and
- Consider compensation requirements versus re-alignment options to mitigate / avoid impact on the remaining commercial tree plantations currently identified within the re-alignment ROW.

## ANNEX A: RESULTS OF BIODIVERSITY FIELD ASSESSMENT

**Table A1 Most common flora species identified in habitat types**

Scientific Name	Family	Habit	IUCN Status
<i>Alangium kurzii</i>	Cornaceae	T	N/A
<i>Alpinia galanga</i>	Zingiberaceae	H	N/A
<i>Ancistrocladus tectorius</i>	Ancistrocladaceae	C	N/A
<i>Anisoptera costata</i>	Dipterocarpaceae	T	EN
<i>Aporosa cascarillioides</i>	Phyllanthaceae	TL	N/A
<i>Aporosa ficifolia</i>	Phyllanthaceae	TL	N/A
<i>Aporosa villosa</i>	Phyllanthaceae	TL	N/A
<i>Ardisia crispa</i>	Primulaceae	H	N/A
<i>Ardisia helferiana</i>	Primulaceae	TL	N/A
<i>Aspidistra</i> sp.	Asparagaceae	H	N/A
<i>Bambusa arundinacea</i>	Poaceae	H	N/A
<i>Bauhinia racemosa</i>	Leguminosae	Sh/T	N/A
<i>Bombax anceps</i>	Malvaceae	T	N/A
<i>Buchanania siamensis</i>	Anacardiaceae		N/A
<i>Calamus javensis</i>	Palmae	H	N/A
<i>Careya arborea</i>	Lecythidaceae	T	N/A
<i>Caryota mitis</i>	Arecaceae	H	N/A
<i>Casearia grewiifolia</i>	Salicaceae	TL	N/A
<i>Catimbium bracteatum</i>	Zingiberaceae	H	N/A
<i>Catunaregam tomentosa</i>	Rubiaceae	TL	N/A

Scientific Name	Family	Habit	IUCN Status
<i>Cephalostachyum virgatum</i>	Poaceae	H	N/A
<i>Chromolaena odorata*</i>	Asteraceae	H	N/A
<i>Chrozophora tinctoria</i>	Euphorbiaceae	TL/H	LC
<i>Cratoxylum formosum</i>	Guttiferae	T	LR/LC
<i>Cratoxylum formosum pruniflorum</i>	Guttiferae	T	LR/LC
<i>Croton eluteria</i>	Euphorbiaceae	TL	N/A
<i>Crypteronia paniculata</i>	Cryteroniaceae	T	N/A
<i>Curculigo orchioides</i>	Hypoxidaceae	H	N/A
<i>Cyclea barbata</i>	Menispermaceae	C	N/A
<i>Cyclea sp.</i>	Menispermaceae	C	N/A
<i>Derris sp.</i>	Fabaceae		N/A
<i>Dioscorea triphylla</i>	Dioscoreaceae	C	N/A
<i>Diospyros sp.</i>	Ebenaceae	T	N/A
<i>Dipterocarpus obtusifolius</i>	Dipterocarpaceae	T	LR/LC
<i>Dipterocarpus turbinatus</i>	Dipterocarpaceae	T	CR
<i>Dracaena angustifolia</i>	Asparagaceae	H	N/A
<i>Drynaria quercifolia</i>	Polypodiaceae	Fern	N/A
<i>Eurya tonkinensis</i>	Pentaphylacaceae		N/A
<i>Eurycoma longifolia</i>	Simaroubaceae	TL	N/A
<i>Ficus altissima</i>	Moraceae	T	N/A
<i>Forrestia griffithii</i>	Commelinaceae	H	N/A
<i>Glochidion eriocarpum</i>	Phyllanthaceae	TL	N/A
<i>Glochidion sphaerogynum</i>	Phyllanthaceae	T	N/A
<i>Gonocaryum lobbianum</i>	Stemonuraceae	TL	N/A

