Chapter 9 Possible Application of New Technologies

9.1 Application of the High Temperature Low Sag (HTLS) Conductor

According to the results of the system analysis, the Study team found that one sound circuit will be overloaded when a single circuit fault of this transmission line occurs after commencement of this Project's operations due to the small transmission capacity of the existing transmission line between Mandirancan SS and Ujung Berung SS (60 km). As a countermeasure to avoid this problem, the Study team suggests stopping the remaining sound circuit when one circuit failure occurs.
However, the system corresponding to this countermeasure has not been established in the present system operation of PLN, a new system needs to be developed.

On the other hand, increasing the transmission capacity of the relevant section should be considered as an alternate countermeasure. However, a lot of capital will be needed to increase transmission capacity if it is increased via the simple rebuilding of the transmission line towers. Therefore, the Study team will consider an alternative measure to increase the transmission capacity utilizing the existing transmission line towers. Specifically, the Study team considered having the conductors replaced by the recently developed conductors that can achieve a smaller sag than the conventional conductors with the same tension as before and their applicability to the relevant section.

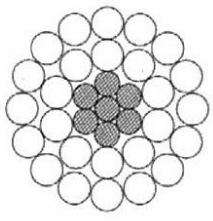
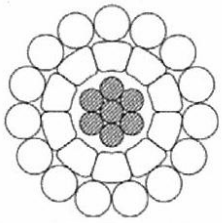
With the conductors' replacement, the replacement of the substation facilities is not required.

9.1.1 Applicable Conductors (for reference)

The applicable conductors for the aforementioned replacement between Mandirancan S/S and Ujung Berung S/S would be the conductor described below that has less or equal weight and more than 1.2 times the capacity compared to the "Dove" used for the existing transmission lines.
Equipment replacement at Mandirancan SS and Ujung Berung S/S will not be necessary, because the increase of the transmission capacity is only 1.2 times at one circuit accident and the equipment satisfies their performance.

- GTACSR 300mm^2

Table 9. 1 Comparison with ACSR and GTACSR

Description		Unit	ACSR "Dove"	GTACSR 300mm^2
Type		-	Existing	Gap type
Construction		Nos/mm	26/3.716-HAL 7/2.891-St	15/3.95- TAL*1 10/TW*2 (3.89) –TAL*1 7/2.55-Est*3
Nominal Diameter		mm	23.53	23.53
Min. breaking load		kN	101.0	101.1
Cross sectional area	AL	mm^2	282.0	302.4
	Core(St or AS)		46.1	35.75
	Total		328.1	338.2
Nominal weight		Kg/km	1140	1136
DC Resistance at 20 deg. C		Ohm/km	0.1024	0.0973
Modulus of electricity	Conductor	GPa	82.0	77.0
	Core		-	205.9
Co-efficient of linear expansion	Conductor	/deg. C	19.0 x 10^{-6}	19.8 x 10^{-6}
	Core		-	23.0 x 10^{-6}
Allowable continuous operation Temp.		Deg. C	80	150
Current capacity (AC resistance)	at 570A (100%)	A (Ω/km)	570A at 80℃ (0.1273)	570A at 79℃ (0.1207)
	at 684A (120%)		-	684A at 91℃ (0.1253)
	at 855A (150%)		-	855A at 112℃ (0.1335)
	at 150℃		-	1086A at 150℃ (0.1483)
Sag at 450m	at 570A (100%)	m	13.78m at 80℃	12.54m at 79℃
	at 684A (120%)		-	12.78m at 91℃
	at 855A (150%)		-	13.20m at 112℃
	at 150℃		-	13.98m at 150℃
Cross sectional view		-		

Notes:
*1: TAL: Thermal resistant aluminum alloy
*2: TW: Trapezoid wire
*3: Est: Extra high strength galvanized steel

9.1.2 Advantages and Disadvantages of Conductor Replacement

The advantages and disadvantages of the conductor replacement compared to the new construction of the planned transmission line are shown below.

(1) Advantages

- Total construction cost will be 43% of the new construction of the planned transmission line.
- Land acquisition and EIA are not necessary due to the application of existing towers.
- Construction period can be only 6 months, if the work starts after operation of the main Project in 2016.

(2) Disadvantages

- Consultations for the transmission line outage with PLN will be consistently needed and proper safety measures and the securing of a construction period are necessary.
- Securing proper safety measures will be necessary for the conductor replacement over residential areas.

9.2 Application of a Four-Circuit Transmission Line Tower

The location of the currently-planned Pemalang SS is just on the north side of the national road between Jakarta and Surabaya as shown in Figure 9. 1. If the two circuits of the incoming and outgoing paths of the existing 500 kV transmission lines as well as the new 500 kV transmission lines are installed at this substation, eight circuits of the transmission line consisting of four routes will be needed to cross over the national road even though all the transmission lines are constructed with double-circuit towers. As shown in Figure 9. 1, both sides of the national road passing through the south side of the planned substation site are used as farm land. Therefore, it seems that the construction of the double-circuit transmission lines of the four routes without resettlement would be possible. However, this land has a borderline width for the construction of 500kV transmission lines comprised of four routes, and four towers as much as 80 meters high will be constructed at quite short clearances. Therefore the Study team considered the application of four-circuit transmission line towers to decrease the number of towers. Furthermore, regarding the transmission line route that reaches Pemalang SS, the transmission lines of the double-circuit towers run side by side for approx. 7 km (Figure 9. 2). Applying the four-circuit tower to the relevant section will be able to reduce the acquisition area for the tower sites as well as the compensation range for ROW and it is also an advantage for land negotiations, therefore the Study team has considered the possibility of a four-circuit tower application.

