



## **TM171 – REPLACEMENT OF CORRODED EARTH WIRES**

---

**BUSINESS CASE 2017/18 - 2018/19**

---





**Prepared by Asset Strategy and Planning**

---

**October 2017**

---

## REVIEW AND APPROVAL SCHEDULE

| Responsibility | Position                                    | Name               | Signature   | Date     |
|----------------|---|--------------------|---|----------|
| Authored       | Renewal Project Development Officer         | Vasan Naidoo       |  | 9/10/17  |
| Reviewed       | Senior Renewal Project Development Engineer | Jonathan Cook      |  | 9/10/17  |
| Endorsed       | Network Investment Planning Manager         | Manoraj Jayasekara |  | 9/10/17  |
| Endorsed       | Manager Asset Strategy and Planning         | Peter Langdon      |  | 10.10.17 |

---

## CONTENTS

---

|   |           |
|---|-----------|
| <b>1.0 EXECUTIVE SUMMARY .....</b>  | <b>4</b>  |
| <b>2.0 INTRODUCTION .....</b>   | <b>4</b>  |
| <b>2.1 PURPOSE.....</b>   | <b>4</b>  |
| <b>2.2 BACKGROUND .....</b>   | <b>5</b>  |
| <b>2.3 SAMPLE IMAGES OF CORRODED EARTHWIRES .....</b>   | <b>5</b>  |
| <b>3.0 PROJECT NEED.....</b>  | <b>6</b>  |
| <b>4.0 OPTIONS TO ADDRESS THE RISK .....</b>  | <b>7</b>  |
| <b>4.1 REPLACE WITH LIKE FOR LIKE.....</b>  | <b>8</b>  |
| <b>4.2 REPLACE OHEW WITH AAAC OR ACSR.....</b>  | <b>8</b>  |
| <b>4.3 REPLACE OHEW WITH OPGW .....</b>   | <b>8</b>  |
| <b>4.4 REPLACEMENT PRIORITY .....</b>   | <b>8</b>  |
| <b>5.0 SCOPE OF WORK.....</b>   | <b>10</b> |
| <b>5.1 FEEDER 934 – FROM WALLERAWANG BSP TO HAWKESBURY TS .....</b>                             | <b>10</b> |
| <b>5.2 FEEDERS 940/941/942/93E WALLERAWANG BSP TO PENRITH TS .....</b>                          | <b>11</b> |
| <b>5.3 FEEDER 223/237/23C/23F – SYDNEY WEST BSP TO ROOTY HILL ZS / BHP /<br/>DOONSIDE .....</b> | <b>12</b> |
| <b>5.4 FEEDER 93U – SYDNEY WEST BSP TO ABBOTSBURY ZS .....</b>                                  | <b>12</b> |
| <b>5.5 FEEDER 988 – DAPTO BSP TO TEE 1 - BURRAWANG PUMPS .....</b>                              | <b>13</b> |
| <b>5.6 FEEDER 7510 – BOMADERRY ZS TO MEROO MEADOW TEE.....</b>                                  | <b>13</b> |
| <b>5.7 FEEDER 7176 – GERRINGONG ZS TO BERRY ZS .....</b>  | <b>14</b> |
| <b>5.8 FEEDER 7534 – ULLADULLA ZS TO RECLOSER A8324 .....</b>                                   | <b>14</b> |
| <b>5.9 FEEDER 7175 – GERRINGONG ZS TO JERRARA SS .....</b>                                      | <b>15</b> |
| <b>6.0 COST ESTIMATES .....</b>   | <b>15</b> |
| <b>6.1 DISPOSAL OF SCRAP METAL .....</b>  | <b>16</b> |
| <b>6.2 CONTINGENCY PROVISION .....</b>  | <b>16</b> |
| <b>7.0 FUNDING PROVISION .....</b>  | <b>16</b> |
| <b>8.0 RECOMMENDATIONS .....</b>  | <b>16</b> |
| <b>9.0 APPENDICES .....</b>   | <b>17</b> |
| <b>10.0 REFERENCES.....</b>   | <b>17</b> |

## 1.0 EXECUTIVE SUMMARY

The purpose of this business case is to seek approval for the funding for the next phase of the corroded steel OHEW replacement program TM171 to replace corroded overhead earthwires on sub-transmission lines across the network in the period from 2017/18 - 2018/19.

Endeavour Energy has approximately 3,200 km of overhead lines constructed to operate at 132, 66 and 33kV. 2,300 km of these lines are fitted with overhead earth wires to provide protection from lightning strikes and to provide earthing functions. Some of these earth wires (approximately 726 km) are galvanised steel which corrodes over time.

Due to age and exposure to the atmosphere, a number of these earth wires have lost their protective galvanising and are now suffering from significant corrosion damage.

Overhead earth wires which have lost their mechanical strength due to corrosion damage are at risk of failure and falling with a resultant risk of hazards to personnel, damage to property and loss of supply. A broken earth wire can strike a live phase conductor (located below) on its way to the ground and cause sparks and molten material to fall to the ground and with the risk of initiating a bushfire.

Likewise, overhead earth wires which have reduced conductivity due to corrosion damage are at risk of burning down in the event of a lightning strike or a fault occurring in a critical location with similar risks of hazards to personnel, damage to property, loss of supply and initiation of a bushfire.

The steel OHEW replacement program began in 2013/14 under project TM01701 – *Replacement of overhead earth wires due to corrosion damage*. TM01701 noted that the above works were the first stage of an overall earth wire replacement program and further lines will be addressed in forthcoming years as required by their condition.

In 2015 a scoping study to assess the condition of the remaining steel OHEW in the network was conducted. This study surveyed the remaining steel OHEW and prioritised their condition in accordance with technical bulletin TB-0194.

TB-0194 requires that category 5 steel overhead earthwires be replaced as soon as possible and as a result program TM171 includes the replacement of category 5 earthwires in the short term followed by the replacement of category 4 and category 3 in later stages of the program.

This business case seeks to replace the remaining 222km of Category 5 and Category 4 corroded OHEW in the network. The cost estimate for these works is \$7.6 million (in real 2017/18 terms) and it is proposed that the works be carried out in the two year period from 2017/18 to 2018/19.

PIP V 8.5 includes a funding provision of \$10.6 million for the replacement of corroded OHEW in this period which is sufficient for this project.

A contingency allowance of \$0.4 million is proposed to allow for additional fittings needing replacement which may be discovered during the replacement works.

Accordingly, it is recommended that:

- A capital expenditure of \$7.7 million for TM171 – Replacement of corroded earth wires as outlined in this business case during 2017/18 – 2018/19 be approved; and
- A contingency sum of \$0.4 million, representing approximately 5% of the estimated cost of the project to cover the replacement of additional fittings that may be discovered during the replacement works.

The total project estimate, including the base cost and contingency allowance totals \$8.1 million.

## 2.0 INTRODUCTION

### 2.1 PURPOSE

The purpose of this business case is to obtain approval for the funding for replacement of corroded category 5 and category 4 OHEWs in the financial years FY18 and FY19.



## 2.2 BACKGROUND

Endeavour Energy has approximately 3,200 km of overhead lines constructed to operate at 132, 66 and 33kV. 2,300 km of these lines are fitted with overhead earth wires and of these approximately 726 km are galvanised steel (excluding Hardex pilot wires and ACSR).

The steel OHEW replacement program began in 2013/14 under TM01701 and was later progressed under TM171.

In 2015 a scoping study to assess the condition of the remaining steel OHEW in the network was approved. Refer TM171 – *Replacement of corroded earth wires, Business Case for 2015/16 Scoping Study* for further details about the scoping study.

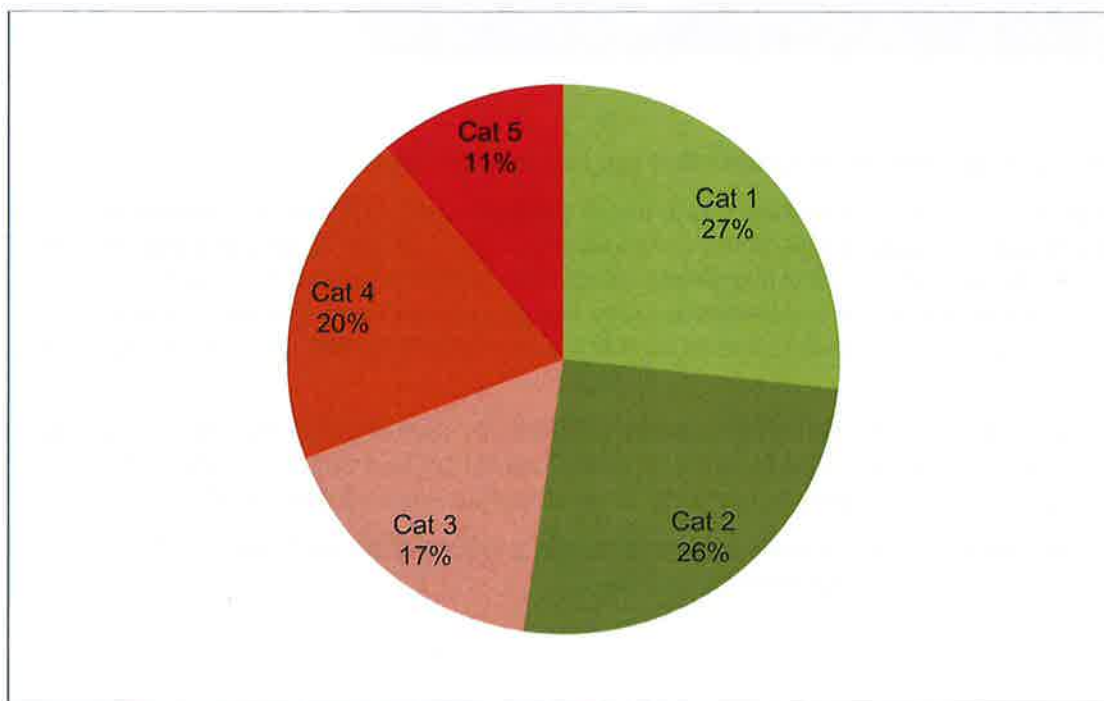
TABLE 1 below shows a distribution of the condition of the remaining OHEWs where category 1 is as new and category 5 is corroded to such an extent that replacement is required as soon as practicable. The categories are as provided by Technical Bulletin, "TB-0194 *Assessment Criteria for Overhead Steel Conductors*" published in July 2015. TB-0194 further states that the location and criticality of the feeder may also influence the replacement priority. Refer Appendix A for further detail of TB-0194.

Details of the feeders and the survey categories identified by the scoping study are provided in Appendix B.

TABLE 1 : CLASSIFICATION OF STEEL OHEWs

| Location                                 | Categories |     |     |     |     | Total |
|--|------------|-----|-----|-----|-----|-------|
|  | 1          | 2   | 3   | 4   | 5   |       |
| Number of feeders in category            | 13         | 13  | 14  | 10  | 1   | 51    |
| Total route length in km of the category | 195        | 186 | 122 | 142 | 81  | 726   |
| category percentage of total OHEW        | 27%        | 26% | 17% | 20% | 11% | 100%  |

FIGURE 1: DISTRIBUTION OF CONDITION OF STEEL OHEW



## 2.3 SAMPLE IMAGES OF CORRODED EARTHWIRES

The survey provided the following images of category 5 and category 4 earthwires.

FIGURE 2 : FEEDER 934 – EARTHWIRE IN CATEGORY 5 CONDITION



FIGURE 3 : FEEDER 941 – EARTHWIRE IN CATEGORY 4 CONDITION



### 3.0 PROJECT NEED

This project addresses corroded steel OHEW that are in poor condition.

Overhead earth wires which have lost their mechanical strength due to corrosion damage are at risk of failure and falling with a resultant risk of hazards to personnel, damage to property and loss of supply. A broken earth wire can strike a live phase conductor (located below) on its way to the ground and cause sparks and molten material to fall to the ground and with the risk of initiating a bushfire. As most of the targeted feeders are in bushfire prone locations this threat is highly likely to occur.

Likewise, overhead earth wires which have reduced conductivity due to corrosion damage are at risk of burning down in the event of a lightning strike or a fault occurring in a critical location with similar risks of hazards to personnel, damage to property, loss of supply and initiation of a bushfire.

Table 2 below assesses the principal risks associated with a failure of an earth wire and the proposed treatment to reduce the risk level to ALARP.

