westernpower

Our ref: Greg Turnbull 9326 4476

14th June 2011

Mr Lyndon Rowe
Chairman
Economic Regulation Authority
Level 6, 197 St George's Terrace
Perth WA 6000

Dear Lyndon

Request for Waiver of Regulatory Test

Western Power is pleased to enclose a submission seeking the waiver of the application of the regulatory test by the Economic Regulation Authority in accordance with section 9.23 of the *Electricity Networks Access Code 2004* (the Code) in relation to a major augmentation to the Great Southern portion of the covered transmission network. Western Power presents this submission in accordance with section 9.24 of the Code.

Western Power's consideration of the major augmentation follows a request from a joint venture comprising Grange Resources Limited and Sojitz Resources & Technology Limited (the **SDJV**) to supply a magnetite mine located at Southdown (**Southdown Mine**), approximately 90 kilometres north-east of Albany, with 180 MW directly to the Southdown Mine and 11 MW at Albany to support related transportation infrastructure.

The Southdown Mine forms the core component of the broader project (**Southdown Project**), which encompasses the mining and processing of magnetite into concentrate at the Southdown Mine, and pumping that concentrate as slurry approximately 100 kilometres to a facility at the Albany Port, for shipment to Asia. The Southdown Project also includes an expansion of the Albany Port and the construction of a 100 km slurry pipeline and water return line, a concentrator plant and a desalination plant.

Construction of the transmission line is on the Southdown Project's critical path with the supply scheduled to commence by March 2014.

The Great Southern portion of the covered transmission network, particularly south of Muja, is facing long term capacity and voltage performance issues which will require major augmentation and investment by Western Power. These requirements will need to be addressed, regardless of whether the proposed major augmentation proceeds.

While Western Power initially developed a proposal which involved a dedicated supply for the Southdown Project, Western Power subsequently conducted a study (annexed to the enclosed submission) to ascertain the benefits and viability of integrating the works required to supply the Southdown Project with the future required upgrades to the Great Southern portion of the covered transmission network.

DM#: 8322029v3

Following a consideration of alternative options set out in this study, and in light of the Chapter 9 objectives, Western Power has concluded that the most appropriate major augmentation which maximises the net benefit to users while achieving the schedule required for the Southdown Project, comprises:

- Reinforcing the existing network by replacing the existing Muja to Kojonup 81 route with a 330 kV double circuit MUJ-KOJ section and rehabilitating the pre-existing line route; and
- building a single circuit 330 kV line from Kojonup to Southdown.

The estimated new facilities investment associated with this work is approximately $387.5 million. The work will meet SDJV's project requirements and also provide benefits to all users by reinforcing the Greater Southern transmission network, which will:

- realise up to $19.9 million in savings (in net present terms) to Western Power, when compared with Western Power undertaking the Southdown Mine transmission works separately from the reinforcement works;
- address the long term capacity and voltage performance issues in the Great Southern portion of the covered transmission network; and
- allow users who have projects in the vicinity of the proposed transmission line to connect to the transmission line.

Western Power considers that the enclosed submission demonstrates that a waiver of the regulatory test by the Authority is appropriate in the circumstances as it will not result in a net increase in cost to other users, there are no viable alternative options and the application of the regulatory test will cause significant project delay, contrary to the Chapter 9 objectives.

Western Power looks forward to the Authority's publication of a notice, pursuant to section 9.23(f) of the Code, that a waiver is necessary to meet the Chapter 9 objectives.

Western Power confirms that this submission and its annexures may be made public. Documents to which the submission or study refer are available to the Authority on request.

Yours sincerely

Doug Aberle
Managing Director

Submission to the Economic Regulation Authority

REQUEST FOR WAIVER OF REGULATORY TEST

Major Augmentation to Great Southern transmission network to supply the Southdown Mine

Date:

Western Power
ABN 18 540 492 861
GPO Box 1921, Perth WA 6842

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Introduction

1. Western Power requests that the Authority waive the application of the regulatory test in respect of a proposed major augmentation to the Great Southern portion of the covered transmission network.

2. The purpose of the major augmentation is to supply power to a magnetite mine located at Southdown (**Southdown Mine**) by March 2014 for a joint venture between Grange Resources Limited and Sojitz Resources & Technology Limited (the **SDJV**). The Southdown Mine forms the core component of the broader project (**Southdown Project**), which encompasses the mining and processing of magnetite into concentrate at the Southdown Mine, and pumping that concentrate as slurry approximately 100 kilometres to a facility at the Albany Port, for shipment to Asia. The Southdown Project also includes an expansion of the Albany Port and the construction of a 100 km slurry pipeline and water return line, a concentrator plant and a desalination plant.

3. Construction of the transmission line is on the Southdown Project's critical path with the supply scheduled to commence by March 2014. As part of the revised negotiations, Western Power and the SDJV have explored a range of options to supply power to the Southdown Project, including options which incorporate a dedicated transmission line and others which involve integrating the transmission line with works planned by Western Power for the Great Southern transmission network to meet future demand requirements.

4. Western Power has concluded that an integrated option for the major augmentation which comprises the construction of a double circuit line between Muja and Kojonup and a single circuit line from Kojonup to the Southdown Mine represents the best and most cost effective way of meeting the SDJV's project needs and the needs of the Great Southern network. The SDJV has also agreed that if the Southdown Project proceeds, the SDJV will meet any capital contributions required under Western Power's Contributions Policy comprising the costs associated with the major augmentation which do not subsequently meet the requirements of the new facilities investment test (**NFIT**) under the *Electricity Networks Access Code 2004* (**Code**).

5. Given the unique circumstances of this major augmentation, the project timing constraints for the SDJV, the nature of the funding arrangements, the lack of alternative options and there being no net cost to users of the network, Western Power considers that a waiver of the regulatory test is justified.

Regulatory Requirements

6. Under section 9.2 of the Code, a service provider must not commit to a major augmentation before the regulatory test is satisfied. Section 9.2 is reproduced below:

9.2 A service provider must not commit to a major augmentation before the Authority determines, or is deemed to determine, under section 9.13 or 9.18 as applicable, that the test in section 9.14 or 9.20, as applicable, is satisfied.

7. The Code defines an augmentation to the network to be a major augmentation where the investment exceeds $30 million (CPI adjusted) for transmission assets. The definition of a major augmentation is reproduced below:

   "major augmentation" means an augmentation for which the new facilities investment for the shared assets:

   (a) exceeds $10 million (CPI adjusted), where the network assets comprising the augmentation are, or are to be, part of a distribution system; and

   (b) exceeds $30 million (CPI adjusted), where the network assets comprising the augmentation are, or are to be, part of:

   (i) a transmission system; or

   (ii) both a transmission system and a distribution system.

8. Under certain circumstances the Authority may form the view that the application of the regulatory test would be contrary to the Chapter 9 objectives and that waiver of the regulatory test is necessary to meet those objectives. This is captured in section 9.23 and is reproduced below:

   Regulatory test may be expedited, otherwise modified or waived

   9.23 If the Authority forms the view that the application of the regulatory test under sections 9.10 to 9.14 or sections 9.15 to 9.22 in respect of a proposed major augmentation would be contrary to the Chapter 9 objectives, including because:

   (a) there are no, or it is unlikely that there are any, viable alternative options to the proposed major augmentation; or

   (b) the nature of the proposed major augmentation is such that significant advance planning is required and no alternative options exist; or

   (c) the nature of the proposed major augmentation, or part of it, is such that it should be submitted to the Independent Market Operator established under the Electricity Industry (Independent Market Operator) Regulations 2004; or

   (d) the nature of the funding of the proposed major augmentation means that the proposed major augmentation will not cause a net cost (measured in present value terms to the extent that it is possible to do so) to those who generate, transport and consume electricity in the covered network and any interconnected system;

   then the Authority may, by publishing a notice:

   (e) expedite or otherwise modify the application of the regulatory test in respect of the major augmentation to the extent the Authority considers necessary to meet the Chapter 9 objectives; or

(f) waive the application of the regulatory test in respect of the major augmentation if the Authority considers it necessary to do so to meet the Chapter 9 objectives.

9. The Chapter 9 objectives are reproduced below:

Objectives of this Chapter 9

*9.1 The objectives of this Chapter 9 ("**Chapter 9 Objectives**") are:*

(a) to ensure that before a service provider commits to a proposed major augmentation to a covered network, the major augmentation is properly assessed to determine whether it maximises the net benefit after considering alternative options;

(b) to provide an incentive to a service provider, when considering augmentation to a covered network, to select the option (which may involve a major augmentation or may involve not proceeding with an augmentation at all) which maximises the net benefit after considering alternative options; and

(c) to minimise:

(i) delay to projects and other developments;

(ii) administrative and regulatory costs; and

(iii) any other barriers to the entry of generators and consumers into the electricity market,

arising from the application of the regulatory test.

10. An 'alternative option', in relation to a major augmentation, is defined the Code to mean:

"...alternatives to part or all of a major augmentation, including demand-side management and generation solutions (such as distribution generation), either instead of or in combination with network augmentation.

11. The phrase 'net benefit after considering alternative options' is defined in section 9.4 of the Code to mean:

"...a net benefit (measured in present value terms to the extent that it is possible to do so) to those who generate, transport and consume electricity in the covered network and any interconnected system, having regard to all reasonable alternative options, including the likelihood of each alternative option proceeding."

12. Western Power considers that a transmission line which will be built to, among other things, supply power the Southdown Project, constitutes a shared asset. As the asset is a transmission asset which exceeds $30 million (CPI adjusted), it falls within the definition of a major augmentation for the purposes of the Code. Accordingly, the Authority is required to consider whether the regulatory test is satisfied, unless the Authority considers that the regulatory test should be waived, expedited or modified in order to meet the Chapter 9 objectives.

Background to Major Augmentation

13. Western Power's consideration of the major augmentation follows a request from the SDJV to supply 180MW directly to the Southdown Mine located at Southdown approximately 90 kilometres north-east of Albany, and 11 MW at Albany to support related transportation infrastructure. This request was originally received in 2005 with a supply date of 3 to 4 years from the request. Subsequently, the project was put on hold in 2008 but was recommenced in 2010 with a revised date to supply power to the Southdown Mine of March 2014. A description of the mining project proposed for Southdown and its potential value to the Western Australian community is set out in a supporting letter from the SDJV together with this submission.

14. The only alternative option to connecting to Western Power's network was to consider onsite generation, involving the construction of a power plant and onsite supply of gas or diesel. However, given the location of the mine and the extent of power generation required, this option was considered uneconomic compared with connecting with Western Power's network and was therefore rejected by the SDJV. Further details in relation to the SDJV's request to connect to Western Power's network are contained in their supporting letter. In addition, supply of this magnitude to a greenfields site cannot be provided from the current network under any circumstances and consequently demand management is not a realistic "alternative option" for provision of this capacity.

15. As no other alternative options to supply the Southdown Project were considered viable, Western Power and the SDJV considered options to connect to the network. The SDJV also confirmed that, should the Southdown Project proceed, it would fund any portion of the works required that were not subsequently found to meet NFIT, through a capital contribution under Western Power's Contributions Policy, in addition to any network access charges payable.

16. Western Power originally developed a proposal to meet the SDJV's requirements on a dedicated basis, comprising a single circuit overhead line between Muja and Southdown, over a distance of 288 kilometres with dedicated easements. The proposal was developed in the context of the original power supply date which required Western Power to select an option which minimised the time required to secure environmental approvals and community support.

17. As noted in section 3 of the attached study, a 330 kV line with a twin conductor per phase was considered the preferred dedicated proposal compared with a 220 kV line (with a single or twin conductor per phase) because:

    (a) it presented greater thermal and voltage capacity to meet the Southdown Project's demand and a lower risk of additional equipment being required;

    (b) it included additional capacity for increased load or other connections;

    (c) it will not require major reinforcement works at Muja or reactive compensation at Southdown; and

(d) line losses are minimised.

18. Supplying the Southdown Project utilising the 330 kV single circuit line on an independent basis with dedicated easements is further detailed in the attached study as option 0.

19. In developing its proposal, Western Power undertook extensive overhead line routing work and identified a proposed route corridor for the overhead line. The route identified was designed to minimise the physical and environmental impact of the line, meet landowner concerns and achieve the SDJV's original power supply date.

20. The corridor has been the subject of extensive community engagement and discussion with various approval bodies who have a stake in the project. In this regard:

    (a) State environmental approvals were obtained from the Environmental Protection Authority (EPA) in August 2007 and the Department of Environment and Conservation (DEC) (clearing permit) in September 2007.

    (b) Consultations were also held with flora and fauna consultants and relevant government agencies. Due to the potential impact of clearing on the Carnaby Black Cockatoo's habitat, a referral is due to made to the Commonwealth for approval this year. Significant design reviews and replanning of the precise route and location of towers and poles has been undertaken to minimise the environmental impact of the proposed transmission line particularly with regard to nesting, breeding and foraging habitat for Carnaby Black Cockatoos, The redesign works have reduced the potential impact to an acceptable level commensurate with or below that of other projects approved by the Commonwealth in recent years. Consequently, Western Power is of the view that this approval will be obtained during 2011 and will not delay construction start.

Further details in relation to community and stakeholder engagement are contained in a report annexed to this submission entitled 'Summary of Community Consultations for Major Augmentation to Supply Southdown Project'.

21. During the course of community engagement and as details of the potential transmission line became known, Western Power received a number of enquiries and formal applications from potential users of the network seeking to connect in the event that the major augmentation proceeded. These included mines and wind farm projects proposed to be located east of Kojonup. Accordingly, Western Power considers that there will be potential for community-wide benefits if the major augmentation is undertaken as the reliability of the network will be enhanced and new users will be able to connect their projects to the transmission line.

22. While a single circuit 330 kV line from Muja to Southdown will effectively supply the SDJV's power requirements for the Southdown Mine, as a prudent service provider, Western Power has considered whether integrating a portion of the works with the existing network may generate additional benefits for the network. In this regard, Western Power considered the works required to address the existing and emerging

need for increased capacity in the Great Southern transmission network. These capacity issues are detailed in the following section.

Great Southern Transmission Network

23. The Great Southern transmission network incorporates the Muja Terminal, Kojonup, Mount Barker and Albany substations. Between Muja and Kojonup, two easements exist (routes 81 and 82) to accommodate two circuits which supply the Kojonup, Mt Barker and Albany substations. There are two circuits between Kojonup and Albany, one of which is direct, and one of which passes through the Mt Barker substation.

24. The 132 kV transmission circuits in the Muja to Albany area were constructed in the 1960s and 1970s and are of wood pole construction, save that the circuits from Kojonup to Mount Barker and Mount Barker to Albany were replaced with concrete poles in recent years.

25. The attached study describes the current details, ages and thermal ratings of each portion of the system.

26. The study highlights that this area is facing long term capacity problems due to thermal and voltage performance issues which will require major augmentation and investment by Western Power. This investment will be required, regardless of whether the proposed major augmentation proceeds.

27. An initial plan to address these matters in the short to medium term is currently being implemented and is expected to defer the need for major augmentation until 2016. The details of these measures are outlined in the attached study. While a portion of these works is still subject to a tendering process, the basis of the attached study assumes that the plan will be implemented as proposed and that major augmentation requirements will not arise until 2016.

28. While voltage issues will affect the Muja to Albany area generally from 2016, thermal limits will be particularly acute for the Muja to Kojonup circuits 81 and 82, and the Kojonup to Albany circuit 81.

Major Augmentation Options

29. As a prudent service provider, Western Power conducted a study to assess whether integrating the major augmentation to supply the Southdown Project with other works required for the Great Southern transmission network might generate additional benefits for the network and its users while still meeting the Southdown Project's schedule. This required Western Power to ensure that its study was conducted on a broader, system-wide basis to identify in net present cost terms the major augmentation that would best integrate with future requirements for the network. The portion of the major augmentation that offered options for integration was the section between Muja and Kojonup. In this regard, the options considered compared the

construction of a dedicated single circuit 330 kV line with a double circuit 330 kV line. The portion of the major augmentation between Kojonup and Southdown were uniform in all options. The options were then compared with a base case, option 0, comprising a stand-alone major augmentation with dedicated easements, and the reinforcement of the Great Southern network being conducted separately.

30. In addition to the base case, the study considered two variations to the single circuit proposal. The first included a single circuit 330 kV line between Muja and Kojonup which does not utilise the circuit 81 route, and a 330/132 kV transformer and 132 kV bay at Kojonup to enable future integration with the network (see option 1 in attached study). The second variation on the single circuit proposal included utilising the circuit 81 easement to install a single circuit 330 kV line between Muja and Kojonup with a 330/132 kV transformer and 132 kV bay at Kojonup (see option 2 in attached study).

31. The double circuit options to integrate the Southdown Project supply works with the Great Southern network augmentation involved the construction of a double circuit 330 kV line from Muja to Kojonup utilising the existing circuit 81 easement (see options 3a, b and c in attached study).

32. The study concluded that by utilising the circuit 81 easement, rather than creating a new route for this portion of the major augmentation, the double circuit options and option 2 minimise the environmental impact. These options also reduce the distance of this portion of the transmission line from 99.7 kilometres (in the base case) to 87.5 kilometres, which generates efficiencies in associated project costs and construction timing.

33. The remaining issue that was considered was whether a double or single circuit line between Muja and Kojonup was preferred. In this regard, the Study concluded that a double circuit option for the Muja to Kojonup section (option 3a) had the potential to generate greater benefits than a single circuit option, when considered in combination with the reinforcement works required for the Great Southern transmission network.

34. In economic terms, using a double circuit option could generate up to $19.9 million in savings (net present cost) for the combined works, compared with the base case, $11.7 million in savings compared with the next best option (option 1, refer to executive summary), and $31.1 million in savings compared with option 2. While option 2 had comparable economic gains to the double circuit options by reducing the length of the Muja to Kojonup section, as the single circuit line is not adequate to meet future load requirements for the Great Southern network, option 2 requires the eventual construction of a replacement 330 kV line along the circuit 82 easement between Muja and Kojonup.

35. In terms of additional benefits, the study confirms that a double circuit line between Muja and Kojonup is preferable to a single circuit line because, in addition to the matters noted in paragraph 32 above, it enables Western Power to undertake the remainder of the Great Southern network reinforcement works at a lower

environmental cost through the eventual relinquishment and revegetation of the circuit 82 easement between Muja and Kojonup. A double circuit line also provides improved long-term asset utilisation, a greater capability to absorb major load increases or large scale generation, and the opportunity for future asset rationalisation.

36. While using a double circuit line between Muja and Kojonup increases the stand-alone cost of the major augmentation compared with the single circuit options, the economic and additional benefits in relation to the combined works are greater for the double circuit option.

37. Western Power notes that while the time horizon used in the study for the combined works is 50 years and may lead to a degree of uncertainty in cost estimates, equivalent assumptions have been applied to each option assessed to ensure that this effect is minimised.

38. On this basis, and considering the Chapter 9 objectives, Western Power has concluded that the most appropriate major augmentation which maximises the net benefit to users while achieving the project schedule required to supply the Southdown Project comprises:

    (a) an 87.5 km double circuit 330 kV line from Muja to Kojonup (utilising the existing circuit 81 easement);

    (b) a 188 km single circuit 330 kV line from Kojonup to Southdown;

    (c) related infrastructure works at Muja and Southdown substations; and

    (d) the removal and rehabilitation of the current 81 line between Muja and Kojonup.

39. The new facilities investment for these works (option 3a) comprises $387.5 million based on current estimates.

40. This proposal is detailed in the following section of this submission.

41. While various scenarios for the Great Southern transmission network augmentation were considered as combinations with the double circuit major augmentation, these do not need to be finally resolved at this stage and are likely to be the subject of further study. The issue of importance for this submission is to resolve the content of the major augmentation required to supply the Southdown Project and maximise the benefits to the network and its users, which the attached study achieves.

Proposed Major Augmentation

42. Western Power considers that the most appropriate major augmentation comprises the following elements:

    (a) Design and construction of a 330 kV double circuit steel tower construction line (87.5 km) which is initially operated on one side of the 330 kV line at 132 kV (by March 2014);

(b) Design and construction of a single circuit 330kV line (188 km) from Kojonup to Southdown including substation works at Muja and Southdown (by March 2014);

(c) Removal of existing Muja to Kojonup 81 line and rehabilitation of the route corridor (by 2016);

43. The options analysed in the attached study indicate that the above major augmentation based on a double circuit line between Muja and Kojonup when combined with various scenarios for augmenting the Great Southern transmission network will generate savings of up to $19.9 million (net present cost) when compared with the base case.

44. None of the options considered in the study comprise 'alternative options' for the purposes of the Code, such as distribution generation and demand-side management. The nature of the reinforcement works and works required to supply the Southdown Project are of such a scale that only a major augmentation would meet all those requirements.

45. As noted in paragraph 14 there are no viable alternative options to the proposed major augmentation.

46. The double circuit major augmentation is considered the most appropriate because it will:

(a) be the most cost effective of all options by realising up to $19.9 million (see option 3a) in savings (net present terms) to Western Power when combined with planned upgrades to the Great Southern transmission network, compared with conducting the Southdown Project works independently of those upgrades (option 0);

(b) facilitate the planned upgrades to the Great Southern transmission network in the most efficient manner consistent with environmental impact minimisation requirements, optimal asset utilisation and the capacity to absorb major load increases or large-scale generation which will stimulate the earlier growth of customers and projects within the region;

(c) facilitate other third party projects and their associated benefits in connecting to the new transmission line, as demonstrated by the third party interest referred to in paragraph 21 above;

(d) involve funding by the SDJV through a capital contribution under Western Power's Contributions Policy in the manner set out in paragraph 4 above, comprising that portion of the works that does not meet NFIT, thus insulating users of the network from net increases in costs.

(e) minimise the environmental impact of the overall works by reducing the length, and easements required to construct the transmission line to supply the Southdown Mine;

(f) generate cost efficiencies associated with the works and reduce the construction timing by an estimated 3 months due to the reduction in the length of the transmission line.

(g) subject to the regulatory waiver being granted:

(i) be built in time to meet the Southdown Project's schedule, which includes optimal weather conditions to commence construction in early 2012 and approvals in place for this purpose; and

(ii) enable SDJV to make a final investment decision by 31 March 2012, which will allow the works to be completed by the targeted supply date of March 2014.

Waiver of Regulatory Test

47. Western Power considers that a waiver in respect of the proposed major augmentation is justified because of the reasons set out below.

47.1 There are no, or it is unlikely that there are any, viable alternative options to the proposed major augmentation (section 9.23(a), the Code) as:

(a) there are no demand-side management options appropriate to meet the requirements for the Southdown Mine (see paragraph 1 above); and

(b) an onsite generation option would not be economically viable, compared with connecting to Western Power's network, in light of the location and capacity supply requirements for the Southdown Mine (see paragraph 14 above).

47.2 The nature of the proposed major augmentation is such that significant advance planning is required and no alternative options exist (section 9.23(b), the Code) as:

(a) the scale of the major augmentation means that associated approvals and consultation required are significant. As noted in paragraphs 20 and 21 above, significant community engagement and consultation with key stakeholders and approval bodies have already been undertaken by Western Power to facilitate the proposed major augmentation to supply the Southdown Mine and reinforce the Great Southern portion of the covered transmission network;

(b) the construction of the transmission line is on the Southdown Project's critical path and, to enable project start-up in the current favourable iron ore pricing window, construction must commence in early 2012; and

(c) as noted above in paragraph 14, there are no viable alternative options to supply the Southdown Mine.

