APPENDIX B: Bat Study for the proposed Kipeto Transmission Line Project, Kenya

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2 Executive Summary

Bats have been shown in the past, to be affected by wind turbines and associated activities. More Recent studies in US and Europe have shown specific causes and effects involved. Less is known locally, hence this baseline study. As a result guidelines for protecting bats from wind power and transmission line projects have been developed. Finance lending agencies under World Bank Group, under International Finance Corporation (IFC) has policy and guidelines (Performance Standards) that compels members and stakeholders to uphold Environmental and Social Sustainability.

IFC performance standards 1 and 6, and National law; Environment Management and Coordination Act (EMCA) were used as policy and legal guidelines for study of bats in Kipeto-Isinya Power Transmission line. United Kingdom's and South African Guidelines for Bat study in Wind Power project have also been used to inform the bat survey.

Bats were studied using standard methods as detailed in the Kipeto Wind Farm ESIA Bat Study (Kurrent Technologies 2013). Mistnets were used to capture for inventory surveys. Automatic bat detectors including Anabat SD2 bat ultrasonic sound recorder was used to investigate diversity and monitor bat activities in selected static positions along proposed transmission line. Hand-held Bat box detector was used to monitor bat activities along selected habitats on the Transmission line. Reference specimen collections and bat call library at National Museums of Kenya were used to identify bats and construct inventory. 6-month bat study data at Kipeto Wind farm was also used in preparing this report.

Fifteen species of bats from 8 families were recorded in the general area of Kipeto between March and December 2012. This includes bats with low wing load and fly low below transmission cables, medium height fliers and high load, high and fast flying species that are vulnerable to cables.

Several processes and activities associated with establishing and operating Transmission line from Kipeto to Isinya, were identified to have potential risk to bats in that area. Habitat loss disturbance and alteration, during construction and maintenance of right of way were identified as potential threat to bats foraging, breeding and roosting habitats. Hazardous chemicals including spilled coolants, engine oil, herbicides for vegetation clearance wer also identified as potential environmental pollutants and source of poisons to species feeding and watering in the area.

Collision with overhead electric cables and electrocution by energized overhead cables were further noted as potential risks in the Operational Phase.

Risks of these processes were screened using Kurrent Technologies Risk Assessment Matrix. Consequently, mitigation measures on the impacts are recommended following IFC Performance standard 1 and 6, as guidelines.

Impact of habitat loss, alteration and disturbance could be ameliorated by maximizing use of existing roads and trucks for vehicles. Waste management plan is also recommended to proactively guide on-site and off-site waste disposal.

Since results show that resident bats have smaller wings span (<40cm), transmission over head cables should be 60cm or more apart to eliminate any chance of electrocuting bats.

Bats documented are not of critical conservation concern, nationally or regionally. Non is either IUCN listed as threatened or known to be endemic, hence the overall remark that Kipeto-Isinya area is a moderate bat conservation.

Due to paucity in our knowledge on how local bat species including suspected migratory ones, could be affected by wind turbines and power lines, a monitoring plan is strongly recommended during operations. The monitoring plan should be integrated within the construction and operational plans.

2.1 Introduction

Even though bats have been known since 1960s to be affected by wind turbines and associated structures, it is only recently when systematic studies mostly in US and Europe have begun to show specific causes and how the bats are affected (Hortker et al 2005). As a result guidelines for protecting bats from wind power and transmission line projects have the developed. The International Finance Corporation (IFC)Policy and Performance Standards articulates and compels members and stakeholders to uphold Environmental and Social Sustainability (IFC 2012). IFC's Performance Standard Six (Biodiversity Conservation and Sustainable Living Natural Resources) in particular covers safeguards for critical habitat and species in general terms and covers bats especially those listed in IUCN, CMS and national lists. Kenya is one of the few countries that do not have specific safeguards for bats with regards to power generation and transmission. However, the second schedule of Kenya law, Environment Management and Coordination Act (EMCA) compels certain projects to undergo environmental impact assessment, which includes bats among other environmental elements specified.

In fulfilling these policy and legal conditions of the law (EMCA) and IFC Performance Standard Guidelines 1 and 6, a specialized study of bats was conducted between Kipeto and Isinya town, Kajiado County in an area where an electric power transmission line is proposed. The study design took into account the narrow-linear site traversing different habitats that could qualify as critical habitats as defined in Performance Standards in IFC (2012). Identification of key ecological impact issues on bats were done while reflecting on those documented in International Finance Corporation Environmental Health and Safety Guidelines for Transmission line and Distribution (IFC2007). Physical inspection of the entire stretch of the proposed site of 17Km was done on foot to identify habitat types lying on the Right-of-Way of the proposed Transmission line. Representative of each habitat class identified was then studied for bats in detail.

Bats were studied using standard methods as detailed in the Kipeto Wind Farm ESIA Bat Study (Kurrent Technologies 2013). Mistnets were used to capture bats in habitats under detailed study. Anabat SD2 bat ultrasonic sound recorder was used to document bat diversity and monitor activities in static positions in selected bat habitats such as fly-ways. Bat box detector was used to record bats in walk transects within target habitats.

3 Results

3.1 Bat Diversity in the General Area of Kipeto and Isinya

Fifteen species of bats from 8 families were recorded in the general area of Kipeto between March and December 2012. Transmission line specific data was collected in March and May 2013. Desktop and reference collection and studies were also conducted to optimize data across seasons and area. This includes wind power generation project foot print and covers a quarter of the transmission area. The species recorded include Rusty Pipistrelle, *Pipistrellus rusticus*, Tiny Pipistrelle, *P. nanulus*, Schlieffen's Twilight bat, *Nycticienops cf. schlieffeni* and Yellow-bellied House bat, *Scotophillus dinganii* (Family: Vespertilionidae); Hildebrandt's Horseshore bat, *Rhinolophus hildebrandtii*, Ruppell's Horseshoe bat, *Rhinolophus fumigatus* (Family: Rhinolophidae); Heart-nosed bat *Cadioderma cor*, Yellow-winged bat, *Lavia frons* (Family: Megadermatidae),Greater Long-fingered bat, *Miniopterus inflatus* (Family: Miniopteridae); Sundevall's Leaf-nosed bat, *Hipposideros caffer* (Family: Hipposideridae), Little Free-tailed bat, *Chaerophon pumila*, Angolan Free-tailed bat, *Mops condylurus*, Giant/Guano Free tailed bat, *Tadarida cf ventralis* (Family: Molossidae); Egyptian Slit-faced bat, *Nycteris thebaica* (Family: Nycteridae); and Wahlberg's epauletted fruit bat, *Epomophorus wahlbergi* (Family: Pteropodidae).