TABLE 2: RISK ASSESSMENT

| Asset      | Event   | Likelihood   | Consequence | Risk rating | Consequence and comments   | Proposed treatment               | Expected risk after treatment |
|------------|---|--------------|-------------|-------------|--|----------------------------------|-------------------------------|
| Earth wire | Earth wire falls onto conductor and ground.   | Possible (C) | Major (4)   | High (C4)   | Mechanical failure causing earth wire to contact live conductor and ground. May result in serious injury to personnel, damage to surrounding equipment, loss of supply, high incident recovery costs.  | Replace earth wire and fittings. | Medium (E4)                   |
|            | Earth wire falls on major road.   | Possible (C) | Major (4)   | High (C4)   | Earth wire falling across a major road can cause significant safety implications for the road users. Consequences may also include significant damage to the brand.  | Replace earth wire and fittings. | Medium (E4)                   |
|            | Earth wire fails during a fault.  | Possible (C) | Major (4)   | High (C4)   | During system fault conditions the earth wire fails due to overcurrent which will then allow more current to flow in the ground and can result in Earth Potential Rise (EPR) which may result in serious injury to the public in the vicinity.   | Replace earth wire and fittings. | Medium (E4)                   |
|            | Earth wire falls onto live conductor causing sparks and molten material falling to the ground | Possible (C) | Major (4)   | High (C4)   | Corroded OHEW may fall onto live conductors and thereby causing arcs and sparks which may result in molten material falling to the ground and initiating a bushfire. As most of the OHEW are in bushfire prone locations, this is likely to occur. Bushfires can result in the loss of properties in the area. | Replace earth wire and fittings. | Medium (E4)                   |
|            | Earth wire burns down during a lightning strike   | Possible (C) | Major (4)   | High (C4)   | Corrosion damage may result in reduced electrical conductivity which can result in the OHEW burning down in the event of a lightning strike or a fault occurring in a critical location.   | Replace earth wire and fittings. | Medium (E4)                   |

#### 4.0 OPTIONS TO ADDRESS THE RISK

Whilst the obvious remedy is the like for like replacement of corroded OHEW's, there are a number of other factors which need to be considered including:

1. The existing galvanised steel earthwires are no longer EE approved earthwires;
2. Increases in fault levels in sections of the network, due to augmentation works, requiring higher fault rated earthwires than the current OHEW. This is especially true for line to ground faults close to some substations;
3. Correctly fault rated approved earthwires such as ACSR and AAAC usually require significant upgrades to elements of the line (such as poles and tower peaks) due to increased loading and tension requirements;
4. A requirement in the overhead line standard, AS/NZS AS7001:2016 which states that if any part of the line is to be upgraded then the line must comply with this standard. This standard however is not intended to apply retrospectively to installations that were designed to older standards and where no part of the line is modified;
5. The growing need for protection communication links between sections of the network due to the ageing copper based pilot wire systems; and
6. The developing need for communication links to support other network data requirements such as VOIP (voice over internet protocol), power quality monitoring and substation security system.



Consequently, the following options to reduce the risks posed by corroded OHEW were considered:

1. Like for like replacement with steel (SC/GZ) earthwire;
2. Replace with AAAC or ACSR; and
3. Replace with OPGW.

#### 4.1 REPLACE WITH LIKE FOR LIKE

The benefit of a like for like replacement is that it allows for the existing structures and fittings to be reused which has significant cost benefits compared to the replacement with an aluminium earthwire. If the earthwire is replaced with one of the standard ACSR, AAAC or OPGW earthwires then that section of the feeder has to be redesigned to AS/NZS AS7001:2016.

Table 3 below is an example of the cost comparison between the various OHEW earthwire replacement options and shows the incremental cost increases from SC/GZ to ACSR (or AAAC) and the increase from ACSR (or AAAC) to OPGW.

TABLE 3: EXAMPLE COST COMPARISON OF OPTIONS

| FDR no.                    | Description              | Length (KM) | Cost per km in \$ |         |         | Total cost in \$ |           |           |
|----------------------------|--------------------------|-------------|-------------------|---------|---------|------------------|-----------|-----------|
|                            |                          |             | SC/GZ             | ACSR/   | OPGW    | SC/GZ            | ACSR/     | OPGW      |
| 7120                       | Dapto ZS to Unanderra ZS | 8           | 120,800           | 150,200 | 163,500 | 970,000          | 1,201,600 | 1,308,000 |
| Cost increase from SC/GZ   |                          |             |                   | 29,400  | 42,700  |                  | 231,600   | 338,000   |
| % Cost increase from SC/GZ |                          |             |                   |         |         |                  | 24%       | 35%       |

The cost increase from SC/GZ to ACSR is due to allowance for 50% of existing structures and accessories to be replaced due to the larger earth wires and to comply with the current standards. The cost increase from ACSR to OPGW is due to the optical fibre cost differential (over ACSR), jointing and some additional structure replacements that may be necessary. An added benefit of like for like replacement is the potentially shorter project delivery as the older overhead line designs can be re-used and no structure replacements are necessary.

At a project stakeholder meeting it was agreed that unless there was an earthing risk or a foreseeable protection or communication requirement, the existing OHEW should be replaced on a like for like basis, which is the lowest cost approach.

It should be noted that the existing OHEW types 7/0.128 SC/GZ or SC/GZ 7/0.144 are not approved earthwires for use on EE's network. If this earthwire is to be installed then a special dispensation from Manager Asset Standards and Design will be required to allow this earthwire to be fitted in the network. Manager Asset Standards and Design has agreed to provide this dispensation when required.

#### 4.2 REPLACE OHEW WITH AAAC OR ACSR

If an upgrade of the existing OHEW is required then the earth wire will be replaced with AAAC or ACSR and the structures and fittings will be replaced as necessary to comply with current standards.

#### 4.3 REPLACE OHEW WITH OPGW

There may be situations where communication links for network protection or communication may be required in the foreseeable future. In these instances OPGW may be considered in lieu of ACSR.

OPGW will place additional load on the existing structures and therefore these structures and other elements will be upgraded to comply with AS/NZS 7000.

#### 4.4 REPLACEMENT PRIORITY

The replacement priority schedule shown in Table 4 below was developed using:

- a. Condition category from TB-0194;
- b. The Network Bushfire Risk Analysis spreadsheet developed by Assets Standards & Design using the CSIRO Phoenix/Tolhurst models and NSW Rural fire service fire history data to develop the bushfire risk for each feeder; and
- c. Maximum wind speeds along the feeder using data from the CSIRO (The NSW WIND ATLAS) [1].



TABLE 4: STEEL OHEW REPLACEMENT PRIORITY

| Feeder number   | Location   | Voltage | Approx feeder route length (km) | Approx. route length of steel EW (km) | Approx. route length of corroded steel EW (km) | Survey category | Bushfire risk (probability of a bushfire and the consequential number of properties lost) | Wind Speed max metres per second | Replacement /Removal priority |
|-----------------|--|---------|---------------------------------|---------------------------------------|--|-----------------|---|----------------------------------|-------------------------------|
| 934             | Wallerwang BSP - O/B Hawkesbury TS (used at 11kV in parts) | 132kV   | 80.8                            | 80.8                                  | 80.8   | 5               | 73  | 9.2                              | 1                             |
| 940/941/942/93E | Wallerawang BSP to Penrith TS                              | 132kV   | 77.7                            | 77.7                                  | 65.2   | 4               | 1106  | 9.2                              | 2                             |
| 7510            | Bomaderry ZS to Meroo Meadow Tee                           | 33kV    | 4.5                             | 4.5                                   | 4.5  | 4               | 581   | 8.2                              | 3                             |
| 223/237         | Sydney West BSP - Rooty Hill ZS / BHP                      | 132kV   | 10.8                            | 6.2                                   | 6.2  | 4               | 56  | 6.5                              | 4                             |
| 93U             | Sydney West BSP - Abbotsbury ZS                            | 132kV   | 10.5                            | 5                                     | 5  | 4               | 56  | 6.5                              | 5                             |
| 237/23C         | Rooty Hill ZS - Onesteel                                   | 132kV   | 1.9                             | 1.08                                  | 1.08   | 4               | 56  | 6.5                              | 6                             |
| 7176            | Gerringong ZS to Berry ZS                                  | 33kV    | 13.1                            | 13.1                                  | 13.1   | 4               | 35  | 8.2                              | 7                             |
| 988             | Dapto BSP - Tee 1 (Burrawang Pumps)                        | 132kV   | 32.6                            | 21.6                                  | 21.6   | 4               | 10  | 7.5                              | 8                             |
| 7534            | Ulladulla ZS to Rec A8324                                  | 33kV    | 14                              | 14                                    | 14   | 4               | 8   | 8.2                              | 9                             |
| 23C/23F         | Doonside ZS - Rooty Hill ZS/Doonside ZS - Onesteel         | 132kV   | 3.3                             | 1.4                                   | 1.4  | 4               | 5   | 6.5                              | 10                            |
| 7175            | Gerringong ZS to Jerrara SS                                | 33kV    | 10.4                            | 10.4                                  | 10.4   | 4               | 0   | 8.2                              | 11                            |
| 93J             | Sydney West BSP - West Wetherill Park TS                   | 132kV   | 6.5                             | 2.1                                   | 2.1  | 3               | 56  | 6.5                              | 12                            |
| 93J             | West Wetherill Park TS - Guildford TS                      | 132kV   | 4.6                             | 4.6                                   | 4.6  | 3               | 56  | 6.5                              | 13                            |
| 98M             | Evans lane to Batemans Bay Tee                             | 132kV   | 53.7                            | 52.5                                  | 52.5   | 3               | 23  | 8.2                              | 14                            |
| 464             | Kingswood ZS - tee to Glenmore Park ZS                     | 33kV    | 3.9                             | 3.9                                   | 3.9  | 3               | 21  | 7.5                              | 15                            |
| 933             | Penrith TS - near Mt Druitt TS                             | 132kV   | 9.4                             | 9.4                                   | 9.4  | 3               | 7   | 7.5                              | 16                            |
| 685             | Guildford TS to Yennora ZS                                 | 33kV    | 5.1                             | 5                                     | 5  | 3               | 2   | 6.5                              | 17                            |
| 686_2           | Tee to Yennora ZS  | 33kV    | 4.2                             | 1.6                                   | 1.6  | 3               | 2   | 6.5                              | 18                            |
| 686_1           | Tee to Comalco HVC   | 33kV    | 4.2                             | 0.6                                   | 0.6  | 3               | 2   | 6.5                              | 19                            |
| 7041            | Mt Terry TS to Dapto ZS                                    | 33kV    | 12                              | 11                                    | 11   | 3               | 2   | 8.2                              | 20                            |
| 7120            | Dapto ZS to Unanderra ZS                                   | 33kV    | 8                               | 8                                     | 8  | 3               | 2   | 8.2                              | 21                            |
| 93W             | Abbotsbury ZS - West Liverpool TS                          | 132kV   | 5.2                             | 4.9                                   | 4.9  | 3               | 0   | 6.5                              | 22                            |
| O/S 31          | Pole 801353 to PL 536261                                   | 33kV    | 0.3                             | 0.3                                   | 0.3  | 3               | 0   | 6.5                              | 23                            |
| 9J3/9J4         | Blacktown TS - Baulkham Hills TS                           | 132kV   | 5.47                            | 3.962                                 | 3.962  | 3               | 0   | 6.5                              | 24                            |
| 7515            | Recloser 27291 to Berry ZS                                 | 33kV    | 14                              | 14                                    | 14   | 3               | 0   | 8.2                              | 25                            |
| 98L             | Mt Terry TS - Shoalhaven TS                                | 132kV   | 46.1                            | 36.4                                  | 36.4   | 2               | 581   | 8.2                              | 26                            |
| 98U             | Mt Terry TS - Shoalhaven TS                                | 132kV   | 46.3                            | 35.4                                  | 35.4   | 2               | 581   | 8.2                              | 27                            |
| 93X             | Sydney West BSP - Nepean TS (tee Bringelly)                | 132kV   | 32.3                            | 24.9                                  | 24.9   | 2               | 566   | 7.5                              | 28                            |
| 9L5             | Nepean TS - Denham Court TS (tee South Leppington ZS)      | 132kV   | 14.4                            | 9.1                                   | 9.1  | 2               | 347   | 7.5                              | 29                            |
| 937             | Regentville BSP - North Warragamba ZS                      | 132kV   | 10.2                            | 10.2                                  | 10.2   | 2               | 265   | 7.5                              | 30                            |
| 93Y             | West Liverpool TS - Nepean TS                              | 132kV   | 9.4                             | 6                                     | 6  | 2               | 185   | 6.5                              | 31                            |
| 988/98C         | Tee B - Fairfax Lane TS                                    | 132kV   | 2.9                             | 2.9                                   | 2.9  | 2               | 151   | 7.5                              | 32                            |
| 98C             | Marulan BSP - Tee B  | 132kV   | 35.5                            | 34.4                                  | 34.4   | 2               | 151   | 7.5                              | 33                            |
| 988             | Tee 1 - Tee B  | 132kV   | 8                               | 8                                     | 8  | 2               | 10  | 7.5                              | 34                            |
| 988/1           | Tee 1 - Burrawang Pumps                                    | 132kV   | 2.2                             | 2.2                                   | 2.2  | 2               | 10  | 7.5                              | 35                            |
| 933             | - Mt Druitt TS   | 132kV   | 0.5                             | 0.5                                   | 0.5  | 2               | 7   | 7.5                              | 36                            |
| 7123            | Albion Park ZS to Open Bond at PL 4AV794                   | 33kV    | 15.5                            | 9.8                                   | 9.8  | 2               | 3   | 8.2                              | 37                            |
| 7341            | Kembla Grange ZS to Dapto ZS                               | 33kV    | 6                               | 6                                     | 6  | 2               | 2   | 8.2                              | 38                            |