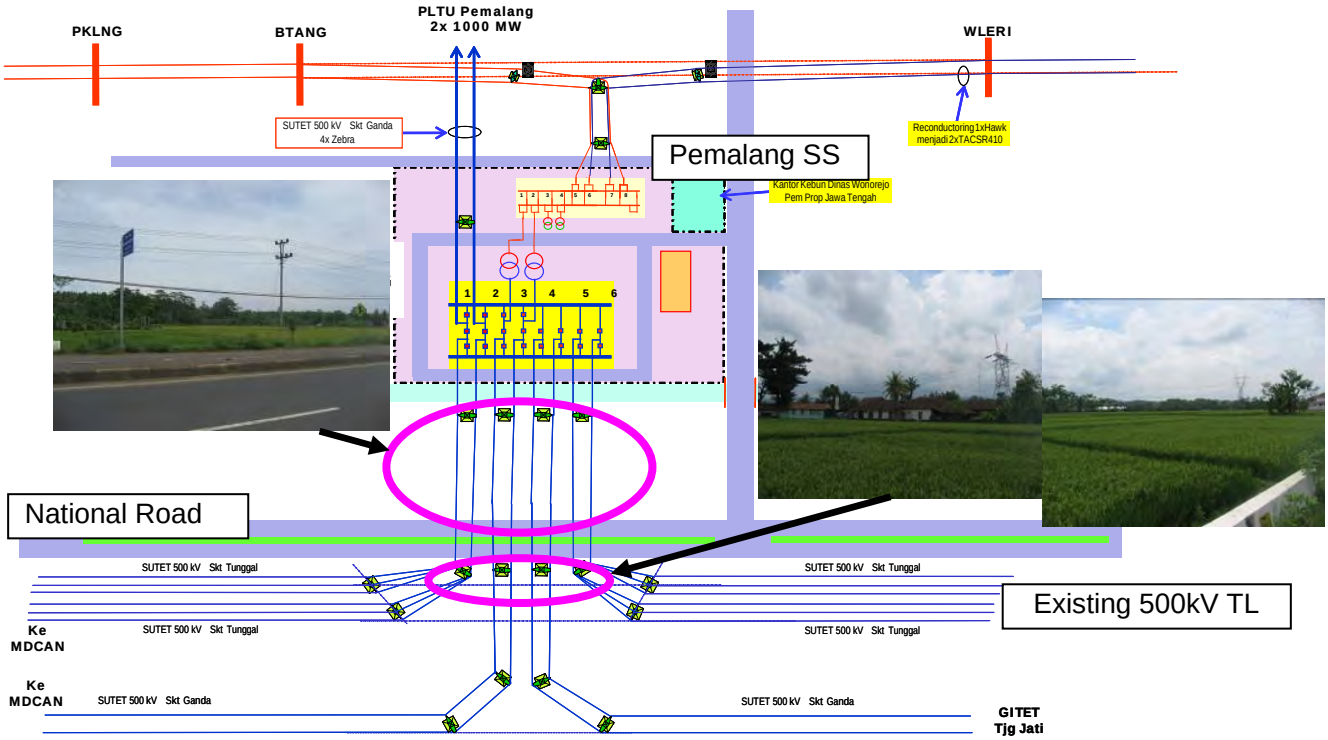


Figure 9. 1 Original Plan to pull into Pemalang S/S by Double-Circuit Towers

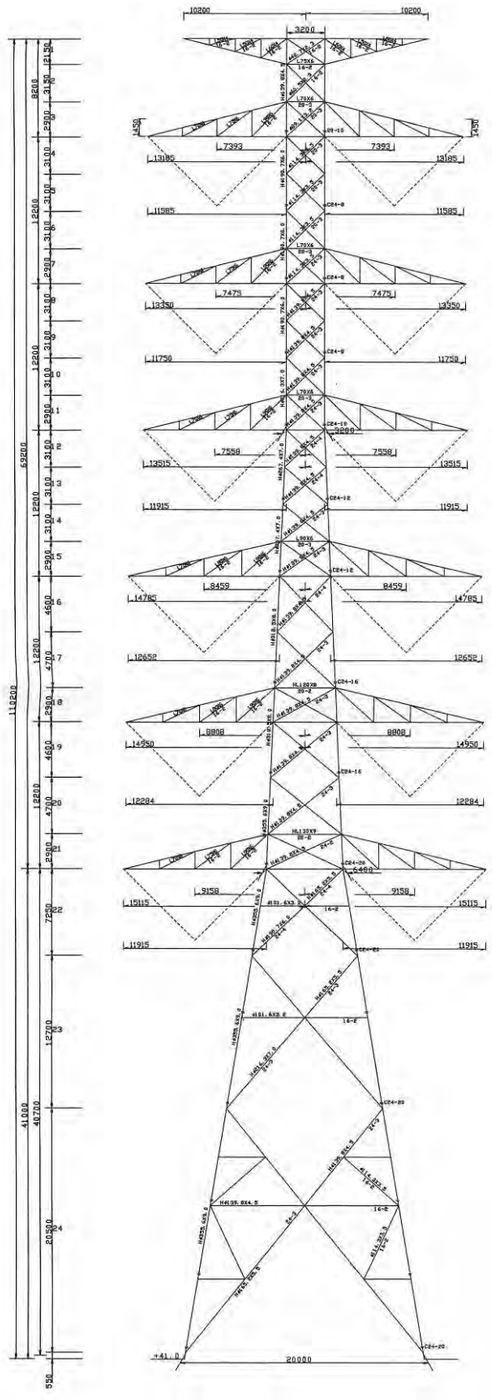
Figure 9. 2 Parallel Route of Double Circuit Towers to Pemalang S/S

(1) Advantages and Disadvantages of the Application for the 500kV Four-circuit Tower

The tower configurations of the original 500kV double-circuit tower and the 500kV four-circuit tower are shown in Figure 9. 3.

Four Circuits 500 kV Tower

4AA



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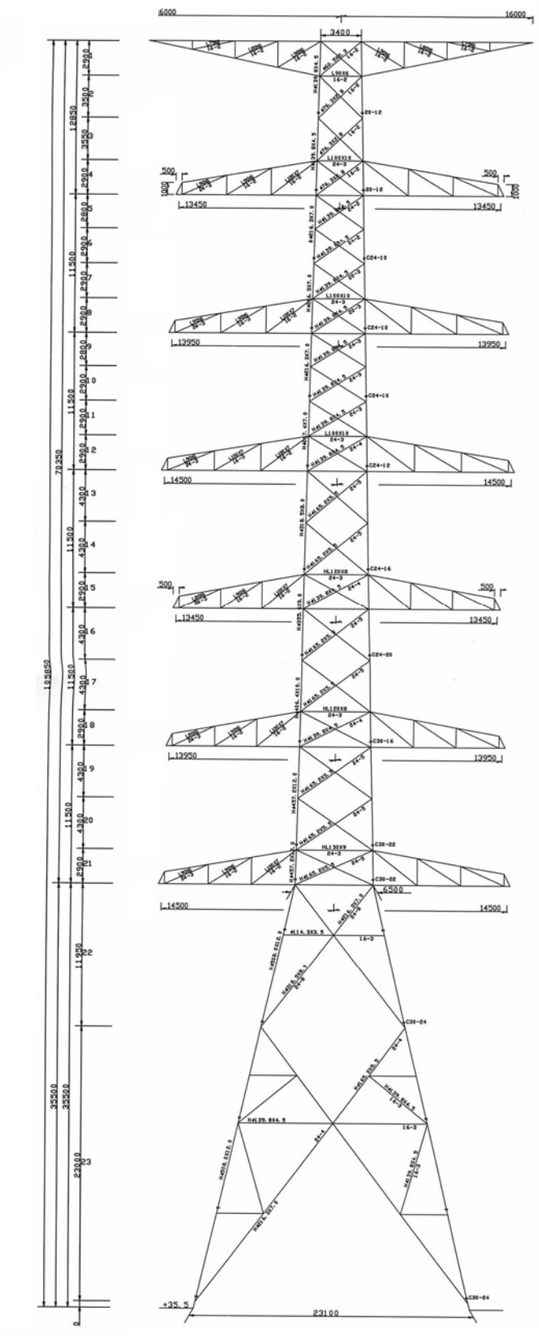
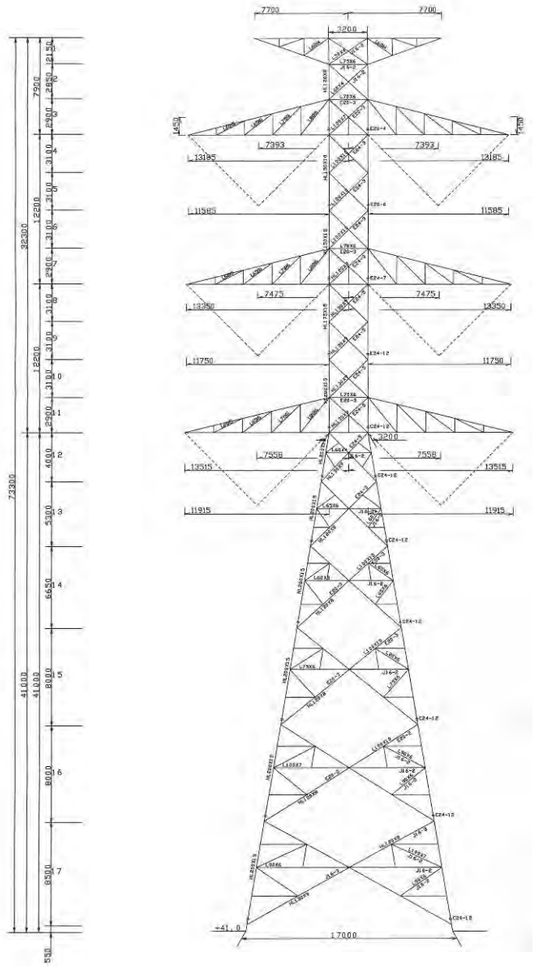