3.2 Bat Diversity Recorded in Target Habitats along the Proposed Transmission line and Kipeto Area

The line passes through a gently sloping topography beginning from Kipeto highest 1952 meters above sea level at proposed substation, S 01^{o}42.635; E036^{o}41.645 and lowest at Isinya 1769 m a.s.l.

Whereas the vegetation remains generally the same, there are detailed differences marked by more open rocky fields in Kipeto to shrubby or woody country in Isinya. In between is mixed valleys rock cliffs and water points including springs.

Non-the-less the following are habitats that were given attention in baseline and monitoring March and May 2013to help gain more insight into potential risks and impacts on bats from proposed construction of electricity pylons

A. Point Bat_St2: S01^{o}42.822; E036^{o}41.645

- Characterized with large rocky cliff slopping eastward
- A patch of thick woodland dominated by *Euphobia* sp trees and *Ficus sp.*
- This habitat is unique island; forest like in the middle of open country
- The rocky cliffs are sites for bat roosting, while the fig trees are foraging site for both fruit and insect bats especially when the figs are on fruits.
- Wahlberg's Epauletted fruit bat (*Epomophorus wahlbergi*), *Neoromicia* sp., Slit-faced bat (*Nycteris hispida*), Horseshoe bat, (*Rhinophus fumigatus*) and False vanmpire (*Cardioderma cor*) were recorded in this habitat in a single night survey.

B. Point Bat_St3 S01^{o}43.027; E036^{o}43.072

- This is point is a confluence where 3 valleys meet and has series of small water spring.
- There is also human made water pond at this site
- Grass is short but green, apparently trimmed by frequent grazing animal
- The bats species recorded here include *Neoromicia sp*, and Little free-tailed bat (*Chaerophon pumila*) area could be frequented by other foraging bats in the general areas.

C. Point Bat_St4 S01^{o}43.303; E036^{o}43.142

- This is deep river valley

- It has series of seemingly permanent water bodies (pools) on rocky valley bottom mixed with soft ground where human has sunk ponds.
- There were tracks of zebra, Thomson gazelle watering here too.
- Enerau primary school and a church are situated near this point presumably because of this water.
- According to IFC performance standards guidance note 6, it is a potential critical habitat for biodiversity not just bats
- Baseline survey Slit-faced bat (Nycteris hispida), Little free-tailed bat (*Chaerophon pumila*), Wrickle lipped bat, (*Mops condylurus*) and unidentified Pipistrelle.

D. Point Bat_St5 Easting 0250362; Northing 9807719

- This is bush/woodland more high in height and dense than elsewhere westward
- The wood/bush is dominated by Whistling acacia, *Acacia drepanolobium.*
- It is also a habitat close to buildings near Isinya and could be a foraging where house roosting bats could be an issue.
- Survey of bats in this habitat was conducted near water pan measuring 30m by 20m and following species were registered: *Tadarida* sp, Little free-tailed bat (*Chaerophon pumila*), *Mops condylurus*, and Rusty pipistrell (*Pipistrellus rusticus*).

Species recorded in these habitants are same as those recorded during baseline survey and activity studies for Kipeto.

3.3 Identification of Vulnerable Species in Kipeto and Transmission line

Evolution has produced among bats, a diversity of flight strategies that suit different structures of environment and preferred food types. Bats with big (long and broad) wings tend to move slowly among branches of vegetation and pick their prey in the clutter. In contrast, bats with small (narrow short) wings can only manage to fly fast which is unattainable in the cluttered environment hence prefer open areas. Bats with intermediate wing-body adaptation often use semi open environmental set up, between (not within) bushes and along hedgerows.

Aligned to this morphology-habitat adaptation are flight height and echolocation signals. Bats with low wing loading and low aspect ratio tend to fly slowly and low near ground among clutter.

Conversely, bats that have high wing loading, high aspect ratio often move fast, preferring open space typical of above vegetation space, where there are less risks of crushing into an object. There are intermediate species too, having medium size aspect ratio and medium wing loading and thus adapted to semi open habitats.

The bats recorded in Kipeto fall in the 3 categories: Low feeders, intermediate, high and very high heights and on this basis are variably vulnerable to 50meter long rotating turbines blades mounted on 80meter high rotor hub.

3.3.1 IUCN Conservation status of bats recorded in Kipeto and along Transmission line

All the bat species recorded in the study are category Least concern of the IUCN Redlist of threatened species. The species are neither country endemics nor in country threatened species list. Details on each species are covered in the species account in the subsequent sections of the report.

3.3.2 Natural Vulnerability due to High Flight: High Flying Bats

High flying bats (above vegetation) typically tend to possess narrow and long wings coupled with high aspect ratio[1]. Details on species acoustic and morphological adaptations and flight patterns are summarized in Table 2. The high flying bats tend to prefer open spaces where they are able to cruise and catch their prey in-flight. Bats in this category are potentially at a higher risk of collisions with wind turbines than low and slow flying bats.

The Giant/Guano free tailed bat, *Tadarida ventralis*, is the only species in this category recorded in Kipeto. It prefers open country or low bushland where it feeds above vegetation (Tailor P et al., 2003). It is in the **Least Concern** category of IUCN Red List of Threatened Species. Whereas records at the National Museums shows it is widespread in Kenya especially in the semi-dry to dry counties, it was one of the least abundant in Kipeto according to the results of this study. *T. ventralis* roosts in houses, feeds on beetles in open spaces high in space. It is one of the least abundant bat in Kipeto, according to the records this study, making only 1/26 records at T42.

3.3.3 Natural Vulnerability due to Medium Height Flight: Flying Bats

These are bats that neither fly high over bushes and trees rather nor low near the ground among bushes and trees. They possess moderately long and broad wings. Several species recorded in this study fall in this category and include Little free-tailed bat, *Chaerophon pumilus*, Angolan free-tailed bat, *Mops condylurus*, Yellow winged bat, *Lavia frons*, Yellow bellied house bat, *Scotophillus dinganii*, and Hildebrandt's horse-shoe bat, *Rhinolophus hildebrandtii.*

The little free-tailed bat, *Chaerophon pumilus* roosts in houses, churches, schools and stores. Its FM coupled with tiny CF tail echolocation call is adapted for medium range echolocation (table 2 has details). The species is widespread in Kenya and Eastern Africa region[2]and is classified as **Least Concern** in the IUCN Red list.

Angolan free-tailed bat, *Mops condylurus*, though not as abundant as *C. pumila*, is also widespread in Kenya and E. Africa especially in semi-dry regions where it roosts in houses. It is also in the **Least Concern** category of the IUCN Red list.

Yellow winged bat, *Lavia frons* roosts on trees and feeds from a tree perch as opposed to flying around and catching its prey in the process. It is widespread in Savannah woodlands in Kenya but can be locally rare[3]. It is classified as **Least Concern** in the IUCN Red list.