| Feeder number           | Location  | Voltage | Approx. feeder route length (km) | Approx. route length of steel EW (km) | Approx. route length of corroded steel EW (km) | Survey category | Bushfire risk (probability of a bushfire and the consequential number of properties lost) | Wind Speed max metres per second | Replacement /Removal priority |
|-------------------------|---|---------|----------------------------------|---------------------------------------|--|-----------------|---|----------------------------------|-------------------------------|
| 98J                     | Shoalhaven TS - Evans Lane SS                         | 132kV   | 59.4                             | 32.3                                  | 32.3   | 1               | 1474  | 8.2                              | 39                            |
| 98P                     | Shoalhaven TS – West Tomerong TS                      | 132kV   | 15.5                             | 15.5                                  | 15.5   | 1               | 1474  | 8.2                              | 40                            |
| 28P                     | West Tomerong TS - Evans Lane SS                      | 132kV   | 39.5                             | 39.5                                  | 39.5   | 1               | 468   | 7.5                              | 41                            |
| 7253                    | Darkes Forest ZS to Helensburgh ZS                    | 33kV    | 6.9                              | 0.96                                  | 0.96   | 1               | 309   | 8.2                              | 42                            |
| 7252/3                  | Fdr 7252/3 Plateau Rd Stanwell Tops den Stanwell Tops | 33kV    | 7                                | 7                                     | 7  | 1               | 309   | 8.2                              | 43                            |
| 7095                    | FROM ABS 79473 to ABS 73347 near Lake Cordeaux        | 33kV    | 14.4                             | 14.4                                  | 14.4   | 1               | 307   | 8.2                              | 44                            |
| 220/239                 | Blacktown TS - Doonside ZS                            | 132kV   | 4.5                              | 2.6                                   | 2.6  | 1               | 26  | 6.5                              | 45                            |
| 98H                     | Evans Lane Sw/Stn to Moruya North TS                  | 132kV   | 72.4                             | 71.3                                  | 71.3   | 1               | 23  | 7.5                              | 46                            |
| 7252/2                  | Fdr 7252/2 Saywell Place Wombarra Fdr 7252/2 St 5Y    | 33kV    | 3.5                              | 3.5                                   | 2  | 1               | 6   | 8.2                              | 47                            |
| 7252                    | Darkes Forest ZS to TEE                               | 33kV    | 0.92                             | 0.92                                  | 0.92   | 1               | 6   | 8.2                              | 48                            |
| 983/987                 | Dapto BSP - Tallawarra SS                             | 132kV   | 3.1                              | 3.1                                   | 3.1  | 1               | 2   | 7.5                              | 49                            |
| 931                     | Baulkham Hills TS - Carlingford TS                    | 132kV   | 7.4                              | 4.5                                   | 4.5  | 1               | 0   | 6.5                              | 50                            |
| 7252/1                  | Fdr 7252/1 ICC Princes Hwy Maddens Plain              | 33kV    | 0.93                             | 0.93                                  | 0.93   | 1               | 0   | 8.2                              | 51                            |
| Total route length (km) |   |         | 940                              | 740                                   | 726  |                 |   |                                  |                               |

## 5.0 SCOPE OF WORK

It is proposed that approximately 222km (route length) of corroded steel OHEW are replaced in the FY18 and FY19 period on the feeders listed below:

### 132kV Feeders

1. Feeder 934 located near Transgrid's Wallerawang Bulk Supply Point to Hawkesbury TS (80.8km);
2. Feeder 940/941/942/93E which runs from Wallerawang Bulk Supply Point to Katoomba North TS, Lawson TS, Warrimoo TS and Penrith TS (65.2km);
3. Feeder 223/237/23C/23F – Sydney West BSP to Rooty Hill ZS / BHP (8.7km);
4. Feeder 93U – Sydney West BSP to Abbotsbury ZS (5km);
5. Feeder 988 – Dapto BSP to Tee 1 - Burrawang Pumps (21.6km);

### 33kV Feeders

1. Feeder 7510 – Bomaderry ZS to Meroo Meadow Tee (2.8km);
2. Feeder 7176 – Gerringong ZS to Berry ZS (13.1km);
3. Feeder 7534 – Ulladulla ZS to Relcoser A8324 (14km);
4. Feeder 7175 – Gerringong ZS to Jerrara SS (10.4km).

## 5.1 FEEDER 934 – FROM WALLERAWANG BSP TO HAWKESBURY TS

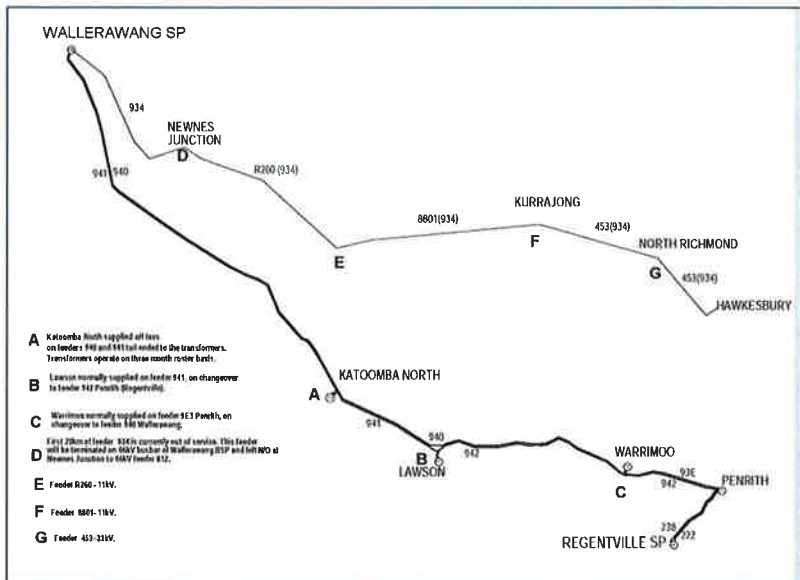
Feeder 934 was originally 132kV construction on twin wood poles with two OHEW and was 81km long. It is now split up and is operated as follows:

1. The original Feeder 934 from Wallerawang BSP to Newnes Junction which is 20km in length and is currently out of service. However, there is a plan to re-use this section to supply the Marangaroo development project at 66kV from Wallerawang BSP with an alternate open connection point to Feeder 812 at Newnes Junction;
2. From Newnes Junction to pole PL480331 (16km), it is operated at 11kV and is called Feeder R260;
3. From pole PL480331 to pole PL435155 which is near Kurrajong ZS it is called Feeder 8801 (28km) and is operated at 11kV. R260 and 8801 are connected to each other with underslung links at pole PL480331; and

4. The last 17 km section runs from near Kurrajong ZS to North Richmond ZS tee then on to Hawkesbury TS and is called Feeder 453, which is operated at 33kV.

Refer FIGURE 4 below for the arrangement of Feeder 934.

FIGURE 4 : FEEDER 934 ARRANGEMENT

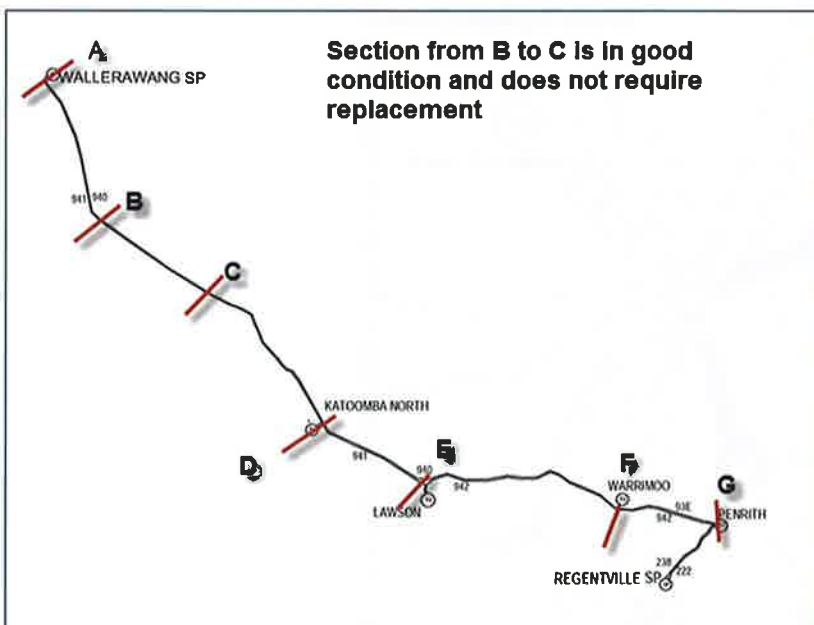


## 5.2 FEEDERS 940/941/942/93E WALLERAWANG BSP TO PENRITH TS

This 132kV steel tower double circuit line originally ran from Wallerawang BSP to Penrith TS and since then it has been teed off to Katoomba North TS and turned in and out of Lawson TS and Warrimoo TS on its way to Penrith TS. The total route length is 78km.

The majority of the twin OHEW on these towers are classified as category 4. However, there is a 12.5km section midway between Wallerawang BSP and Katoomba North TS which appears to have been replaced and is in good condition (category 2) and therefore does not require replacement. This section is shown in FIGURE 5 below.

FIGURE 5 : FEEDERS 940/941/942/93E LAYOUT

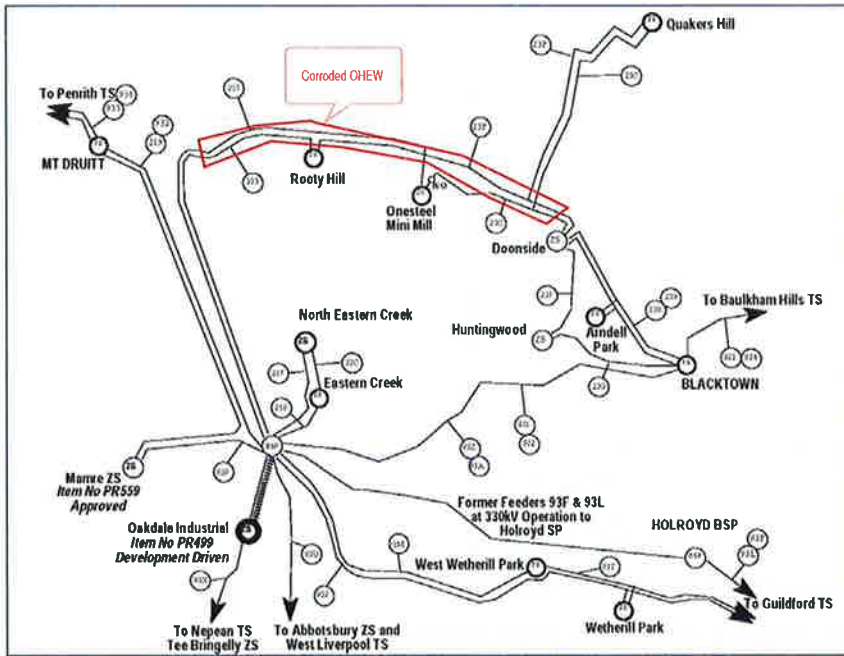




### 5.3 FEEDER 223/237/23C/23F – SYDNEY WEST BSP TO ROOTY HILL ZS / BHP / DOONSIDE

The corroded earth wires are in the vicinity of tower PL530324 and extend in both directions as shown by the red outline in FIGURE 6 below.