47.3 The nature of the funding of the proposed major augmentation means that the proposed major augmentation will not cause a net cost (measured in present value terms) to those who generate, transport and consume electricity in the covered network and any interconnected system (section 9.23(d), the Code) as:

(a) any costs associated with the major augmentation which do not meet NFIT will be funded by SDJV as further elaborated in paragraphs and 46; and

(b) the double circuit line between Muja and Kojonup replaces necessary works that would have been undertaken by Western Power in respect of the Great Southern network in the next five years regardless of the Southdown Project's requirements.

47.4 The application of the regulatory test would unacceptably delay the Southdown Project as:

(a) it will delay SDJV's ability to make a financial investment decision in relation to the Southdown Project within the current favourable pricing window as detailed in their supporting letter attached to this submission; and

(b) it will defer the construction of the transmission line beyond early 2012, which is the most favourable timing window required to enable the SDJV to take advantage of the favourable iron ore price window and thus affect the Southdown Project's revenues and commercial viability. This may also lead the SDJV to decide not to proceed with the Southdown Project, which would prevent the benefits of the project that may be derived by the Western Australian community and other potential third party projects (section 9.1(c)(i), the Code).

47.5 In the circumstances noted above, the application of the regulatory test would unnecessarily increase the regulatory and administrative costs for Western Power (section 9.1(c)(ii), the Code) particularly in light of the fact that there are no viable alternative options.

47.6 The delay caused by the application of the regulatory test as noted above will comprise a barrier to entry by the SDJV and other projects along the proposed transmission line (section 9.1(c)(iii), the Code).

47.7 Detailed work undertaken by Western Power and demonstrated in the attached study indicates that Western Power has considered a range of network options to supply the Southdown Project and has elected to pursue one which maximises net benefits to all users of the network, including the SDJV.

Conclusion

48. Each of the grounds for waiver of the regulatory test set out in section 9.23(a) to (d) of the Code are disjunctive, such that the satisfaction of any of them will be sufficient

to support a waiver. The requirements in section 9.23(a) to (d) are also not an exhaustive list of circumstances that could be considered by the Authority to establish that the application of the regulatory test would be contrary to the Chapter 9 objectives.

49. The above discussion establishes that in respect of each element of the major augmentation, a waiver is justified on each of the following grounds:

    (a) There are no viable alternative options for the major augmentation to supply the required capacity to the Southdown Project by the required supply date (section 9.23(a) of the Code).

    (b) The nature of the proposed major augmentation is such that significant advance planning is required and no alternative options exist (sections 9.23(b) of the Code);

    (c) The nature of the funding of the proposed major augmentation means that the proposed major augmentation will not cause a net cost (measured in present value terms) to those who generate, transport and consume electricity in the covered network and any interconnected system (section 9.23(d), the Code)..

    (d) The application of the regulatory test would result in significant delays to the construction of the transmission line due to the optimal construction windows being missed. This would also cause further delays to the Southdown Project which would prevent the SDJV from taking advantage of an optimal iron ore pricing window. These delays are likely therefore to risk the future of the Southdown Project and its benefits to the Western Australian community.

    (e) In the above circumstances the project delay, regulatory and administrative costs, and consequent barrier to Grange's access to the network are not justifiable in light of the Chapter 9 objectives.

50. Western Power therefore considers that a waiver of the regulatory test is required in order to meet the Chapter 9 objectives and is justified in the circumstances.

Attachment 1 Project Planning Report

PROJECT PLANNING REPORT

Options for integrating a major augmentation proposal for Southdown Mine with reinforcements to the existing transmission network from Muja to Albany

westernpower

May 2011
Strategic Network Development Section
Network Planning & Development

DM#: 8143040

Executive Summary

Preamble

This Project Planning Report (**PPR**) investigates the construction of a major new transmission line in the Great Southern region of Western Australia to meet the discreet needs of an individual customer. Coincident with this customer-driven project is the need to replace end-of-life assets and augment transmission capacity in the same region over the next 15 to 23 years. This PPR seeks to identify the transmission requirements of the Great Southern region and to resolve whether economic and non-economic efficiencies and other benefits may be gained through integrating these two work programs. The PPR concludes by outlining whether and to what extent this analysis affects the choice made with respect to the major augmentation undertaken to supply power to the individual customer.

Western Power usually conducts its long-term planning studies within a 20-25 year planning envelope. Detailed project planning occurs within a 10 year horizon at which time load forecasts are typically more accurate and planning can be conducted with greater certainty of customers' needs.

Often, given the long economic life of assets such as transmission lines, these timeframes are insufficient to understand the economic impact of asset replacement or investment in assets which will remain in the field for between 60 and 80 years.

To provide context to deliberations of this nature, Western Power conducts 50 year forecasts, developing an understanding of how load growth beyond the normal 20-25 year envelope might influence network planning and development. This 50-year view of system needs emphasises the prudence of making a strategic investment in transmission capacity that ensures the commissioned assets are appropriate and provide for the most efficient long term needs of the network.

This long-term view of asset replacement and augmentation allows Western Power, funders and regulators to see the long-range impacts of state development, asset retirement and capacity expansion on the investment profile required for the safe and effective operation of the South West Interconnected Network (SWIN).

To an extent, this allows Western Power to moderate its investment profile in order to develop a network development plan that optimises the efficiency with which the business manages its obligations as a network owner, developer and operator.

This PPR has therefore been conducted with a 50-year view of how the system could reasonably be expected to develop in order to present a whole-of-life view of assets required to meet the load forecast in the near-term as well as in the next 25-50 years and beyond.

Background

Western Power load growth

The load demand in the Great Southern region of Western Australia, as supplied by the South West Interconnected Network (SWIN), via substations at Kojonup, Albany and Mount Barker is forecast to increase by more than 330% over the next fifty years.

Supply limitations already exist in the form of thermal and voltage constraints on the 132 kV transmission system that supplies these districts from Muja.

The most onerous thermal loading conditions occur generally during the summer peak, coincident with the lowest transmission circuit ratings.

From 2016, when the proposed Albany NCS is expected to expire, the most capacity constrained 132 kV lines will be:

- KOJ-ALB 81 (rating 45/95 MVA summer/winter), overloaded from summer 2009/10, but managed by the proposed Albany NCS until expiry in 2015/16;
- MU-KOJ 81 (rating 77/113 MVA summer/winter), overloaded from summer 2013/14, but managed by the proposed Albany NCS until expiry in 2015/16; and
- MU-KOJ 82 (rating 91/133 MVA summer/winter), overloaded in summer 2016/17 and beyond.

The voltage gradient and proximity to voltage collapse make further capacitor installation not technically viable. Without maintaining and substantially increasing NCS capability (which is not considered likely or viable at this time), or a major augmentation, the voltage collapse point will be exceeded after 2016.

The transmission lines supplying the district reach the end of their technical lives at various points in the next 14 – 27 years.

Assuming a 60 year technical-life, replacement of the existing lines would occur as follows:

- MU-KOJ 81 in 2025;
- KOJ-ALB 81 in 2032;
- MU-KOJ 82 in 2038; and
- MBR-ALB 81 in 2052 (recently upgraded); and
- KOJ-MBR 81 in 2061 (recently upgraded).

Given the growth in load and the limited opportunity for reactive voltage support at each supply node, the most efficient manner in which Western Power can continue to meet its supply obligations in this district is the phased replacement and upgrade of transmission infrastructure emanating from Muja and supplying Kojonup, Albany and Mount Barker which, on a stand-alone basis, would be required to commence in 2016.

Southdown mine load development

Coincident with Western Power's analysis of options to meet the medium to long-term energy loads of the Kojonup, Albany and Mount Barker districts, a significant mining load in the same proximate area has sought connection to Western Power's network.

Southdown Joint Venture (**SDJV**), a joint venture of 70% Grange Resources Limited and 30% Sojitz Resources & Technology Limited Pty Ltd ,is developing a magnetite mine (Southdown Mine) at Wellstead approximately 90 km north-east of Albany. SDJV has sought access to the SWIN to supply power to the Southdown Mine with a contract maximum demand of 180 MW by March 2014.[1]

Western Power initially considered SDJV's request on a discrete basis and concluded that a single circuit 330 kV overhead line connection between the Southdown Mine and the existing 330 kV substation at Muja (approximately 288 km in length) would be the most economic method of meeting the mine-site's power demand within the requested.

As indicated in the previous section, Western Power will be required to meet the transmission requirements of the Great Southern region regardless of whether the Southdown Mine proceeds. Forecasts indicate that at a point beyond the economic life of the existing assets, transmission capacity in the region between Muja and Kojonup and Kojonup, Albany and Mount Barker will need to be augmented in order to maintain compliance with the Technical Rules as they relate to voltage performance in the south-eastern corner of the SWIN.

[1] Western Power has no visibility of the factors driving the customer's demand therefore planning is based on the contractual requirement for Western Power to be able to supply a maximum demand of 180 MW in order for the customer to exercise optimum operational flexibility.

Western Power therefore resolved to undertake a study to assess the economic and non-economic benefits of integrating the required works to meet SDJV's transmission requirements within their project timeframe, and to meet the reinforcement requirements for the Great Southern region.

The study sought to:

- Determine the most economically efficient transmission line voltage to meet the SDJV load requirement at the Southdown Mine;
- Analyse potential options to integrate the new transmission line with the augmentations required to be made to the existing transmission system south-east of Muja;
- Determine whether there are any benefits in integrating the SDJV supply with the augmentations required to be made to the existing system in order to address medium to long-term capacity and voltage performance issues, and
- Identify a preferred development path that is technically and economically prudent and takes into account the 60 to 80 year technical life of the assets to be deployed.

Achieving short-term needs while ensuring long-term efficiency

This study examines how the network to the south-east of Muja might be developed for six different supply options, and compares the net present cost of each as well as their individual technical merits. These options incorporate the major augmentation required to meet the load requirements of the Southdown Mine and the reinforcement works required to meet the general load requirements for the region. A base case was also analysed to demonstrate the net present cost of undertaking these works independently of one another.

The various supply options reflect the manner in which investment decisions made now to meet immediate supply obligations will have a significant bearing on the ability of Western Power to continue to efficiently meet the evolving demands of the system and customer loads over the next 50 years. Therefore, options have not only been assessed on the efficiency with which they meet immediate needs but also against how they underpin the continued efficient development of the supply area into the future.

As stated previously, given the long technical life of assets, it is prudent to ensure the options for meeting current supply obligations are assessed against their alignment with the long term needs of the load area to ensure assets are not forced into early retirement due to their inability to meet long-term needs.

The options chosen for analysis in the study involve routing a portion of the new 330 kV line forming part of the Southdown Mine major augmentation via an existing direct route easement currently utilised by the 132 kV wood pole Muja-Kojonup 81 line.

It was recognised that, if elements of the existing 132 kV easement were redeveloped as a 330 kV line there would be a significant environmental advantage in avoiding having to create a new line route for this section to supply the Southdown Mine. In addition, economic benefits would result from integrating the supply to the Southdown Mine with the network's existing augmentation requirements. This is because the section of the proposed 330 kV transmission route corridor Muja to Kojonup has a length of 99.7 km, while the existing direct route (MU-KOJ 81 line) has a length of 87.5 km – 12.2 km shorter, resulting in a reduction in the project cost.

This form of integration with the existing network was also considered suitable for the study because a greater level of integration with the existing network (such as integrating works between Muja and Mt Barker) would not be able to be undertaken within the timeframe required to supply power to the Southdown Mine. In summary, each of the options analysed in the study are premised on meeting SDJV's project deadline consistent with Western

Power's obligation to meet SDJV's project requirements in addition to the existing augmentation needs of the network.

The core findings of the study were that:

- due to the technical issues in supplying an increasing Albany load at 132 kV over a distance of 245 km from Muja, each of the options demonstrated the judiciousness of an eventual transition to a 330 kV transmission voltage over a 25 to 50 year horizon.
- undertaking the major augmentation to supply the Southdown Mine independently of the augmentation of the Kojonup, Albany and Mount Barker area was significantly less efficient and up to $20 million more expensive than integrating these augmentations; and
- the most cost effective option comprises a double circuit 330 kV transmission line from Muja to Kojonup, replacing the existing circuit 81 route, and a single circuit 330 kV transmission line from Kojonup to the Southdown Mine.

The NPC for each of the options, with the options ranked in order, is shown in the table below. Each of the options below includes a connection to Southdown mine.

Scenario	Description	NPC ($M)	Base 2011 Cost ($M)	Rank	Benefit c/w Option 0
Option 3a	Southdown Mine major augmentation: 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and rebuild KOJ-ALB 81 as 132 kV double circuit	$435	$742	**1**	$19.9
Option 1	Southdown Mine major augmentation: 330 kV Single circuit MU-KOJ section (indirect new route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and replace MU-KOJ 81 with new 330 kV single circuit line	$447	$779	**2**	$8.2
Option 0 (Base Case)	Southdown Mine major augmentation: 330 kV Single circuit MU-KOJ section (indirect new route), 330 kV single circuit KOJ-SDN Existing network augmentation: undertaken independently	$455	$770	**3**	$0
Option 3c	Southdown Mine major augmentation: 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and rebuild KOJ-ALB 81 as 330 kV double circuit	$463	$652	**4**	-$7.9
Option 2	Southdown Mine major augmentation: 330 kV Single circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and replace MU-KOJ 82 with 330 kV single circuit line	$467	$769	**5**	-$11.2

Option 3b	Southdown Mine major augmentation: 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and build 330 kV single circuit triangle KOJ-SDN-ALB	$467	$655	**6**	- $11.9

The above NPC analysis indicates that the integration of the Southdown Mine major augmentation and the augmentation of the existing network generates greater benefits in NPC terms compared with conducting them independently (option 0).

The NPC analysis also indicates that a Southdown Mine major augmentation incorporating a double circuit 330 kV transmission line between Muja to Kojonup which replaces the Muja to Kojonup 81 route (Options 3a, b and c) is the preferred option for the major augmentation since it provides the underlying transmission backbone required to implement any of the variations of Option 3 as system augmentation requirements become clearer over time.

Taking the 50-year view outlined in the PPR, Option 3a is the preferred option on an economic basis being $19.9 million lower in NPC than the base case option 0, and $11.7 million lower in NPC than the next highest option, 1. Using the same planning perspective, 3c is the preferred option on a technical basis. Option 3c also generates greater environmental and network configuration benefits in enabling the eventual relinquishment of two line easements instead of one, as is the case with option 3a.

It is noted that both options 3a and 3c incorporate the same major augmentation to supply the SDJV Southdown Mine and only differ in terms of the subsequent augmentation undertaken between Kojonup and Albany to secure a third circuit into Albany by December 2016.

On the strength of the comparison between the options detailed in this study, it is recommended that option 3a be adopted as the ultimate solution to meet the combined requirements of the Southdown Mine (within the project timeframe) and the Kojonup, Albany, and Mount Barker load area.

The benefits are:

- This option is the lowest NPC option of the six alternatives considered to meet the SDJV requirement to have the infrastructure in place for March 2014;
- This option utilises the existing MU-KOJ 81 line easement for construction of a new 330 kV double circuit line foregoing the requirement for a new easement between Muja and Kojonup;
- This option presents the most efficient manner to meet the medium term requirements of the Kojonup, Albany and Mount Barker load area while facilitating the upgrade to 330 kV at a lower environmental cost to the alternatives (eventual relinquishment of the MU-KOJ 82 line easement);
- It realises a $19.9 million dollar benefit in net present cost compared to a wholly independent SDJV connection from Muja outlined in option 0.

It can therefore be concluded from the results of this study that integration into the Great Southern network is preferable to providing a dedicated supply to the Southdown mine only. The major augmentation which is a double circuit line replacing the existing MUJ-KOJ 81 line and the single circuit line from Kojonup to Southdown maximises the benefits of integrating with the existing network augmentations while also achieving SDJV's project timeframe.

It is noted that, for present purposes, it is not necessary to resolve the precise nature of the augmentation to be undertaken between Kojonup and Albany, but rather to identify whether integration is preferable and, if so, the nature of the major augmentation that best integrates with the augmentation of the existing network, which both options clearly achieve.

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Acronym	Definition
MU	Muja Terminal
KOJ	Kojonup Substation
ALB	Albany Substation
MBR	Mount Barker Substation
SDN	Southdown Substation
LGSR	Lower Great Southern Region
kV	Kilo Volt (1,000 volts)
NCS	Network Control Services
SDJV	Southdown Joint Venture
SVC	Static VAR Compensator

1 Introduction

A joint venture of Grange Resources Limited and Sojitz Resources & Technology Limited (**SDJV**) is developing a magnetite mine (Southdown Mine) near Wellstead approximately 90 km north-east of Albany (shown in Figure 1). The customer has requested access to the SWIN to supply power to the Southdown Mine at a Contract Maximum Demand of 180 MW and a connection/energisation date planned for March 2014.

The Southdown Mine will also require an additional 11 MW supply at Albany to supply transportation infrastructure associated with the proposed mine.

Western Power initially considered SDJV's request on a discreet basis and concluded that the Southdown Mine's power requirements could be most economically met within the timeframe required through a major augmentation to the SWIN comprising a single circuit 330 kV overhead line connection between the Southdown Mine and the existing 330 kV substation at Muja (approximately 288 km in length).

This analysis was made without consideration of potential co-optimisation benefits that might be obtained by integrating the mine's supply with the existing transmission system's future augmentation requirements to meet anticipated load growth, thermal and voltage performance issues.

As the augmentation requirements to reinforce the existing transmission system are required to be undertaken by Western Power regardless of whether the Southdown Mine proceeds, Western Power, acting as a prudent operator, resolved to undertake a study to assess the economic and non-economic benefits of integrating the Southdown Mine major augmentation with the augmentation required for the existing network. If integration was found to generate these benefits, the study would also seek to identify whether any changes to the nature of the major augmentation would be required in that context to maximise those benefits.

Accordingly, this study seeks to:

- Determine the most economically efficient transmission line voltage to meet the SDJV load requirement at the Southdown Mine;
- Analyse potential options to integrate the new transmission line with the augmentations required to be made to the existing transmission system south-east of Muja;
- Determine whether there are any benefits in integrating the Southdown Mine supply with the augmentations required to be made to the existing system, and
- Identify a preferred development path that is technically and economically prudent and takes into account the 60 to 80 year useful life of the assets to be deployed.

The options chosen for analysis in the study involve routing a portion of the new 330 kV line forming part of the Southdown Mine major augmentation via an existing direct route easement currently utilised by the 132 kV wood pole Muja-Kojonup 81 line.

It was recognised that, if elements of the existing 132 kV easement were redeveloped as a 330 kV line there would be a significant environmental advantage in avoiding having to create a new line route for this section to supply the Southdown Mine. In addition, economic benefits would result from integrating the supply to the Southdown Mine with the network's existing augmentation requirements. This is because the section of the proposed 330 kV transmission route corridor Muja to Kojonup has a length of 99.7 km, while the existing direct route (MU-KOJ 81 line) has a length of 87.5 km – 12.2 km shorter, resulting in a reduction in the project cost.

This form of integration with existing network was also considered suitable for the study because a greater level of integration with the existing network (such as integrating works between Muja and Mt Barker) would not be able to be undertaken within the timeframe require to supply power to the Southdown Mine.

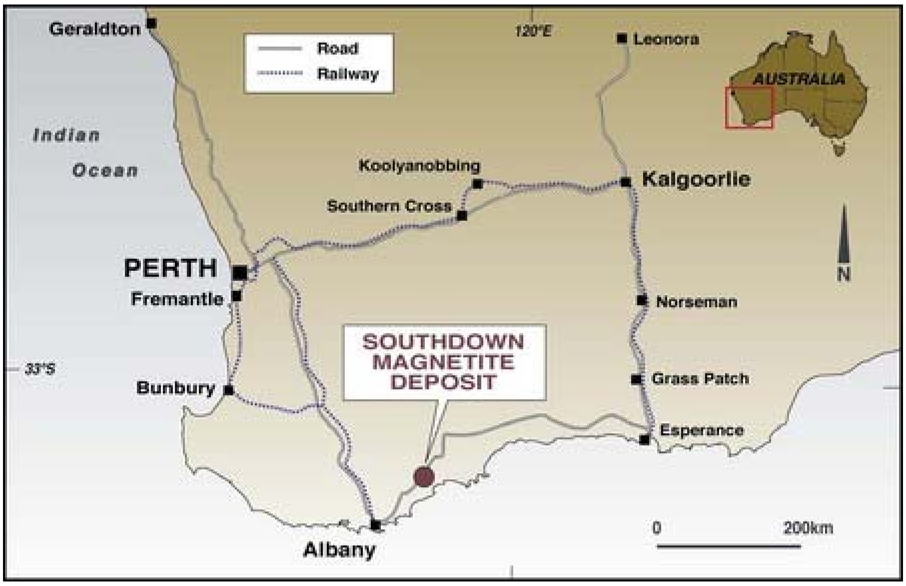


Figure 1: Location of Southdown Mine

1.1 Background

SDJV originally applied to Western Power in 2005 to connect the proposed mining development at Southdown to the SWIN.

The only alternative option to connecting to Western Power's network was to consider onsite generation, involving the construction of a power plant and onsite supply of gas or diesel. However, given the location of the mine and the magnitude of the power required, this option was considered by SDJV to be uneconomic compared with connecting to the SWIN and was therefore rejected by SDJV. Similarly, supply of this magnitude to a greenfield site cannot be provided from the current network under any circumstances and, consequently, demand management is not a viable alternative option for provision of this capacity.

In the absence of alternative options, Western Power, in discussions with SDJV, initially proposed a major augmentation to the SWIN comprising a single circuit 330 kV overhead line single circuit connection between the Southdown Mine and the existing 330 kV substation at Muja as the most economic option that would meet SDJV's timeframe.

At the customer's expense, extensive overhead line routing work was carried out and a proposed route corridor for the single circuit 330 kV overhead line was established as detailed in Figure 2 and Figure 3 below. The proposed 330 kV transmission route corridor is shown in red and is approximately 288 km in length. The indirect route selected represented an attempt to:

- Minimise the impact of the proposed line,
- Avoid routing through sensitive areas, and
- Meet landowner concerns.

All of these considerations were set against a need to achieve SDJV's very challenging connection date of March 2014. The blue line in Figure 2 and Figure 3 shows the route of the two existing 132 kV wood pole construction circuits from Muja to Kojonup.

The proposed 330 kV transmission route corridor has been the subject of community engagement work and discussion with the various approval bodies who have a stake in the project.

In particular, necessary State environmental approvals were obtained from the Environmental Protection Authority (EPA) in August 2007 and the Department of Environment and Conservation (DEC) (Clearing Permit) in September 2007. Following consultation with State agencies and reports from fauna consultants, Commonwealth approvals were not deemed necessary at that time.