[1] Altringham JD.1999. Bats: Biology and Behavior, Oxford University Press, London
[2] Thorn and Kerbis 2009. Keys to Ugandan bats, shrews and Tenerec-Golden moles
[3] Kingdon J 1997: Kingdon Guide to African Mammals

A typical example of low flying bats recorded in Kipeto area is the greater long-fingered bat, *Miniopterus inflatus*. Because this bat species is often confused with *M. schrebersii* which is speculated to be migratory (Simmons 2005), a sample caught in mist net at a valley near T26 was collected and compared with reference collection at NMK to confirm its identity. The species was registered around T26, T34 and T62. Its relative abundance compared to others was on average 17% at T26, 2% at T34 and 10.5% at T62 in November/ December combined data. This species is listed as **Least Concern** in IUCN Red list[4] , and not listed in any regional and national conservation lists. It has been recorded elsewhere in Kenya[5] in Chyulu, and some coastal Kenya caves.

Echolocation signals recorded on Anabat in Kipeto from this bat is low duty FM at around 48kHz and are fairly brief 2-4ms. The bat is known to have high wing loading (narrow long wings) and moderate aspect ratio (Monadjen *et al.*, 2010). These three traits: call duration, wing loading and aspect ratio, typifies edge feeders, between or along vegetation (Altringham, 2001) at intermediate height (2-10meters above ground).

Several other species recorded in Kipeto share similar traits with *M. inflatus*. They include the following

- Tiny Pipistrelle, *Piptrellus nanulus*, was relatively more abundant, 47% around T26. IUCN Red list category**: Least Concern**
- Rusty Pipistrelle, *Pipitrellus rusticus*, was least abundant at T42 and T64 but was the only bat around T13 over water pan. IUCN Red list category**: Least Concern**
- Schlieffen's Twilight bat, *Nycticeinops schlieffeni* but is less abundant, only recorded once around T62. IUCN Red list category: **Least Concern**

Overall, the bats in this category are vulnerable to colliding with turbines made of 50-meter long blades mounted on 80 meter long hub. However, most species in this category were registered in bushes and valleys away from actual turbine sites.

3.3.4 Vulnerability due to Low Height Flight: Low Flying Bats

Bats in this category possess broad big wings enabling them to fly slowly and even hover and have high frequency calls with broad band or several harmonics to help them 'scan the cluttered environment. This category comprise Slit-faced bat, *Nycteris thebaica* and to lesser extent *Rhinolophus fumigatus.*

Slit-faced bat is a clutter feeder enabled by having low loading, low aspect ratio coupled with variable steep, high pitched brief echolocation FM signals (113-70 kHz). It widely distributed in wooded parts of Kenya. It uses pit latrines, caves, aardvark holes as roosts. It classified as **Least Concern** in the IUCN Red list.

Ruppel's horseshoe bat is also a clutter feeder, flying low and slowly among vegetation. This behavior is supported by low wing loading, low aspect ratio and broad band CF echolocation signals. Records from NMK shows it occurs in Nairobi (c. 160 km north of Kipeto) among other areas in Kenya. It is in the **Least Concern** category of IUCN Red list. Refer to Table 2 for characteristics of low flying clutter feeding bats.

[4] Schlitter, D. 2008. Miniopterus inflatus. In: IUCN Red list of Threatened species. Version 2012.2www.iucnredlist.org downloaded on 02. Feb 2013
[5] Kuzmin I., et al., 2009. New Species of bat lyssavirus, Shimoni bat virus. Pubmed
Agwanda B. 2011. Bats of Fikirini cave, Shimoni. National Museums of Kenya, Nairobi

3.4 Potential Impacts on Bats Associated with the Development of the Power Transmission Line from Kipeto to Isinya and Mitigation Measures

Development of electricity transmission line to transmit electric energy from Kipeto Wind Farm (the point of generation) to the national grid substation in Isinya will involve two Phases: 1) constructing the infrastructure and 2) operating the transmission line. The construction phase will involve constructing concrete foundation and erecting metal towers or pylons before establishing overhead electric cables on the towers or pylon from Kipeto to Isinya. The operation phase will involve putting high voltage electric current through the cables, maintaining vegetation on the right-of-way, and using coolants in the transformers (presumably at the beginning and end of the transmission line).

The assessment of impacts to bats at construction and operational phases of Power transmission line between Kipeto and Isinya is done taking into consideration the following published authorities and sources of data and information:

- Performance Standard 6 of IFC Performance Standards Guidelines (IFC 2012) as guide to important environmental issues such as critical habitats of bats (e.g for breeding, roosting, foraging etc)
- Environmental Health and Safety Guidelines for Power Transmission lines(IFC 2007) as a guide to characterize mechanisms by which transmission power lines may impact on bats
- Diversity and activity data from bat studies on the proposed Right-of-Way in February 2013 and general Kipeto-Isinya project footprint area from March to December 2012. Secondary data sources from reference collection in National Museums of Kenya and reports were also used in the final analysis.
- Guidelines by International Commission on Non-Ionizing Radiotion Protection (ICNIRP) for limiting Exposure to time varying electric, magnetic and electromagnetic fields (ICNIRP 1998).
- Assessment tool to assist in arriving at levels of magnitude, extent, duration and probability of impacts using, a criteria by Kurrent Technologies Risk and Impact assessment Matrix criteria 2012 was used as an assessment tool (table 1).

Table 1: Kurrent Technology Ltd. Criteria Matrix for Impact assessment

EXTENT

Localized (At localized scale and a few hectares in extent)	**1**
Study area (The proposed site and its immediate environs)	**2**
Regional (County level)	**3**
National (Country)	**4**
International (Beyond Kenya)	**5**

MAGNITUDE

Small and will have no effect on the environment	**0**
Minor and will not result in an impact on the processes	**2**
Low and will cause a slight impact on the processes	**4**
Moderate and will result in process continuing but in a modified way	**6**
High (processes are altered to the extent that they temporarily cease)	**8**
Very high and results in complete destruction of patterns and permanent cessation of the processes	**10**

DURATION

Very short (0 – 1 Years)	**1**
Short (1 – 5 Years)	**2**
Medium term (5 – 15 years)	**3**
Long term (>15 years)	**4**
Permanent	**5**

PROBABILITY

Highly improbable (<20% chance of occurring)	**1**
Improbable (20 – 40% chance of occurring)	**2**
Probable (40% - 70% chance of occurring)	**3**
Highly probable (>70% - 90% chance of occurring)	**4**
Definite (>90% chance of occurring)	**5**

Risk = (Extent + Duration + Magnitude) x Probability

Measurement of the significance of risk

		CONSEQUENCE (Extent+Duration+Magnitude)																			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
PROBABILITY	**1**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
	5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

Low	<30	Where this impact would not have a direct influence on the decision to develop in the area
Medium	30-60	Where the impact could influence the decision to develop in the area unless it is effectively mitigated
High	>60	Where the impact must have an influence on the decision process to develop in the area

Confidence of assessment

The degree of confidence in predictions based on available information, Kurrent Technologies Ltd. judgment and/or specialist knowledge	Low
	Medium
	High

3.5 Potential Impacts on Bats

The following are mechanisms through which Transmission line between Kipeto and Isinya potentially may impact on bats during the construction and operational phases of the development.