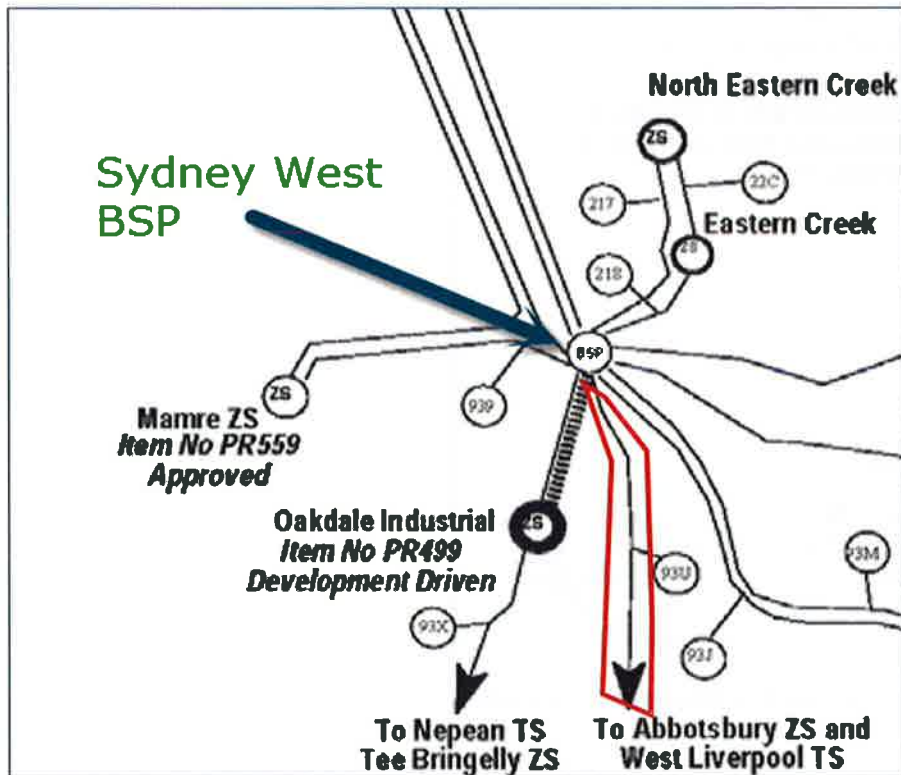
FIGURE 6 : FEEDER 223/237/23C/23F



### 5.4 FEEDER 93U – SYDNEY WEST BSP TO ABBOTSBURY ZS

The corroded OHEW is on the 93U side of the double circuit line and runs the entire length from Sydney West BSP to Abbotsbury ZS as shown by the red outline in FIGURE 7 below. The other OHEW is OPGW and does not require replacement.

FIGURE 7 : FEEDER 93U

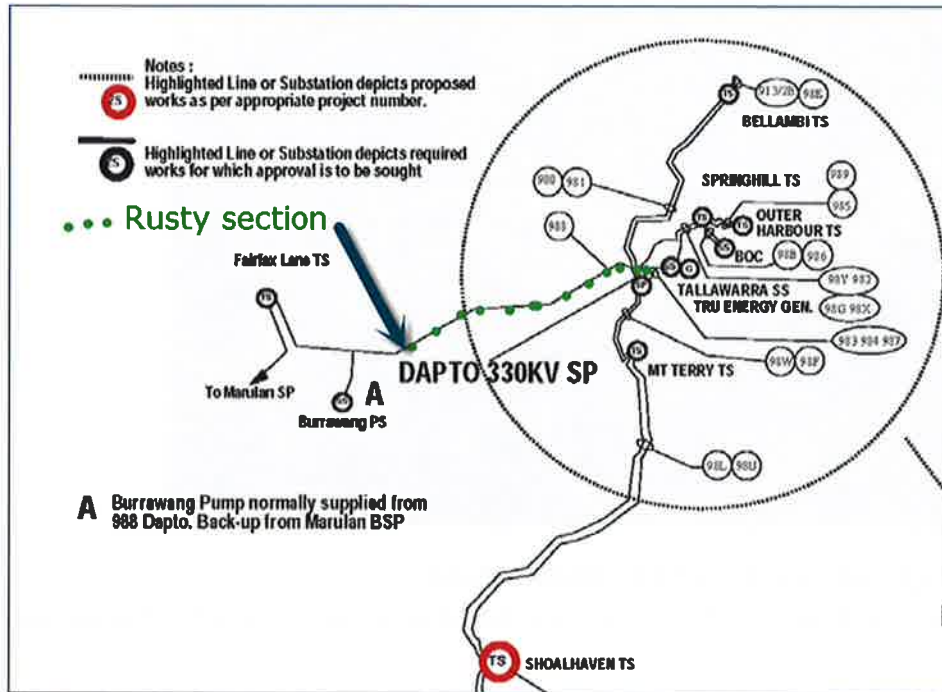




## 5.5 FEEDER 988 – DAPTO BSP TO TEE 1 - BURRAWANG PUMPS

Feeder 988 runs from Dapto TS to Fairfax Lane TS with a tee to Burrawang Pumping station. The corroded section is approximately 20km in length and is located between Dapto TS and the tee to Burrawang Pumping Station. Refer FIGURE 8 below which shows the corroded section as green dots.

FIGURE 8 : FEEDER 988



## 5.6 FEEDER 7510 – BOMADERRY ZS TO MEROO MEADOW TEE

The OHEW on the entire feeder from Bomaderry ZS to the tee at Merroo Meadow ZS as shown in FIGURE 10 is corroded.

FIGURE 9 : FEEDER 7510



## 5.7 FEEDER 7176 – GERRINGONG ZS TO BERRY ZS

The OHEW on the entire feeder from Gerringong ZS to Berry ZS as shown in FIGURE 10 is corroded.

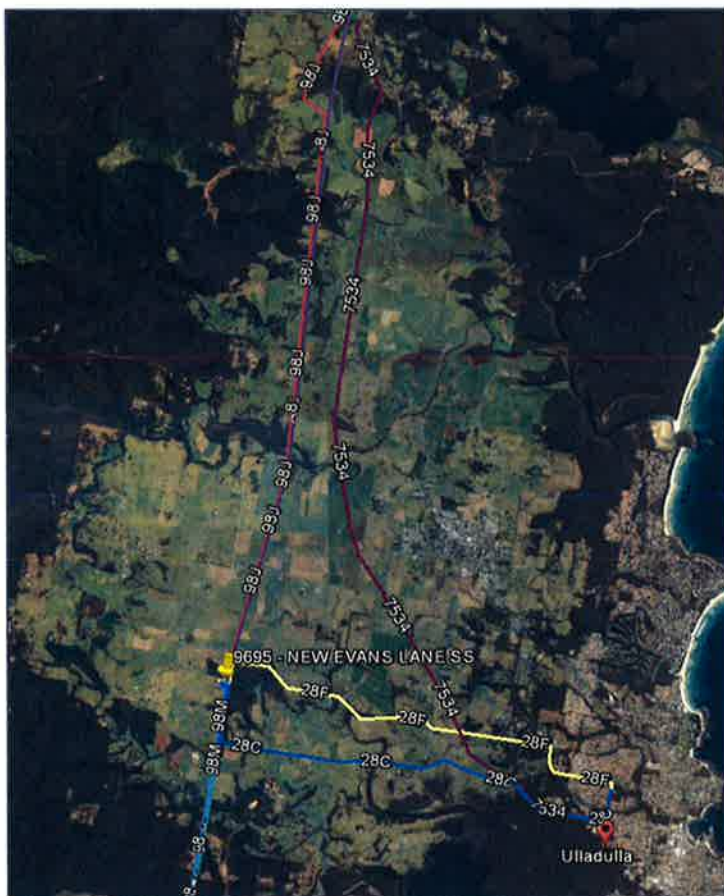
FIGURE 10 : FEEDER 7176



## 5.8 FEEDER 7534 – ULLADULLA ZS TO RECLOSER A8324

The OHEW on the entire feeder from Ulladulla ZS to the recloser A8324 as shown in FIGURE 11 is corroded.

FIGURE 11 : FEEDER 7534

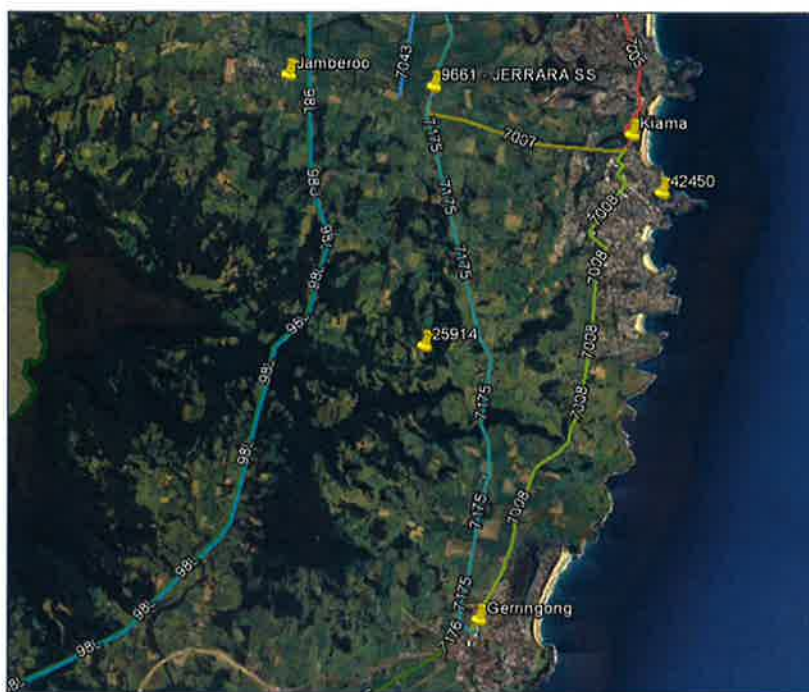




## 5.9 FEEDER 7175 – GERRINGONG ZS TO JERRARA SS

The OHEW on the entire feeder from Gerringong ZS to Jerrara SS as shown in FIGURE 12 is corroded.

FIGURE 12 : FEEDER 7175



## 6.0 COST ESTIMATES

Cost estimates have been provided by Assets Standards and Design section taking into account major road crossings and access issues. Table 5 below shows a summary of the cost estimates in real 2017/18 terms. The average unit rate is \$34,000 per route length km. The actual unit rate varies from site to site due to constraints such as access, road and rail crossings and is shown as per circuit length basis (rather than the per route length) in the table.

Refer Appendix C for further detail of the cost estimates.

TABLE 5 : COST ESTIMATES FOR STEEL OHEW REPLACEMENTS (REAL\$ 2017/18)

| Feeder number                                | Location  | Voltage | Construction | Feeder route length (km) | Route length of steel EW (km) | Cost Estimate (\$) | Unit rate/km based on circuit length (\$) |
|--|---|---------|--------------|--------------------------|-------------------------------|--------------------|---|
| 934  | Wallerawang BSP - Hawkesbury TS (used at 11kV in parts) | 132kV   | SC WP        | 80.8                     | 80.8                          | 3,250,000          | 20,000                                    |
| 940/941/942/93E                              | Wallerawang BSP to Penrith TS                           | 132kV   | DC ST        | 77.7                     | 65.2                          | 2,170,000          | 17,000                                    |
| 223/237                                      | Sydney West BSP - Rooty Hill ZS / BHP                   | 132kV   | DC ST        | 10.8                     | 6.2                           | 240,000            | 39,000                                    |
| 237/23C                                      | Rooty Hill ZS - Onesteel                                | 132kV   | DC ST        | 1.9                      | 1.08                          | 90,000             | 42,000                                    |
| 23C/23F                                      | Doonside ZS – Rooty Hill ZS/Doonside ZS - Onesteel      | 132kV   | DC ST        | 3.3                      | 1.4                           | 140,000            | 50,000                                    |
| 93U  | Sydney West BSP - Abbotsbury ZS                         | 132kV   | DC ST        | 10.5                     | 5                             | 120,000            | 24,000                                    |
| 988  | Dapto BSP - Tee 1 (Burrawang Pumps)                     | 132kV   | SC WP        | 32.6                     | 21.6                          | 640,000            | 30,000                                    |
| 7510   | Bomaderry ZS to Meroo Meadow Tee                        | 33kV    | SC WP        | 4.5                      | 2.8                           | 90,000             | 32,000                                    |
| 7176   | Gerringong ZS to Berry ZS                               | 33kV    | SC WP        | 13.1                     | 13.1                          | 310,000            | 24,000                                    |
| 7534   | Ulladulla ZS to Rec A8324                               | 33kV    | SC WP        | 14                       | 14                            | 320,000            | 23,000                                    |
| 7175   | Gerringong ZS to Jerrara SS                             | 33kV    | SC WP        | 10.4                     | 10.4                          | 200,000            | 19,000                                    |
| <b>Totals</b>                                |   |         |              | <b>260</b>               | <b>222</b>                    | <b>7,570,000</b>   |   |
| <b>Total cost (to nearest \$0.1 million)</b> |   |         |              |                          |                               | <b>7,600,000</b>   |   |

## 6.1 DISPOSAL OF SCRAP METAL

OHEW removed from the network is to be disposed of as per the scrap metal disposal process, "GSU 0009 DISPOSAL OF SCRAP METAL". Generally the disposal of scrap steel is cost neutral (as the scrap metal dealer supplies and picks up the bins containing scrap metal at no cost to Endeavour Energy) and therefore this is expected to have no impact on the cost of this project.

## 6.2 CONTINGENCY PROVISION

A contingency amount of \$0.4 million is proposed to allow for additional costs, which may be incurred due to additional fittings needing replacement that may be discovered during the replacement works.

The specific contingencies that are allowed are shown in Table 6 below and represent 5% of the base cost of the project.

Table 6: CONTINGENCY ALLOWANCE

| Contingency item   | Allowance (\$) |
|--|----------------|
| Additional fittings requiring replacement which are discovered whilst the work is being carried out. | 400,000        |
| Total  | 400,000        |

## 7.0 FUNDING PROVISION

Funding for these works are provided in SARP program TM171-Replacement of Corroded Earthwires. It is estimated that these OHEW replacements will be carried out over the two year period from 2017/18 to 2018/19.