During the course of community engagement and as details of the potential major augmentation became known, Western Power received interest from potential users of the network including major projects for connection to the SWIN should the major augmentation proceed. These included those loads identified in Eastern Great Southern Potential Loads Report [6] as well as Wellstead, Wellstead 1, Nightwell & Moonies Hill wind farms.

The global financial crisis resulted in the Southdown Mine project being put on hold for a period of time.

When the project recommenced in May 2010, the Commonwealth's position on the impact of the proposed line route on the habitats of the Carnaby's Black Cockatoo had changed. This change was based on a greater understanding of the science of Cockatoo population dynamics. The trigger for project referrals was reduced to the clearing of 0.5 ha of Cockatoo habitats. Accordingly, the project will be referred to the Commonwealth for approval in 2011.

Subsequently, and due to the need to address existing and emerging capacity, thermal and voltage performance issues in the Kojonup, Albany and Mount Barker supply area, Western Power reviewed its original proposal and resolved to undertake a study to ascertain the benefits that could be derived from integrating the major augmentation to supply the Southdown Mine with augmentations required to be made to the existing network. These capacity, thermal and voltage performance issues are detailed in the subsequent section of this study.

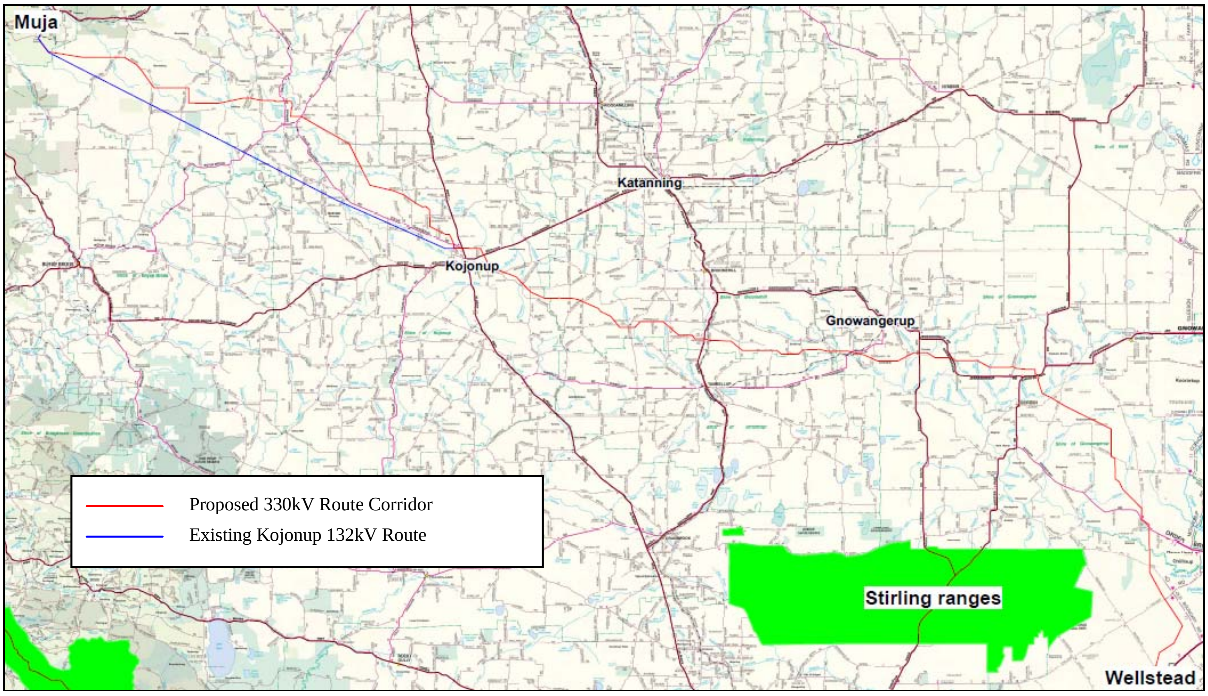


Figure 2: Proposed Muja to Southdown Mine 330 kV overhead line route corridor

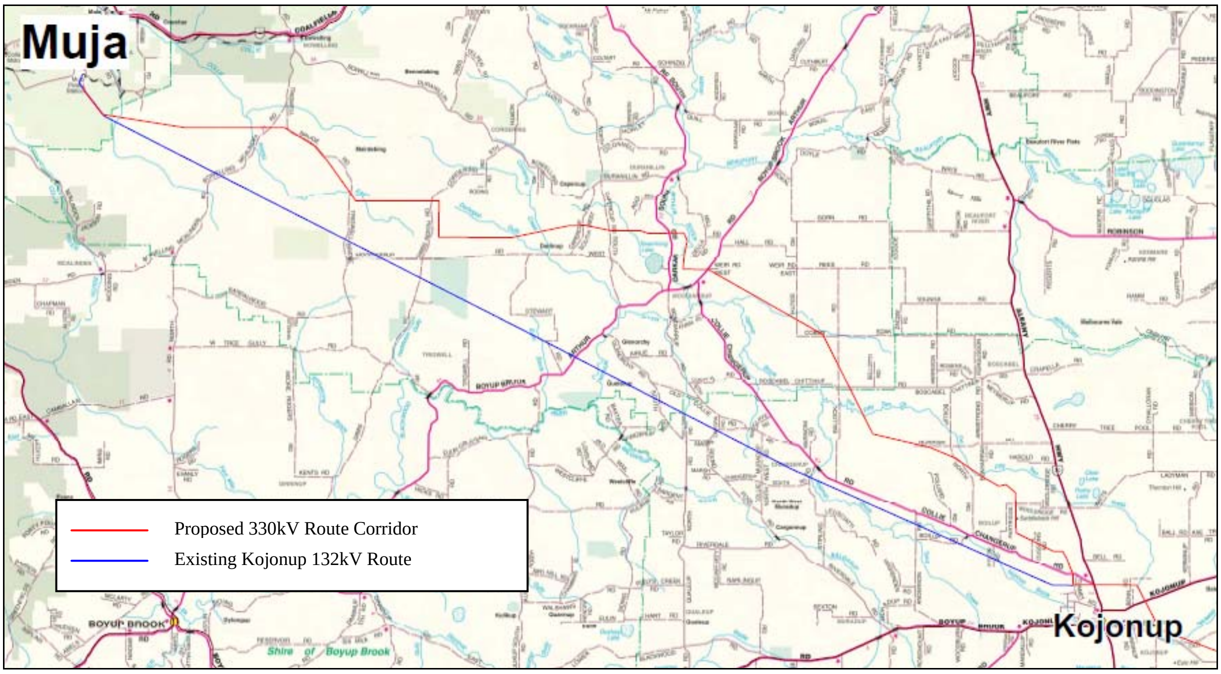


Figure 3: Proposed Muja to Southdown Mine 330 kV overhead line route corridor

2 Existing transmission system issues

The 132 kV transmission circuits in the Muja to Albany area were constructed in 1960s and 1970s and are of predominantly wood pole construction, with some of the 132 kV lines having been upgraded in recent years with concrete poles.

Table 1 shows the construction and rating details for each line, and Figure 4 shows a map of the transmission system to Albany with the summer thermal ratings of these lines.

Table 1: Construction details and ratings of existing 132 kV lines

LINE	Constructed	AGE of poles (in 2010)	Length [km]	Summer thermal rating	Winter thermal rating	Comments
MU-KOJ 81	1965	45	87.9	77 MVA	113 MVA	1st line (uprated to 65°C in 1996)
KOJ-MBR 81	2001	9	103	87 MVA	102 MVA	1st line (originally constructed in 1970 rebuilt with concrete poles in 2001)
MBR-ALB 81	1992	18	49	87 MVA	102 MVA	1st line (originally constructed in 1970 rebuilt with concrete poles in 1992)
MU-KOJ 82	1978	32	88.7	91 MVA	133 MVA	2nd line (uprated to 65°C in 1998)
KOJ-ALB 81	1972	38	157	45 MVA*	95 MVA	2nd line (uprated to 55°C in 1999)

* Note there is currently a project to increase the thermal rating of this overhead line using weather data and sag measurement techniques. The driver for this is to reduce reliance on NCS generation up until 2016.

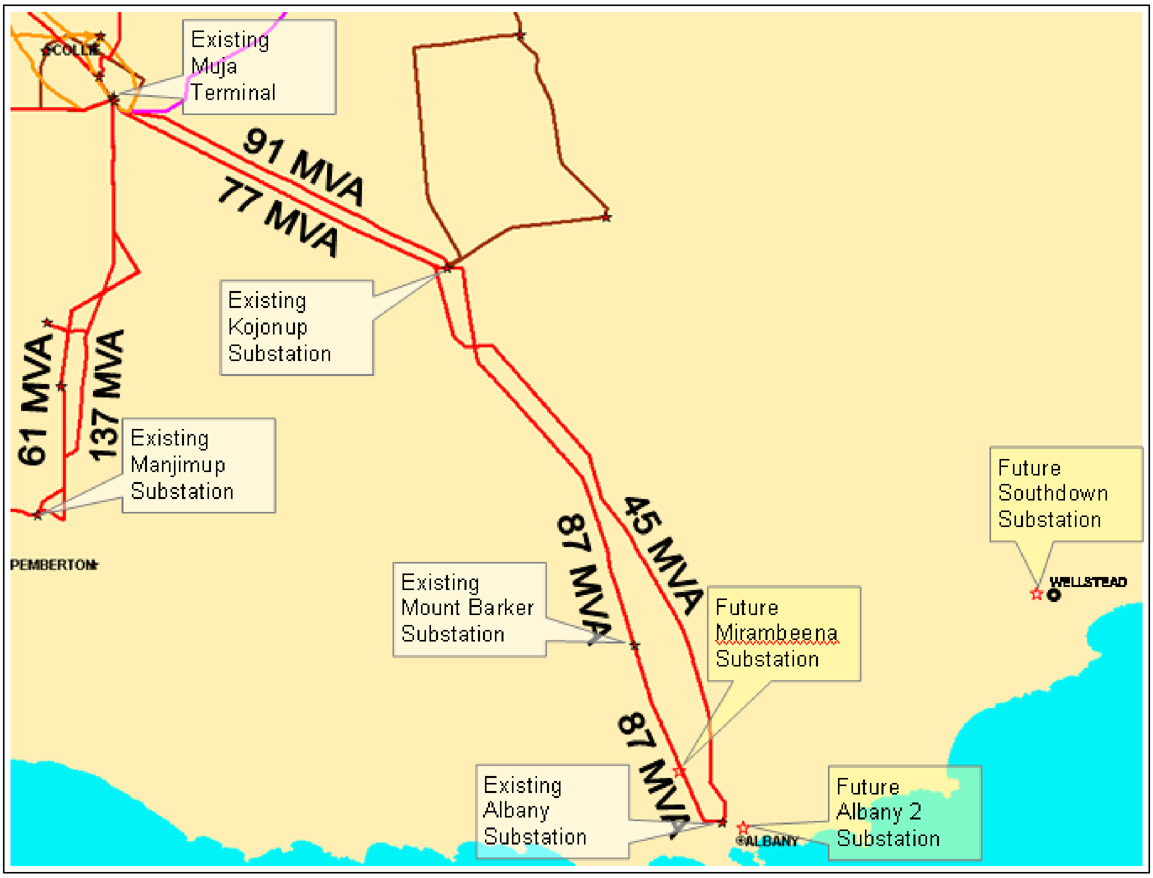


Figure 4: Existing transmission system south east of Muja (shown with summer ratings)

Legend: existing ▬ 330 KV line, ▬ 220 KV line, ▬ 132 KV line, ▬ 66 KV line; ★ existing terminal or substation, ☆ future terminal or substation

Of critical concern is thermal and voltage performance in the Albany and Mount Barker area. This has been investigated in detail [1], and a strategic plan to address these issues in the short to medium term has been endorsed and implemented [2]. This involves:

- A project to install 2 x 20 MVAr, 132 kV capacitor banks at Albany[2], currently in progress: one will be installed in May 2011, and the second bank in June 2012.
- Tendering for Network Control Services (NCS) the form of demand management or generation to address the thermal overloading issues and voltage constraints for a period of 5 years.
- Investigation into the feasibility of upgrading the thermal capacity of the of the KOJ-ALB line.

It is presently expected that the above projects will be sufficient to address the current issues and defer major augmentation until approximately 2016, however beyond this the economics and capability of the proposed NCS are very uncertain, in which case major augmentation to the transmission system will be required.

This study assumes that the proposed NCS will proceed, and as shown in Table 2 below[3] will cease to be of value after approximately five years in service. Therefore, the focus here is on transmission augmentations that will address both the thermal capacity and voltage performance issues after this time. While studies indicate NCS will cease to be of value in

[2] Refer to DM#: 7626583 & 7703390.

[3] Refer to DM# 8172963 *Albany and Geraldton Reinforcement – Determination of Network Control Service (NCS) Duration*

2017, for the purposes of this study it is assumed NCS will cease in 2016 reflecting the difficulty in determining the cost of NCS over the longer term and the prudency of conservatism in transmission planning. If NCS remains a positive-value proposition it will allow for the further deferral of capital expenditure but will not change the nature of the final investment.

Table 2: NCS Cost Comparison with savings from deferred investment

	2013	2014	2015	2016	2017	2018	2019	2020
NCS Cost pa ($000)								
KOJ-ALB - Augmentation								
MUJ-KOJ - Augmentation								
Net Benefit	$4,696	$8,876	$6,845	$5,064	$1,729	-$1,687	-$7,513	-$25,774

Note – Certain numbers from Table 2 have been removed due to commercial confidentiality

2.1 Load forecast

The loads in the 132 kV system currently supplied by the MU-KOJ 81 and 82 circuits comprise the Kojonup, Albany, and Mount Barker substations.

The forecast peak summer and winter loads for the next 50 years are shown in Table 3. The forecast loads are based on a probability of exceedance (POE) of 10%, which is the basis of Western Power's planning for future demand.

A more detailed table for summer and winter can be found Appendix [A].

Table 3: Load forecast for Kojonup, Mount Barker, and Albany – 50 years

Summer		Winter	
Year	Forecast peak (MW)	Year	Forecast peak (MW)
2009/10	65.8 (actual)	2010	78.0 (actual)
2015/16	86.8	2016	110
2019/20	106	2020	128
2024/25	119	2025	144
2029/30	132	2030	161
2034/35	146	2035	178
2039/40	159	2040	195
2044/45	173	2045	212
2049/50	186	2050	229
2054/55	200	2055	245
2059/60	213	2060	262

2.2 Thermal limits

The thermal limits of the existing system are documented in the project planning report *Reinforce Albany Supply.*[4]

The most onerous thermal loading conditions generally occur during the summer peak, coincident with the lowest transmission circuit ratings.

From 2016, when the proposed Albany NCS is assumed to expire, the most capacity constrained 132 kV lines will be:

- KOJ-ALB 81 (rating 45/95 MVA summer/winter), overloaded from summer 2009/10, but managed by the proposed Albany NCS until its expiry in 2015/16;

[4] Refer to DM# 762583

- MU-KOJ 81 (rating 77/113 MVA summer/winter), overloaded from summer 2013/14, but managed by the proposed Albany NCS until its expiry in 2015/16; and
- MU-KOJ 82 (rating 91/133 MVA summer/winter), overloaded in summer 2016/17 and beyond.

2.3 Voltage limits

The thermal limits of the existing system are documented in the project planning report *Reinforce Albany Supply.*[5]

The most onerous voltage loading condition is during the summer peak, with a slightly higher load achievable in winter due to the difference in power factor between summer and winter.

A project to install 2 x 20 MVAr, 132 kV capacitor banks at Albany[6] is currently in progress: one will be installed in May 2011, and the second bank in June 2012. This, combined with the proposed NCS, is expected to address the current voltage constraints on the 132 kV busbars at Albany and Mount Barker until 2016, when the NCS contract is expected to expire.

The voltage gradient and proximity to voltage collapse make further capacitor installation not technically viable – the capacitor banks currently being installed are large enough to result in voltage step changes of about 7%.

Without maintaining and substantially increasing NCS capability, or a major augmentation, the voltage collapse point would be exceeded after 2016.

2.4 Asset condition

The existing 132 kV overhead lines are predominantly wood pole construction, although the KOJ-MBR and MBR-ALB lines have been upgraded with some concrete poles.

While asset condition, rather than asset age would be a stronger determinant of the decision to replace these assets, Western Power does not currently have a published condition-based asset replacement plan for these lines. Western Power considers that the 60-year economic life is a conservative assumption to determine the replacement profile of these assets in this context.

Assuming a 60-year economic life, the replacement of the existing lines would occur as follows:

- MU-KOJ 81 in 2025;
- KOJ-ALB 81 in 2032;
- MU-KOJ 82 in 2038;
- MBR-ALB 81 in 2052; and
- KOJ-MBR 81 in 20612052 and 61 respectively (both these lines have been upgraded).

In Section 4.1 of this report reference is made to the Australian Standard on timber structures (AS 1720.2 – 2006) which gives as guidance a probable life expectancy of 40 years for the wood type used in Western Power overhead lines. As a result of regular inspection and prudent asset management, including wood pole replacement, significant extensions to life expectancy can be realised. The 60 year technical life represents a reasonable assumption on life expectancy.

[5] Refer to DM# 762583
[6] Refer to DM#: 7626583 & 7703390.

2.5 Summary

The existing thermal and voltage issues affecting the Kojonup, Albany and Mount Barker transmission system will be managed by a combination of projects including a proposed NCS at Albany, which is assumed to be adequate until 2016.

With the assumed expiry of the Albany NCS in 2016, and the extension or expansion of the NCS or similar measures not being considered a viable or efficient option to meet medium- to long-term capacity, thermal and voltage requirements, major transmission augmentation to the Kojonup, Albany and Mount Barker system will be required.

Augmentation of the existing system is required irrespective of the requirements of the SDJV Southdown Mine development. However, the mine's development may present substantial symbiotic benefits by way of integrating the proposed new transmission line with the existing system's augmentation needs.

3 Transmission voltage level required to supply the Southdown Mine load

The load flow access studies[4] undertaken to connect SDJV's Southdown Mine examined four options, three of which were found to be technically viable to supply the mine load:

1. A 220 kV single circuit line with a single conductor per phase.
2. A 220 kV single circuit line with a twin conductor per phase.
3. A 330 kV single circuit line with a twin conductor per phase.

All the options related to a new single circuit transmission line between Muja and a new substation at the Southdown Mine. SDJV requires N security for the Southdown Mine, a double circuit line option solely for Southdown mine was not investigated.

All three options were deemed technically viable based on load flows, and a project cost estimated (to +/- 50% accuracy - reflecting the level of detail available) for each [5], as shown in Table 4. It is noted that the accuracy of the project cost estimates does not affect the results of the load flow access studies as consistent project cost assumptions have been used in analysing each option.

The number of conductors and operating voltage of a transmission line makes a considerable difference when determining the losses in a transmission line. Table 44 also shows the cost of losses for each option, based on the following parameters:

- $56/MWh for losses.[7]
- A NPC period of 30 years (expected operating lifetime of the mine).
- A load factor of 0.85 (based on industrial loads being mostly constant demand).

Table 4: Project costs for Southdown Mine connection options, including cost of losses

Option/Description	Project cost ($M)	Cost of Line Losses ($M NPC over 30 years)	Total ($M)
A - 220 kV single conductor	330.7	59.5	**390.2**
B - 220 kV twin conductor	333.4	36.1	**369.5**
C - 330 kV twin conductor	356.1	14.1	**370.2**

Including the impact of losses, the cost comparison of all three options indicates that options B and C are identical, with A being $20 million more expensive (about 5%). Given the small difference, and considering the accuracy of the project costs, it would not be prudent for an economic comparison alone to form the sole basis for selecting a preferred option.

A non-economic assessment indicates that the 220 kV options (A and B), while both technically viable based on the load flows, were less favourable than the 330 kV option (C), due to the following:

- Option A was a very marginal proposal as the voltage collapse point was only 3 MW higher than the required load demand of 180 MW, and required a 100 MVAr SVC at Southdown in order to control the voltage. There was no margin for any additional load off-take, which also carried a substantial risk to the customer if the load demand exceeded 180 MW.

[7] See Appendix B- Cost of losses

- Option B required a 60 MVAr capacitor bank but no SVC was found to be required.
- Both the 220 kV options required a further dynamics study to be able to fully validate and confirm their technical viability. SDJV would have needed to provide detailed load data in order to carry out such a study, however SDJV has not been able to provide this to date.[8] This is in part due to the additional time required to undertake such a study which would carry the risk of delaying and increasing the cost of the project if the 220 kV options proved non-viable or required additional equipment to be procured.
- By comparison the 330 kV option (C) has considerably greater thermal and voltage capacity to meet the Southdown Mine demand and any future increase. Given the lack of available detailed load data, the 330 kV option has significantly lower risk of additional equipment being required.
- Both the 220 kV options required substantial reinforcement works at Muja to connect to the 220 kV bus. A new 300 MVA, 330/220 kV transformer and an extension of the existing 220 kV bus and associated works was required to achieve the required capacity and maintain the N-1 security of the 220 kV bus. The lead time associated with procurement of a new transformer is approximately two years, however, with a three-year construction time for the overhead line, it is not on the critical path for the project.
- Western Power currently has only one 220 kV line – between Muja and Kalgoorlie, and is investigating future options to progressively upgrade this to a higher voltage to address power transmission constraints to Kalgoorlie with a view to eventually discontinuing the use of 220 kV as an operating voltage. Expansion of the 220 kV network at Muja to supply the Southdown Mine will increase the cost of upgrading the Muja to Kalgoorlie network.

3.1 Preferred option for transmission voltage to supply mine load

As the cost comparisons are effectively equivalent within the accuracy of the estimates for all three options, 330 kV may be identified as the preferred transmission voltage option for the major augmentation to supply the Southdown Mine on the basis of technical and risk considerations as it:

- provides additional capacity for increased load from existing or new connections,
- does not require major reinforcement works at Muja and capacitor banks or SVC's at Southdown.
- minimises losses over the lifetime of the project.

While the above analysis results from load flow access studies undertaken in the context of considering the Southdown Mine major augmentation as a stand-alone, single circuit line, it is equally applicable to integrated options which incorporate double circuit lines integrated with the existing transmission network. Accordingly, the options considered in this study for the integration of the Southdown Mine major augmentation with the existing network's required augmentations maintain the 330 kV transmission voltage as the preferred voltage option.

[8] Detailed engineering design of the Southdown mine plant will be required to provide this data. It is unclear when SDJV will be able to provide the detailed load data as a previous commitment to early 2011 has not been met.

4 Connection and network integration options

This section identifies possible options for integrating the proposed 330 kV transmission line major augmentation required to connect the Southdown Mine with the existing system augmentation requirements to determine whether there are benefits to be gained.

The integration options are compared with Option 0, a base case development plan comprising undertaking the Southdown Mine major augmentation wholly independently of the augmentations required to address the capacity, thermal and voltage requirements of the Kojonup, Albany, and Mount Barker area.