- Habitat alteration and disturbance
- Construction site waste generation
- Fugitive dust and waste generated by heavy machines, trucks and vehicles
- Noise from heavy construction and transport machines and vehicles
- Potential oil spill and other hazardous materials

3.5.1 Habitat Alteration and Disturbance during the Construction Phase

During the construction of concrete foundations to hold the power pylons considerable use of machines, trucks and other vehicles is envisaged. This will result in the removal of surface vegetation, trampling, and even clearance culminating into the alteration of natural habitat presently used by bats as foraging and roosting, especially foliage roosting bats. Trees or shrubs used as roost by resident bats on the right-of-way may be removed to give way for pylon foundation. That could lead to the loss of roosting habitat for bats. The sheer presence of heavy construction machines and vehicles in habitats used by bats may also affect bats through visual and auditory scare in the area. In general terms individual bats presently using the proposed site for foraging, breeding or roosting will be impacted if construction proceeds by clearing vegetation at pylon sites, access tracks and involves noisy heavy engines. Magnitude, extent of impacts to bats associated with construction activities needs to be evaluated and if significant then appropriate mitigation measures should be considered. Mitigation measures may include keeping present vegetation in the right-of-way as long as it doesn’t reach the overhead cables. Construction activities should also be timed to avoid breeding seasons of resident bats.

Unmitigated Impact: Habitat alteration and disturbance during Construction Phase					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	4	4	3	Medium (-30)
Mitigation: Use of existing tracks and roads in the general as far as possible will help minimize construction of access roads to deliver materials. Clearance of plants (trees and shrubs especially) should be minimized unless necessary. This should be easy to observe as trees and shrubs in the area are already short below overhead cables. Pylons positions should be aligned to avoid water points identified in above section.					
Mitigated Impact: Habitat alteration and disturbance during Construction Phase					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	1	4	2	3	Low(-21)
Confidence of assessment: high					

3.5.2 Habitat Alteration and Disturbance during the Operation Phase

Habitat alteration and disturbance as an impact on bats may happen during construction phase as shown above. Bat habitats may also be altered (to the detriment of resident bats) when vegetation maintenance activities on the Transmission Right-of-way involves clearance of growing vegetation under the power lines. The size of trees, bushes cleared and frequency of clearance may determine ultimately magnitude of alteration and impact thereof[6].

Unmitigated Impact: Habitat alteration and disturbance during Operation of Transmission line					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	4	4	3	Medium (-30)
Mitigation: Frequent and regular maintenance of vegetation on the Right-of-Way may help resident bats get used to routine changes. The clearance (should not be total) and the activity should be done outside breeding season of most resident species					
Mitigated Impact: Habitat alteration and disturbance during Operation of Transmission line					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	2	2	5	2	Low(-18)
Confidence of assessment: high					

3.5.3 Construction Site Waste Generation during the Construction Phase

Construction activities that lead to the erection of power pylons, substations at either end involve moving soil and vegetation to and from the sites. For instance, is expected that soil and surface rocks will be removed to create concrete foundation for the pylons. How this top soil is disposed of may or not have impact on habitats of bats in and around the right-of-way. The top soils may affect bats by silting surface waters used by resident bats. Because of the small sizes of water points observed in the proposed right-of-way the soils generated may actually fill the water points. Oil spill from construction engines transformer coolants could also spread to surface waters used by foraging thereby poisoning bats. Assessment of the extent and magnitude of this potential impact on bats is necessary with requisite mitigation. A comprehensive waste management plan will be in place before onset of construction activities. Removal of wastes from project site should be done regularly to avoid accumulations.

Unmitigated Impact: Waste generated on site during Construction Phase					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	2	2	5	Medium(-30)
Mitigation: Comprehensive waste management should help in minimizing waste accumulation on site. Oil spill handling strategy especially mopping up oil immediately after spill, engine maintenance particularly oil change off site plan should help avoid pollution due to oils					
Mitigated Impact: Waste generated on site during Construction Phase					

[6] IFC., 2007. Environmental Health and Safety Guidelines

Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	2	2	1	2	Low(-10)
Confidence of assessment: high					

3.5.4 Operational Phase Hazardous Materials from Transformer Coolants and Vegetation Management Herbicides

The operation of Power transmission line involves use of coolants in the transformers and electric cables. It also involves maintaining the vegetation in Right-of-Way low and short below overhead electric cables. The latter may be done by hand-slashing manually or use of chemical herbicides. Chemicals used as coolants and herbicides may be environmental pollutants or hazardous to bats and other organisms. They may end up as spills or wastes in the bat habitats. Hazardous chemicals used in electricity sector include insulating oil and gases such as Polychlorinated Biphenyls (PCB) and Sulfur Hexafluoride (SF6). The latter is a greenhouse gas whose effect may span beyond project footprint and affect more species beyond bats. PCB is highly refined oil whose spill in the environment may find its way to surface waters, food resources (fruits, insects) for bats with detrimental health effects. Herbicides used in the Right-of-Way vegetation maintenance may also have health risks to resident bats. If this is the recommended means of maintaining vegetation then a clear plan of handling, storage and preventing spills should be developed and discussed with stakeholders before construction. Overall, comprehensive hazard chemical handling strategy is therefore emphasized throughout the stretch of the transmission line.

Unmitigated Impact: Hazardous wastes during Operation Phase of Transmission line					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	4	5	4	medium(-44)
Mitigation: SF6 use should be minimized and if used in high voltage circuitry such as >350Kv then equipment with low leakage rate (<99%)[7]. PCB use should be accompanied by comprehensive handling, response strategy in case of spill. Old transformers should be changed on time to minimize leakages. They should be stored in concrete floors and rooms with roofs to avoid precipitation					
Mitigated Impact: Hazardous wastes during Operation Phase of Transmission line					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	2	0	5	2	Low(-14)
Confidence of assessment: high					

3.5.5 Fugitive Dust and Waste Generated by Heavy Machines, Trucks and Vehicles

Dust generated during the construction of foundations and heavy vehicles movements on access tracks can also affect the foraging success of resident bats especially at night when they are active. There is therefore a need to assess the risk of resident bats starving due to dust-induced poor visibility of pray. Dust control measures are necessary during constructions to avoid accumulation of dust on fruits, vegetation used by bats as food, preys and roosting sites.