Double Circuits 500 kV Tower

AA



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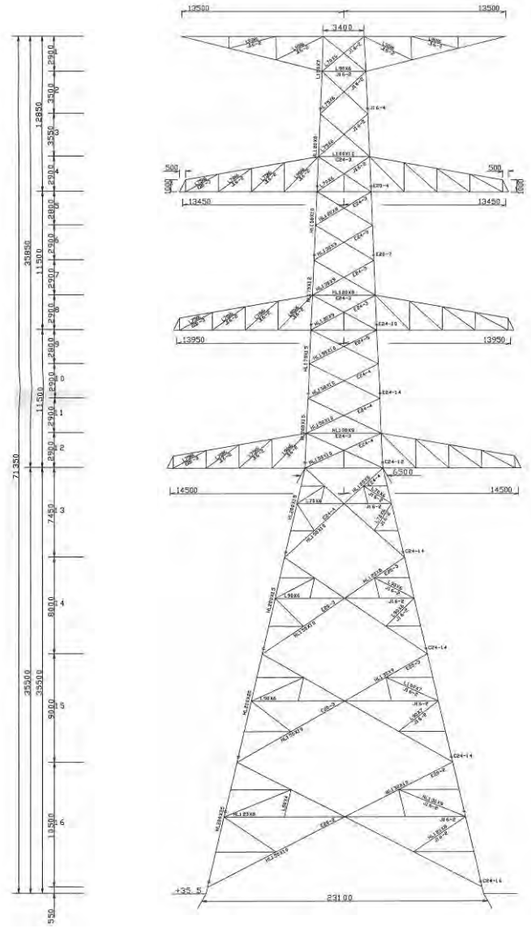


Figure 9. 3 Tower Configurations of 500 kV Double-Circuit Tower and 500 kV Four-Circuit Tower

The study team compared both towers from the perspectives of electrical/structural performances, land negotiations, construction costs etc.
As for the results, the tower height and weight increase 1.5 times and 1.2 times respectively, however ROW decreases by half.
The total construction costs will be almost doubled due to the use of tubular steel pipes for tower members and obtaining a larger size of the foundations.
There is not so much of a difference in the probability of accidents occurring due to lightning strikes (shielding faults, reverse flashover) to the towers in total.

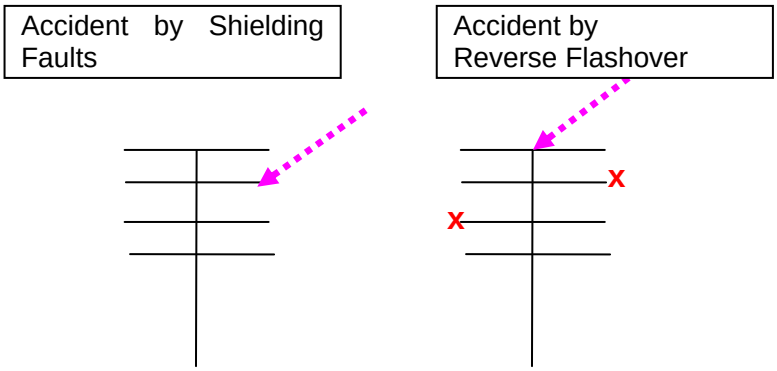


Figure 9. 4 Accidents due to the Lightning Strikes

The maximum electric field intensity at 1 meter above the ground of the four-circuit towers that has a phase arrangement described below will be equivalent to the double-circuit towers.

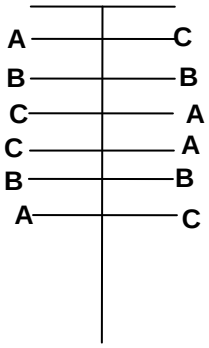


Figure 9. 5 Phase Arrangement of the Four-Circuit Towers

There is a concern about the internal corrosion of the steel pipe due to the application of the tubular steel pipes to the four-circuit towers, however the relevant area is 10 km away from the sea and there is no problem based on experiences in Japan.

Therefore, although the total construction costs of the four-circuits tower increases, our evaluations show that the other performances and parameters between these towers are almost equal.

Table 9. 2 Comparison between Double-Circuit Tower and Four-Circuit Tower

	500 kV 2cct TL * 2 Routes	500 kV 4cct TL * 1 Routes	Note
Height	73m (1.0)	110 m (1.5)	Suspention Tower
Weight	38 ton:× 2 units=76 ton (1.0)	88 ton (1.2)	Suspention Tower
Right of Way	34 m×2 routes = 68 m (1.0)	34 m (0.5)	
Construction Cost (Reference)	1.0	Around 2.0 times	Refer to Table 6.30
Lighting Accident (Reference)	0.3919 times/100km・year (1.0)	0.2826 times/100km・year (0.7)	Suspention Tower
Electric Field Strength at Ground	1.4 kV/m (1.0)	1.8 kV/m (1.3)	Suspention Tower
Corrosion of tower members	None (L angle members)	None (Tube Pipe members)	

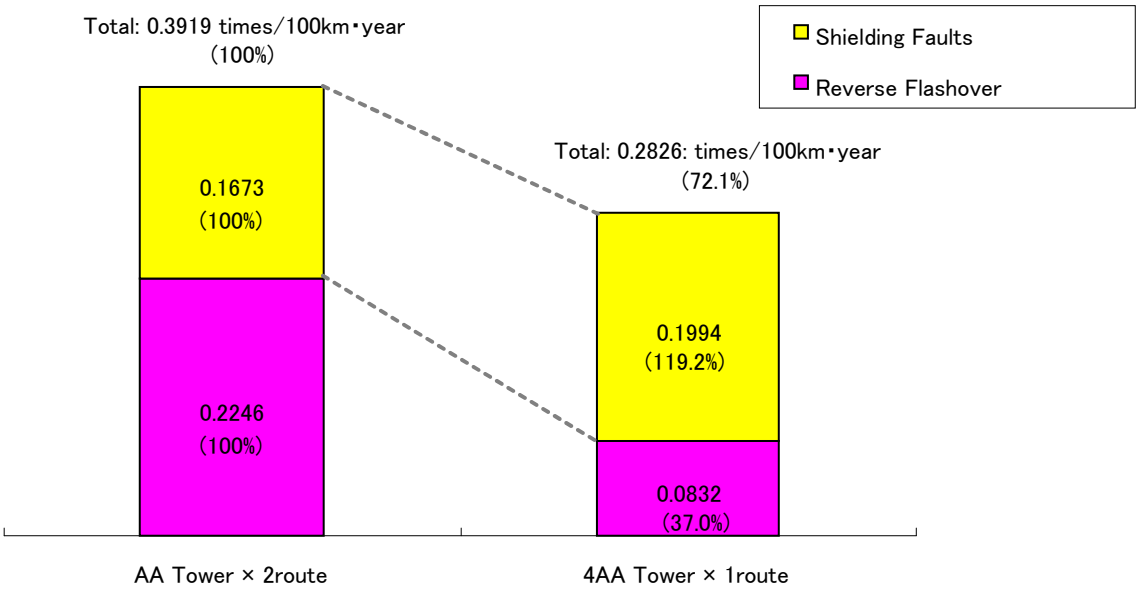


Figure 9. 6 Times of Lightning Accident (Simulation by TEPCO's Prediction Program)

(2) Possibility for application of four-circuit tower to around Pemalang substation

Since it has the advantage of reducing the social impacts at the crossing point of the national road, the study team recommends that PLN applies the four-circuit towers at around Pemalang SS as shown in Figure 9. 7.