The options considered are:

- Option 0 (base case): the Southdown Mine major augmentation comprises a 330 kV Single circuit MU-KOJ section (indirect new route) and a 330 kV single circuit section KOJ-SDN, and the existing network augmentation is undertaken independently;
- Option 1: the Southdown Mine major augmentation comprises a 330 kV Single circuit MU-KOJ section (indirect new route) and a 330 kV single circuit section KOJ-SDN, and the existing network augmentation comprises a KOJ 330/132 kV transformer, and replacing MU-KOJ 81 with new 330 kV single circuit line;
- Option 2: the Southdown Mine major augmentation comprises a 330 kV Single circuit MU-KOJ section (replacing existing MUJ-KOJ 81 route) and a 330 kV single circuit section KOJ-SDN, and the existing network augmentation comprises a KOJ 330/132 kV transformer, and replacing MU-KOJ 82 with 330 kV single circuit line; and
- Option 3: the Southdown Mine major augmentation comprises a 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route) and a 330 kV single circuit section KOJ-SDN, and the existing network augmentation comprises:
    - o 3a: a KOJ 330/132 kV transformer, and rebuilding KOJ-ALB 81 as a 132 kV double circuit;
    - o 3b: a KOJ 330/132 kV transformer, and building a 330 kV single circuit triangle KOJ-SDN-ALB;
    - o 3c: a KOJ 330/132 kV transformer, and rebuilding KOJ-ALB 81 as a 330 kV double circuit.

4.1 Assumptions and option development principles

Each development option is designed to meet the immediate Southdown Mine requirements through a major augmentation within the project timeframe and the subsequent requirements to augment the existing network. The requirements for the Southdown Mine and the existing network are detailed in Section 3, several assumptions, common to each option have been made, as follows:

- A commissioning date of March 2014 for the Southdown Mine must be achieved.
- The individual project costs have been developed using Building Block Estimated Unit Cost Data[9] except for the 330 kV overhead line costs which are route specific and have been supplied by Western Power's overhead line design group.
- The net present cost calculations have been completed using a hurdle rate of 10.65% and an inflation rate of 2.72%.
- Replacement of existing 132 kV wood pole transmission line assets is assumed to occur when the asset reaches 60 years of age. The Australian Standard on timber structures (AS 1720.2 – 2006) gives guidance on the natural durability & probable life expectancy of timber, on page 12, table 5. A Class 2 wood (such as Jarrah) has an

[9] See DM# 7426252v3

in-ground life expectancy of 15 to 20 years and an above ground life expectancy 15 to 40 years. Western Power currently operates a condition-based pole replacement policy although recent analysis on wood pole replacement does show a strong correlation between age and condition. However the 60 year replacement assumption does reflect that Western Power is, through prudent inspection and asset management processes, regularly able to extend asset lives beyond those stated in the Australian Standard.

Each of the options proposes a series of investments over a 50-year time horizon. In order to construct each series of investments over such a period of time, assumptions must be made on future investment decisions, particularly in relation to new transmission lines, whether replacing existing lines or constructing new lines, beyond a 15 to 20 year timeframe.

The reasons for using this time horizon are detailed in the preamble to this study. While this time horizon is subject to a degree of uncertainty and may affect the accuracy of cost estimates and other assumptions, as equivalent assumptions have been used in the development of each option, this impact is effectively minimised for the purpose of option comparison and selection.

For 132 kV overhead lines supplying the area south of Muja, supplying loads above 150 to 200 MW, over long distances generally becomes impractical without increasing the number of circuits (and line easements required), so a transition to a higher voltage is the preferable outcome for technical, environmental, economic and regulatory compliance[10] reasons. The combined load forecast (excluding the Southdown Mine connection) for the Albany area (including Kojonup) is forecast to exceed 175 MW in 2035 and 2045/46 for winter and summer respectively within a 25 to 35 year timeframe[11] based on the forecast detailed in Appendix A.

Each option considered in this study includes the replacement of existing 132 kV transmission lines or the construction of new lines at some stage, and given the eventual magnitude of load that must be met, provision for a future transition to 330 kV is allowed for, particularly in the case of new lines being constructed or the replacement of existing lines more than 15 to 20 years into the future.

The timing and staging of the voltage transition is a feature of each option.

4.2 Option 0: Construct Muja – Southdown 330 kV single circuit independent of existing network (base option)

Figure 5 shows the Southdown Mine major augmentation comprising the initial development of a new 330 kV line between Muja and Southdown in 2014, routed via Kojonup substation. The section between Muja and Kojonup is a new (indirect) route independent from, and 12.2 km longer than, the existing 81 and 82 routes. The background to this portion of option 0 and the identification of the new route is detailed in section 1.1 of this study to progress towards SDJV's demanding timescale of a March 2014 commissioning date.

[10] Technical Rules 2.2.2 Steady State Power *Frequency Voltage*
[11] See forecast Appendix A – Forecast load at Kojonup, Mount Barker and Albany substations

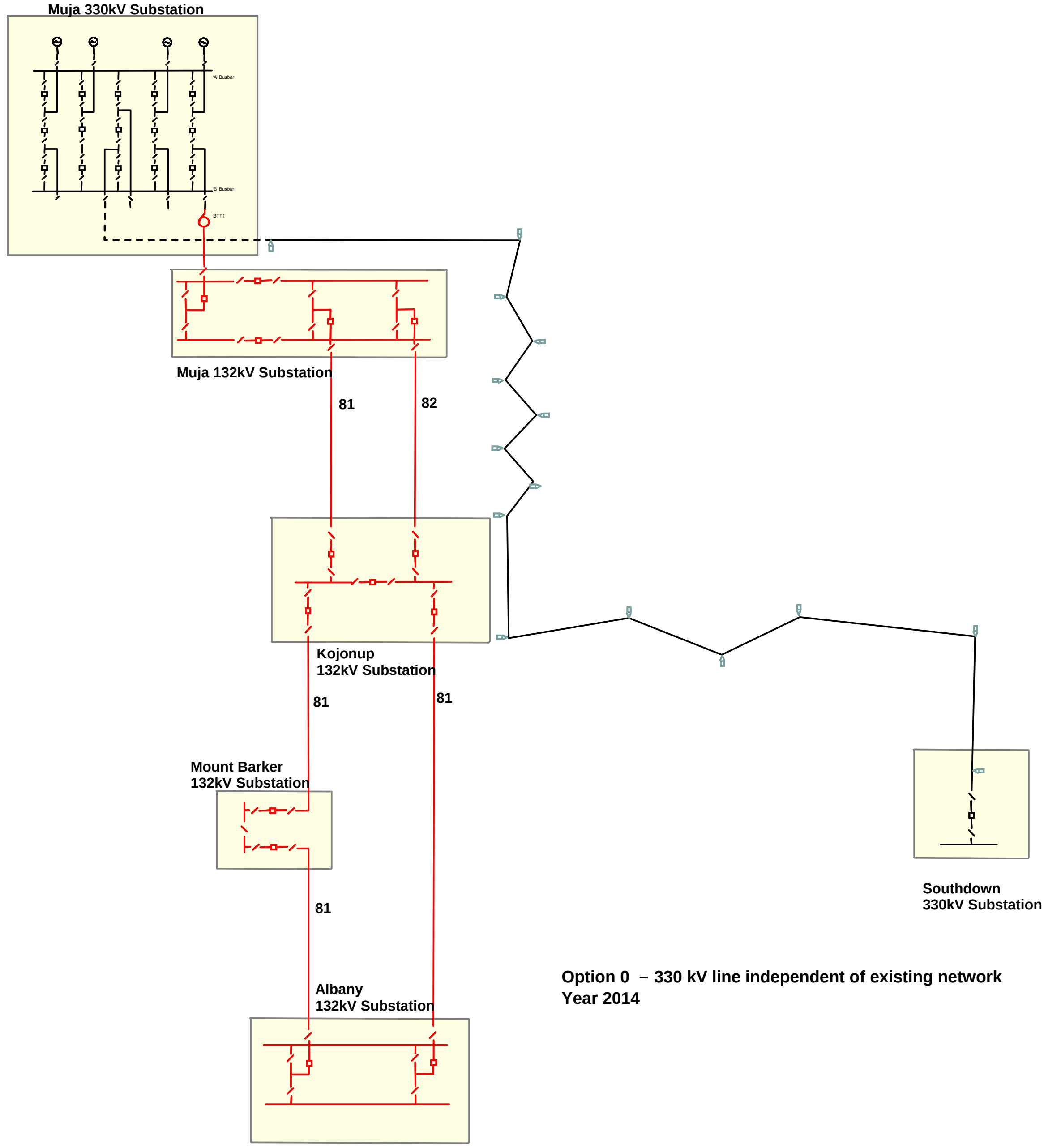


Figure 5: Option 0 – with proposed Southdown Mine 330 kV single circuit connection in 2014

The existing Muja – Kojonup 81 circuit is forecast to overload in summer 2013/14 (rating 77 MVA), and the existing Muja – Kojonup 82 circuit is forecast to be overloaded and in breach of the Technical Rules in summer 2016/17 (rating 90 MVA).

There are also overloads and voltage performance issues in the transmission system to the south of Kojonup.

Network developments and strategies to manage these short-term issues at Albany (refer to section 2) are currently being implemented and will serve to defer the need for augmentation for the MU-KOJ circuits and the network south of Kojonup until 2016.

The following augmentations outline how the development of the existing network might proceed without integrating with the SDJV connection, or what might occur if the SDJV connection did not proceed or was delayed significantly.

Part A: In 2016/17[12], reinforce the supply from Muja to Kojonup with a third circuit.

(i) Given the limited rating and age of the existing MU-KOJ 81 circuit, the logical first development would be replacement of this line with a new 132 kV double circuit, steel pole line. Rebuilding with double circuit construction is much more cost effective than two single circuit constructions. A new 132 kV bay at both Muja and Kojonup is also required to connect the third circuit.

(ii) This replaces the existing 77 MVA rated circuit with two 180 MVA summer rated circuits (assuming a Mango conductor).

(iii) Combined with the existing MU-KOJ 82 circuit (90 MVA rating) the firm capacity into Kojonup is approximately 180/266 MVA for summer/winter respectively (the worst case contingency is a new MU-KOJ circuit).

(iv) The existing 82 circuit does not significantly contribute to thermal capacity, but is required to remain in service to provide voltage support. At least three 132 kV circuits are required between Muja and Kojonup to achieve and maintain voltage compliance with the Technical Rules[13].

Part B: In 2016/17, reinforce the supply from Kojonup to Albany with a third circuit.

(i) If a 132 kV transmission voltage is maintained then Albany will require at least three 132 kV circuits due to the 157 km distance between Kojonup and Albany and 88 km between Muja and Kojonup. Series compensation is also required to boost the Albany fault level and achieve adequate long-term voltage performance.

(ii) The most limiting restriction between Kojonup and Albany is the KOJ-ALB 81 line. Replacing this line with a 132 kV double circuit steel pole line in 2016, combined with series capacitors,[14] is a means of addressing both thermal and voltage issues at Albany.

(iii) The existing KOJ-ALB 81 line will be 44 years old in 2016, will be decommissioned and removed some time after 2016.

(iv) Rating of the three circuits between Kojonup and Albany will therefore be 87 / 180 / 180 MVA (summer) for KOJ-MBR 81 / KOJ-ALB 81 / KOJ-ALB 82 respectively.

[12] Financial year.

[13] Technical Rules 2.2.2 Steady State Power *Frequency Voltage*

[14] Up to 70% compensation is assumed for the capacitor banks, which would make the reactance of a 157 km line equivalent to that of a 47 km line.

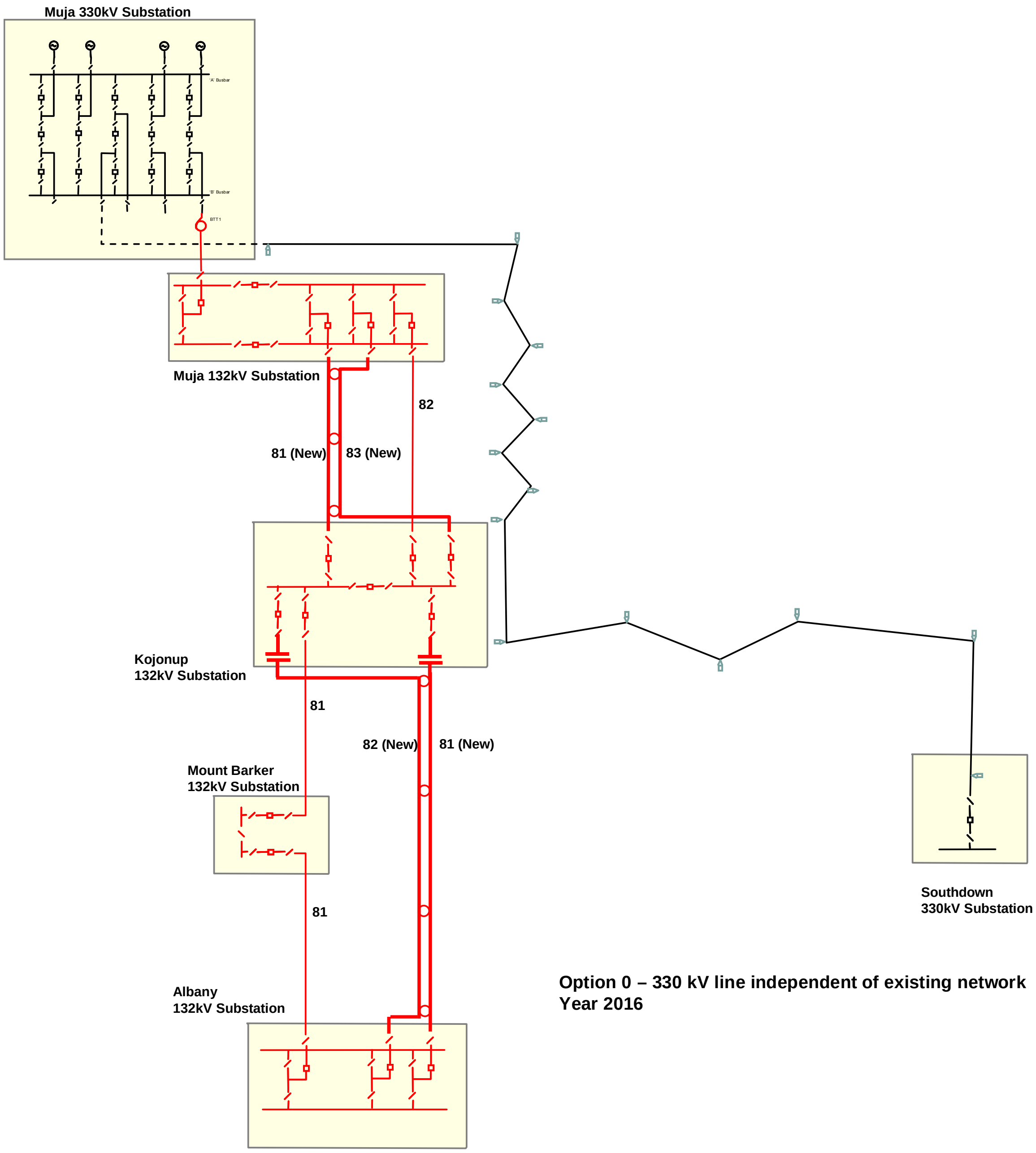


Figure 6: Option 0 – with independent 132 kV developments in 2016

The system after existing network augmentation in 2016 is shown in Figure 6 above. The thermal capacity that these upgrades provide is limited to the following loads:

- for an outage of the new 132 kV MU-KOJ 81 circuit the existing MU-KOJ 82 circuit (90 MVA rated) limits the thermal loading to 180 MW, which is adequate to summer 2046/47 based on the load forecast; and
- for an outage of the new KOJ-ALB 81 (series compensated) circuit, the new KOJ-ALB 82 (series compensated) circuit (180 MVA rated) limits the thermal loading to 210 MW - adequate to summer 2057/58 based on the load forecast.

The former is the most limiting outage for thermal rating.

The voltage performance is shown in Figure 7, with the limitations being:

- with the MU-KOJ 81 (new) circuit out of service, the minimum voltage of 0.9 pu at Albany is reached at 210 MW load which is adequate to winter 2044; and
- likewise, with a new KOJ-ALB (series compensated) circuit out of service, the minimum voltage of 0.9 pu at Albany is also reached at 210 MW load which is adequate to winter 2044.

Both contingencies are almost identical in terms of voltage performance.

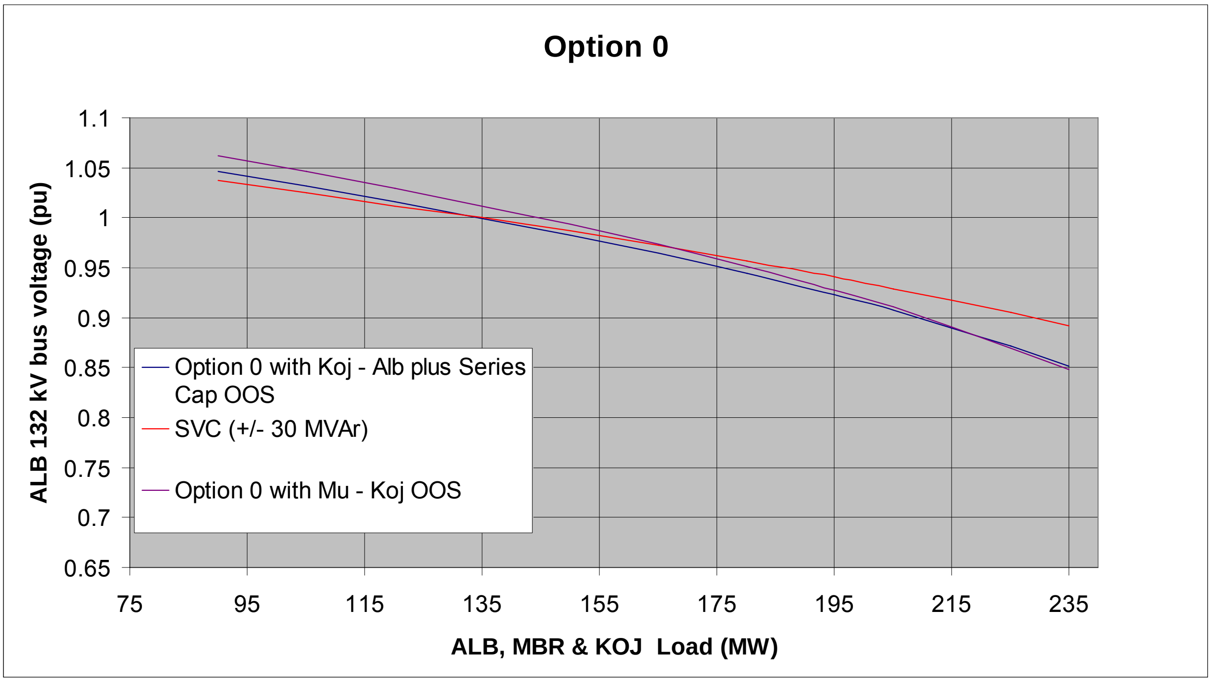


Figure 7: Option 0 – Voltage performance of 132 kV developments in 2016

The impact of installing a +/-30 MVAr SVC at Albany 132kV busbar has been assessed as part of this option. As shown in Figure 7 the limit is increased to an approximate 225 MW load which results in a potential voltage relief of about five years, however this is practically constrained to three years due to the thermal limit.

In this instance, it is assumed that a SVC would not be an efficient investment given the estimated $21 million capital cost, and since it is also preceded by an asset replacement requirement for the MU-KOJ 82 line.

At this point, the practical limitations of supplying such a large load over approximately 245 km using 132 kV circuits is reached and a transition to 330 kV is the most prudent way to meet continuing growth in load demand. This leads to Parts C and D works below.

Part C: In 2038, replace the MU-KOJ 82 line, with a new 330 kV double circuit line.

(i) In 2038 the existing MU-KOJ 82 line would also be 60 years old, so it would nominally be replaced. The purposes of this analysis it has been assumed that the investment will take place in 2038.

(ii) The Muja and Kojonup bay infrastructure is unchanged as the existing MU-KOJ 81 and 83 circuits will be bonded together at this point to form a single 132 kV circuit (81), with the new 132 kV (330 kV design) circuits connecting into the existing 83 and 82 bays. There is no need for additional substation infrastructure.

In 2038 the transmission network performance limits are as follows:

- for an outage of the new KOJ-ALB 81 (series compensated) circuit the new KOJ-ALB 82 (series compensated) circuit (180 MVA rated) limits the thermal loading to 210 MW - adequate to summer 2057/58 based on the load forecast; and
- with either of the new KOJ-ALB (series compensated) circuits out of service, the minimum voltage of 0.9 pu at Albany is reached at 235 MW load – adequate to winter 2052.

Part D: In 2052, replace the MBR-ALB 81 and KOJ-MBR 81 lines, with a new 330 kV double circuit line but strung one side only, and initial operation at 132 kV.

(i) The MBR-ALB 81 and KOJ-MBR 81 lines will be approximately 60 years old in 2052 and 2061, respectively so at some stage after this they would need to be replaced based on condition. However in practice it may be efficient for construction of both lines as a single project in 2052. Due to the voltage limitation it has been assumed that both investments will take place in 2052.

Construction of a 330 kV double circuit line, would result in two 330 kV rated circuits between Muja and Albany. It is assumed that the initial operation would be at 132 kV. This capitalises on the incremental gain in performance by replacing the old lines, but with the capability for a future transition to 330 kV to be achieved.

The development post-2052 is shown in Figure 8, with the interim operation of the 330 kV lines at 132 kV prior to the transition to 330 kV operation.