[7] IFC 2007. Environmental Health and Safety Guidelines

Unmitigated Impact: Fugitive dust generated by Construction vehicles and engines					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	2	1	3	Low(-15)
Mitigation: This impact is low but can be made less in magnitude and extent when dust mufflers are used and watering is done on the construction sites where dust more likely to be an issue. Construction can be timed when the ground is not too dry and dusty and bats are not desperate.					
Mitigated Impact: Fugitive dust generated by Construction vehicles and engines					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	1	2	1	3	Low(-12)
Confidence of assessment: high					

3.5.6 Noise from Heavy Construction and Transport Machines and Vehicles during the Construction Phase

Resident bats in the proposed transmission line live in natural habitats and perhaps village *manayattas* away from loud noise from heavy machines and vehicles. The use of these loud-noise producing vehicles in an otherwise quiet present both audible and visual scare which may affect foraging, mating and roosting habits of the resident bats. Noise mufflers on heavy commercial engines are recommended to reduce noise and minimizing idling engines.

Unmitigated Impact: Noise from construction engines during construction Phase					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	4	1	4	Low(-28)
Mitigation: Noise will depend on types and duration of use of heavy engines in the construction. Silencers fitted to the engines could significantly reduce impact of noise to bats. Switching off engines not in use can also reduce noise duration and intensity.					
Mitigated Impact: Noise from construction engines during construction Phase					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	1	2	1	4	Low(-16)
Confidence of assessment: high					

3.5.7 Bat Collisions with the Transmission Line

Overhead power transmission cables, towers at substations, distribution poles or pylons rise high enough in space to pose risks of collision of flying animals. There is therefore concern that cumulatively there could be risk of bats crushing into the pylons especially when they are erected in migratory paths, congregatory habitats such as roosts.[8]There could be positive impacts of towers acting as roosts to some bats. However, constructions of pylons should be aligned to habitats that are not critical to bats' breeding and mass migration.

Unmitigated Impact: Bat collision with transmission line, pylons and towers during Operation Phase

[8] IFC., 2007. Environmental Health and Safety Guidelines page 5.

Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	2	2	3	Low(-18)
Mitigation: Echolocating bats are less likely to fall victim of crushing into overhead cables. According to study results, Fruit bats which could be vulnerable are rare and often fly lower than proposed height(figure 2)					
Mitigated Impact: Bat collision with transmission line, pylons and towers during Operation Phase					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	1	2	2	3	Low(-15)
Confidence of assessment: high					

3.5.8 Bat Electrocution during the Operation Phase of the Transmission Line

Bats may be electrocuted by electric power lines when a part of their body, normally wing membranes simultaneously get in contact with energized wire and neutral, energized wire and earthed object or touching two energized wires same time. The probability of this happening is more likely when wires are close together, the size of wing span of a bat (10cm-60cm apart). Bats will not be electrocuted when they get in contact with a single wire, energized or otherwise. To minimize this risk on the transmission line, overhead power cables should be spaced sufficiently wide (>60cm) enough beyond the size of wingspan of the largest bat known or suspected to use the area. Where this is not possible to observe insulation may be considered.

Unmitigated Impact: Electrocution of bats by overhead electric cables					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	4	5	3	Medium(-33)
Mitigation: This risk is real and can be huge if the cables are close to each other. Many bat species recorded in this area include curious species capable of inspecting, and feeding close to cables and could be at risk when their wings touch two cables as explained above. Young bats may be more at risk as they often fly close to potential perches. Keeping cables far apart >60cm, will certainly minimize or eliminate this risk of electrocution along the lines. Where wide spacing of electric cables is not practical then insulation is recommended					
Mitigated Impact:					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	2	2	4	2	Low(-16)
Confidence of assessment: high					

3.5.9 Electric and Magnetic Fields: Coupling Effects during the Operation of Transmission Line

Electric and magnetic fields are invisible lines of force emitted by electric devices such as electric wires/cables[9]. They may affect the living body if exposed, by interfering with electric or magnetic conditions of cell, tissue or organ or system. There are three established basic coupling mechanisms[10] through which time-varying electric and magnetic fields interact directly with living matter:

a. Coupling to low-frequency electric fields (UNEP/WHO/IRPA 1993)

b. Couple to low-frequency magnetic fields (ICNIRP 1998 & UNEP/WHO/IRPA 1993)

c. Absorption of energy from electromagnetic fields (ICNIRP 1998)

There are also indirect ways by which electromagnetic energy may affect living organisms and this is detailed in ICNIRP (1998).

Importantly though, a lot of in vitro tests on short-term exposure to electromagnetic fields (ELF), especially cellular and tissues responses have been observed but with no clear exposure-response[11]. However caution is emphasized in the guidelines provided in ICNIRP, UNEP/WHO 1993) and limits of 100kHz for human exposure, leaving other living organisms to professional judgment. ICNIRP (19998) page2 6-8 and UNEP/WHO/IRPA 1993 pages 4-6 provides some lines of epidemiological and cancer evidence of health effect of ELP on living organism. Other evidence on ELP effects is functional changes in muscle and nervous system in living tissues when electric current density reaches over $10mA/m^2$. Since ICNIRP suggests that effects is inversely proportional to body size and age[12],(table 2 on page 11), smaller animals such as bats could be more at risk if they have prolonged exposure to time varying low-frequency ELPs. The limit is set to 100kHz-30oGHz for human.

Unmitigated Impact: Electric and magnetic fields (Coupling effects) during Operation Phase					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	1	2	4	2	Low(-14)
Mitigation: Bat studies show low densities even at the watering points. Only few individuals are therefore exposed and could at risk. Re-aligning the transmission off the watering points will certainly reduce this risk further. It is hard to eliminate this risk as bats will still wonder near the electric cables.					
Mitigated Impact: Electric and magnetic fields (Coupling effects) during Operation Phase					
Criteria	Extent	Magnitude	Duration	Probability	Risk
Value	1	0	5	2	Low(-12)
Confidence of assessment: high					

[9] IFC., 2007. Environmental Health and Safety Guidelines page 5.

[10] ICNIRP 1998.ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic Fields. Health Physics 74(4): 494-522

[11] Same as above(ICNIRP, 1998)

[12] [12] ICNIRP 1998.ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic Fields. Health Physics 74(4): 494-522

3.6 General Recommended Mitigation Measures

The extent and, magnitude of impacts on bats due to the development of the transmission line depends on the proximity of high bat concentrations to the Right-of-Way. Studies of bats in the proposed site indicate no high concentrations of bat roosts and feeding sites except for the Bat_St1 and watering points along the proposed transmission line. Whereas the watering point (a man-made water point at Bat_St5) can be relocated and the current one sealed off, the permanent springs in the valley (Bat_St3) should be left undisturbed due to its importance to bats and other wildlife species.

Vegetation types in the area proposed for this development naturally grow short (<10meters high) while the overhead cables will be (minimum) 19.6m high. There will be less need (if any) to clear vegetation on the Right-of-Way of the transmission line.