Scientific Name	Family	Habit	IUCN Status
<i>Grewia paniculata</i>	Malvaceae	T	N/A
<i>Hopea ferrea</i>	Dipterocarpaceae	T	EN
<i>Hymenocardia punctata</i>	Phyllanthaceae	TL	N/A
<i>Imperata cylindrica</i> *	Poaceae	H	N/A
<i>Irvingia malayana</i>	Irvingiaceae	T	LR/LC
<i>Lagerstroemia macrocarpa</i>	Lythraceae	T	N/A
<i>Lagerstroemia</i> sp.	Lythraceae	T	N/A
<i>Lithocarpus</i> sp.	Fagaceae	T	N/A
<i>Lygodium flexuosum</i>	Lygodiaceae	Fern	N/A
<i>Mallotus barbatus</i>	Euphorbiaceae	TL	N/A
<i>Mallotus thorelii</i>	Euphorbiaceae	TL	N/A
<i>Memecylon edule</i>	Melastomataceae	TL	N/A
<i>Mesua ferrea</i>	Calophyllaceae		N/A
<i>Millettia pulchra</i>	Leguminosae	TL	LC
<i>Ormosia pinnata</i>	Fabaceae	T	N/A
<i>Oxytenanthera albociliata</i>	Poaceae	H	N/A
<i>Oxytenanthera parvifolia</i>	Poaceae	H	N/A
<i>Parinari annamensis</i>	Chrysobalanaceae		N/A
<i>Peltophorum dasyrrhachis</i>	Fabaceae	T	N/A
<i>Phoebe lanceolata</i>	Lauraceae		N/A
<i>Phoebe</i> sp.	Lauraceae		N/A
<i>Phyllanthus emblica</i>	Phyllanthaceae	TL	N/A
<i>Pterospermum semisagittatum</i>	Malvaceae	T	N/A
<i>Rinorea bussei</i>	Violaceae	TL	N/A

Scientific Name	Family	Habit	IUCN Status
<i>Sapium discolor</i>	Euphorbiaceae	T	N/A
<i>Sauropus androgynus</i>	Phyllanthaceae	H	N/A
<i>Schima wallichii</i>	Theaceae	T	N/A
<i>Scleria terrestris</i>	Cyperaceae	H	LC
<i>Streblus asper</i>	Moraceae	TL	N/A
<i>Streptocaulon griffithii</i>	Apocynaceae	C	N/A
<i>Terminalia elliptica</i>	Combretaceae	T	N/A
<i>Tetracera scandens</i>	Dilleniaceae	H	N/A
<i>Thysanolaena maxima</i>	Poaceae	H	N/A
<i>Trema orientalis</i>	Cannabaceae	TL	N/A
<i>Uvaria macrophylla</i>	Annonaceae	TL	N/A
<i>Vitex tripinnata</i>	Lamiaceae	TL	N/A



## ANNEX B: RESULTS OF COMMERCIAL TREE ASSESSMENT

Table B1 Commercial Trees – Summary of Type and Number

No.	Common Name (Lao)	Species	Family	Forest Type and Plot Number												Total		
				Upper Mixed Deciduous					D. Dip	Old Fallow				Young Fallow				
				3	4	6	7	12	13	1	5	10	11	2	8		9	
1	Muad kieng	<i>Aporosa ficifolia</i>	Euphorbiaceae									1	7				8	
2	Muad ngai	<i>Aporosa villosa</i>	Euphorbiaceae							3							3	
3	Mai Wan	<i>Bauhinia racemosa</i>	Leguminosae/ Caesalpinioideae											1			1	
4	Mai ngiw pah	<i>Bombax anceps</i>	Bombacaceae	1													1	
5	Phi man	<i>Buchanania siamensis</i>	Anacardiaceae							2							2	
6	Ka don	<i>Careya arborea</i>	Lecythidaceae							3							3	
7	Mai tiw som	<i>Cratoxylum formosum</i>	Hypericaceae										2				2	
8	Mai tieu deng	<i>cratoxylum formosum var. Pruniflorum</i>	hupericaceae	1		2						4		4			1	12
9	Mai ka arm	<i>Crypteronia paniculata</i>	Crypteroniaceae			21							6	11				38
10	Mai sa ngon	<i>Derris</i>	Leg./Papilionoideae					2										2
11	Maim nang dam	<i>Diospyros</i>	Ebenaceae					1										1
12	Mai yang dong	<i>Dipterocarpus turbinatuts</i>	Dipterocarpaceae				3											3
13	Mai euria	<i>Eurya tonkinensis</i>	Theaceae	2														2
14	Ton hai	<i>Ficus altissima</i>	Moraceae	1														1
15	Khee mod	<i>Glochidion sphaerogynum</i>	Euphorbiaceae			7				2								9
16	Khom som	<i>Grewia paniculata</i>	Tiliaceae			1					1		1					3
17	mai khaen hin	<i>Hopea ferrea</i>	Dipterocarpaceae	1	2			6										9