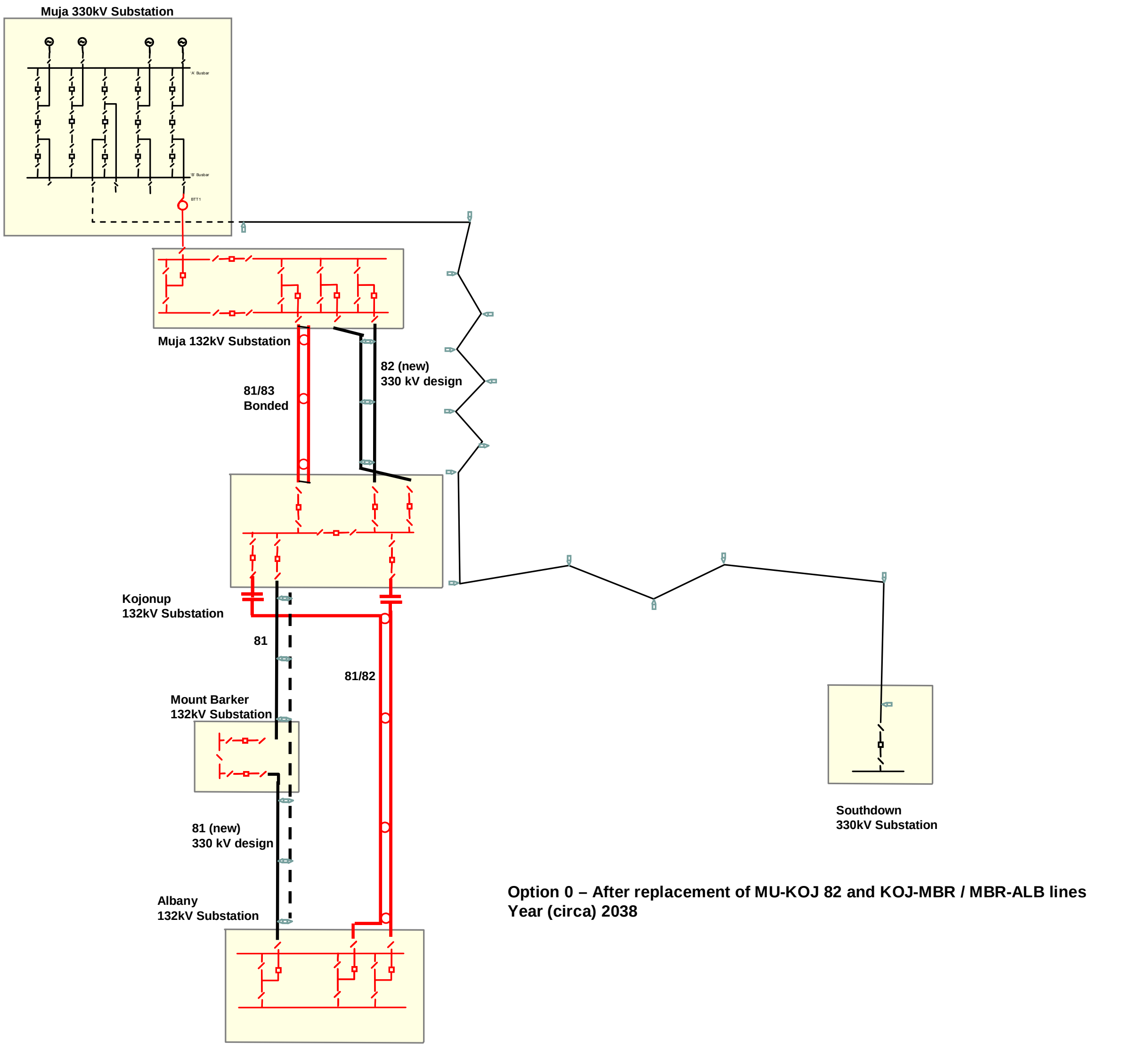


Figure 8: Option 0 - Ultimate development circa 2052 with 330 kV design lines, but operating at 132 kV

The limiting factor on the above network is the voltage performance with the voltage limits as follows:

- following an outage of the KOJ–ALB (series compensated) 81 circuit the thermal limit is 230 MW based on the 180 MVA rating of the KOJ – ALB (series compensated) 82 circuit. This is adequate to beyond summer 2059/60 based on the load forecast; and

- the voltage limit for an outage of the KOJ–ALB (series compensated) 81 circuit is 265 MW. This is adequate to winter 2059 based on the load forecast.

The network transition from 132kV to 330 kV post-2060 could occur by:

- installing 330 kV bay infrastructure for two circuits at Muja; and
- either:
  - o replacing both Mount Barker transformers with 330/22 kV units, and installing two 330/132 kV, 250 MVA transformers at Albany, with associated 330 kV bay infrastructure. Kojonup substation is bypassed completely by the 330 kV circuits; or

- Maintain Mount Barker substation as is but supply at 132 kV via one side of double circuit 330 kV line, and energise this other circuit at 330 kV with a 330/132 kV, 250 MVA transformers at Albany and Kojonup, with associated 330 kV bay infrastructure.

Several other alternatives are possible.

4.2.1 Summary

It is Western Power's view that the Muja-Kojonup-Albany load demand can be met until 2038 with new 132 kV transmission lines combined with series compensation. However, taking advantage of asset replacement projects required from this point on, a planned transition to 330 kV is envisaged, which can be achieved through replacement of the oldest 132 kV lines with new 330 kV double circuit lines.

Thus, in around 2038 there would be a 330 kV double circuit line from Muja to Kojonup, and from 2052, there would be a 330 kV double circuit line from Kojonup to Albany (via Mount Barker), albeit all initially operating at 132 kV.

The upgrade from 132 kV operation to 330 kV operation can then be optimally timed depending on the growth in load demand (or generation development). Currently, it is estimated to take place at a point in time after 2060.

This forms the basis of Western Power's base case development plan for the south-east of Muja conducted wholly independently of the major augmentation requirements required to supply the Southdown Mine.

From an environmental perspective, the existing line easements are likely to be required indefinitely, although depending how the conversion to 330 kV occurs, the KOJ-ALB 81 & 82 line (series compensated) could eventually become redundant, and therefore removal and relinquishment of the easement is a possibility.

Considering the Southdown Mine major augmentation comprising a new 330 kV line, a new and independent line easement would be required. Integrating this line with the existing system would effectively bring forward the 330 kV development of the existing system and thus its associated costs, however, there may by efficiencies and economic benefits in doing so as explored in options 1 to 3 below.

After the works in 2017, further augmentation works are required within 21 years (2038), and then within a further 14 years (2052).

4.2.2 Project and net present costs

The development phases, project base cost, and net present cost are summarised in Table 5.

Table 5: Option 0 - Project elements and NPC

Project	Project Element	Base 2011 Costs ($m)	Delivery Year[15]	Net Present Cost ($m)
1	**SDJV Southdown Mine Major Augmentation**			
1.1	Design and construction of MU-KOJ section 99 km (new indirect route) and KOJ-SDN section 188 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja and Southdown.	356.1	2014	
2	**Existing Network Augmentation: Replace 132 kV MU-KOJ 81 line**			
2,1	Design and construction of 87.5 km of double circuit 132 kV overhead Line, steel pole construction.	56.9	2017	
2.2	Additional bay infrastructure for 3rd circuit at Muja and Kojonup, including 1 km cable section at Muja end.	6.3	2017	
2.3	Removal of the MU-KOJ 81 line and revegetation of route corridor	8.0	2019	
3	**Existing Network Augmentation: Albany reinforcement works**			
3.1	Design and construction of 157 km of double circuit 132 kV overhead Line, steel pole construction, including removal of existing KOJ-ALB 81 overhead line and revegetation of route corridor.	102	2017	
3.2	Design and construct series capacitors for each of the two new KOJ-ALB circuits at Kojonup.	12.0	2017	
3.3	Additional 132 kV bay at Kojonup and Albany for the 3rd 132 kV KOJ-ALB circuit.	3.2	2017	
4	**Existing Network Augmentation: Replace 132 kV MU-KOJ 82 line**			
4.1	Design and construction of MU-KOJ section 88.7 km of 330 kV double circuit, steel tower construction.	87.4	2038	
4.2	Removal of the MU-KOJ 82 line and revegetation of route corridor	7.9	2040	
5	**Existing Network Augmentation: Replace 132 kV KOJ-MBR/MBR-ALB lines**			
5.1	Design and construction of 103 km (KOJ-MBR section) and 49 km (MBR-ALB section) of double circuit 330 kV overhead line, (stung one side only and operating at 132 kV, including removal of existing line.	130.0	2052	
	TOTAL	**770**		**455**

[15] For financial year ending.

4.3 Option 1: Construct Muja – Southdown 330 kV single circuit with 132 kV connection at Kojonup

For this option, the proposed major augmentation to supply the Southdown Mine comprises a 330 kV single circuit overhead line from Muja to the Southdown Mine which is routed as per Option 0 via the new indirect route between Muja and Kojonup. The line is routed past the existing Kojonup 132kV substation in order to facilitate a possible future connection.

This option develops from the basis of Kojonup requiring a third circuit (as per Option 0), although with a different augmentation, as set out below.

Part A: In 2016/17, install a 250 MVA, 330/132 kV transformer at Kojonup.

(i) Given the need to provide a third circuit into Kojonup by 2017, an alternative to a new 132 kV line is to install a 250 MVA, 330/132 kV transformer at Kojonup instead. A new 132 kV bay at Kojonup is required for the transformer connection.

Part B: In 2016/17, reinforce the supply from Kojonup to Albany with a 3rd circuit.

(i) This is still required in 2016/17 as per Option 0.

The network arrangement after the above works is undertaken is shown in Figure 9 below.

The thermal capacity that these upgrades provide is limited to the following loads:

- for an outage of the new Kojonup 330/132kV transformer the existing MU-KOJ 81 circuit (77 MVA rated) limits the thermal loading to 130 MW which is adequate to summer 2028/29 based on the load forecast; and
- for an outage of either of the two new KOJ-ALB (series compensated) circuits the other circuit (180 MVA rated) limits the thermal loading to 210 MW which is adequate to summer 2057/58 based on the load forecast.

The worse case outage gives a thermal limit of 130 MW under the summer rating conditions.

The voltage performance limitation for this option is very similar to Option 0 which as shown in Figure 7, has sufficient capacity to winter 2044.

Thus, the limiting factor is the 130 MW thermal limit which is binding after 2028/29.

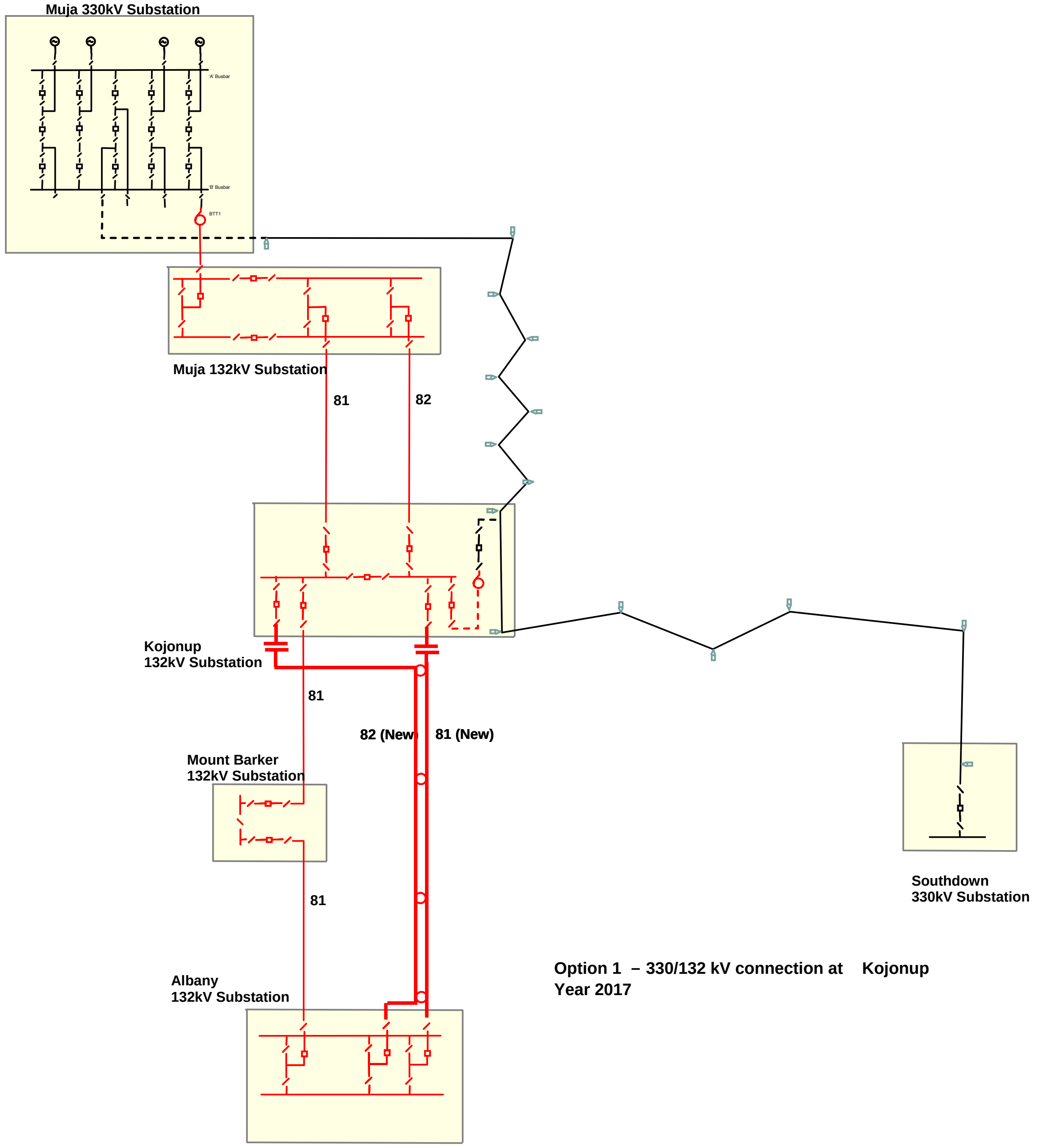


Figure 9: Option 1 – with proposed Southdown Mine 330 kV single circuit connection in 2013, and KOJ 330/132 kV transformer in 2017

In 2025, the MU-KOJ 81 circuit would be 60 years old, therefore in the analysis presented here it is assumed that it will be replaced or removed. Given also the thermal limitation, binding after 2028/29, this leads to Part C works below.

Part C: In 2025, replace MU-KOJ 81 with a new 330 kV single circuit line initially operating at 132 kV.

(i) Since there is already a 330 kV single circuit line between Muja and Kojonup with a 330/132 kV connection at Kojonup the logical long term development of the network would be to replace both the existing 132 kV MU-KOJ 81 and 82 lines with a single circuit 330 kV line. Operating at 132 kV initially capitalises on the incremental gain in capacity that the 330 kV line provides.

Consideration was given to progressing with a double circuit 132 kV line between Muja and Kojonup instead of the 330 kV single circuit. This option was rejected due to the following limitations:

- voltage performance at Albany would eventually require upgrade to a higher voltage and the 132 kV line would prevent a staged progression to 330 kV without a new line route (assuming the MU-KOJ 82 easement was relinquished), and early retirement of the new 132 kV lines at significant cost; and
- the relative cost difference between a single circuit 330 kV line and a double circuit 132 kV line is small[16], so the major cost differences are the additional substation infrastructure at each end for the 330 kV, which is offset by reduced line losses. By comparison, as the load grows the benefit of using a 330 kV single circuit line increases due to improved network performance and reduced line losses.

The system after the works in 2025 is shown in Figure 10.

[16] Based on 330 kV single circuit (57.7 M) line and 132 kV double circuit (56.9 M) line for the Muja-Kojonup corridor – these are line costs only and exclude the substation bay infrastructure.

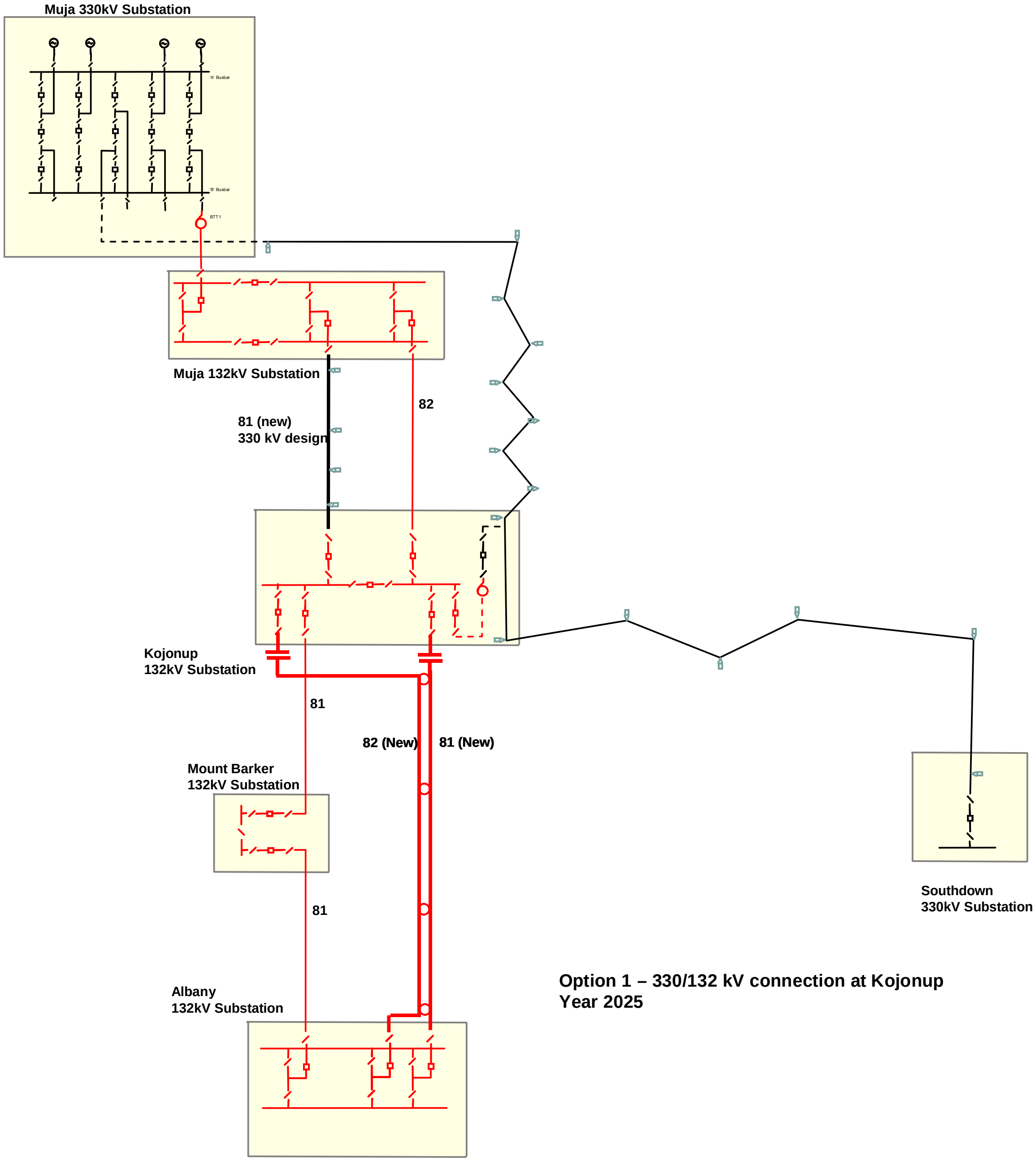


Figure 10: Option 1 – development to 2025 with 330 kV design line replacing MU-KOJ 81

The thermal capacity that these upgrades provide is limited to the following loads:

- for an outage of the new Kojonup 330/132kV transformer the existing MU-KOJ 82 circuit (90 MVA rated) limits the thermal loading to 180 MW which is adequate to summer 2046/47 based on the load forecast.

The voltage performance is shown Figure 11, with the 0.9 pu voltage limit occurring at a load of 250 MW which is adequate to winter 2056.

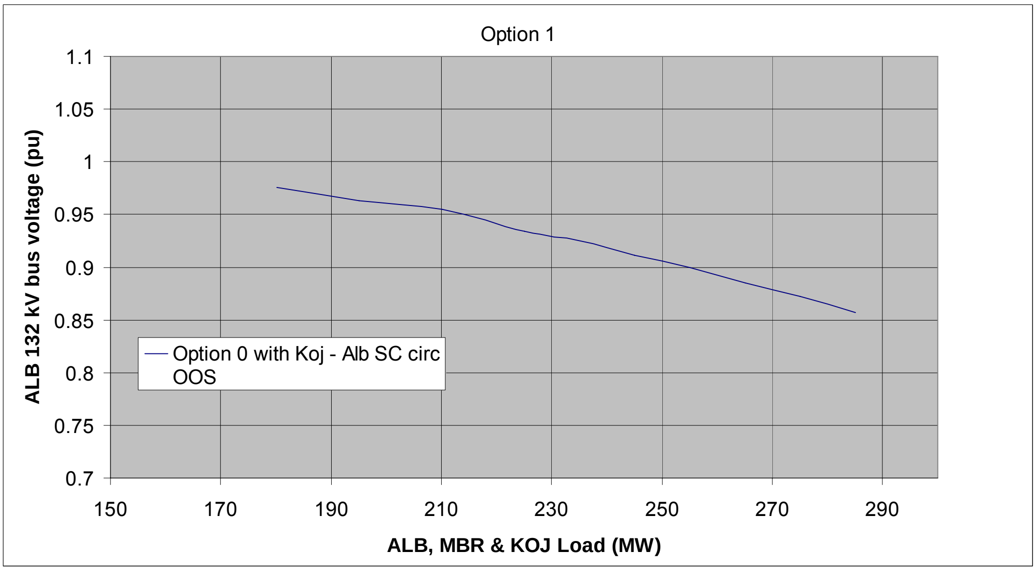


Figure 11: Option 1 – development to 2025 with 330 kV design line replacing MU-KOJ 81 - voltage performance

The limitation, however, is an asset replacement one, with MU-KOJ 82 reaching 60 years age, leading to Part D works below.

Part D: In 2038, replace the existing KOJ-MBR / MBR-ALB line with a new 330 kV double circuit line.

(i) Note that the trigger for this work in 2038 is actually the MU-KOJ 82 circuit reaching 60 years age, at which time it is assumed that condition would dictate replacement. In this case it is removed, as follows:

a. The new 330 kV double circuit line replaces the existing KOJ-MBR / MBR-ALB line, one circuit operates at 132kV and provides a connection to Mount Barker with the second circuit operating at 330 kV.

b. Increase the MU-KOJ 81 circuit to 330 kV operation and connect to the new 330 kV double circuit line from Kojonup to Albany, install 330/132 kV transformer at Albany and a new 330 kV bay at Muja.

c. MU-KOJ 82 is decommissioned and removed, with relinquishment and revegetation of the easement.

The final development is shown in Figure 12.