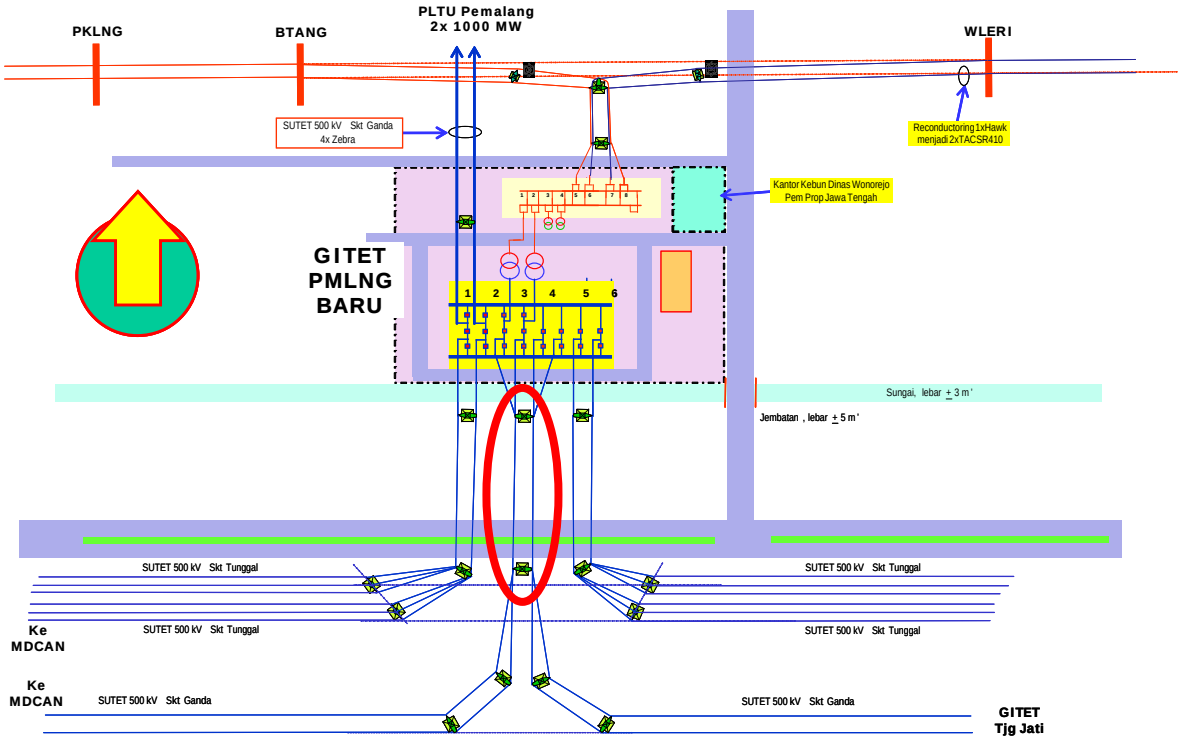
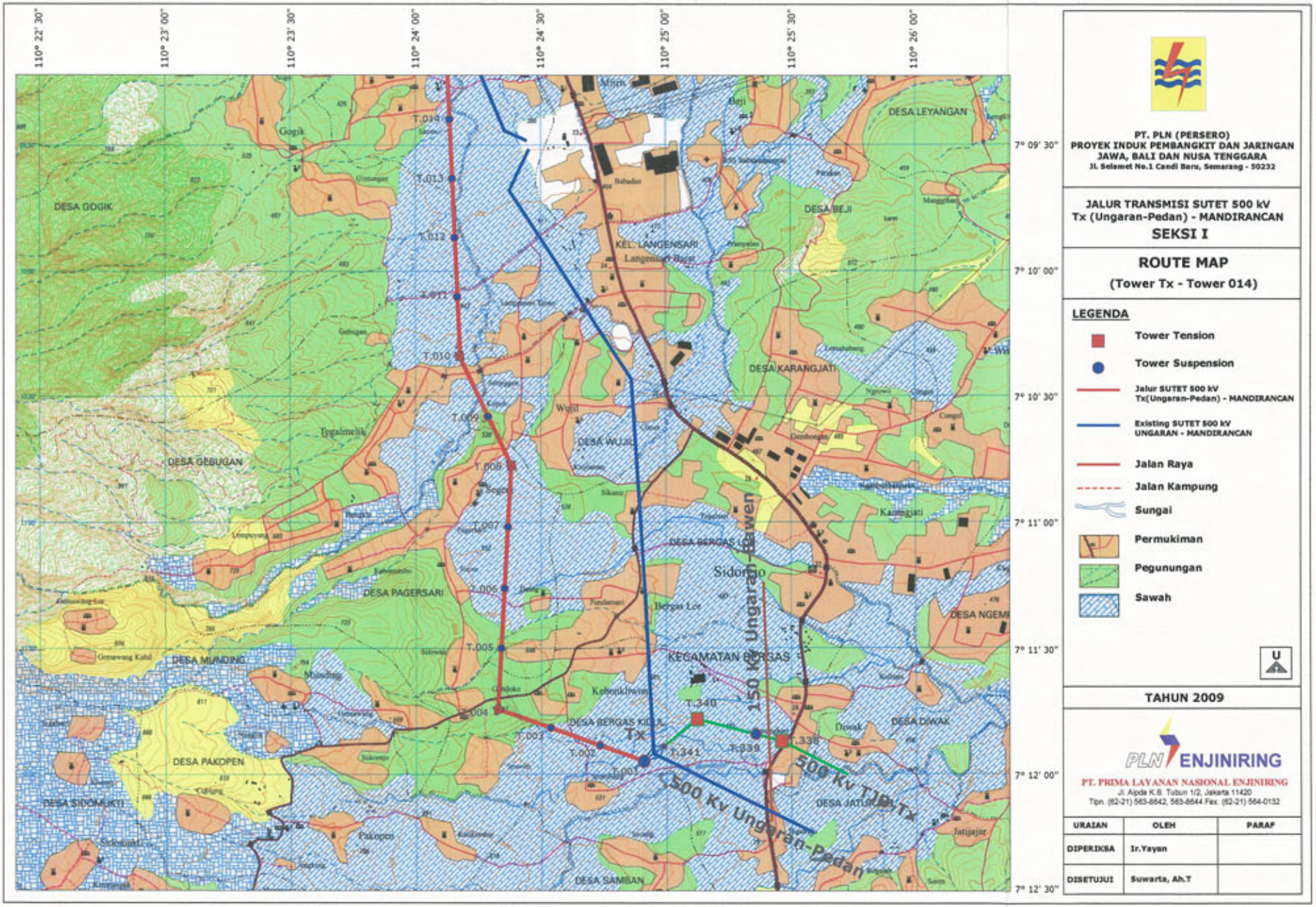