No.	Common Name (Lao)	Species	Family	Forest Type and Plot Number											Total			
				Upper Mixed Deciduous					D. Dip	Old Fallow				Young Fallow				
				3	4	6	7	12	13	1	5	10	11	2		8	9	
18	Mai ka bok	<i>Irvingia malayana</i>	Irvingiaceae				1						1				2	
19	Ka ka lau	<i>Lagerstroemia macrocarpa</i>	Lythraceae							2							2	
20	Mai peuyay	<i>lagerstromia</i>	lythraceae	3				4				1			6		14	
21	Mai Ko ta mou	<i>Lithocarpus sp.</i>	Fagaceae				2											
22	Mai muad ae	<i>Memecylon edule</i>	Melastomataceae					1									1	
23	Mai ka tang	<i>Mesua ferrea</i>	Calophyllaceae				1										1	
24	Mai khee mou	<i>Ormosia pinnata</i>	Leg./Papilionoideae		1	4	4	1					3	3			16	
25	Mai phok	<i>Parinari annamensis</i>	Rosaceae			1											1	
26	Mai saphang	<i>peltophorum dasyrrhachis</i>	leg / caesalp.									9	6		9	1	25	
27	Mai phai ven	<i>Phoebe lanceolata</i>	Lauraceae					1									1	
28	Mai sa mee	<i>Phoebe sp.</i>	Lauraceae										1				1	
29	Ham ao	<i>Pterospermum semisagittatum</i>	Sterculiaceae		1		1										2	
30	Mai leung keo	<i>Rinoria boisseui</i>	Violaceae	2				1									3	
31	Mai mee	<i>Schima wallichii</i>	Theaceae				12						2				14	
32	Mai peuy lerd	<i>Terminalia elliptica</i>	Combretaceae					2									2	
33	Mai sa khang	<i>Vitex tripinnata</i>	Verbenaceae									6					6	
<b>TOTAL</b>				<b>11</b>	<b>4</b>	<b>36</b>	<b>24</b>	<b>19</b>		<b>12</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>39</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>193</b>
<b>Plot Average (20 x 35)</b>				<b>18.8</b>					<b>12</b>	<b>21</b>				<b>1</b>				
<b>Average per Hectare</b>				<b>268.6</b>					<b>171.429</b>	<b>300.0</b>				<b>14.3</b>				

Notes:

- Includes all 13 sample plots conducted during assessment of ROW between Dam site and Tower 54 and new alignment