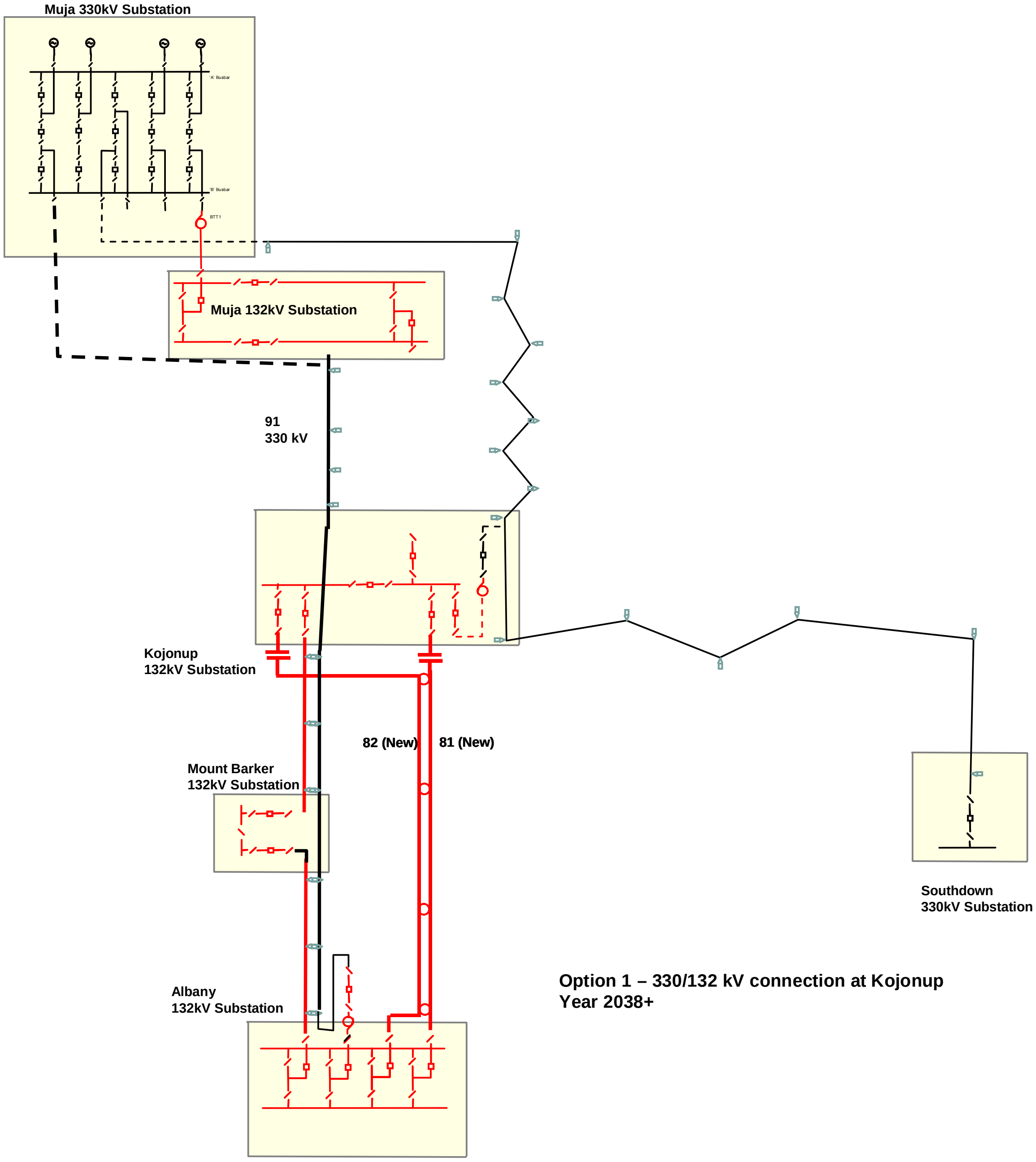


Figure 12: Option 1 – final development to 2038 with 330/132 kV connections at Kojonup and Albany

The network performance limits of this arrangement are as follows:

- for an outage of either the Albany or Kojonup 330/132kV transformer the other transformer overloads (250 MVA rated) limiting the load to 235 MW which is adequate to winter[17] 2051 (and beyond 2060 for summer loads) based on the load forecast; and
- for an outage of the Albany 330/132kV transformer the voltage limit is 255 MW this equates to 2057 against the winter forecast.

[17] Transformer rating is not seasonal – i.e. it is same for both summer and winter.

In order to extend the capacity of the network to beyond 2060, consistent with the other options, there are several possible methods. For the purposes if this analysis it is assumed that this will comprise Part E works below.

Part E: In 2052, install a second 330/132 kV transformer at Albany.

(i) This also requires:

a. Construction of a terminal station at Kojonup,

b. Replacement of the Mount Barker transformers to facilitate an upgrade of the KOJ-MBR and / MBR-ALB circuits to 330 kV operation.

.

The above combined works provide sufficient capacity for the network to beyond 2060.

4.3.1 Summary

An advantage of this option is that the initial transformer installation at Kojonup can be brought forward if it is necessary to reduce reliance upon the proposed NCS at Albany, including if the NCS proves not be economic.

Another consideration is that providing for future outages on the 330 kV single circuit may be extremely difficult so it may in fact be prudent to install the transformer earlier and energise both the new 330 kV overhead line for the SDJV Southdown Mine and the Kojonup transformer in 2014.

From an environmental perspective, only two line routes (or easements) are required between Muja and Kojonup indefinitely, the existing 81 line route, as well as the new route for the 330 kV MU-KOJ-SDN line. The existing line route 82 is relinquished and rehabilitated.

The two existing routes between Kojonup and Albany are required indefinitely, at least within the 50-year horizon being considered.

After the works in 2017, further augmentation works are required within 9 years (2026), then within a further 12 years (2038), and then within a further 14 years (2052).

4.3.2 Project and net present costs

The development phases, project base cost, and net present cost are summarised in Table 66.

Table 6: Option 1 - Project elements and NPC

Project	Project Element	Base 2011 Costs ($m)	Delivery Year[18]	Net Present Cost ($m)
1	**SDJV Southdown Mine Major Augmentation**			
1.1	Design and construction of MU-KOJ section 99.9 km (new indirect route) and KOJ-SDN section 188 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja and Southdown.	356.1	2014	
2	**Existing Network Augmentation: Kojonup/Albany reinforcement works**			
2.1	Design and construction of a 250 MVA 330/132kV transformer at Kojonup, including new 330 kV and 132 kV bay infrastructure.	12.3	2017	
2.2	Design and construction of 157 km of double circuit 132 kV overhead Line, steel pole construction, including removal of existing Kojonup-Albany 81 overhead line and revegetation of route corridor.	102	2017	
2.3	Design and construct series capacitors for each of the two new KOJ-ALB circuits at Kojonup.	12.0	2017	
2.4	Additional 132 kV bay at Kojonup and Albany for the 3rd 132 kV KOJ-ALB circuit	3.2	2017	
3	**Existing Network Augmentation: Replace MU-KOJ 81 with new 330 kV line**			
3.1	Design and construction of MU-KOJ section 87.5 km of 330 kV single circuit, steel tower construction (initial operation at 132 kV).	57.7	2026	
3.2	Removal of the MU-KOJ 81 line and revegetation of route corridor	8.0	2028	
4	**Existing Network Augmentation: Upgrade to 330 kV and 330/132 kV Albany transformer**			
4.1	Design and construction of 103 km (KOJ-MBR section) and 49 km (MBR-ALB section) of double circuit 330 kV overhead line with one circuit operating at 132 kV, including removal of existing line.	149.8	2038	
4.2	Establish a 330 kV switchyard at Albany, and install a 250 MVA 330/132kV transformer.	18.8	2038	
4.3	Design and construction of 330 kV bay infrastructure at Muja including 1 km section of 330 kV cable.	8.8	2038	
4.4	Removal of the MU-KOJ 82 line and revegetation of route corridor	7.9	2040	
4	**Existing Network Augmentation: Install 2nd 330/132 kV Albany transformer**			
2.5	Kojonup works to establish 330 kV switchyard	10.9	2052	
	Upgrade Mount Barker transformers to 330 kV	19.0	2052	
	Albany 2nd transformer and 330 kV bay infrastructure	12.8	2052	
	TOTAL	779		**447**

[18] For financial year ending.

4.4 Option 2: Construct Muja – Southdown 330 kV single circuit (via existing route) with 132 kV connection at Kojonup

For this option the Southdown Mine major augmentation comprises a 330 kV single circuit overhead line from Muja to Southdown Mine routed via the existing direct route used by the MU-KOJ 81 line. Installing a 330 kV single circuit on this shorter and straighter route (87.5km between Muja and Kojonup as compared with a 99.6 km single circuit along the new indirect route between Muja and Kojonup in Options 0 and 1) will reduce overhead line construction costs by $6.3 million and reduce construction time for the major augmentation by an estimated three months. The new line is routed past the existing Kojonup 132kV substation in order to facilitate a possible future connection.

This option develops from the basis of early replacement of MU-KOJ 81, as follows:

Part A: In 2014, install a 250 MVA, 330/132 kV transformer at Kojonup.

(i) In order to secure the existing direct route the existing 132 kV MU–KOJ 81 circuit is removed, and replaced with the new 330 kV line, and a 250 MVA, 330/132 kV transformer at Kojonup, which is energised with the new 330 kV line in 2014.

The system in 2014 is shown in Figure 13.

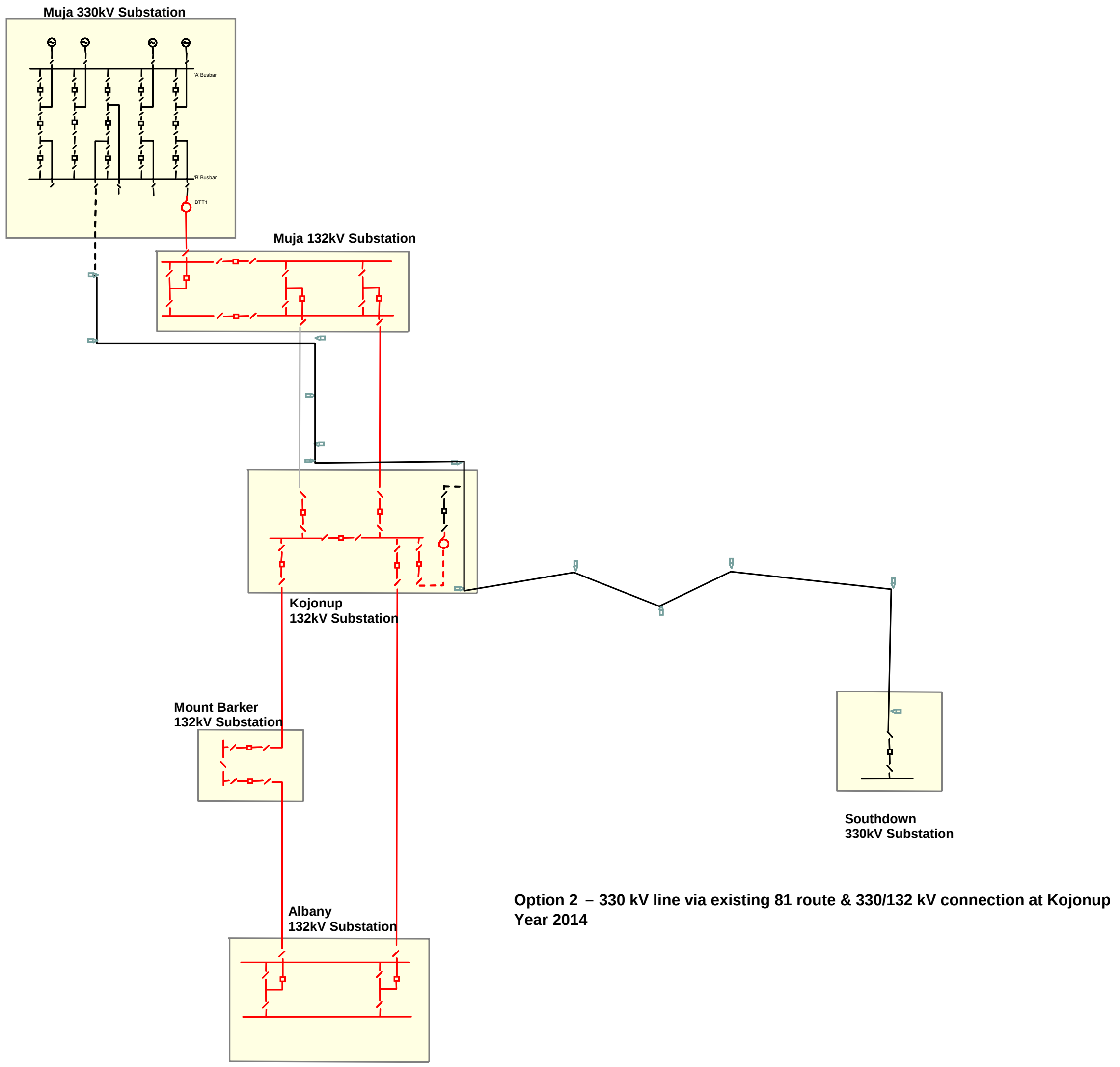


Figure 13: Option 2 - single circuit 330 kV line (in existing 81 route) with transformer at Kojonup, in 2014.

The remaining 132 kV MU–KOJ 82 circuit has a summer rating of 90 MVA which is forecast to reach capacity in 2017 and be in breach of the Technical Rules thereafter. This leads to the following augmentations.

Part B: In 2017, replace MU-KOJ 82 with a new 330 kV single circuit line, with a new 330 kV bay at Muja and 330/132 kV transformer at Kojonup.

(i) Since there is already a 330 kV single circuit line between Muja and Kojonup with a 330/132 kV connection at Kojonup, the prudent long-term development option for the network would be to replace the remaining 132 kV MU-KOJ 82 line with a single circuit 330 kV line.

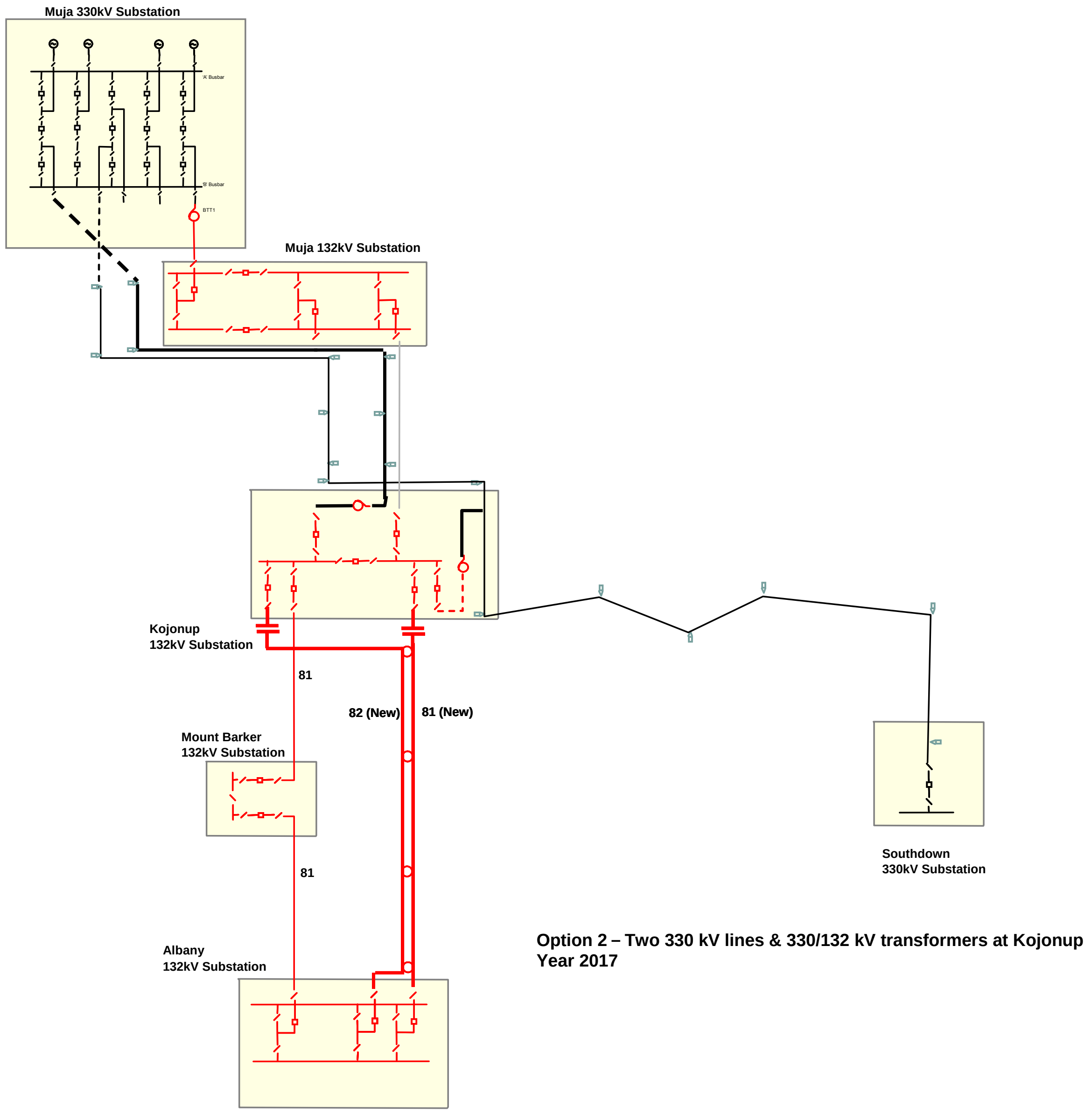


Figure 14: Option 2 – 2nd single circuit 330 kV circuit (in existing 82 route) with second transformer at Kojonup, in 2017.

Consideration was given to progressing with a double circuit 132 kV line between Muja and Kojonup instead of the 330 kV single circuit. This option was rejected due to the following limitations:

- voltage performance at Albany would eventually require upgrade to a higher voltage and the 132 kV would prevent a staged progression to 330 kV without a new line route or, alternatively, early retirement of the new 132 kV line, at significant cost. .
- The relative cost difference between a single circuit 330 kV line and a double circuit 132 kV line is small[19], so the major cost differences are the additional substation infrastructure at each end for the 330 kV but offset by reduced line losses (as the load grows this becomes and increasing larger benefit).

[19] Based on 330 kV single circuit (57.7 M) line and 132 kV double circuit (56.9 M) line for the Muja-Kojonup corridor – these are line costs only and exclude the substation bay infrastructure.

Part C: In 2016/17, reinforce the supply from Kojonup to Albany with a 3rd circuit.

This is still required in 2016/17 as per Option 0.

The network arrangement is shown in Figure 14 and the performance limits are as follows:

- For an outage of either of the new Kojonup to Albany series compensated circuits (each 180 MVA rated) the other one limits the thermal loading to 210 MW – adequate to summer 2057/58 based on the load forecast.
- For an outage of the new Kojonup to Albany series compensated circuits the voltage limit is 215 MW – adequate to winter 2047 based on the load forecast. This is demonstrated in Figure 15.

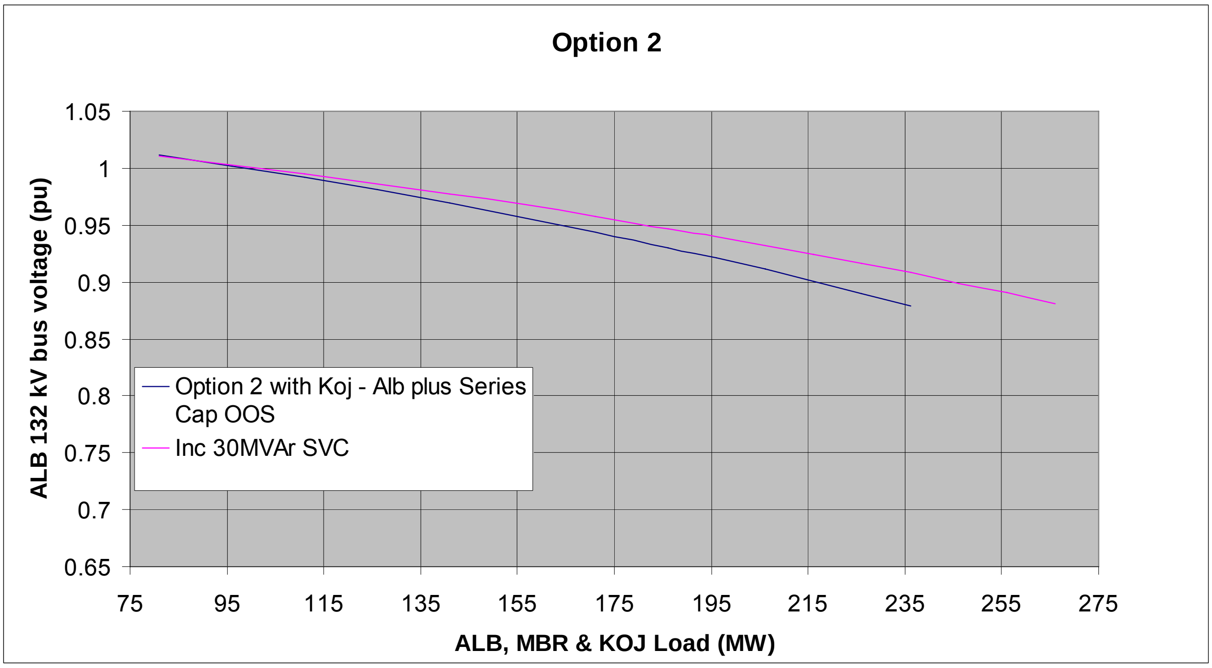


Figure 15: Option 2 – Second single circuit 330 kV circuit (in existing 82 route) with second transformer at Kojonup – Voltage performance.

The subsequent developments would be achieved by:

Part D: In 2047, install an SVC at Albany 132kV.

This increases the voltage limit to 245 MW – adequate to winter 2055 based on the load forecast.

The thermal limit of 235 MW is reached in winter 2052 for an outage of one of the KOJ 330/132 kV transformers overloading the other transformer.

Subsequently, then:

Part E: In 2052, replace the KOJ-MBR 81 line, and MBR-ALB 81 line, with a new 330 kV double circuit line.

In 2052 the KOJ-MBR 81 and MBR-ALB 81 lines will be 60 years old and 51 years old respectively and therefore the KOJ-MBR 81 line is due for asset replacement (with MBR-ALB 81 following 9 years later).

The new 330 kV double circuit line replaces both the existing KOJ-MBR and the MBR-ALB 132kV lines, one circuit operates at 132kV and provides a connection to Mount Barker with the second circuit operating at 330 kV and connecting to a 330 kV bus at Kojonup, a new 330/132 kV transformer installed at Albany.

The final arrangement is shown in Figure 16 and the takes the voltage and thermal limit to beyond 2060.