A general inspection of vegetation in the Right-of-Way is however recommended to clear accumulated neuromas fuel which may result into spontaneous eruption of fire. Control of necrosis is expected to happen naturally as terrestrial herbivores will naturally graze vegetation down.

Invasive species may also creep into the Right of Way either through accidental introduction or ignorance by human. This must be monitored and managed early to avoid impacta and complications of containing it within project foot print.

Specific plans for use, handling, storage and rapid response in case of accidental spill of hazardous chemicals need to be considered beforehand. This includes, greenhouse SF6 used for insulation of high voltage and highly purified oil and fuels used in the transformers[13].

3.7 Movement patterns: Dispersals and migration

There is a fairly large number of scientific studies that have shown that the majority of bats negatively affected by wind energy especially killed on the turbines, are migrant species (Cameron & Associates 2010, Kunz et al 2007, Brickmann 2007, Annet 2005, Johnson 2005, UNEP/Eurobat 2005). It is in view this scientific fact that more attention has been given to bats in wind energy development with closer focus on migrant ones (Kunz et al 2007). Similarly, IFC (2012) in paragraph 16 of Performance Standard 6 specifies migratory/congregatory species as a criterion for deciding critical habitats to be accorded close attention in the impact assessment process.

Results from bat study in Kipeto project area (wind farm) and Transmission line area shows only one possible migrant species, Long-fingered bat. However, from literature desktop studies (reference collections at NMK), additional local migrant species, Giant mastiff bat (*Otomops martiensseni*) could be another species to be considered.

[13] IFC 2007. Environmental Health and Safety Guidelines

Long fingered bat, *Miniopterus inflatus*, is not known to be a migrant, though its relative, M. schrebersi (Simmons 2005) is suspected to migrate between Arabia and Africa. There is therefore no scientific basis to regard *M. inflatus* as migrant, though no study has tested this theory. Large colonies of this species have been recorded in Chyulu (SE of Kipeto), Suswa, (NW of Kipeto). Agwanda and Webala (in unpublished Museum records) documented breeding colony in Chyulu caves in December 2012(unpublished Museum records). In the absence of data to suggest the species migratory and in view of baseline study results of recording the species in Kipeto, it is logical to speculate dispersal movements between and among these main colonies in Chyulu. There is no substantial scientific ground however to speculate migration.

In view of the data records during baseline survey, *M. inflatus* has been recorded at point T26 and near T34 and theoretically if in dispersal process would potentially move SW or NW of point of record in Kipeto and Transmission line (fig 1 below). The potentially negative impact during the movement would be wind turbine during flight along habitual flights routes if any. However, the risk of collision with turbine blades is ameliorated by the fact that this bat is alow height flier with low aspect ratio (Monadjen et al 2010), while the turbines are 30m off-ground high. As recommended above, a monitoring program is necessary to detect mortality or use of this bat in the project foot print area.

Form desktop studies, Giant Mastiff bat(*Otomops martiesseni*) colonies known today in Kenya are confined to Chyulu (breeding colony in December) and Suswa (Agwanda: unpublished data). Study by Mutere(1975) suggested that interchange of roosts between these colonies, hence could be migratory. In the context of this study and assessment, Kipeto project foot print is a highly probable dispersal route between these colonies (Chyulu caves in SE and Suswa caves in NW of Kipeto). This proposition is made more probable by recent observations on fluctuations and breeding of the colonies in Suswa and Chyulu respectively. This species however was neither detected nor captured during the baseline surveys and monitoring studies in Kipeto between March and December 2012 and Transmission line in March and May 2013.

Theoretically, this species could be affected by the wind power development in Kipeto and Power Transmission Line, if it uses the Kipeto area as dispersal route as suggested by Mutere in 1975 and anecdotal observations on the colonies by Agwanda and Webala(unpublished Museum data). To that extent, the movement pattern is likely to be to be SE-NW in October/December (see directions in fig 1).

Notably, this molossid bat is high height flier, armed with high wing aspect ratio, adapted to fast speed and long distant flights. This flight habits suggest a potential risk to collision to wind turbines. Its echolocation strategy (range detection) is human audible low duty, long duration chips at 10kHz. To what extent this echolocation strategy can help the bat avoid colliding with wind turbines on turbine, can only speculated. It certain however that it helps in avoiding colliding with overhead electricity cables, as colonies in Durban successfully roost in town building with many overhead cables (Fenton et al., 2002, Tailor 1999). There is a need to establish a monitoring plan that will include detecting this bat in the project area.

3.8 Impact of Multiple Transmission line on bats in Isinya

The transmission lines under consideration here are shown in figure 4 below and include

1. Kipeto-Isinya 220kV Transmission line
2. Suswa-Isinya 220kV Transmission line
3. Rabai-Isinya 400kV Transmission Line
4. Isinya-Embakasi Transmission line

Clearly, the sheer convergence of these transmission lines in one site at Isinya, with attending activities during installation and operation phases is bound to change physical structure of environmental and associated ecological configurations. It is this change that may pose some levels of risks to bats ecology and hazard to individual bats.

Constructions activities during installations envisaged to affect the physical and subsequently impact on bats ecology have been mentioned above but summarized below to include, inter alia:

- constructing concrete foundations to hold steel lattice towers (GIBB International 2012), clearance of tall vegetation on right of way,
- accumulation of soil plant, and other wastes around Isinya,
- trampling (by man and machine)on vegetation during construction in one general area,
- access tracks/roads along the lines

In view of the above activities, the most conspicuous risk in the installation phase is bat habitat loss or alteration. This has been addresses above for only Kipeto Transmission line. The extent and magnitude of impact of these multiple lines at Isinya is however greater (X4), than in the single Transmission line, and may last longer (5-15 years) before bat community in the area adjust.