**Table B2 Commercial Trees - Upper Mixed Deciduous**

No.	Common Name (Lao)	Species	Family	Number of Trees Per Plot					Total Number (all Plots)	Tree Size (DBH)			Average Basal Area (Tree) (m <sup>2</sup> )	Basal Area (plot) (m <sup>2</sup> )						
				3	4	6	7	12		Average	Min	Max		3	4	6	7	12		
1	Mai ngiw pah	<i>Bombax anceps</i>	Bombacaceae	1					1	20.70	20.70	20.70	0.03	0.03	-	-	-	-		
2	Mai tieu deng	<i>cratoxylum formosum var. Pruniflorum</i>	hupericaceae	1		2			3	25.37	17.52	29.94	0.05	0.05	-	0.11	-	-		
3	Mai ka arm	<i>Crypteronia paniculata</i>	Crypteroniaceae			21			21	23.46	14.33	35.03	0.05	-	-	0.96	-	-		
4	Mai sa ngon	<i>Derris</i>	Leg./Papilionoideae					2	2	27.71	11.46	16.24	0.02	-	-	-	-	0.03		
5	Maim nang dam	<i>Diospyros</i>	Ebenaceae					1	1	22.61	22.61	22.61	0.04	-	-	-	-	0.04		
6	Mai yang dong	<i>Dipterocarpus turbinatus</i>	Dipterocarpaceae				3		3	24.95	20.70	31.85	0.05	-	-	-	0.15	-		
7	Mai euria	<i>Eurya tonkinensis</i>	Theaceae	2					2	23.89	19.11	28.66	0.05	0.09	-	-	-	-		
8	Ton hai	<i>Ficus altissima</i>	Moraceae	1					1	82.80	82.80	82.80	0.54	0.54	-	-	-	-		
9	Khee mod	<i>Glochidion sphaerogynum</i>	Euphorbiaceae			7			7	17.97	9.55	23.89	0.03	-	-	0.19	-	-		
10	Khom som	<i>Grewia paniculata</i>	Tiliaceae			1			1	22.29	22.29	22.29	0.04	-	-	0.04	-	-		
11	mai khaen hin	<i>Hopea ferrea</i>	Dipterocarpaceae	1	2			6	9	24.91	11.15	44.59	0.06	0.06	0.11	-	-	0.33		
12	Mai ka bok	<i>Irvingia malayana</i>	Irvingiaceae				1		1	20.70	20.70	20.70	0.03	-	-	-	0.03	-		
13	Mai peuyay	<i>lagerstromia</i>	lythraceae	3				4	7	18.29	11.46	34.39	0.03	0.09	-	-	-	0.12		
14	Mai Ko ta mou	<i>Lithocarpus sp.</i>	Fagaceae				2		2	28.66	25.48	31.85	0.07	-	-	-	0.13	-		
15	Mai muad ae	<i>Memecylon edule</i>	Melastomataceae					1	1	41.40	41.40	41.40	0.13	-	-	-	-	0.13		
16	Mai ka tang	<i>Mesua ferrea</i>	Calophyllaceae				1		1	25.48	25.48	25.48	0.05	-	-	-	0.05	-		
17	Mai khee mou	<i>Ormosia pinnata</i>	Leg./Papilionoideae		1	4	4	1	10	20.73	11.15	35.03	0.04	-	0.04	0.16	0.16	0.04		
18	Mai phok	<i>Parinari annamensis</i>	Rosaceae			1			1	35.03	35.03	35.03	0.05	-	-	0.05	-	-		
19	Mai phai ven	<i>Phoebe lanceolata</i>	Lauraceae					1	1	27.39	27.39	27.39	0.06	-	-	-	-	0.06		
20	Ham ao	<i>Pterospermum semisagittatum</i>	Sterculiaceae		1		1		2	18.31	14.33	22.29	0.03	-	0.03	-	0.03	-		
21	Mai leung keo	<i>Rinoria boisseui</i>	Violaceae	2				1	3	21.76	19.11	25.48	0.04	0.08	-	-	-	0.04		
22	Mai mee	<i>Schima wallichii</i>	Theaceae				12		12	20.70	9.87	43.63	0.04	-	-	-	0.48	-		
23	Mai peuy lerd	<i>Terminalia elliptica</i>	Combretaceae					2	2	30.25	9.55	20.70	0.02	-	-	-	-	0.04		
<b>TOTAL</b>				<b>11</b>	<b>4</b>	<b>36</b>	<b>24</b>	<b>19</b>	<b>94</b>	<b>27.19</b>	<b>9.55</b>	<b>82.80</b>	<b>0.07</b>	<b>0.94</b>	<b>0.18</b>	<b>1.51</b>	<b>1.04</b>	<b>0.84</b>		
<b>Plot Average (20 x 35)</b>				<b>18.8</b>							<b>21.88</b>	<b>31.39</b>							<b>0.90</b>	
<b>Average per Hectare</b>				<b>268.6</b>																<b>12.88</b>

Notes:

- Includes sample plots conducted during assessment of ROW between Dam site and Tower 54 and new alignment