Figure 9. 7 New Plan to pull into Pemalang S/S by Four-Circuits Tower

Appendix I

Proposed Transmission Line Route (Tx – Indramayu)



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JAWA, BALI DAN NUSA TENGGARA
Jl. Selamet No.1 Candi Baru, Semarang - 50232

JALUR TRANSMISI SUTET 500 kV
Tx (Ungaran-Pedan) - MANDIRANCAN
SEKSI I

ROUTE MAP
(Tower Tx - Tower 014)

LEGENDA

- Tower Tension
- Tower Suspension
- Jalur SUTET 500 kV Tx(Ungaran-Pedan) - MANDIRANCAN
- Existing SUTET 500 kV UNGARAN - MANDIRANCAN
- Jalan Raya
- Jalan Kampung
- Sungai
- Permukiman
- Pegunungan
- Sawah

TAHUN 2009

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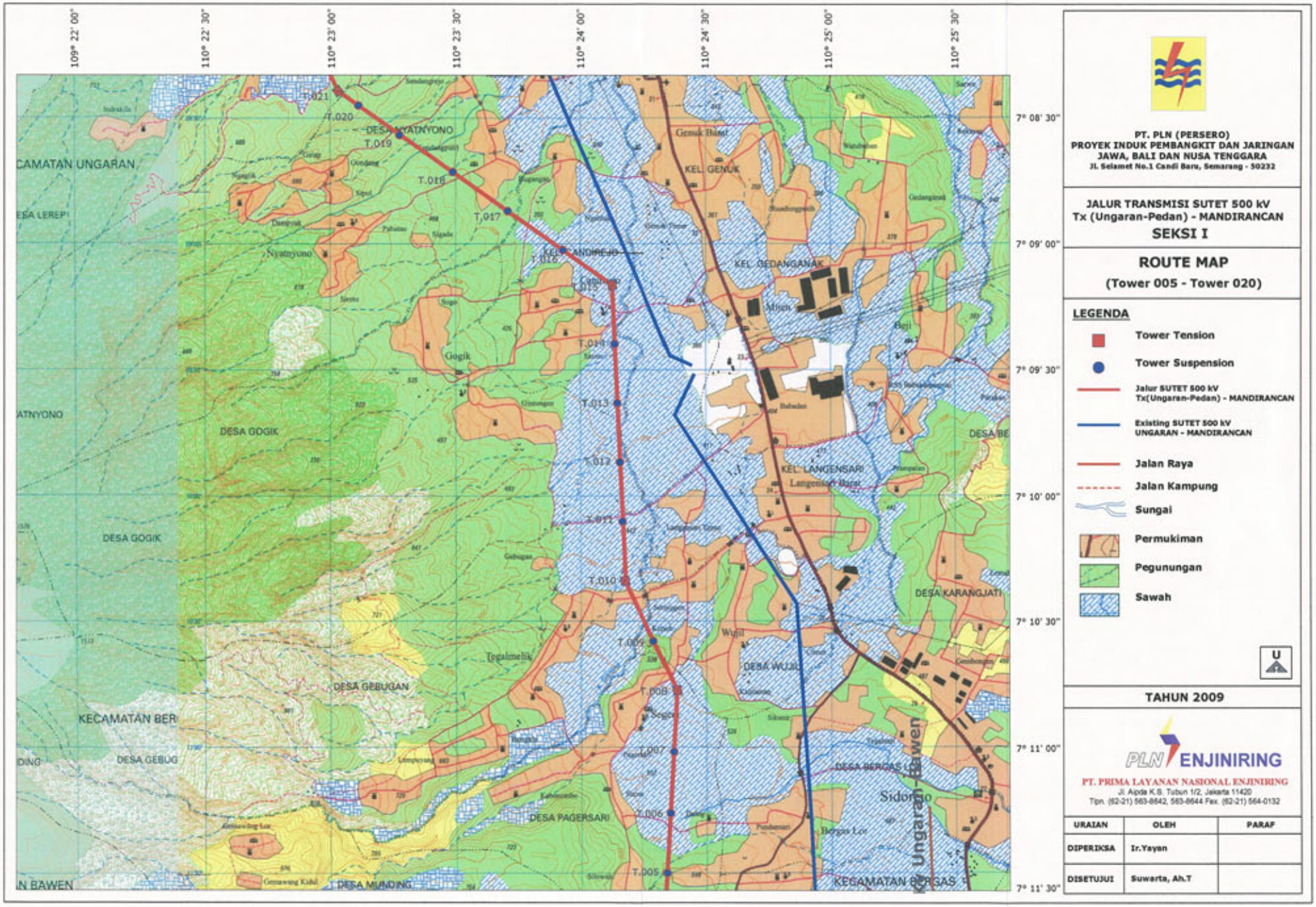
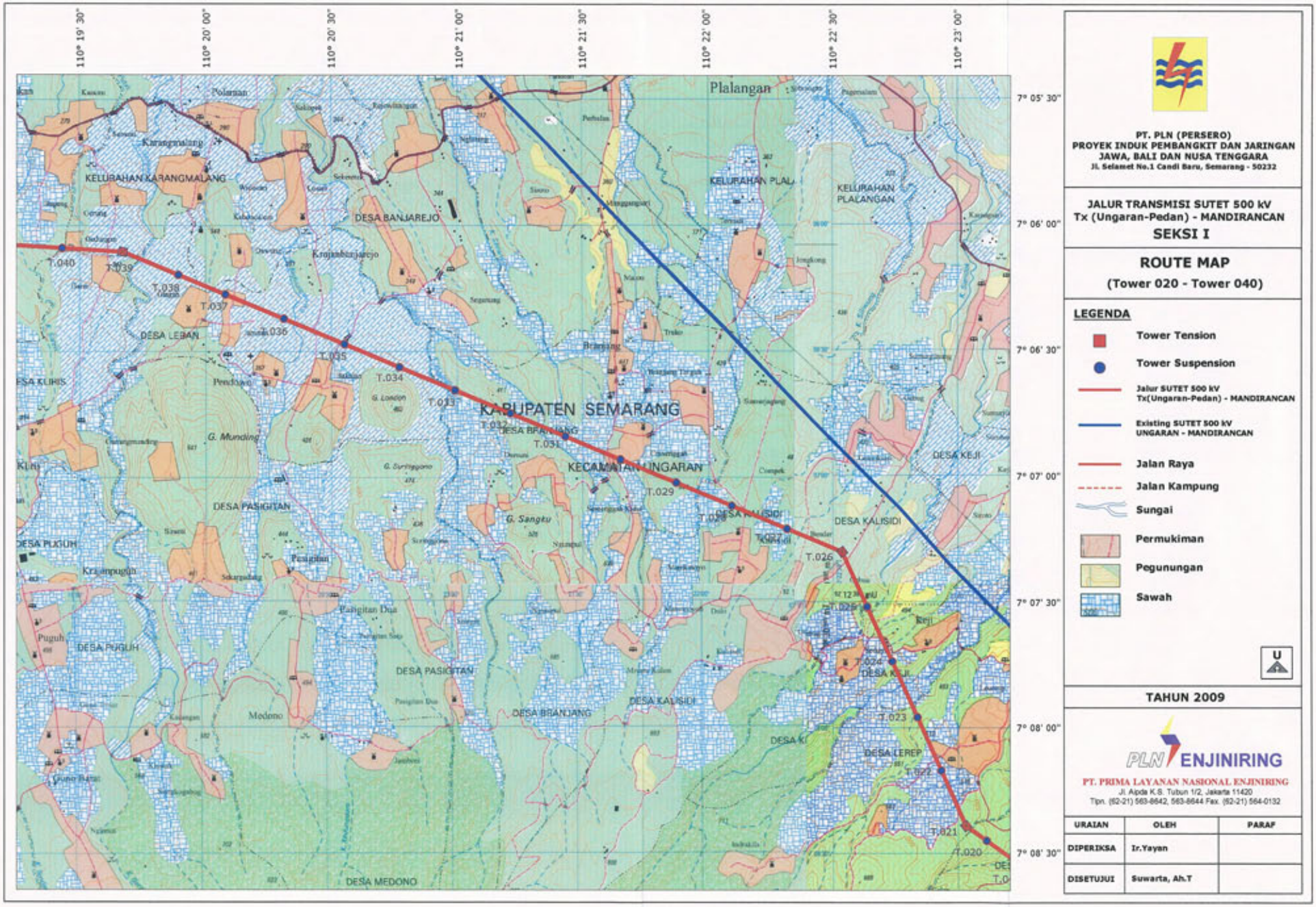
DISETUJUI	Suwarta, Ah.T	