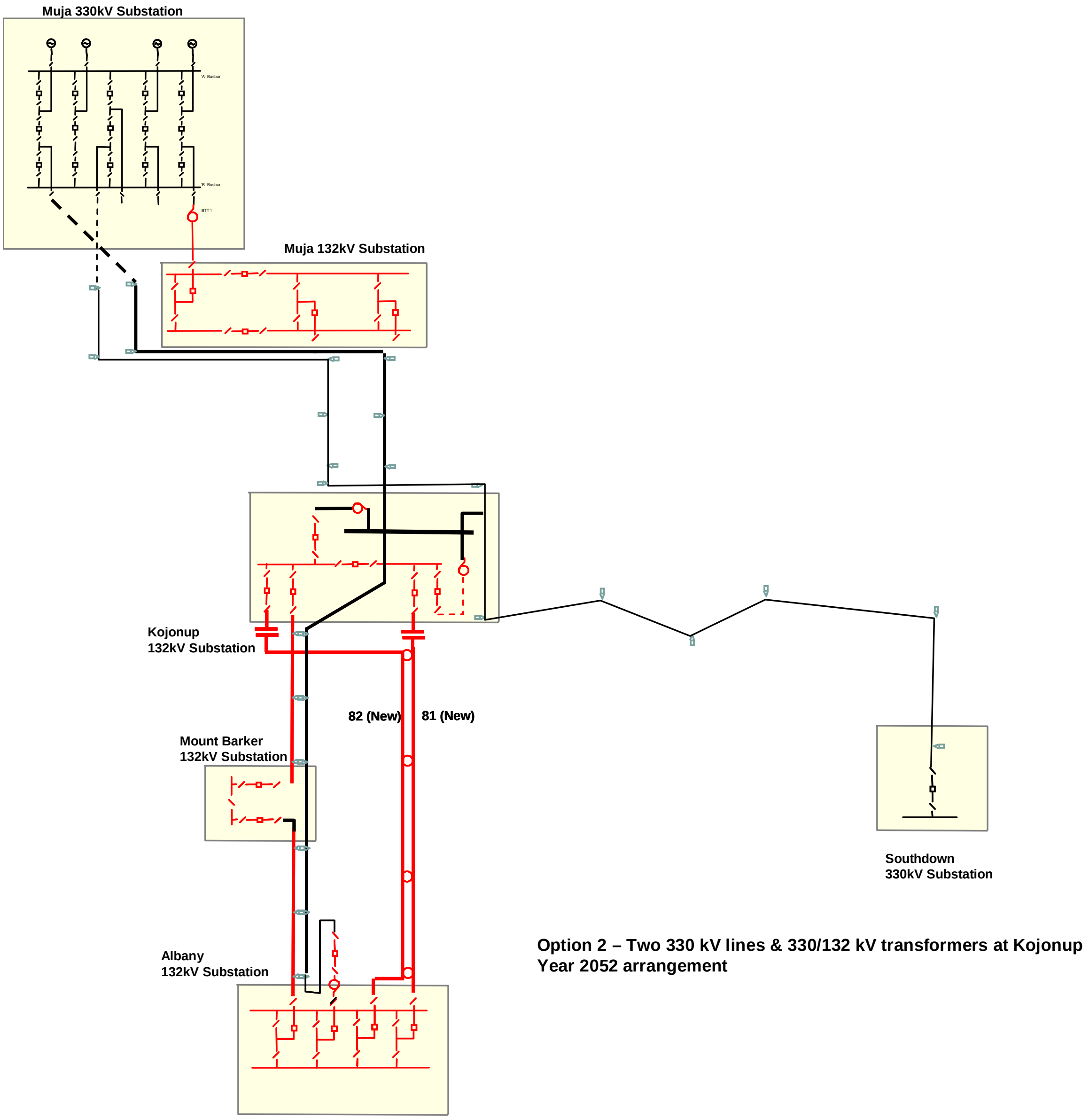


Figure 16: Option 2 - Ultimate arrangement post 2052 after 330 kV connection to Albany

4.4.1 Summary

This option integrates with the existing network three years earlier than Options 0 or 1, due to the existing MU-KOJ 81 line being replaced with the new 330 kV line as part of the major augmentation to connect the Southdown Mine.

There is an environmental advantage as this option does not require a new route (or easement) between Muja and Kojonup to connect Southdown mine. However this option does have the environmental disadvantage of requiring two line routes (or easements) between Muja and Kojonup indefinitely, with the MU-KOJ 82 route being upgraded to single circuit 330 kV in 2017. Likewise between Kojonup and Albany, the two existing routes are required indefinitely. In both cases, new transmission lines are required on each of the routes.

After the works in 2017, no other augmentation works are required for 30 years until 2047.

4.4.2 Project and net present costs

The development phases, project base cost, and net present cost are summarised in Table 7.

Table 7: Option 2 - Project elements and NPC

Project	Project Element	Base 2011 Costs ($m)	Delivery Year[20]	Net Present Cost ($m)
1	**SDJV Southdown Mine Major Augmentation**			
1.1	Design and construction of MU-KOJ section 87.5 km and KOJ-SDN section 188 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja and Southdown.	349.8	2014	
1.2	Design and Construction of a 330 kV switchyard, 250 MVA 330/132kV transformer at Kojonup	19.1	2014	
1.3	Removal of the MU-KOJ 81 line and revegetation of route corridor	8.0	2016	
2	**Existing Network Augmentation: Kojonup/Albany reinforcement works**			
2.1	Design and construction of MU-KOJ section 88.7 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja.	62.2	2017	
2.2	Design and construction of 157 km of double circuit 132 kV overhead Line, steel pole construction, including removal of existing Kojonup-Albany 81 overhead line and revegetation of route corridor.	102	2017	
2.3	Design and construct series capacitors for each of the two new KOJ-ALB circuits at Kojonup.	12.0	2017	
2.4	Additional 132 kV bay at Kojonup and Albany for the 3rd 132 kV KOJ-ALB circuit	3.2	2017	
2.5	Design and Construction of a 2nd 250 MVA 330/132kV transformer at Kojonup	11.4	2017	
3	**Existing Network Augmentation: Albany SVC**			
3.1	30 MVAr SVC at Albany 132kV substation	21.5	2047	
4	**Existing Network Augmentation: Upgrade Albany to 330 kV**			
4.1	Design and construction of 103 km (KOJ-MBR section) and 49 km (MBR-ALB section) of double circuit 330 kV overhead line with one circuit operating at 132 kV, including removal of existing line.	149.8	2052	
4.2	Establish a 330 kV switchyard at Albany, and install a 250 MVA 330/132kV transformer.	18.8	2052	
4.3	Add additional 330 kV bay at Kojonup to bus in the KOJ-ALB 330 kV circuit.	3.6	2052	
	TOTAL	769		**467**

[20] For financial year ending.

4.5 Option 3 – Construct Muja – Southdown 330 kV double circuit (via existing route to Kojonup) + single circuit from Kojonup

For this option the major augmentation to supply the Southdown Mine comprises a 330 kV line from Muja to the Southdown Mine routed via the existing direct route used by the MU-KOJ 81 line, but built as double circuit line for the portion of the transmission line between Muja and Kojonup, followed by a single circuit line from Kojonup to Southdown, in 2014. The new line is routed past the existing Kojonup 132kV substation in order to facilitate a possible future connection.

Due to the shorter route length of 87.5 km between Muja and Kojonup for the proposed double circuit as compared with a 99.6 km single circuit along the new indirect route between Muja and Kojonup, there would be an estimated three month reduction in the construction duration for this section of the overhead line, offset by the increased cost of a double circuit line.

The network arrangement in 2014 is shown in Figure 17.

For Option 3, which incorporates a the same major augmentation for the Southdown Mine outlined above, three alternatives for the development of the existing network south of Kojonup to address the capacity, thermal and voltage issues after 2016 were considered. These are:

a) the development of a 132 kV line from Kojonup to Albany along the existing route as per Options 0, 1, and 2;

b) the development of a 330 kV 'triangle' between Kojonup, Southdown and Albany with Albany supplied at 330 kV; and

c) the development of a 330 kV line from Kojonup to Albany direct, with Albany supplied at 330 kV.

Option 3b utilises the much shorter 90 km route between Albany and Southdown as the initial investment to secure a third circuit to Albany, as opposed to the 157 km route from Kojonup to Albany.

Option 3c achieves the upfront extension of 330 kV from Kojonup to Albany via the existing route to determine whether there are any related benefits compared with Option 3a.

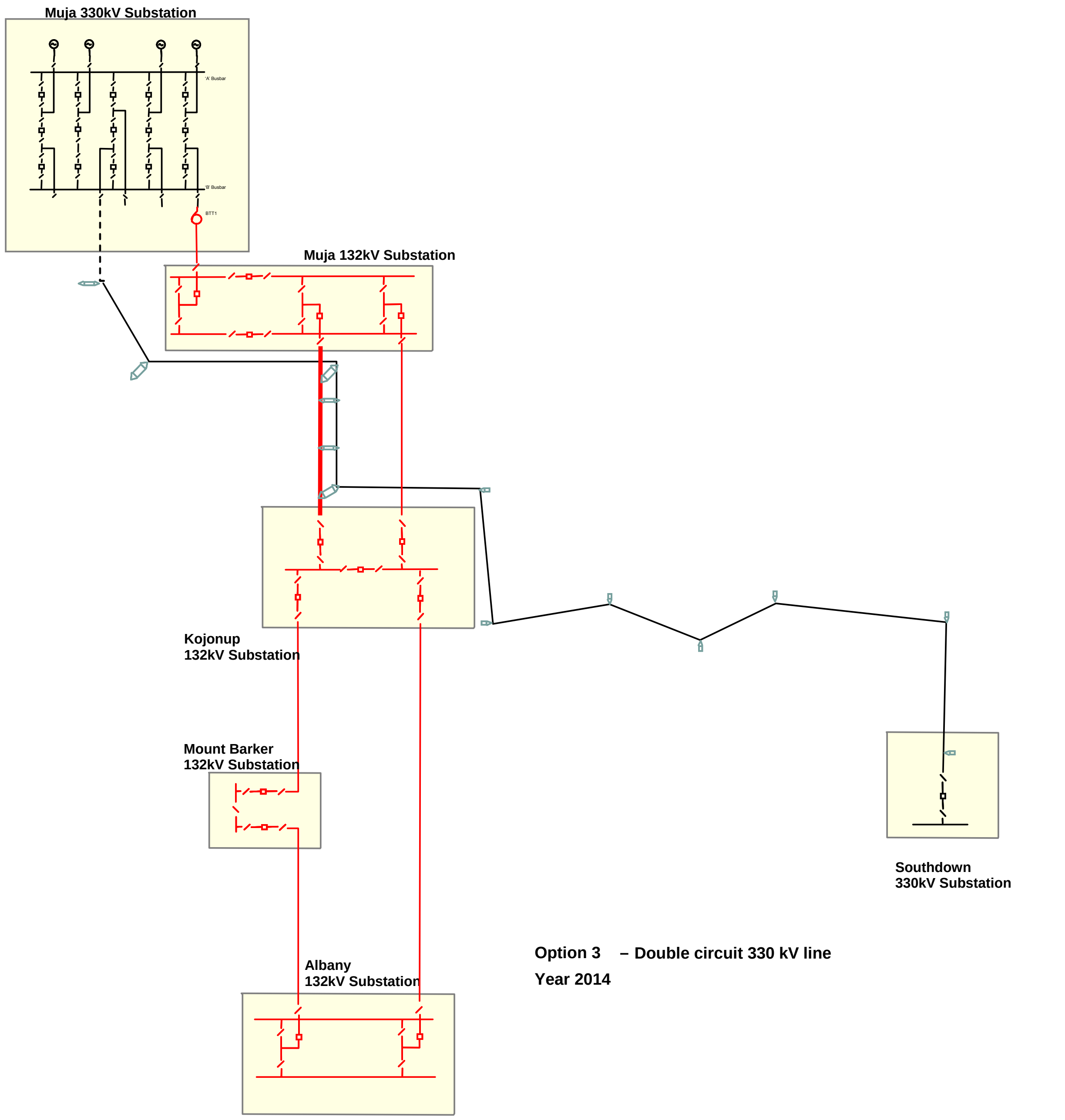


Figure 17: Option 3 - Double circuit 330 kV line for Muja-Kojonup section with one circuit operating at 132 kV

4.5.1 Option 3a

As described above, for this option the major augmentation to supply the Southdown Mine comprises a 330 kV line from Muja to the Southdown Mine routed via the existing direct route used by the MU-KOJ 81 line, but built as double circuit line for the portion of the transmission line between Muja and Kojonup, followed by a single circuit line from Kojonup to Southdown, in 2014. The new line is routed past the existing Kojonup 132kV substation in order to facilitate a possible future connection.

The Kojonup to Albany reinforcement works follow a similar path to that of Options 0, 1, and 2. The development in 2017, shown in Figure 18, involves the following augmentations.

Part A: In 2016/17, install a 250 MVA, 330/132 kV transformer at Kojonup.

(i) A new 132 kV bay at Kojonup is required for the transformer connection.

Part B: In 2016/17, reinforce the supply from Kojonup to Albany with a 3rd circuit.

(i) This is as per Option 0, and involves replacing the existing KOJ-ALB 81 line with a new 132 kV double circuit steel pole line, with series compensation to 70%.

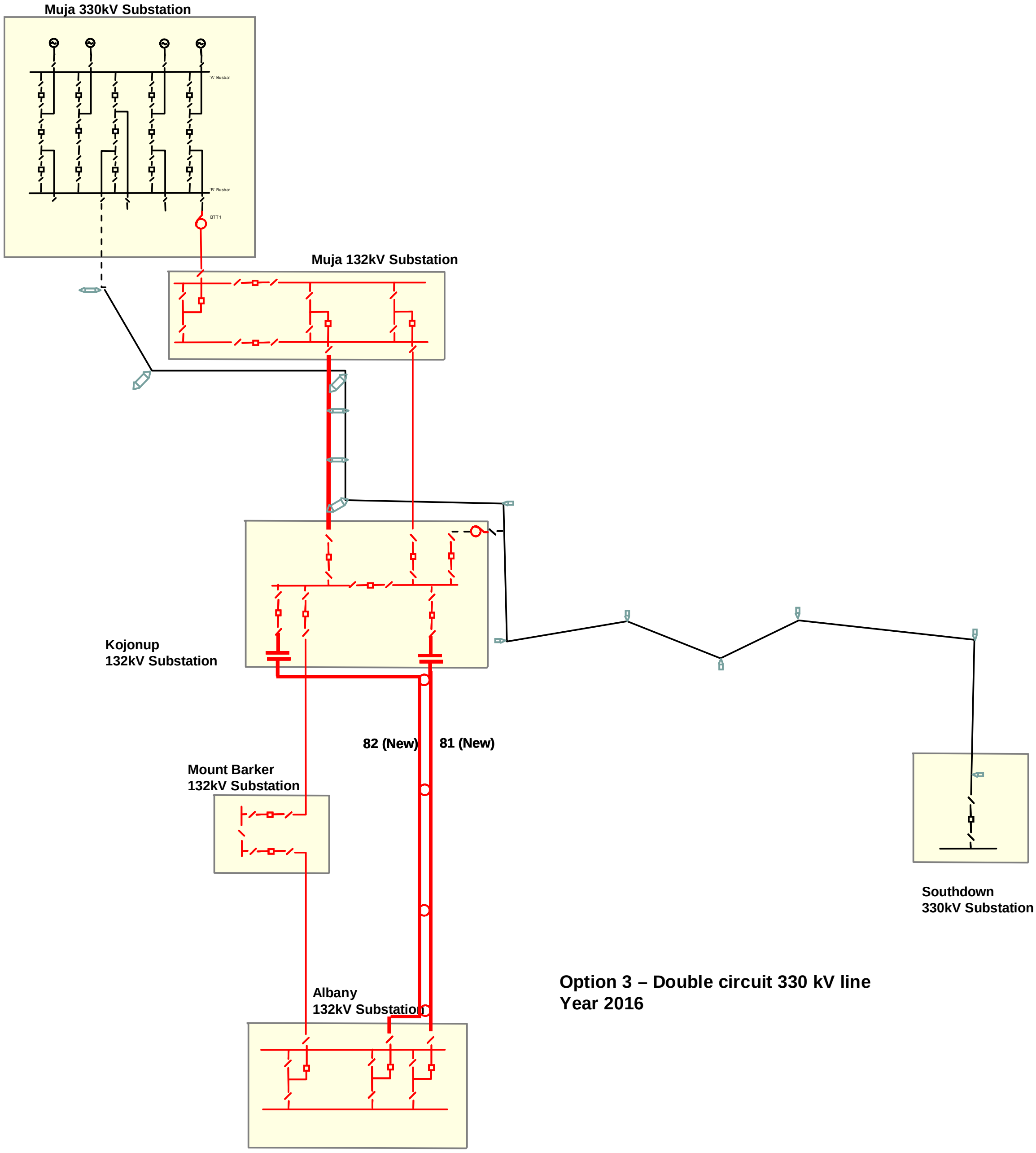


Figure 18: Option 3a - Double circuit 330 kV option post 2016 with two 132 kV circuits and a transformer at Kojonup

The network performance limits of the Figure 18 arrangement are as follows:

- for an outage of the Kojonup 330/132kV transformer the existing Muja to Kojonup 82 circuit (90 MVA rated) limits the thermal loading to 180 MW which is adequate to summer 2046/47 based on the load forecast; and
- for an outage of the new Kojonup to Albany 81 series compensated circuit the voltage limit is 225 MW which is adequate to winter 2049 based on the load forecast. This is demonstrated in Figure 19.

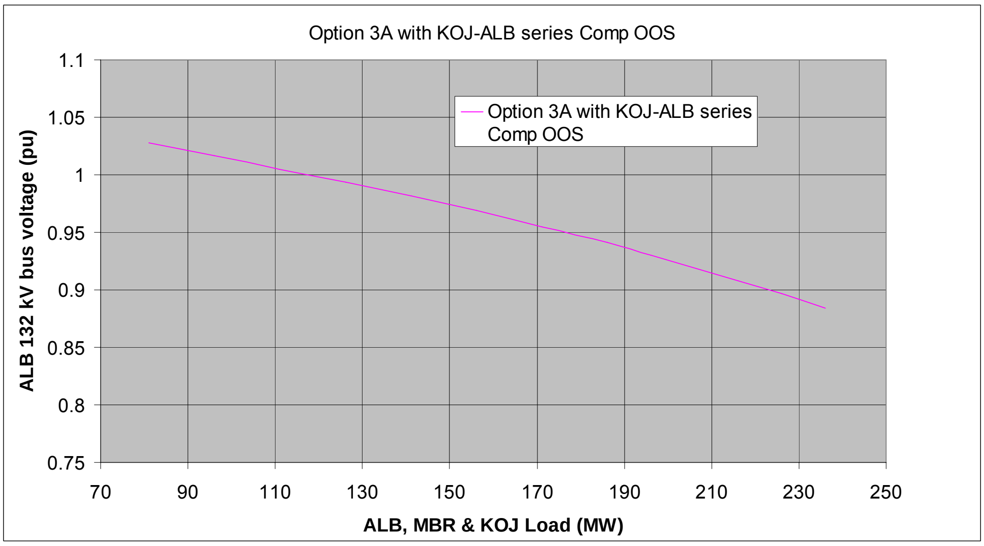


Figure 19: Option 3a – Voltage performance post 2017 with two 132 kV circuits and a transformer at Kojonup

The next augmentation is based on asset condition rather the thermal and voltage limitations above.

Part C: In 2038, upgrade the MU-KOJ 81 circuit to 330 kV operation and install a 2nd transformer at Kojonup.

(i) The MU-KOJ 82 circuit would be 60 years old in 2038, so in the analysis presented here it is assumed that its condition would require replacement, or in this case, trigger the increase of the operating voltage of MU-KOJ 81 from 132 kV to 330 kV.

(ii) This option is shown in Figure 20 and is largely identical Option 2, shown in Figure 16. Option 2 however adopts this arrangement in 2017 rather than 2038.

The voltage and thermal performance is, as expected, identical as follows:

- for an outage of either of the new Kojonup to Albany series compensated circuits (each 180 MVA rated) the other one limits the thermal loading to 210 MW which is adequate to summer 2057/58 based on the load forecast; and
- for an outage of the new Kojonup to Albany series compensated circuits the voltage limit is 215 MW which is adequate to winter 2047 based on the load forecast.

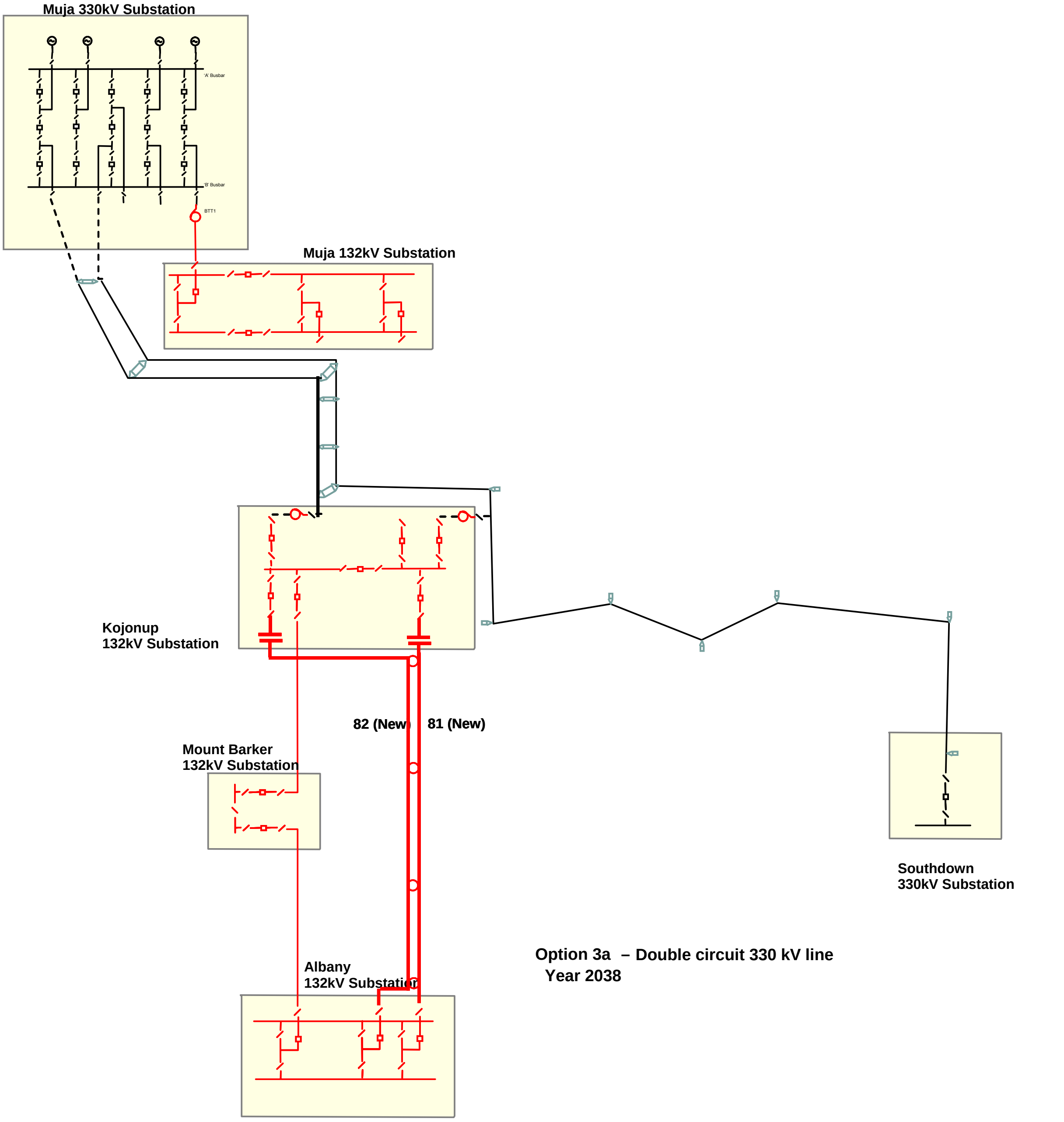


Figure 20: Option 3a - Double circuit 330 kV option post 2038 with two 132 kV circuits and a transformer at Kojonup

The same series of investments as option 2 is also followed until post 2060.

Part D: In 2047, install an SVC at Albany 132kV.

(i) This increases the voltage limit to 245 MW which is adequate to winter 2055 based on the load forecast.

(ii) The thermal limit of 235 MW is reached in winter 2052 due to an outage of one of the KOJ 330/132 kV transformers overloading the other transformer.

Part E: In 2052, replace the KOJ-MBR 81 line, and MBR-ALB 81 line, with a new 330 kV double circuit line.

(i) In 2052 the KOJ-MBR 81 and MBR-ALB 81 lines will be 60 years old and 51 years old respectively and therefore the KOJ-MBR 81 line is due for asset replacement (with MBR-ALB 81 following 9 years later).