3.8.1 Impact of multiple lines and Mitigation

Assessment of bat habitat loss, alteration and disturbance ion of construction of multiple transmission lines at Isinya sub-station

Unmitigated Impact: Habitat loss, alteration and disturbance during Construction Phase					
Criteria	Geographic Extent	Magnitude of Impact	Duration of Impact	Probability	Risk
Value	2	6	4	3	Medium (-36)
Mitigation: Use of existing tracks and roads in the general as far as possible will help minimize construction of access roads and damage to vegetation that bats use for food and roost. Clearance of plants (trees and shrubs especially) should be minimized unless necessary. This should be easy to observe as trees and shrubs in the area are already short below overhead cables. Lattice towers positions should be aligned to avoid the many water points identified around proposed Isinya substation. No need to relocate water pans in the area as long as overhead cables are far apart. Astute Waste management is critical, preferably off-site disposal					
Mitigated Impact: Habitat loss, alteration and disturbance during Construction Phase					
Criteria	Extent	Magnitude	Duration	Probability	Risk

Value	1	4	2	3	Low(-21)
Confidence of assessment: high					

3.9 Observations and Recommendations

- The area considered in this section (multiple lines) is 10km sq. around Isinya sub-station, hence do not include other areas affected by individual lines from respective substations (Rabai, Embakasi, Suswa). There is no known bat conservation area, critical habitat as defined by IFC (2012), that requires special assessment attention in this general area.
- Based on baseline study results of Kipeto, Transmission line area, species data of the general area from NMK database, no bat species is of critical conservation concern (endangered, critically endangered or habitat restricted) that would require special assessment.
- Suswa transmission line, in its course from Suswa should be assessed for its potential impact on Giant Masstif bat, *Otomops martiesseni*, not recorded in this study, but noted in other studies as possibly migrating between Suswa to Chyulu(through unknown route). Mt. Suswa has extensive larva tunnels which the biggest colony of this species use as roost.
- The potential impact on bats in Isinya area can be mitigated comprehensively by proper planning on careful construction of lattice towers, access roads and avoidance of clearance of vegetation.
- As indicated above, risks of collision, electrocution and electromagnetic are very minimal once the overhead cables are spaced appropriately far apart(>60cm).
- Potential impacts associated with operational phase activities such as clearance of vegetation on right-of –way should be done be done manually (not by use of herbicides that may affect non-target herbs or fauna). Only tree species with potential to grow high to the height of the overhead cables should be targeted.

Figure 1: Kipeto-Isinya, Rabai-Isinya and Suswa-Isinya Transmission Lines

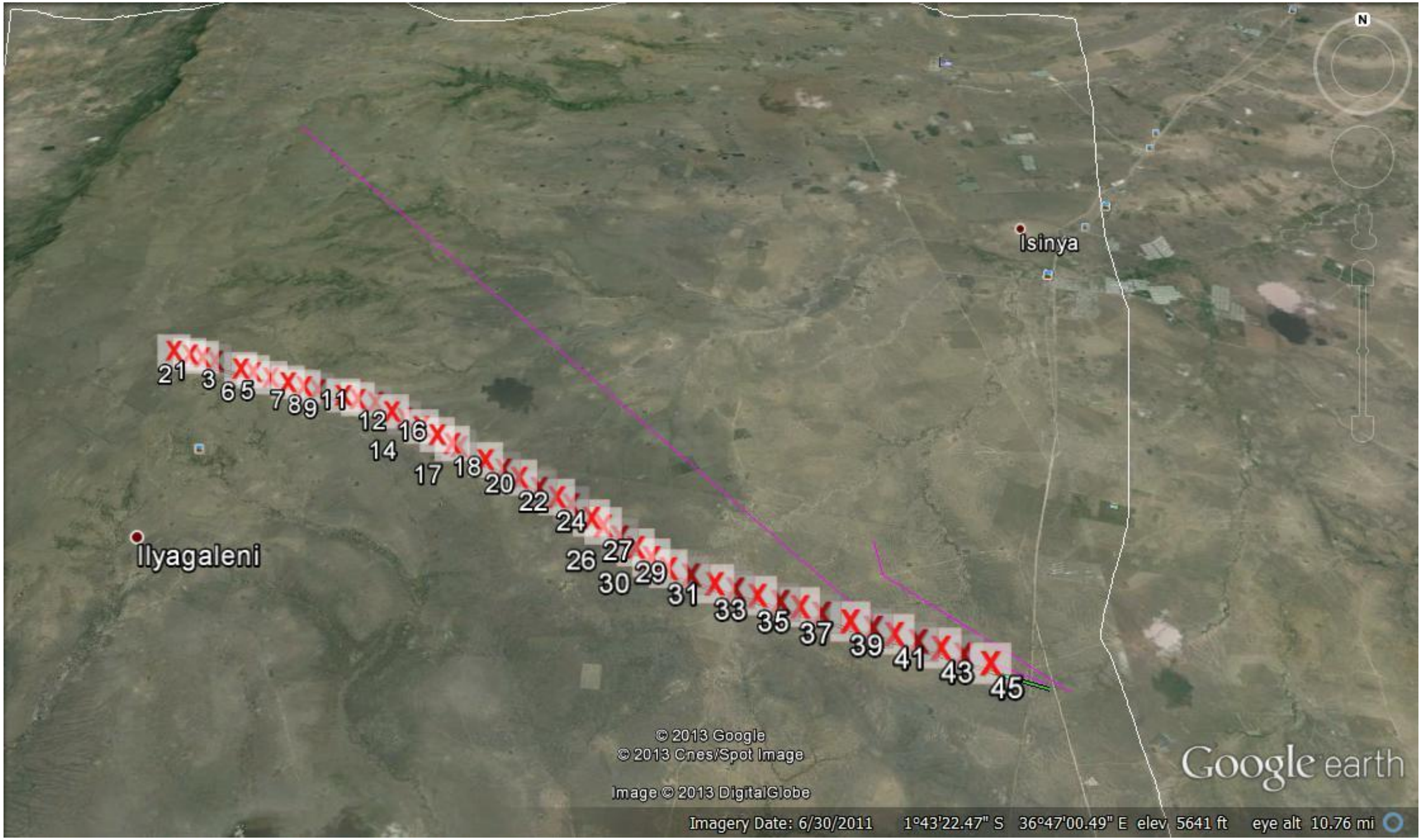


Figure 2:Map of Republic of Kenya: showing possible movement directions (red arrow) of Otomopps martiensseni and Miniopterus inflatus across Kipeto (green star) to and from Chyulu and Suswa

Figure 3: Kipeto bat study sites (yellow pegs), Transmission line (Blue line) and possible movement directions of Miniopterus inflatus and Otomops martiesseni through Kipeto to and from Chyulu to Suswa