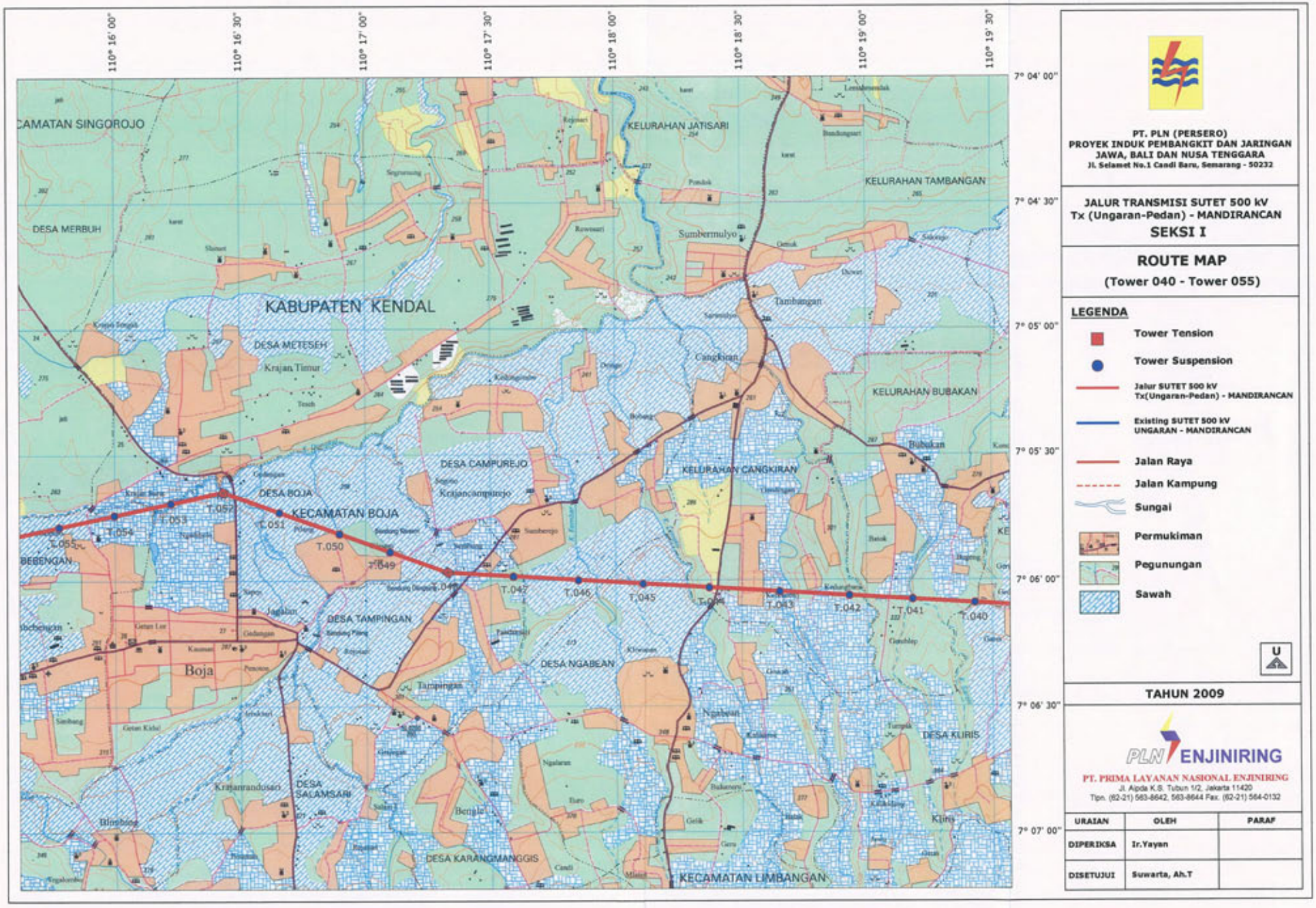
Appendix 4.3-1 Transmission Line Route Map_Tx-T014 (1/23)