**Table B3 Commercial Trees - Dry Dipterocarp**

No.	Common Name (Lao)	Species	Family	No. Trees Per Plot	Total Number	Tree Size (DBH)			Avg Basal Area (Tree) (m <sup>2</sup> )	Basal Area (m <sup>2</sup> ) Plot 1
						Average	Min	Max		
						13	(all Plots)			
2	Muad ngai	<i>Aporosa villosa</i>	Euphorbiaceae	3	3	13.91	11.78	15.29	0.02	0.05
5	Phi man	<i>Buchanania siamensis</i>	Anacardiaceae	2	2	47.77	11.78	54.14	0.09	0.17
6	Ka don	<i>Careya arborea</i>	Lecythidaceae	3	3	14.65	10.51	20.38	0.02	0.05
15	Khee mod	<i>Glochidion sphaerogynum</i>	Euphorbiaceae	2	2	89.01	15.29	162.74	1.05	2.10
19	Ka ka lau	<i>Lagerstroemia macrocarpa</i>	Lythraceae	2	2	12.74	12.74	12.74	0.01	0.03
<b>TOTAL</b>				<b>12</b>	<b>12</b>	<b>35.62</b>	<b>10.51</b>	<b>162.74</b>	<b>0.24</b>	<b>2.40</b>
<b>Plot Average (20 x 35)</b>				<b>12</b>			<b>12.42</b>	<b>53.06</b>		<b>2.40</b>
<b>Average per Hectare</b>				<b>171.4</b>						<b>34.24</b>

**Table B4 Commercial Trees – Old Fallow Forest**

Common Name (Lao)	Species	Family	No. Trees per Plot				Total Number (all Plots)	Average	DBH		Average Basal Area (Tree) (m <sup>2</sup> )	Basal Area (plot) (m <sup>2</sup> )			
			1	5	10	11			Min	Max		1	5	10	11
			Muad kieng	<i>Aporosa ficifolia</i>	Euphorbiaceae					1		7	8	14.96815	14.96815
Mai tiw som	<i>Cratoxylum formosum</i>	Hypericaceae				2	2	5.360934	15.92357	19.10828	0.022957	0.00000	0.00000	0.00000	0.04591
Mai tieu deng	<i>cratoxylum formosum var. Pruniflorum</i>	hypericaceae	4			4	8	13.21656	9.55414	15.92357	0.014287	0.05715	0.00000	0.00000	0.05715
Mai ka arm	<i>Crypteronia paniculata</i>	Crypteroniaceae			6	11	17	14.862	12.73885	15.92357	0.017516	0.00000	0.00000	0.10510	0.19268
Khom som	<i>Grewia paniculata</i>	Tiliaceae	1		1		2	16.2155	12.73885	22.29299	0.021597	0.02160	0.00000	0.02160	0.00000
Mai ka bok	<i>Irvingia malayana</i>	Irvingiaceae			1		1	16.56051	12.73885	20.38217	0.022675	0.00000	0.00000	0.02268	0.00000
Mai peuyay	<i>lagerstromia</i>	lythraceae	1			6	7	19.10828	19.10828	19.10828	0.028662	0.02866	0.00000	0.00000	0.17197
Mai khee mou	<i>Ormosia pinnata</i>	Leg./Papilionoideae		3	3		6	24.52229	24.52229	24.52229	0.047205	0.00000	0.14162	0.14162	0.00000
Mai saphang	<i>peltophorum dasyrrhachis</i>	leg / caesalp.	9	6		9	24	17.51592	16.87898	18.15287	0.024116	0.21705	0.14470	0.00000	0.21705
Mai sa mee	<i>Phoebe sp.</i>	Lauraceae			1		1	22.18684	16.56051	27.38854	0.040008	0.00000	0.00000	0.04001	0.00000
Mai mee	<i>Schima wallichii</i>	Theaceae			2		2	21.01911	11.78344	36.30573	0.041844	0.00000	0.00000	0.08369	0.00000
Mai sa khang	<i>Vitex tripinnata</i>	Verbenaceae			6		6	12.73885	12.73885	12.73885	0.012739	0.00000	0.07643	0.00000	0.00000
<b>TOTAL</b>			<b>15</b>	<b>15</b>	<b>15</b>	<b>39</b>	<b>84</b>	<b>16.52291</b>	<b>9.55414</b>	<b>36.30573</b>	<b>0.062239</b>	<b>0.32445</b>	<b>0.362747</b>	<b>0.43227</b>	<b>0.80787</b>
<b>Plot Average (20 x 35)</b>			<b>21</b>						<b>15.02123</b>	<b>20.56794</b>		<b>0.481835689</b>			
<b>Average per Hectare</b>			<b>300.0</b>									<b>6.9</b>			

Notes:

- Includes sample plots conducted during assessment of ROW between Dam site and Tower 54 and new alignment