PIP V 8.5 includes a funding provision of \$10.6 million over this period, which is adequate for this project.

A cash flow representing the expected expenditure spread is shown in Table 7 below.

TABLE 7 – CAPEX PROJECT EXPENDITURE SPREAD

| Estimated cost                       | 2017/18 | 2018/19 | Total costs<br>(\$ ) |
|--------------------------------------|---------|---------|----------------------|
| PIP 8.5 (nominal \$)                 | 2.3     | 8.3     | 10.6                 |
| Project base costs (real 2017/18 \$) | 3.8     | 3.8     | 7.6                  |
| Project costs (nominal \$)           | 3.8     | 3.9     | 7.7                  |
| Contingency                          | 0.2     | 0.2     | 0.4                  |
| Total project costs (\$)             |         |         | 8.1                  |

## 8.0 RECOMMENDATIONS

Accordingly, it is recommended that:

- A capital expenditure of \$7.7 million for TM171 – Replacement of corroded earth wires as outlined in this business case during 2017/18 – 2018/19 be approved; and
- A contingency sum of \$0.4 million, representing approximately 5% of the estimated cost of the project to cover the replacement of additional fittings that may be discovered during the replacement works.

The total project estimate, including the base cost and contingency allowance totals \$8.1 million.



## 9.0 APPENDICES

Appendix A - TB-0194 Assessment criteria for overhead steel conductors

Appendix B - TM171 – Steel OHEW Survey 2015/16

Appendix C – Cost estimate detail

## 10.0 REFERENCES

1. TM171 – Replacement of corroded earth wires, Business Case for 2015/16 Scoping Study, October 2015.
2. The New South Wales Wind Atlas - Wind Energy Research Unit and their wind resource assessment tools is available online at <http://www.clw.csiro.au/products/windenergy/>

This page intentionally blank

## APPENDIX A - TB-0194 ASSESSMENT CRITERIA FOR OVERHEAD STEEL CONDUCTORS

This page intentionally blank



# TECHNICAL BULLETIN

## TB-0194

### Assessment Criteria for Overhead Steel Conductors

#### Purpose

The purpose of this technical bulletin is to inform staff and/or contractors of the assessment criteria for overhead steel conductors, to be used in conjunction with "TB-0189 - Further actions for overhead conductors found in poor condition".

#### Background

In TB-0189, it was stated that closer inspections of overhead steel conductors shall be undertaken if an overhead line was found to be in a poor condition. The following assessment criteria shall be used to evaluate the condition of overhead steel conductors and assign a defect priority for the replacement of the affected conductor span.

#### Actions

For overhead steel conductor inspections, particular attention should be given to the colour and pitting of the metal as well as fraying or broken strands. Other contributory factors such as the location of the overhead mains (e.g. bush fire prone area), and the criticality of the feeder may be included in a risk assessment. The risk assessment may necessitate a more immediate defect prioritisation than those given in the table below.

The following table provides guidance on the prioritisation of defects for the condition of overhead steel wires:

**Table 1 – Conditional categories for Overhead Steel Wires**

| Category | Description   | Defect Priority  |
|----------|---|--|
| 1        | <ul style="list-style-type: none"><li>No corrosion, 100% galvanized</li></ul>   | No action required   |
| 2        | <ul style="list-style-type: none"><li>Light surface corrosion with negligible pitting</li></ul>   | No action required   |
| 3        | <ul style="list-style-type: none"><li>Medium surface corrosion with mild pitting</li></ul>  | Plan to replace within 5 years.  |
| 4        | <ul style="list-style-type: none"><li>Heavy surface corrosion with mild to medium pitting (refer to Category 4 in Appendix 1)</li><li>Annealing or thinning of conductor</li></ul>  | Replace within 1 year  |
| 5        | <ul style="list-style-type: none"><li>Heavy surface corrosion with medium to heavy pitting (refer to Category 5 in Appendix 1)</li><li>Broken, frayed or split conductors under tension</li><li>Heavy surface corrosion as well as a history of conductor failure</li></ul> | Replace within 3 months or prior to the commencement of the bushfire season, whichever is earliest |

**Contact:** Andrew Tang

**Phone:** 9853 6714

**Date:** 2 July 2015

**Authorised by:** Jude Perera, Manager Primary Systems

51 Huntingwood Drive, Huntingwood NSW 2148

Telephone: 131 718 Fax: (02) 9853 6000

Postal Address: PO Box 811 Seven Hills NSW 1730.

Page 1 of 2



# TECHNICAL BULLETIN

## TB-0194

---

### Assessment Criteria for Overhead Steel Conductors

#### Appendix 1 - Visual comparison of conductor corrosion categories

- Category 1
- Category 2
- Category 3
- Category 4
- Category 5



---

**Contact:** Andrew Tang

**Phone:** 9853 6714

**Date:** 2 July 2015

**Authorised by:** Jude Perera, Manager Primary Systems

---

51 Huntingwood Drive, Huntingwood NSW 2148

Telephone: 131 718 Fax: (02) 9853 6000

Postal Address: PO Box 811 Seven Hills NSW 1730.

Page 2 of 2



# Appendix B- TM171 – STEEL OHEW SURVEY 2015/16

| Feeder number   | Location  | Voltage | Construction | Approx route length feeder (km) | Approx route length of steel EW (km) | Approx route length of corroded steel EW (km) | Steel OHEW type             | Approx location of steel EW section  | Survey category | Comments   |
|-----------------|---|---------|--------------|---------------------------------|--------------------------------------|---|-----------------------------|--|-----------------|--|
| 7253            | Darques Forest ZS to Helensburgh ZS                     | 33kV    | SC WP        | 6.9                             | 0.96                                 | 0.96  | 7/0.128 SC/GZ               | Entire length  | 5.00            | Near Darques Forest ZS 875m and near Parkes St Helensburgh 80m                               |
| 7095            | FROM ABS 79473 to ABS 73347 near Lake Cordeaux          | 33kV    | SC WP        | 14.4                            | 14.4                                 | 14.4  | 7/0.128 SC/GZ               | Entire length  | 5.00            | majority of the feeder   |
| 934             | Wallerawang BSP - Hawkesbury TS (used at 11kV in parts) | 132kV   | SC WP        | 80.8                            | 80.8                                 | 80.8  | 2 x SC/GZ 7/0.128           | Check EW entire length – confirm details   | 5.00            | To be replaced   |
| 220/239         | Blacktown TS - Doonside ZS                              | 132kV   | DC ST        | 4.5                             | 2.6                                  | 2.6   | 2 x SC/GZ 7/0.144           | Near Doonside ZS   | 5.00            | some sections have been replaced - Need OPGW   |
| 7252/2          | Fdr 7252/2 Saywell Place Wombarra Fdr 7252/2 St 5Y      | 33kV    | SC WP        | 3.5                             | 3.5                                  | 0.36  | 7/0.128 SC/GZ               | Entire length  | 5.00            | 364m section from the bottom to top of the escarpment from pole PL793542 to pole PL779360    |
| 7252            | Darques Forest ZS to TEE                                | 33kV    | SC WP        | 0.92                            | 0.92                                 | 0.92  | 7/0.128 SC/GZ               | Entire length  | 5.00            | From Darques Forest ZS across Princess Highway to pole PL3JT019 (the Tee)s in poor condition |
| 931             | Baulkham Hills TS - Carlingford TS                      | 132kV   | DC ST        | 7.4                             | 4.5                                  | 4.5   | SC/GZ 7/0.128               | Steel EW at Carlingford end, one side, OPGW other side   | 5.00            | 930 is on the same tower and has OPGW  |
| 940/941/942/93E | Wallerawang BSP to Penrith TS                           | 132kV   | DC ST        | 77.7                            | 62.2                                 | 62.2  | 2 x SC/GZ 7/0.128           | Entire length  | 4.00            |  |
| 223/237         | Sydney West BSP - Rooty Hill ZS / BHP                   | 132kV   | DC ST        | 10.8                            | 6.2                                  | 6.2   | 2 x SC/GZ 7/0.144           | Sections 3km away from Sydney West   | 4.00            |  |
| 93U             | Sydney West BSP - Abbotsbury ZS                         | 132kV   | DC ST        | 10.5                            | 5                                    | 5   | SC/GZ 7/0.128 + OPGW        | Near Abbotsbury ZS   | 4.00            |  |
| 237/23C         | Rooty Hill ZS - Onesteel                                | 132kV   | DC ST        | 1.9                             | 1.08                                 | 1.08  | 2 x SC/GZ 7/0.144           | Almost entire section  | 4.00            |  |
| 7176            | Gerrigong ZS to Berry ZS                                | 33kV    | SC WP        | 13.1                            | 13.1                                 | 13.1  | 7/0.128 SC/GZ               | Entire length  | 4.00            | some sections cat 4  |
| 988             | Dapto BSP - Tee 1 (Burrawang Pumps)                     | 132kV   | SC WP        | 32.6                            | 21.6                                 | 21.6  | 2 x SC/GZ 7/0.128           | 1.6km 330m from Daplo BSP + 20km to tee to Burrawang. Note 3.6km section of CDC 4.1km from Daplo | 4.00            | half the feeder 10km   |
| 23C/23F         | Doonside ZS - Rooty Hill ZS/Doonside ZS - Onesteel      | 132kV   | DC ST        | 3.3                             | 1.4                                  | 1.4   | 2 x SC/GZ 7/0.144           | Near Doonside ZS   | 4.00            | 23C OPGW 23F STEEL   |
| 7510            | Bomaderry ZS to Meroo Meadow Tee                        | 33kV    | SC WP        | 4.5                             | 4.5                                  | 4.5   | 7/0.128 SC/GZ               | Entire length  | 4.00            | Not in original scope  |
| 7534            | Ulladulla ZS to Rec A8324                               | 33kV    | SC WP        | 14                              | 14                                   | 14  | 7/0.128 SC/GZ               | Entire length  | 4.00            | Not in original scope  |
| 7175            | Gerrigong ZS to Jerrara SS                              | 33kV    | SC WP        | 10.4                            | 10.4                                 | 10.4  | 7/0.128 SC/GZ               | Entire length  | 4.00            | Not in original scope  |
| 93J             | Sydney West BSP - West Wetherill Park TS                | 132kV   | DC ST        | 6.5                             | 2.1                                  | 2.1   | SC/GZ 7/0.128 + 11.4mm OPGW | Steel EW last 2.1km into West Wetherill Park TS  | 3.00            | 93M OPGW/ 93J STEEL  |
| 93J             | West Wetherill Park TS - Guildford TS                   | 132kV   | DC ST        | 4.6                             | 4.6                                  | 4.6   | SC/GZ 7/0.128 + 11.4mm OPGW | Steel EW 4.6km out of West Wetherill Park TS   | 3.00            | 93T on the same tower - OPGW   |
| 98M             | Evans Lane SS - Batemans bay TS                         | 132kV   | SC WP        | 53.7                            | 52.5                                 | 52.5  | 2.7 GAL                     | Steel EW starts 1.2km south of Evans Lane SS   | 3.00            | about half the feeder is 3 most sections 1   |
| 933             | Penrith TS - near Mt Druitt TS                          | 132kV   | DC ST        | 9.4                             | 9.4                                  | 9.4   | 2 x SC/GZ 7/0.128           | Check EW type  | 3.00            | 936 on same tower - OPGW   |