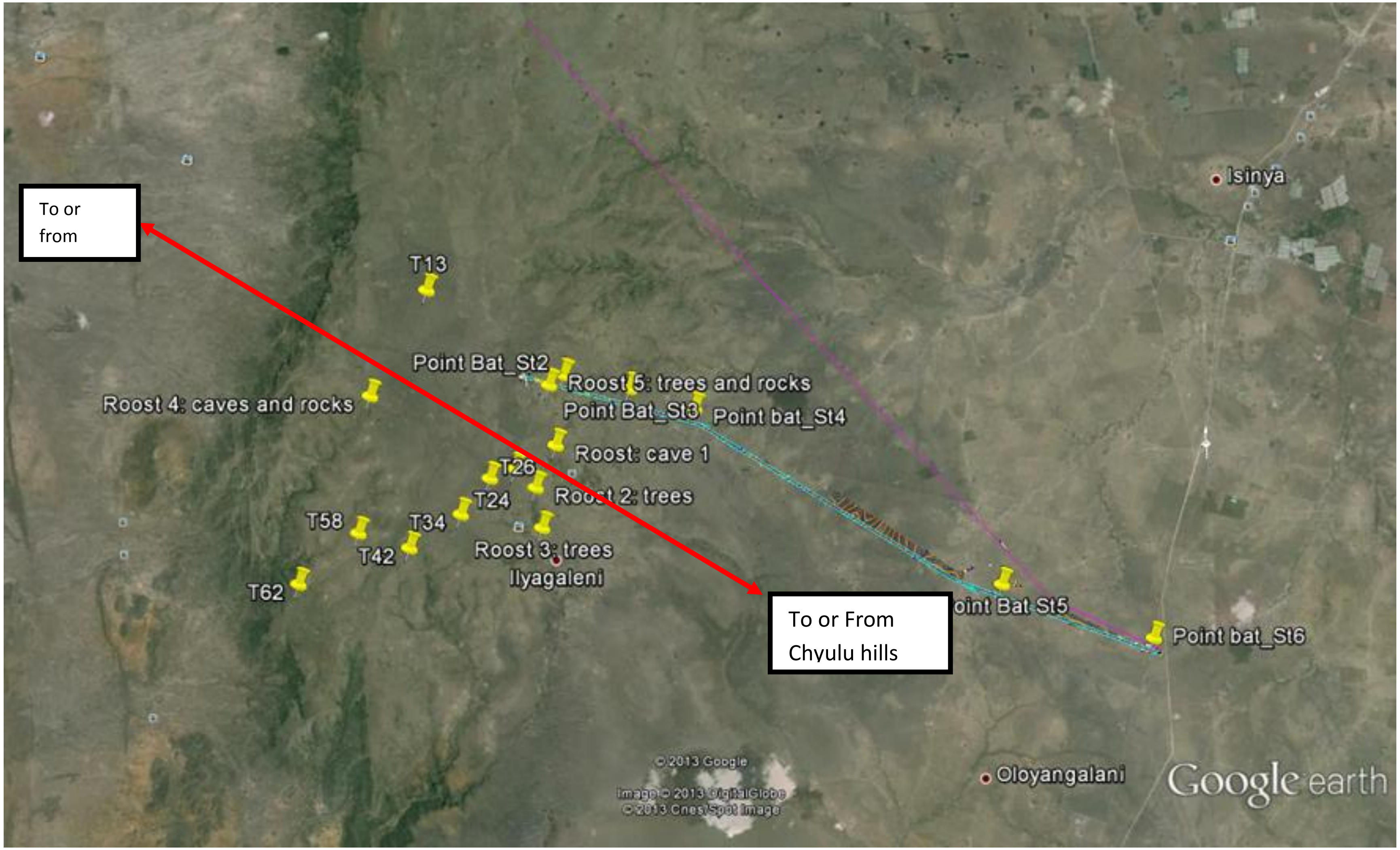
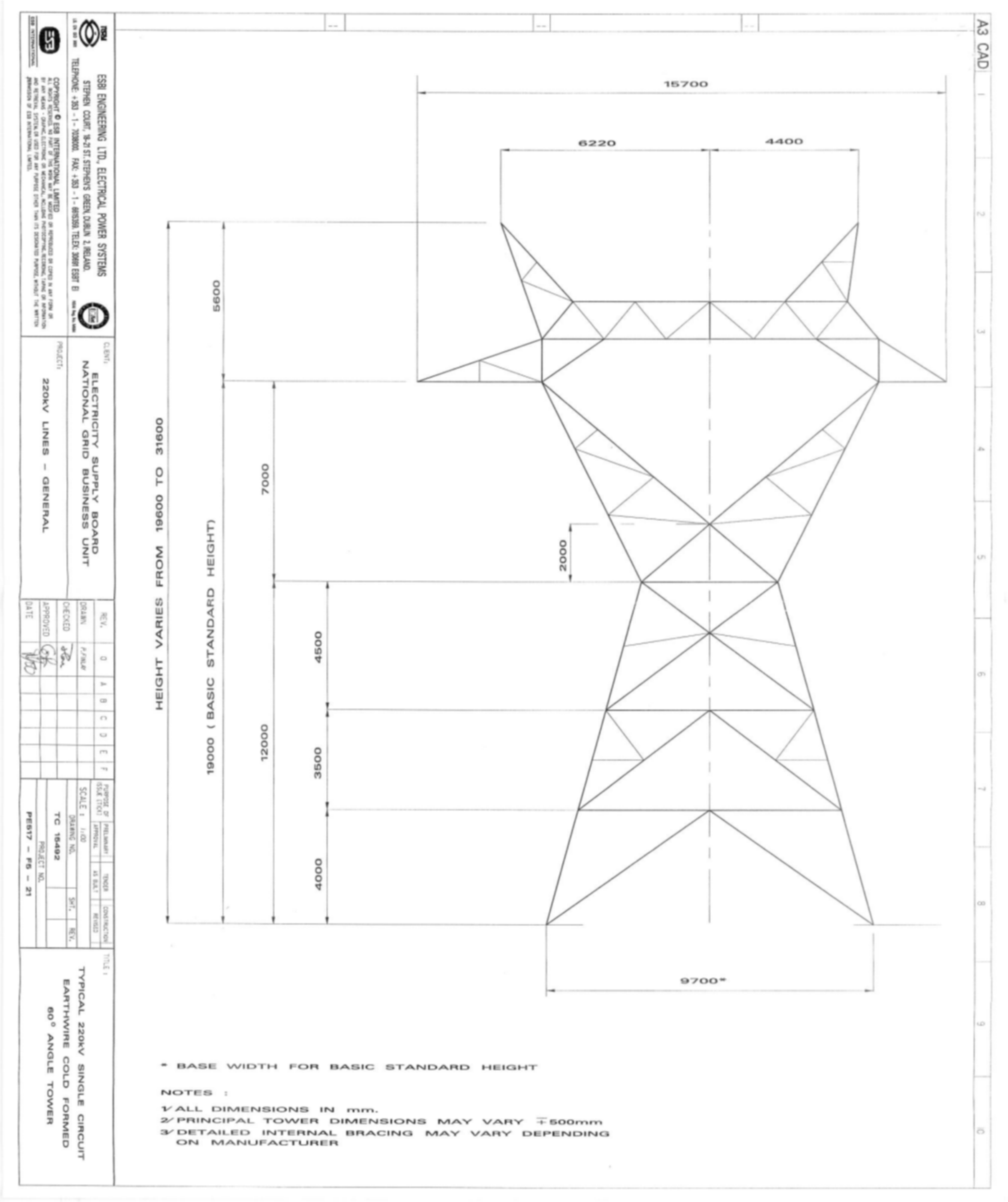


Figure 4: Transmission Tower, size and height; possible sample to be used in the Transmission line



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