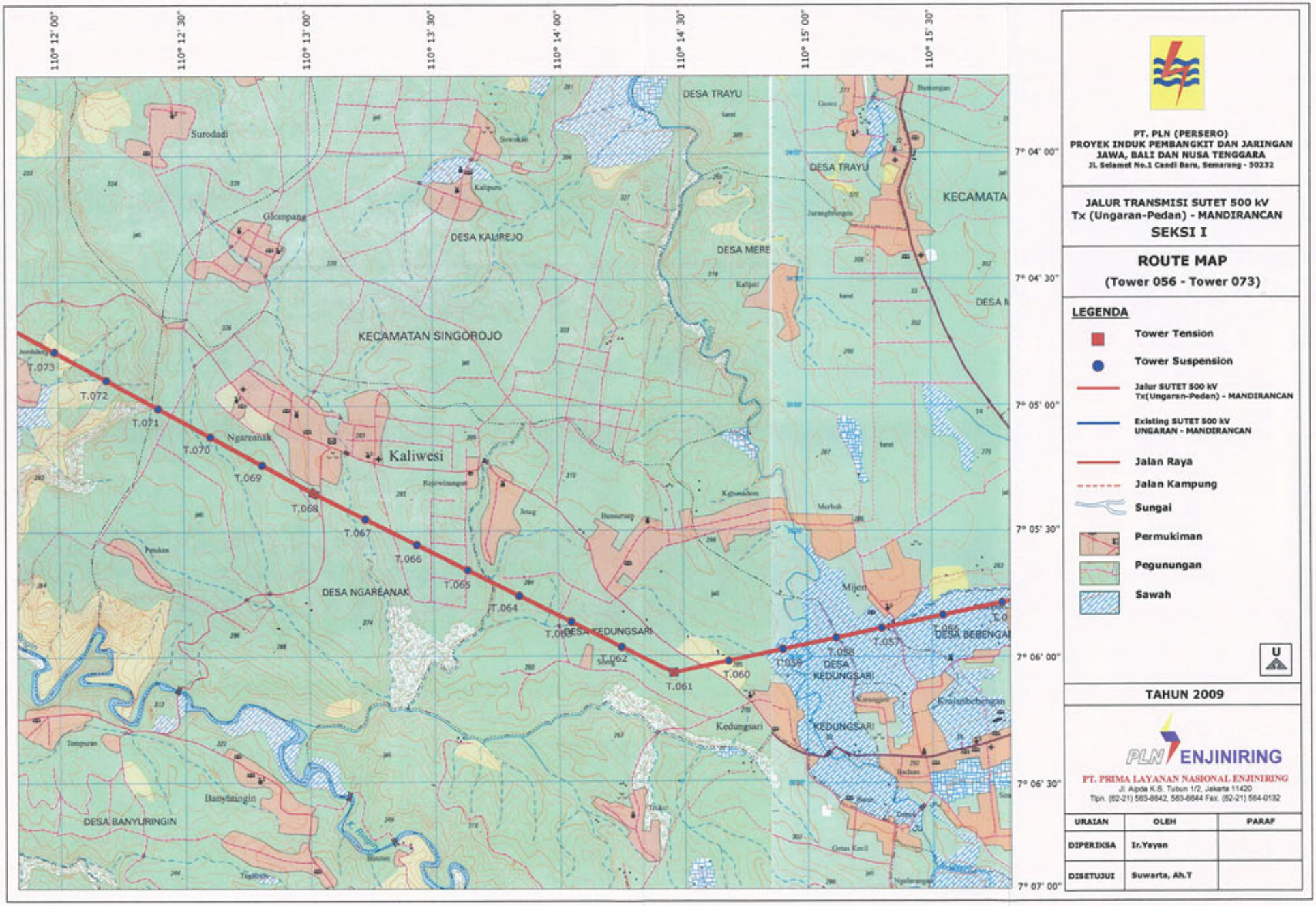
Appendix 4.3-2 Transmission Line Route Map_T005-T020 (2/23)



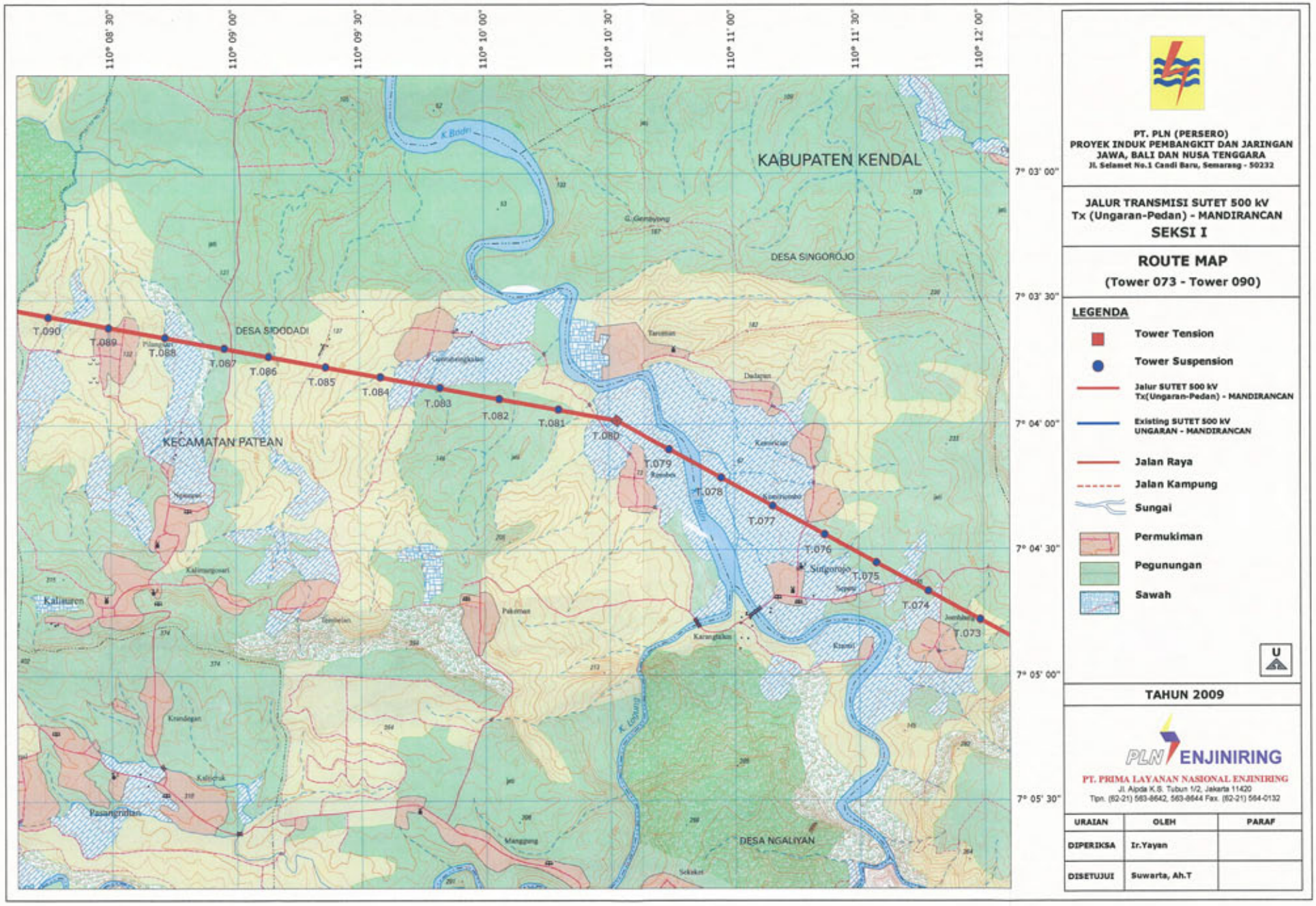
Appendix 4.3-3 Transmission Line Route Map_T020-T040 (3/23)