| Feeder number | Location  | Voltage | Construction | Approx. feeder route length (km) | Approx. route length of steel EW (km) | Approx. route length of corroded steel EW (km) | Steel OHEW type           | Approx location of steel EW section   | Survey category | Comments  |
|---------------|---|---------|--------------|----------------------------------|---------------------------------------|--|---------------------------|---|-----------------|---|
| 7041          | Mt Terry TS to Dapto ZS                               | 33kV    | SC WP        | 12                               | 11                                    | 11   | 7/0.128 SC/GZ             | First section from Mount Terry TS   | 3.00            | 6.5 km section from pole PL4DJ048 (pole 51) to pole PL4AX074 (pole 14) - OPGW ?   |
| 685           | Gulldford TS to Yennora ZS                            | 33kV    | SC WP        | 5.1                              | 5                                     | 5  | 7/0.104 SC/GZ             | Entire Length   | 3.00            |   |
| 686_2         | Tee to Yennora ZS                                     | 33kV    | SC WP        | 4.2                              | 1.6                                   | 1.6  | 7/0.104 SC/GZ             | Near Yennora ZS   | 3.00            |   |
| 686_1         | Tee to Comalco HVC                                    | 33kV    | SC WP        | 4.2                              | 0.6                                   | 0.6  | 7/0.104 SC/GZ             | Near Comalco HVC  | 3.00            | HVC decommissioned - line OOS   |
| 93W           | Abbotsbury ZS - West Liverpool TS                     | 132kV   | DC ST        | 5.2                              | 4.9                                   | 4.9  | SC/GZ 7/0.128 + OPGW      | Entire length   | 3.00            |   |
| O/S 31        | Pole 801353 to PL 536261                              | 33kV    | SC WP        | 0.3                              | 0.3                                   | 0.3  | 7/0.104 SC/GZ             | Binalong Road to Wentworth Ave. Pendle Hill                                       | 3.00            |   |
| 9J3/9J4       | Blacktown TS - Baulkham Hills TS                      | 132kV   | DC ST        | 5.47                             | 3.962                                 | 3.962  | 2 x SC/GZ 7/0.128         |   | 3.00            |   |
| 464           | Kingswood ZS - tee to Glenmore Park ZS                | 33kV    | SC WP        | 3.9                              | 3.9                                   | 3.9  | SC/GZ 7/0.104             | Entire length   | 3.00            |   |
| 7120          | Dapto ZS to Unanderra ZS                              | 33kV    | SC WP        | 8                                | 8                                     | 8  | 7/0.128 SC/GZ             | Entire length   | 3.00            | Not in original scope - OPGW ?  |
| 7515          | Recloser 27291 to Berry ZS                            | 33kV    | SC WP        | 14                               | 14                                    | 14   | 7/0.128 SC/GZ             | Entire length   | 3.00            | Not in original scope   |
| 98L           | Mt Terry TS - Shoalhaven                              | 132kV   | SC WP        | 46.1                             | 36.4                                  | 36.4   | 2 x SC/GZ 7/3.25          | Steel EW for 32km starting 4.2km south of Mt Terry and for 4km into Shoalhaven TS | 2.00            | good - some sections AAC  |
| 98U           | Mt Terry TS - Shoalhaven                              | 132kV   | SC WP        | 46.3                             | 35.4                                  | 35.4   | 2 x SC/GZ 7/3.25          | Steel EW for 32km starting 4.2km south of Mt Terry and for 4km into Shoalhaven TS | 2.00            | Entire length in good condition   |
| 93X           | Sydney West BSP - Nepean TS (tee Bringelly)           | 132kV   | SC WP        | 32.3                             | 24.9                                  | 24.9   | 2 x SC/GZ 7/0.128         | Scattered along length of the feeder  | 2.00            | New ADSS proposed   |
| 9L5           | Nepean TS - Denham Court TS (tee South Leppington ZS) | 132kV   | SC WP        | 14.4                             | 9.1                                   | 9.1  | 2 x SC/GZ 7/0.128         | Scattered along length of the feeder  | 2.00            | New ADSS link from Smeaton Grange to Narellan proposed. Together with existing link from Nepean will make OPGW on PL5 unnecessary |
| 937           | Regentville BSP - North Warragamba ZS                 | 132kV   | SC ST        | 10.2                             | 10.2                                  | 10.2   | SC/GZ 7/0.128             | Entire length   | 2.00            |   |
| 93Y           | West Liverpool TS - Nepean TS                         | 132kV   | SC WP        | 9.4                              | 6                                     | 6  | 2 x SC/GZ 7/0.128         | Scattered along length of the feeder  | 2.00            |   |
| 98C           | Marulan BSP - Tee B                                   | 132kV   | SC WP        | 35.5                             | 34.4                                  | 34.4   | 2 x SC/GZ 7/0.128         | Almost entire length  | 2.00            | All inspected but no camera available, all earth wire in good condition for the complete feeder length                            |
| 933           | - Mt Druitt TS  | 132kV   | SC WP        | 0.5                              | 0.5                                   | 0.5  | SC/GZ 7/0.128 + aluminium | Section into Mt Druitt TS   | 2.00            |   |
| 7123          | Albion Park ZS to Open Bond at PL 4AV794              | 33kV    | SC WP        | 15.5                             | 9.8                                   | 9.8  | 7/0.104 SC/GZ             | First section from Albion Park ZS   | 2.00            | in good condition   |
| 7341          | Kembla Grange ZS to Dapto ZS                          | 33kV    | SC WP        | 6                                | 6                                     | 6  | 7/0.128 SC/GZ             | Entire length   | 2.00            | Entire length in good condition   |
| 988/98C       | Tee B - Fairfax Lane TS                               | 132kV   | DC ST        | 2.9                              | 2.9                                   | 2.9  | 2 x SC/GZ 7/0.128         | DC section into Fairfax Lane TS   | 2.00            | half the feeder   |



| Feeder number           | Location  | Voltage | Construction | Approx. feeder route length (km) | Approx. route length of steel EW (km) | Approx. route length of corroded steel EW (km) | Steel OHEW type             | Approx. location of steel EW section  | Survey category | Comments   |
|-------------------------|---|---------|--------------|----------------------------------|---------------------------------------|--|-----------------------------|---|-----------------|--|
| 988                     | Tee 1 – Tee B   | 132kV   | SC WP        | 8                                | 8                                     | 8  | 2 x SC/GZ 7/0.128           | Entire length   | 2.00            | half the feeder  |
| 988/1                   | Tee 1 – Burrawang Pumps                               | 132kV   | SC WP        | 2.2                              | 2.2                                   | 2.2  | 2 x SC/GZ 7/0.128           | Entire length   | 2.00            | 8.5 km section from pole PL206618 to Tallarawarra SS is cat 4, S |
| 98J                     | Shoalhaven TS - Evans Lane SS                         | 132kV   | SC WP        | 59.4                             | 32.3                                  | 32.3   | 2 x SC/GZ 7/3.25            | Steel EW for 8.7km starting 3.8km out of Shoalhaven TS then for 23.6km starting at 32.8km from Shoalhaven. Ends 3.0km from Evans Lane SS. | 1.00            |  |
| 98P                     | Shoalhaven TS – West Tomerong TS                      | 132kV   | SC WP        | 15.5                             | 15.5                                  | 15.5   | 2 x SC/GZ 7/3.25            | Entire length   | 1.00            | Entire length in good condition                                  |
| 28P                     | West Tomerong TS - Evans Lane SS                      | 132kV   | SC WP        | 39.5                             | 39.5                                  | 39.5   | 2 x SC/GZ 7/3.25            | Entire length   | 1.00            | Entire length in good condition                                  |
| 7252/3                  | Fdr 7252/3 Plateau Rd Stanwell Tops den Stanwell Tops | 33kV    | SC WP        | 7                                | 7                                     | 7  | 7/0.128 SC/GZ               | Entire length   | 1.00            | good   |
| 98H                     | Evans Lane Sw/Sin to Moruya North TS                  | 132kV   | SC WP        | 72.4                             | 71.3                                  | 71.3   | 2 x SC/GZ 7/0.128           | Steel EW starts 1.1km out of Evans Lane SS  | 1.00            | Entire length in good condition                                  |
| 983/987                 | Dapto BSP - Tallarawarra SS                           | 132kV   | DC ST        | 3.1                              | 3.1                                   | 3.1  | SC/GZ 7/0.128 + 11.4mm OPGW | Entire length   | 1.00            | Entire length in good condition                                  |
| 7252/1                  | Fdr 7252/1 ICC Princes Hwy Maddens Plain              | 33kV    | SC WP        | 0.93                             | 0.93                                  | 0.93   | 7/0.128 SC/GZ               | Entire length   | 1.00            | good   |
| Total route length (km) |   |         |              | 861                              | 740                                   | 726  |                             |   |                 |  |



## APPENDIX C : COST ESTIMATE DETAIL



# TRANSMISSION MAINS DEVELOPMENT

## PROJECT ESTIMATE SUMMARY

|                         |   |               |               |
|-------------------------|---|---------------|---------------|
| Project No              | TM171   | Revision      | A             |
| Project Name            | Replace corroded overhead earthwire feeder 988                            |               |               |
| Estimate Description    | Dapto to tee 1 replace 2 X 1.6km and 2 X 20km corroded overhead earthwire |               |               |
| Estimate Date           | 14/09/2017  | Estimate Type | Business Case |
| Applicable Labour Rates | Std Internal Rates (PPMS)   |               |               |

### Designed & Constructed In-House

|                          |    |         |                  |  |
|--------------------------|----|---------|------------------|--|
| Design                   | \$ | 15,261  | 160              | Design Man Hours   |
| Project Management       | \$ | 45,069  | 400              | Project Management Man Hours                               |
| Labour (Construction)    | \$ | 194,991 | 2448             | Construction Man Hours                                     |
| Plant & Equipment        | \$ | 62,787  | 3008             | Total Man Hours  |
| Materials - Stores       | \$ | 158,182 | \$ 0             | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | 0       |                  |  |
| Direct Charges/Materials | \$ | 119,450 | \$ 0             | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | 10,000  | \$ 0             | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | 0       |                  |  |
| Restoration              | \$ | 0       |                  |  |
| Provisions               | \$ | 30,000  |                  |  |
| Contingency              | \$ | 0       |                  |  |
| Profit                   | \$ | 0       |                  |  |
|                          |    |         | SUB TOTAL \$     | 635,740  |
|                          |    |         | ROUNDED TOTAL \$ | 635,800  |

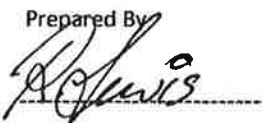
### Outsourcing Adjustment Factors

|                   |   |                          |   |
|-------------------|---|--------------------------|---|
| Design            | % | Plant & Equipment        | % |
| Labour            | % | Direct Charges/Materials | % |
| Civil/Restoration | % | ROUNDED REVISED TOTAL \$ |   |

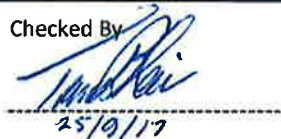
### Notes

1. Provision for overtime RMS & railway crossing

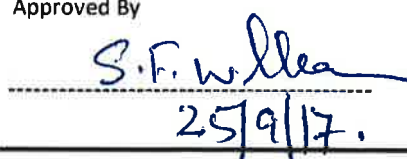
Prepared By



Checked By

  
25/9/17

Approved By

  
25/9/17.



## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |  |  |
|--------------------------|--|--|
| Design                   | \$ <input type="text" value="7,630"/>  | <input type="text" value="80"/> Design Man Hours   |
| Project Management       | \$ <input type="text" value="13,521"/> | <input type="text" value="120"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="29,312"/> | <input type="text" value="368"/> Construction Man Hours                                      |
| Plant & Equipment        | \$ <input type="text" value="8,748"/>  | <input type="text" value="568"/> Total Man Hours   |
| Materials - Stores       | \$ <input type="text" value="18,183"/> | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>      |  |
| Direct Charges/Materials | \$ <input type="text" value="17,980"/> | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="10,000"/> | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>      |  |
| Restoration              | \$ <input type="text" value="0"/>      |  |
| Provisions               | \$ <input type="text" value="0"/>      |  |
| Contingency              | \$ <input type="text" value="0"/>      |  |
| Profit                   | \$ <input type="text" value="0"/>      |  |

SUB TOTAL \$

ROUNDED TOTAL \$

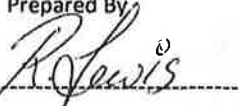
### Outsourcing Adjustment Factors

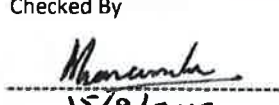
Design  %  
Labour  %  
Civil/Restoration  %

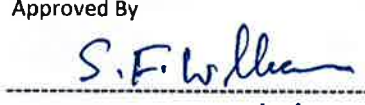
Plant & Equipment  %  
Direct Charges/Materials  %

ROUNDED REVISED TOTAL \$

### Notes

Prepared By  


Checked By  
  
15/9/2017

Approved By  
  
25/9/17

## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |  |  |
|--------------------------|--|--|
| Design                   | \$ <input type="text" value="7,630"/>  | <input type="text" value="80"/> Design Man Hours   |
| Project Management       | \$ <input type="text" value="13,521"/> | <input type="text" value="120"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="81,565"/> | <input type="text" value="1024"/> Construction Man Hours                                     |
| Plant & Equipment        | \$ <input type="text" value="28,582"/> | <input type="text" value="1224"/> Total Man Hours  |
| Materials - Stores       | \$ <input type="text" value="69,650"/> | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>      |  |
| Direct Charges/Materials | \$ <input type="text" value="58,200"/> | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="40,000"/> | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>      |  |
| Restoration              | \$ <input type="text" value="0"/>      |  |
| Provisions               | \$ <input type="text" value="0"/>      |  |
| Contingency              | \$ <input type="text" value="0"/>      |  |
| Profit                   | \$ <input type="text" value="0"/>      |  |
| SUB TOTAL \$             |  | <input type="text" value="299,148"/>   |
| ROUNDED TOTAL \$         |  | <input type="text" value="299,200"/>   |

### Outsourcing Adjustment Factors

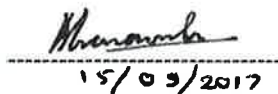
|  |   |
|--|---|
| Design <input type="text"/> %            | Plant & Equipment <input type="text"/> %        |
| Labour <input type="text"/> %            | Direct Charges/Materials <input type="text"/> % |
| Civil/Restoration <input type="text"/> % | ROUNDED REVISED TOTAL \$ <input type="text"/>   |

### Notes

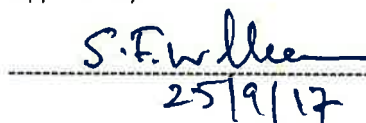
Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17



# TRANSMISSION MAINS DEVELOPMENT

## PROJECT ESTIMATE SUMMARY

|                         |  |               |               |
|-------------------------|--|---------------|---------------|
| Project No              | TM171  | Revision      | A             |
| Project Name            | Replace corroded OHEW feeder 23C/23F Doonside to One Steel 1 X 1.4km |               |               |
| Estimate Description    | Replace overhead earthwires pole 20B to pole12 38 on feeder 23F only |               |               |
| Estimate Date           | 05/09/2017   | Estimate Type | Business Case |
| Applicable Labour Rates | Std Internal Rates (PPMS)  |               |               |

### Designed & Constructed In-House

|                          |    |        |                  |  |
|--------------------------|----|--------|------------------|--|
| Design                   | \$ | 7,630  | 80               | Design Man Hours   |
| Project Management       | \$ | 24,788 | 220              | Project Management Man Hours                               |
| Labour (Construction)    | \$ | 53,527 | 672              | Construction Man Hours                                     |
| Plant & Equipment        | \$ | 8,883  | 972              | Total Man Hours  |
| Materials - Stores       | \$ | 12,606 | \$ 0             | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | 0      |                  |  |
| Direct Charges/Materials | \$ | 10,160 | \$ 0             | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | 0      | \$ 0             | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | 0      |                  |  |
| Restoration              | \$ | 0      |                  |  |
| Provisions               | \$ | 20,000 |                  |  |
| Contingency              | \$ | 0      |                  |  |
| Profit                   | \$ | 0      |                  |  |
|                          |    |        | SUB TOTAL \$     | 137,594  |
|                          |    |        | ROUNDED TOTAL \$ | 137,600  |

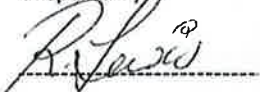
### Outsourcing Adjustment Factors

|                   |   |                          |   |
|-------------------|---|--------------------------|---|
| Design            | % | Plant & Equipment        | % |
| Labour            | % | Direct Charges/Materials | % |
| Civil/Restoration | % | ROUNDED REVISED TOTAL \$ |   |

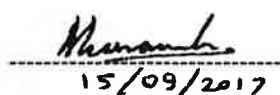
### Notes

1. Provision for 1 X rail crossing span at overtime rates.
2. Provision for 1 X RMS crossing spans at overtime rates.
3. Existing OPGW on feeder 23C (pole 20 to pole 24A)

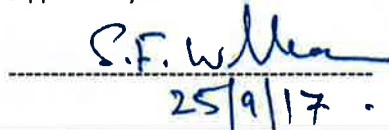
Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17

## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |  |  |
|--------------------------|--|--|
| Design                   | \$ <input type="text" value="7,630"/>  | <input type="text" value="80"/> Design Man Hours   |
| Project Management       | \$ <input type="text" value="24,788"/> | <input type="text" value="220"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="39,508"/> | <input type="text" value="496"/> Construction Man Hours                                      |
| Plant & Equipment        | \$ <input type="text" value="8,947"/>  | <input type="text" value="796"/> Total Man Hours   |
| Materials - Stores       | \$ <input type="text" value="15,683"/> | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>      |  |
| Direct Charges/Materials | \$ <input type="text" value="14,250"/> | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="0"/>      | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>      |  |
| Restoration              | \$ <input type="text" value="0"/>      |  |
| Provisions               | \$ <input type="text" value="10,000"/> |  |
| Contingency              | \$ <input type="text" value="0"/>      |  |
| Profit                   | \$ <input type="text" value="0"/>      |  |
| SUB TOTAL \$             |  | <input type="text" value="120,806"/>   |
| ROUNDED TOTAL \$         |  | <input type="text" value="120,900"/>   |

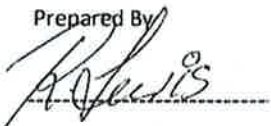
### Outsourcing Adjustment Factors

|   |  |
|---|--|
| Design <input type="text" value=""/> %            | Plant & Equipment <input type="text" value=""/> %        |
| Labour <input type="text" value=""/> %            | Direct Charges/Materials <input type="text" value=""/> % |
| Civil/Restoration <input type="text" value=""/> % | ROUNDED REVISED TOTAL \$ <input type="text" value=""/>   |

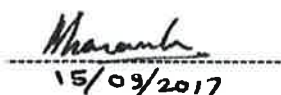
### Notes

1. Provision for 1 X RMS crossing spans at overtime rates.
2. Existing OPGW on feeder replace 1 X steel OHEW only

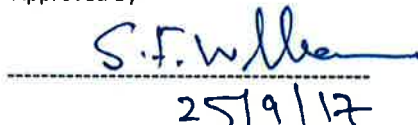
Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17



## TRANSMISSION MAINS DEVELOPMENT

### PROJECT ESTIMATE SUMMARY

Project No

Revision

Project Name

Estimate Description

Estimate Date

Estimate Type

Applicable Labour Rates

#### Designed & Constructed In-House

|                          |    |                                      |                                      |  |
|--------------------------|----|--------------------------------------|--------------------------------------|--|
| Design                   | \$ | <input type="text" value="7,630"/>   | <input type="text" value="80"/>      | Design Man Hours   |
| Project Management       | \$ | <input type="text" value="24,788"/>  | <input type="text" value="220"/>     | Project Management Man Hours                               |
| Labour (Construction)    | \$ | <input type="text" value="116,612"/> | <input type="text" value="1464"/>    | Construction Man Hours                                     |
| Plant & Equipment        | \$ | <input type="text" value="21,857"/>  | <input type="text" value="1764"/>    | Total Man Hours  |
| Materials - Stores       | \$ | <input type="text" value="25,322"/>  | \$ <input type="text" value="0"/>    | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | <input type="text" value="0"/>       |                                      |  |
| Direct Charges/Materials | \$ | <input type="text" value="28,570"/>  | \$ <input type="text" value="0"/>    | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | <input type="text" value="0"/>       | \$ <input type="text" value="0"/>    | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | <input type="text" value="0"/>       |                                      |  |
| Restoration              | \$ | <input type="text" value="0"/>       |                                      |  |
| Provisions               | \$ | <input type="text" value="20,000"/>  |                                      |  |
| Contingency              | \$ | <input type="text" value="0"/>       |                                      |  |
| Profit                   | \$ | <input type="text" value="0"/>       |                                      |  |
|                          |    | SUB TOTAL \$                         | <input type="text" value="244,779"/> |  |

ROUNDED TOTAL \$

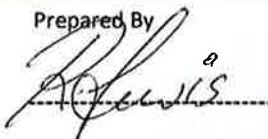
#### Outsourcing Adjustment Factors

|                   |                               |   |                          |                               |   |
|-------------------|-------------------------------|---|--------------------------|-------------------------------|---|
| Design            | <input type="text" value=""/> | % | Plant & Equipment        | <input type="text" value=""/> | % |
| Labour            | <input type="text" value=""/> | % | Direct Charges/Materials | <input type="text" value=""/> | % |
| Civil/Restoration | <input type="text" value=""/> | % | ROUNDED REVISED TOTAL \$ | <input type="text" value=""/> |   |


#### Notes

1. Provision for 1 X rail crossing spans at overtime rates.
2. Provision for 1 X RMS crossing spans at overtime rates.
3. Part existing OPGW on feeder 223 (structure 24 to tower 38)


Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17

## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |  |  |
|--------------------------|--|--|
| Design                   | \$ <input type="text" value="7,630"/>  | <input type="text" value="80"/> Design Man Hours   |
| Project Management       | \$ <input type="text" value="14,647"/> | <input type="text" value="130"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="34,410"/> | <input type="text" value="432"/> Construction Man Hours                                      |
| Plant & Equipment        | \$ <input type="text" value="7,081"/>  | <input type="text" value="642"/> Total Man Hours   |
| Materials - Stores       | \$ <input type="text" value="8,640"/>  | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>      |  |
| Direct Charges/Materials | \$ <input type="text" value="10,460"/> | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="0"/>      | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>      |  |
| Restoration              | \$ <input type="text" value="0"/>      |  |
| Provisions               | \$ <input type="text" value="10,000"/> |  |
| Contingency              | \$ <input type="text" value="0"/>      |  |
| Profit                   | \$ <input type="text" value="0"/>      |  |
|                          |  | SUB TOTAL \$ <input type="text" value="92,869"/>   |
|                          |  | ROUNDED TOTAL \$ <input type="text" value="92,900"/>   |

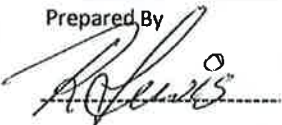
### Outsourcing Adjustment Factors

|   |  |
|---|--|
| Design <input type="text" value=""/> %            | Plant & Equipment <input type="text" value=""/> %        |
| Labour <input type="text" value=""/> %            | Direct Charges/Materials <input type="text" value=""/> % |
| Civil/Restoration <input type="text" value=""/> % | ROUNDED REVISED TOTAL \$ <input type="text" value=""/>   |

### Notes

1. Overtime provision for RMS crossing.
2. Feeder 23C existing 48 fibre OPGW

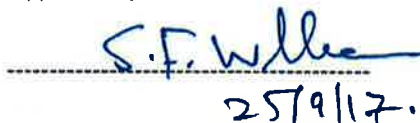
Prepared By



Checked By

  
15/05/2017

Approved By

  
25/9/17.



# TRANSMISSION MAINS DEVELOPMENT

## PROJECT ESTIMATE SUMMARY

Project No TM171

Revision A

Project Name Replacement of corroded overhead earthwire feeder 934 (2 X 70kM)

Estimate Description replace both steel earthwires between Richmond ZS & Wallerawang

Estimate Date 31/08/2017

Estimate Type Business Case

Applicable Labour Rates Std Internal Rates (PPMS)

### Designed & Constructed In-House

|                          |    |           |              |  |
|--------------------------|----|-----------|--------------|--|
| Design                   | \$ | 30,522    | 320          | Design Man Hours   |
| Project Management       | \$ | 67,604    | 600          | Project Management Man Hours                               |
| Labour (Construction)    | \$ | 1,172,492 | 14720        | Construction Man Hours                                     |
| Plant & Equipment        | \$ | 280,270   | 15640        | Total Man Hours  |
| Materials - Stores       | \$ | 412,611   | \$ 0         | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | 0         |              |  |
| Direct Charges/Materials | \$ | 657,000   | \$ 0         | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | 15,000    | \$ 0         | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | 0         |              |  |
| Restoration              | \$ | 0         |              |  |
| Provisions               | \$ | 611,000   |              |  |
| Contingency              | \$ | 0         |              |  |
| Profit                   | \$ | 0         |              |  |
|                          |    |           | SUB TOTAL \$ | 3,246,498  |

ROUNDED TOTAL \$ 3,246,500

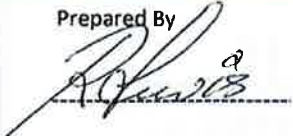
### Outsourcing Adjustment Factors

|                   |  |   |                          |  |   |
|-------------------|--|---|--------------------------|--|---|
| Design            |  | % | Plant & Equipment        |  | % |
| Labour            |  | % | Direct Charges/Materials |  | % |
| Civil/Restoration |  | % | ROUNDED REVISED TOTAL \$ |  |   |

### Notes

1. Provision for \$491,000 access tracks upgrade ★
2. Provision for \$65,000 vegetation management.
3. provision for \$72,00 for traffic control


Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17

## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |   |  |
|--------------------------|---|--|
| Design                   | \$ <input type="text" value="30,522"/>    | <input type="text" value="320"/> Design Man Hours  |
| Project Management       | \$ <input type="text" value="67,604"/>    | <input type="text" value="600"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="1,180,139"/> | <input type="text" value="14816"/> Construction Man Hours                                    |
| Plant & Equipment        | \$ <input type="text" value="264,548"/>   | <input type="text" value="15736"/> Total Man Hours   |
| Materials - Stores       | \$ <input type="text" value="361,685"/>   | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>         |  |
| Direct Charges/Materials | \$ <input type="text" value="627,000"/>   | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="15,000"/>    | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>         |  |
| Restoration              | \$ <input type="text" value="0"/>         |  |
| Provisions               | \$ <input type="text" value="55,000"/>    |  |
| Contingency              | \$ <input type="text" value="0"/>         |  |
| Profit                   | \$ <input type="text" value="0"/>         |  |
| SUB TOTAL \$             |   | <input type="text" value="2,601,496"/>   |
| ROUNDED TOTAL \$         |   | <input type="text" value="2,601,500"/>   |