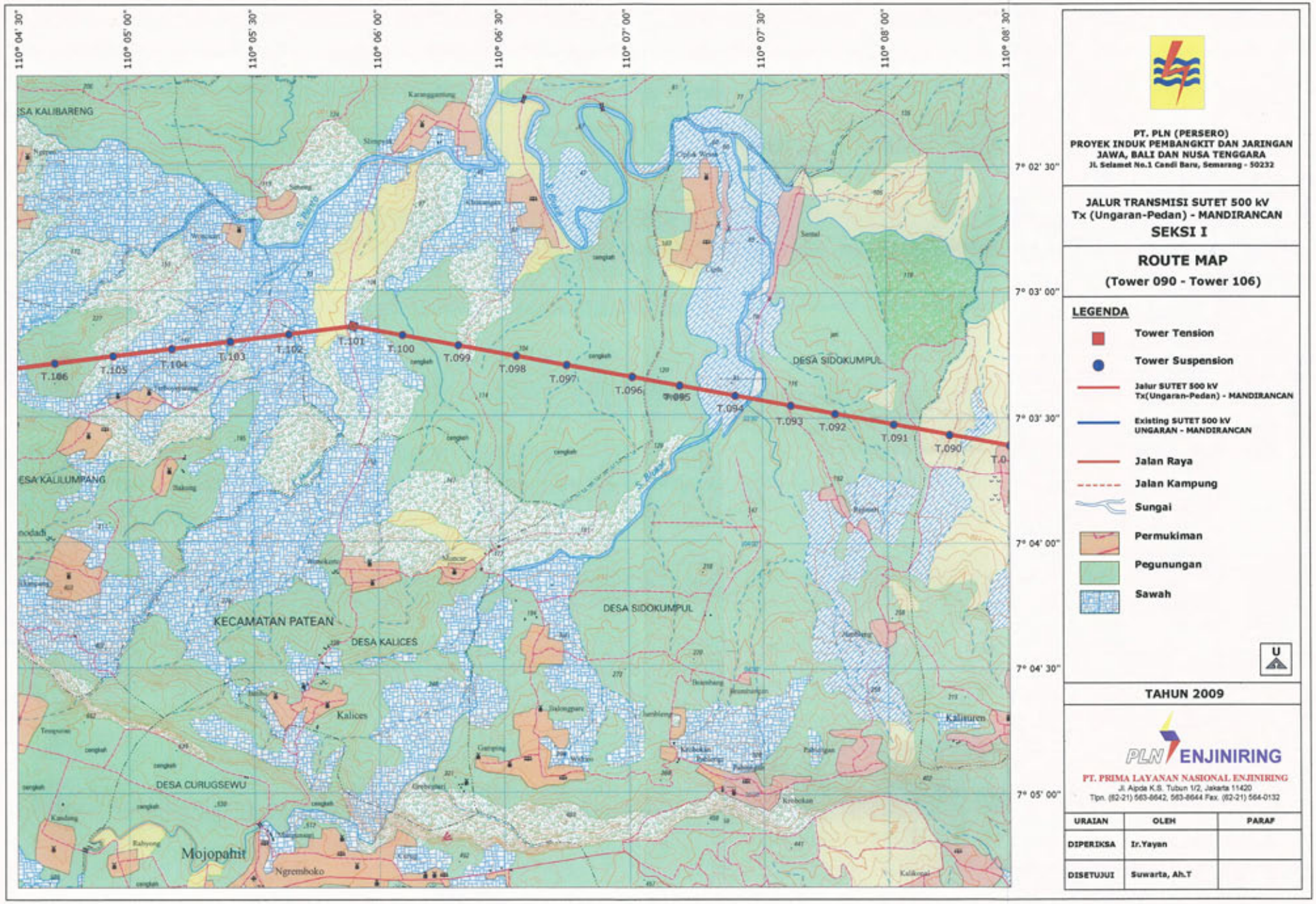
Appendix 4.3-4 Transmission Line Route Map_T040-T055 (4/23)



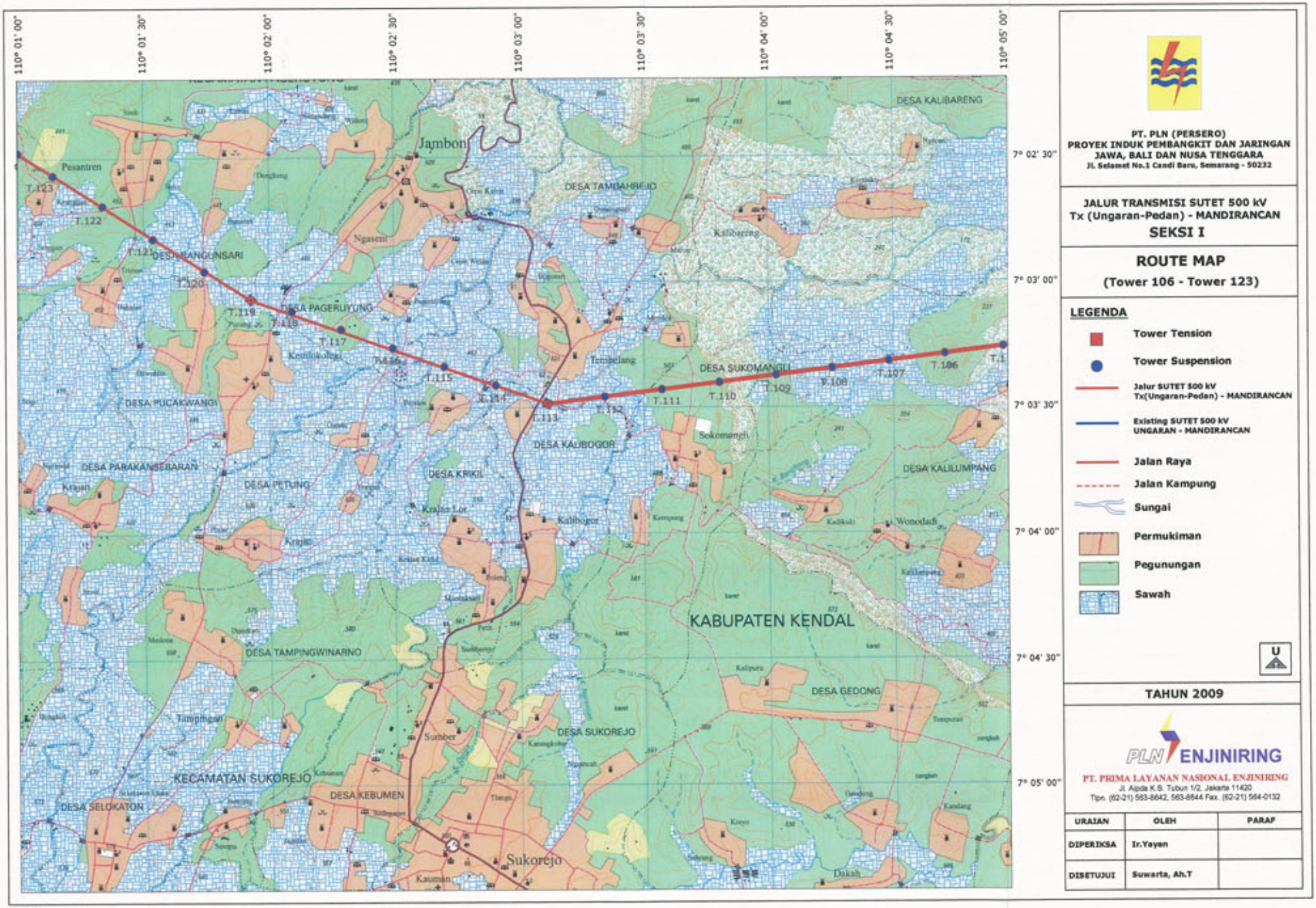
Appendix 4.3-5 Transmission Line Route Map_T056-T073 (5/23)



Appendix 4.3-6 Transmission Line Route Map_T073-T090 (6/23)



Appendix 4.3-7 Transmission Line Route Map_T090-T106 (7/23)



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JALUR TRANSMISI SUTET 500 kV
Tx (Ungaran-Pedan) - MANDIRANCAN
SEKSI I

ROUTE MAP
(Tower 106 - Tower 123)

LEGENDA

- Tower Tension
- Tower Suspension
- Jalur SUTET 500 kV Tx(Ungaran-Pedan) - MANDIRANCAN
- Existing SUTET 500 kV UNGARAN - MANDIRANCAN
- Jalan Raya
- Jalan Kampung
- Sungai
- Permukiman
- Pegunungan
- Sawah

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Appendix 4.3-8 Transmission Line Route Map_T106-T123 (8/23)