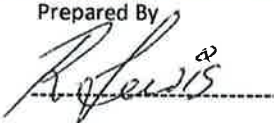
### Outsourcing Adjustment Factors

|                   |                        |                          |                        |
|-------------------|------------------------|--------------------------|------------------------|
| Design            | <input type="text"/> % | Plant & Equipment        | <input type="text"/> % |
| Labour            | <input type="text"/> % | Direct Charges/Materials | <input type="text"/> % |
| Civil/Restoration | <input type="text"/> % | ROUNDED REVISED TOTAL \$ | <input type="text"/>   |

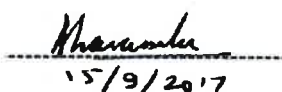
### Notes

1. provision for \$72,00 for traffic control

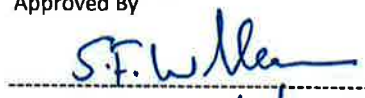
Prepared By



Checked By

  
15/9/2017

Approved By

  
25/9/17



## TRANSMISSION MAINS DEVELOPMENT

### PROJECT ESTIMATE SUMMARY

Project No

Revision

Project Name

Estimate Description

Estimate Date

Estimate Type

Applicable Labour Rates

#### Designed & Constructed In-House

|                          |    |                                     |                                   |  |
|--------------------------|----|-------------------------------------|-----------------------------------|--|
| Design                   | \$ | <input type="text" value="7,630"/>  | <input type="text" value="80"/>   | Design Man Hours   |
| Project Management       | \$ | <input type="text" value="20,281"/> | <input type="text" value="180"/>  | Project Management Man Hours                               |
| Labour (Construction)    | \$ | <input type="text" value="50,341"/> | <input type="text" value="632"/>  | Construction Man Hours                                     |
| Plant & Equipment        | \$ | <input type="text" value="14,021"/> | <input type="text" value="892"/>  | Total Man Hours  |
| Materials - Stores       | \$ | <input type="text" value="20,914"/> | \$ <input type="text" value="0"/> | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | <input type="text" value="0"/>      |                                   |  |
| Direct Charges/Materials | \$ | <input type="text" value="20,550"/> | \$ <input type="text" value="0"/> | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | <input type="text" value="0"/>      | \$ <input type="text" value="0"/> | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | <input type="text" value="0"/>      |                                   |  |
| Restoration              | \$ | <input type="text" value="0"/>      |                                   |  |
| Provisions               | \$ | <input type="text" value="10,000"/> |                                   |  |
| Contingency              | \$ | <input type="text" value="0"/>      |                                   |  |
| Profit                   | \$ | <input type="text" value="0"/>      |                                   |  |

SUB TOTAL \$

ROUNDED TOTAL \$

#### Outsourcing Adjustment Factors

Design  %

Plant & Equipment  %

Labour  %

Direct Charges/Materials  %

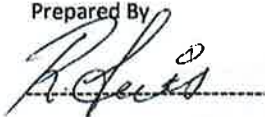
Civil/Restoration  %

ROUNDED REVISED TOTAL \$

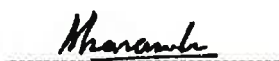
#### Notes

1. Provision for overtime RMS crossing


Prepared By



Checked By

  
13/09/2017

Approved By

  
25/9/17

## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |  |  |
|--------------------------|--|--|
| Design                   | \$ <input type="text" value="7,630"/>  | <input type="text" value="80"/> Design Man Hours   |
| Project Management       | \$ <input type="text" value="22,535"/> | <input type="text" value="200"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="58,625"/> | <input type="text" value="736"/> Construction Man Hours                                      |
| Plant & Equipment        | \$ <input type="text" value="18,762"/> | <input type="text" value="1016"/> Total Man Hours  |
| Materials - Stores       | \$ <input type="text" value="41,889"/> | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>      |  |
| Direct Charges/Materials | \$ <input type="text" value="38,400"/> | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="0"/>      | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>      |  |
| Restoration              | \$ <input type="text" value="0"/>      |  |
| Provisions               | \$ <input type="text" value="10,000"/> |  |
| Contingency              | \$ <input type="text" value="0"/>      |  |
| Profit                   | \$ <input type="text" value="0"/>      |  |
| SUB TOTAL \$             |  | <input type="text" value="197,841"/>   |
| ROUNDED TOTAL \$         |  | <input type="text" value="197,900"/>   |

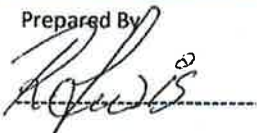
### Outsourcing Adjustment Factors

|                   |                        |                          |                        |
|-------------------|------------------------|--------------------------|------------------------|
| Design            | <input type="text"/> % | Plant & Equipment        | <input type="text"/> % |
| Labour            | <input type="text"/> % | Direct Charges/Materials | <input type="text"/> % |
| Civil/Restoration | <input type="text"/> % | ROUNDED REVISED TOTAL \$ | <input type="text"/>   |

### Notes

1. 3 pans from Gerringong ZS existing 19/3.25AAC - no rail crossing required

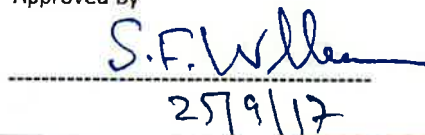
Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17



## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No

Revision

Project Name

Estimate Description

Estimate Date

Estimate Type

Applicable Labour Rates

### Designed & Constructed In-House

|                          |    |                                      |                                   |  |
|--------------------------|----|--------------------------------------|-----------------------------------|--|
| Design                   | \$ | <input type="text" value="7,630"/>   | <input type="text" value="80"/>   | Design Man Hours   |
| Project Management       | \$ | <input type="text" value="24,788"/>  | <input type="text" value="220"/>  | Project Management Man Hours                               |
| Labour (Construction)    | \$ | <input type="text" value="110,877"/> | <input type="text" value="1392"/> | Construction Man Hours                                     |
| Plant & Equipment        | \$ | <input type="text" value="30,912"/>  | <input type="text" value="1692"/> | Total Man Hours  |
| Materials - Stores       | \$ | <input type="text" value="62,992"/>  | <input type="text" value="0"/>    | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | <input type="text" value="0"/>       |                                   |  |
| Direct Charges/Materials | \$ | <input type="text" value="55,390"/>  | <input type="text" value="0"/>    | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | <input type="text" value="0"/>       | <input type="text" value="0"/>    | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | <input type="text" value="0"/>       |                                   |  |
| Restoration              | \$ | <input type="text" value="0"/>       |                                   |  |
| Provisions               | \$ | <input type="text" value="20,000"/>  |                                   |  |
| Contingency              | \$ | <input type="text" value="0"/>       |                                   |  |
| Profit                   | \$ | <input type="text" value="0"/>       |                                   |  |

SUB TOTAL \$

ROUNDED TOTAL \$

### Outsourcing Adjustment Factors

Design  %

Plant & Equipment  %

Labour  %

Direct Charges/Materials  %

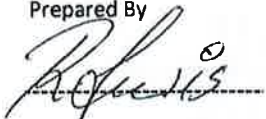
Civil/Restoration  %

ROUNDED REVISED TOTAL \$

### Notes

1. Provision for 1 X rail crossing spans at overtime rates.
2. Provision for 1 X RMS crossing spans at overtime rates.
3. Part existing OPGW from Gerringong ZS (4 spans)

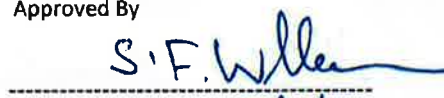
Prepared By



Checked By

  
15/09/2017

Approved By

  
25/9/17

## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No  Revision   
Project Name   
Estimate Description   
Estimate Date  Estimate Type   
Applicable Labour Rates

### Designed & Constructed In-House

|                          |  |  |
|--------------------------|--|--|
| Design                   | \$ <input type="text" value="3,815"/>  | <input type="text" value="40"/> Design Man Hours   |
| Project Management       | \$ <input type="text" value="11,267"/> | <input type="text" value="100"/> Project Management Man Hours                                |
| Labour (Construction)    | \$ <input type="text" value="24,215"/> | <input type="text" value="304"/> Construction Man Hours                                      |
| Plant & Equipment        | \$ <input type="text" value="7,516"/>  | <input type="text" value="444"/> Total Man Hours   |
| Materials - Stores       | \$ <input type="text" value="15,012"/> | \$ <input type="text" value="0"/> Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ <input type="text" value="0"/>      |  |
| Direct Charges/Materials | \$ <input type="text" value="15,410"/> | \$ <input type="text" value="0"/> 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ <input type="text" value="0"/>      | \$ <input type="text" value="0"/> 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ <input type="text" value="0"/>      |  |
| Restoration              | \$ <input type="text" value="0"/>      |  |
| Provisions               | \$ <input type="text" value="10,000"/> |  |
| Contingency              | \$ <input type="text" value="0"/>      |  |
| Profit                   | \$ <input type="text" value="0"/>      |  |
| SUB TOTAL \$             |  | <input type="text" value="87,235"/>  |
| ROUNDED TOTAL \$         |  | <input type="text" value="87,300"/>  |

### Outsourcing Adjustment Factors

|   |  |
|---|--|
| Design <input type="text" value=""/> %            | Plant & Equipment <input type="text" value=""/> %        |
| Labour <input type="text" value=""/> %            | Direct Charges/Materials <input type="text" value=""/> % |
| Civil/Restoration <input type="text" value=""/> % | ROUNDED REVISED TOTAL \$ <input type="text" value=""/>   |

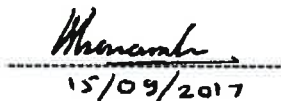
### Notes

1. Provision for 1 X rail crossing spans at overtime rates.
2. Provision for 1 X RMS crossing spans at overtime rates.
3. Part existing OPGW from Geeringong ZS (4 spans)

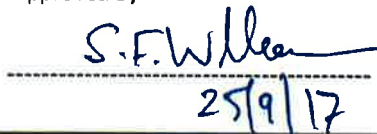
Prepared By

  
A. J. Lewis

Checked By

  
M. M. M. M.  
15/09/2017

Approved By

  
S. F. W. W.  
25/9/17



## TRANSMISSION MAINS DEVELOPMENT PROJECT ESTIMATE SUMMARY

Project No **TM171** Revision **A**  
Project Name **Replace corroded OHEW feeder 7534 Ulladulla ZS to recloser 8324 1 X 14kM**  
Estimate Description **Replace overhead earthwire structure 1 to structure 110A**  
Estimate Date **06/09/2017** Estimate Type **Business Case**  
Applicable Labour Rates **Std Internal Rates (PPMS)**

### Designed & Constructed In-House

|                          |    |               |                |  |
|--------------------------|----|---------------|----------------|--|
| Design                   | \$ | <b>7,630</b>  | <b>80</b>      | Design Man Hours   |
| Project Management       | \$ | <b>22,535</b> | <b>200</b>     | Project Management Man Hours                               |
| Labour (Construction)    | \$ | <b>96,221</b> | <b>1208</b>    | Construction Man Hours                                     |
| Plant & Equipment        | \$ | <b>34,855</b> | <b>1488</b>    | Total Man Hours  |
| Materials - Stores       | \$ | <b>81,438</b> | <b>0</b>       | Total Recovered Overheads<br>Included in subtotals to left |
| Cable - Non Stores       | \$ | <b>0</b>      |                |  |
| Direct Charges/Materials | \$ | <b>70,850</b> | <b>0</b>       | 1.5 OT Included in Labour Subtotal                         |
| Survey                   | \$ | <b>0</b>      | <b>0</b>       | 2.0 OT Included in Labour Subtotal                         |
| Civil Works              | \$ | <b>0</b>      |                |  |
| Restoration              | \$ | <b>0</b>      |                |  |
| Provisions               | \$ | <b>10,000</b> |                |  |
| Contingency              | \$ | <b>0</b>      |                |  |
| Profit                   | \$ | <b>0</b>      |                |  |
| SUB TOTAL \$             |    |               | <b>323,529</b> |  |
| ROUNDED TOTAL \$         |    |               | <b>323,600</b> |  |

### Outsourcing Adjustment Factors

|                   |            |                          |                |
|-------------------|------------|--------------------------|----------------|
| Design            | <b>0</b> % | Plant & Equipment        | <b>0</b> %     |
| Labour            | <b>0</b> % | Direct Charges/Materials | <b>0</b> %     |
| Civil/Restoration | <b>0</b> % | ROUNDED REVISED TOTAL \$ | <b>323,600</b> |

### Notes

1. Provision for 1 X rail crossing spans at overtime rates.
2. Provision for 1 X RMS crossing spans at overtime rates.
3. Part existing OPGW from Geeringong ZS (4 spans)

Prepared By

*A. Lewis*

Checked By

*Muramba*  
15/09/2017

Approved By

*S.F. Wilson*  
25/9/17