(ii) The new 330 kV double circuit line replaces both the existing KOJ-MBR and the MBR-ALB 132kV lines, one circuit operates at 132kV and provides a connection to Mount Barker with the second circuit operating at 330 kV and connecting to a 330 kV bus at Kojonup, a new 330/132 kV transformer installed at Albany.

The final arrangement is similar to that of Figure 16 and the takes the voltage and thermal limit to beyond 2060.

4.5.1.1 Summary

A major environmental advantage of this option is that no new line route between Muja and Kojonup is required due to the configuration of the Southdown Mine major augmentation, and ultimately the number of line routes or easements is reduced to just one.

At Kojonup, a full transition to 330 kV occurs in 2038, with the transition at Albany starting in 2052.

After the works in 2017, further augmentation works are required within 21 years (2038), then within a further 9 years (2047), and then within a further 5 years (2052).

4.5.2 Option 3b

As described above, for this option the major augmentation to supply the Southdown Mine comprises a 330 kV line from Muja to the Southdown Mine routed via the existing direct route used by the MU-KOJ 81 line, but built as double circuit line for the portion of the transmission line between Muja and Kojonup, followed by a single circuit line from Kojonup to Southdown, in 2014. The new line is routed past the existing Kojonup 132kV substation in order to facilitate a possible future connection.

Option 3b follows an alternative development for supplying Albany using a 330 kV supply to Albany from Southdown. The development in 2017, shown in Figure 21, involves the following augmentations.

Part A: In 2016/17, supply Albany with a new 330 kV line. The project involves:

(i) Construction of a new 330 kV single circuit line between Albany and Southdown. The new line is rated 1130 Amps at 65 ^{0}C (645 MVA at 330 kV).

(ii) A 330 kV line bay at Southdown is also required.

(iii) Construction and installation of a 330/132 kV transformer, a 330 kV bay and a 132 kV bay at Albany substation.

(iv) At Kojonup, construct and install a series capacitor (70% compensation) in the KOJ-MBR 81 circuit.

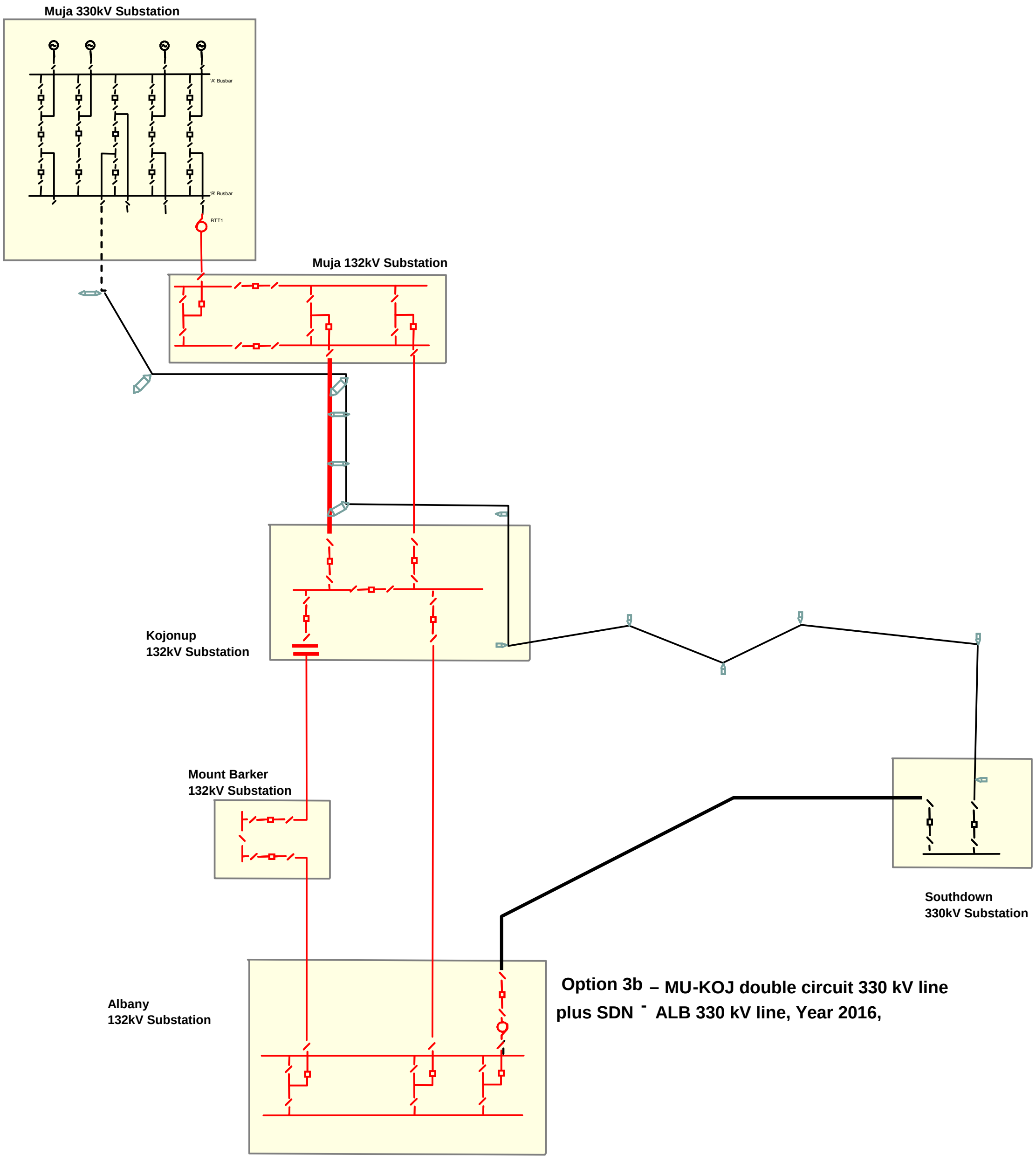


Figure 21: Option 3b– MU-KOJ double circuit 330 kV line with SDN-ALB 330 kV line

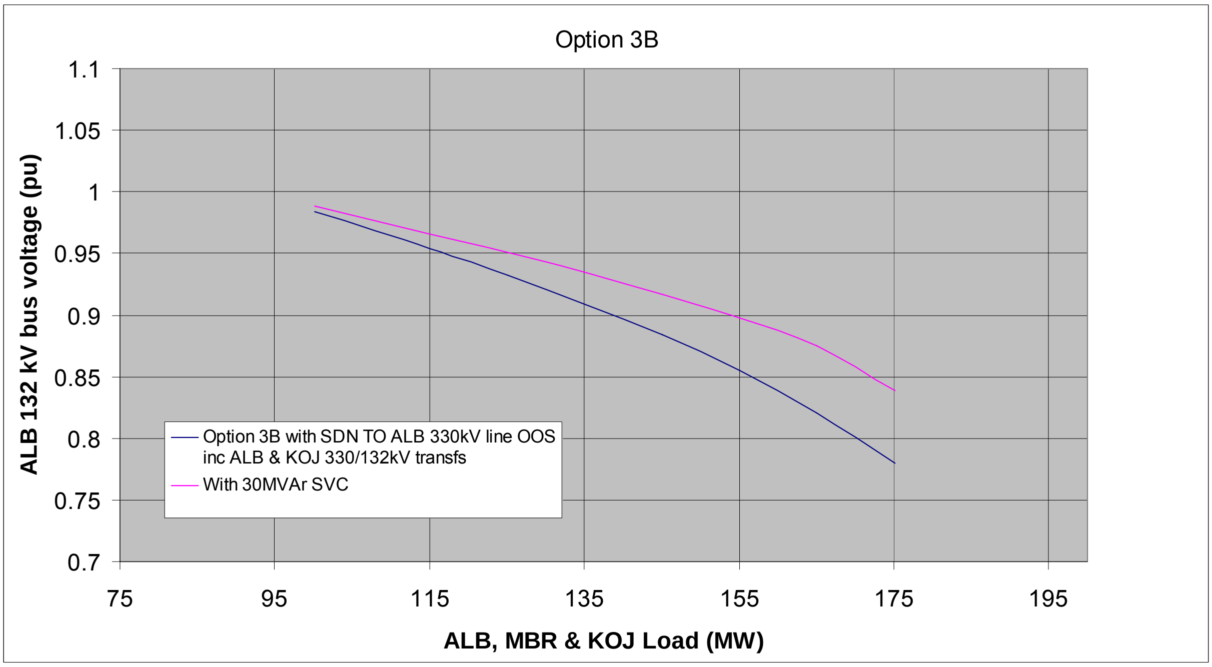
This network configuration results in the following:

- a contingency of the 330 kV circuit MU-SDN (or SDN-ALB). This is equivalent to the existing N system but with a new MU-KOJ 81 circuit (on the 330 kV line) and a series compensated KOJ-MBR 81 circuit;
- a contingency of the KOJ-MBR 81 circuit (series compensated). The power sharing between the 132 kV path from MU via KOJ and the 330 kV path from MU to ALB via SDN, determines when the existing KOJ-ALB 81 circuit will overload; and
- a contingency of the MU-KOJ 81 circuit (one side of 330 kV line operating at 132 kV). The power sharing between the 132 kV path from MU via KOJ and the 330 kV path from MU to ALB via SDN, determines when the existing KOJ-ALB 82 circuit will overload.

In the first two cases, the limitation on supply to Albany is similar to the existing situation i.e. the KOJ-ALB 81 thermal rating and the voltage performance at Albany. The limitations are such that this arrangement would be adequate only until approximately 2018.

The studies indicate that:

- the KOJ-ALB 81 circuit would overload in summer 2017/18 (95 MW) for the contingency in (i) above;
- the KOJ-ALB 81 circuit would overload in summer 2018/19, (105 MW) for the contingency in (ii) above; and
- there is a voltage performance limitation of a 140 MW increasing to 155 MW with a 30 MVAr SVC at Albany. Equating to 2024 and 2027 respectively.



Thus the new 330 kV line Southdown to Albany addresses thermal constraints to Albany for only a short period (2 years).

This leads to the following investments after 2017.

Part B: In 2018 replace the existing KOJ-ALB 81 132kV line with a new 330 kV single circuit line.

(i) The new line is rated 1130 Amps at 65 ^{0}C (645 MVA at 330 kV), with initial operation at 132 kV (258 MVA).

Following the above works, the network performance is as follows:

- for an outage of the 330 kV circuit MU-SDN (or SDN-ALB) the KOJ-MBR 81 series compensated line (87 MVA summer rated) overloads with a thermal limit of 145 MW; and
- the voltage limit is 150 MW (note bypassing the series compensation on the KOJ-MBR circuit increases the thermal limit to 170 MW with the voltage remaining constant at 150 MW due to flow via the 330 kV constructed circuit).

Thus the limitation is voltage performance and is adequate until winter 2026 based on the load forecast. This leads to the following augmentations.

Part C: In 2026/27, increase the operating voltage of MU-KOJ 81 and the KOJ-ALB 81 from 132kV to 330 kV and install a second 330/132kV transformer at Albany.

(i) The development after 2027 is shown in Figure 22.

(ii) The firm capacity into Albany is 250 MVA which is adequate to beyond 2060. Due to the low load at both Kojonup and Mount Barker there are no voltage performance issues with this arrangement.

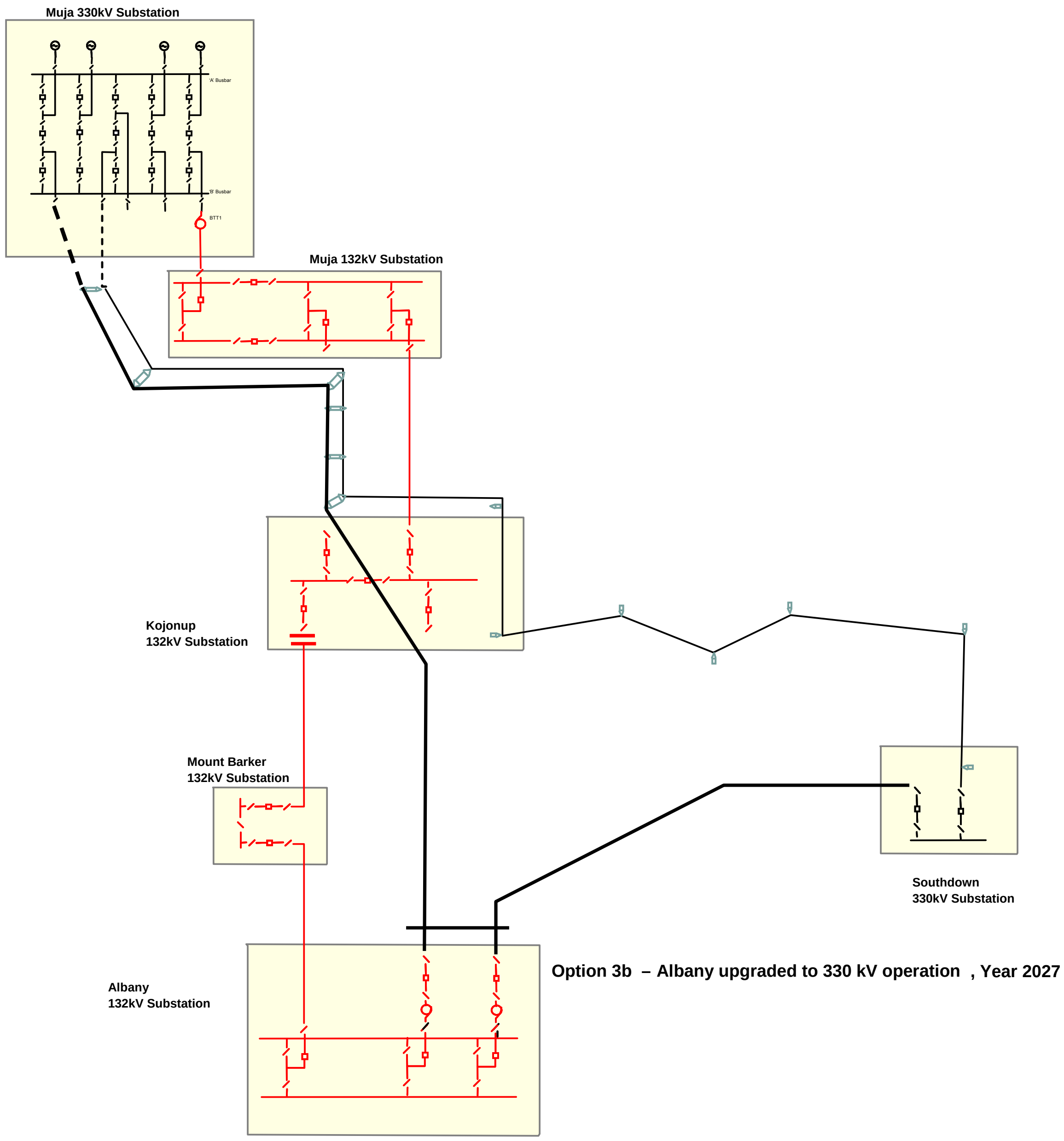


Figure 22: Option 3b – Double circuit 330 kV to Kojonup, with Albany upgraded to 330 kV operation in 2027

The next augmentation is driven by asset replacement requirements.

Part D: In 2038, install a 330/66 kV transformer at Kojonup.

(i) The MU-KOJ 82 circuit would be 60 years old, so in the analysis presented here it is assumed that it will be replaced or removed. Here a transformer replaces the MU-KOJ 82 line, so between the new transformer and the existing KOJ-MBR line, Kojonup still has N-1 security of supply.

(ii) Connecting the transformer direct to 66 kV allows the final stage of decommissioning 132 kV at Kojonup altogether, when the KOJ-MBR and MBR-ALB lines are due for replacement.

The last augmentation is set out below.

Part E: In 2052, replace MBR-ALB 81 with a new 132 kV double circuit line

(i) The MBR-ALB 81 circuit would be 60 years old, so in the analysis presented here it is assumed that it will be replaced or removed. In this case, it is replaced with a double circuit line which will facilitate the decommissioning and removal of KOJ-MBR in 2061.

Further works can occur in 2061, when the KOJ-MBR line is 60 years old, as follows:

- Install a second 330/66 kV, 250 MVA transformer at Kojonup.
- It is assumed the 66 kV network out of Kojonup is to be retained. So in this case all 132 kV assets at Kojonup can be decommissioned and removed, including the existing 132/66 kV transformers. Therefore the works would involve decommissioning and removing the KOJ-MBR 81 lines and revegetating and relinquishing the easement.

However, as these last works are beyond the 50-year time scale, they are not included in the analysis.

4.5.2.1 Summary

Option 3b has the environmental disadvantage of requiring a new route to supply Albany with a third circuit, compared with other options which solely utilise the existing easements, however, there is the long-term potential to remove the MU-KOJ 82 line by 2040, and then revegetate and relinquish the easement.

The KOJ-MBR line could also be removed by 2054 and the easement revegetated and relinquished.

Option 3b also allows the eventual rationalisation of Kojonup, by removing the 132 kV infrastructure altogether.

This option maximises the economic life of the KOJ-MBR-ALB line route, and results in a more optimal configuration than the options where KOJ-ALB is built as double circuit 132 kV line.

After the works in 2017, further augmentation works are required within 1 year (2018), then within a further 9 years (2027), then within a further 11 years (2038), and then within a further 14 years (2052).

4.5.3 Option 3c

As described above, for this option the major augmentation to supply the Southdown Mine comprises a 330 kV line from Muja to the Southdown Mine routed via the existing direct route used by the MU-KOJ 81 line, but built as double circuit line for the portion of the transmission line between Muja and Kojonup, followed by a single circuit line from Kojonup to Southdown, in 2014. The new line is routed past the existing Kojonup 132kV substation in order to facilitate a possible future connection.

In Option 3c the Albany reinforcement works involve the up-front development of the 330 kV operation as set out below.

Part A: In 2016/17, supply Albany with a new 330 kV line.

(i) The project involves:

- Construction and installation of a 330/132kV 250 MVA transformer at Kojonup, to boost the thermal capacity to Kojonup.
- Replacement of the existing KOJ-ALB 81 line with a new 330 kV double circuit steel tower line, but with initial operation at 132 kV.

The network configuration in 2017 is shown in Figure 23.

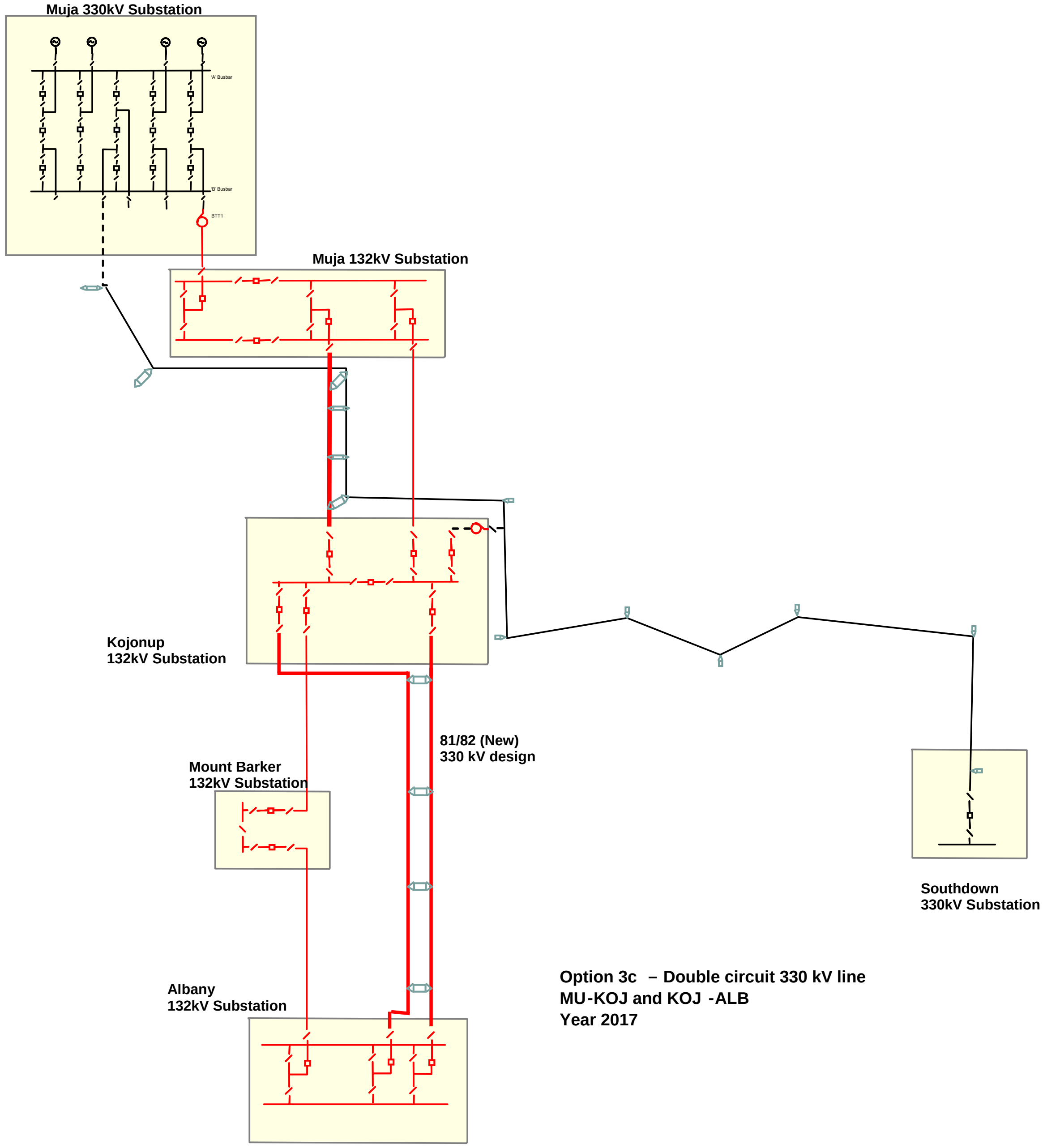


Figure 23: Option 3c - Double circuit 330 kV option post 2017 with new 330 kV line (132 kV operation) from Kojonup to Albany

The following N-1 situations determine the benefit of the augmentation:

i.) a contingency of the 330/132 kV transformer at Kojonup; and

ii) a contingency of the KOJ-ALB 81 circuit (330 kV constructed operating at 132kV).

The network performance (with reference to Figure 23) is as follows:

- for an outage of the KOJ 330/132 kV transformer, the MU-KOJ 82 (90 MVA summer rated) overloads with a thermal limit of 195 MW which is adequate to summer 2052/53 based on the load forecast;
- for an outage of the KOJ 330/132 kV transformer, the voltage limit is 190 MW which is adequate to winter 2038 based on the load forecast. Note that addition of a 30 MVAr SVC could increase this limit to 210 MW which is adequate to winter 2045;

- for an outage of the KOJ-ALB 81 132 kV circuit the KOJ-MBR 82 (87 MVA summer rated) overloads with a thermal limit of 180 MW which is adequate to summer 2046/47 based on the load forecast; and
- for an outage of the KOJ-ALB 81 132 kV circuit, the voltage limit is 165 MW – adequate to winter 2032 based on the load forecast. Note that addition of a 30 MVAr SVC increases this limit to 185 MW which is adequate to winter 2037.

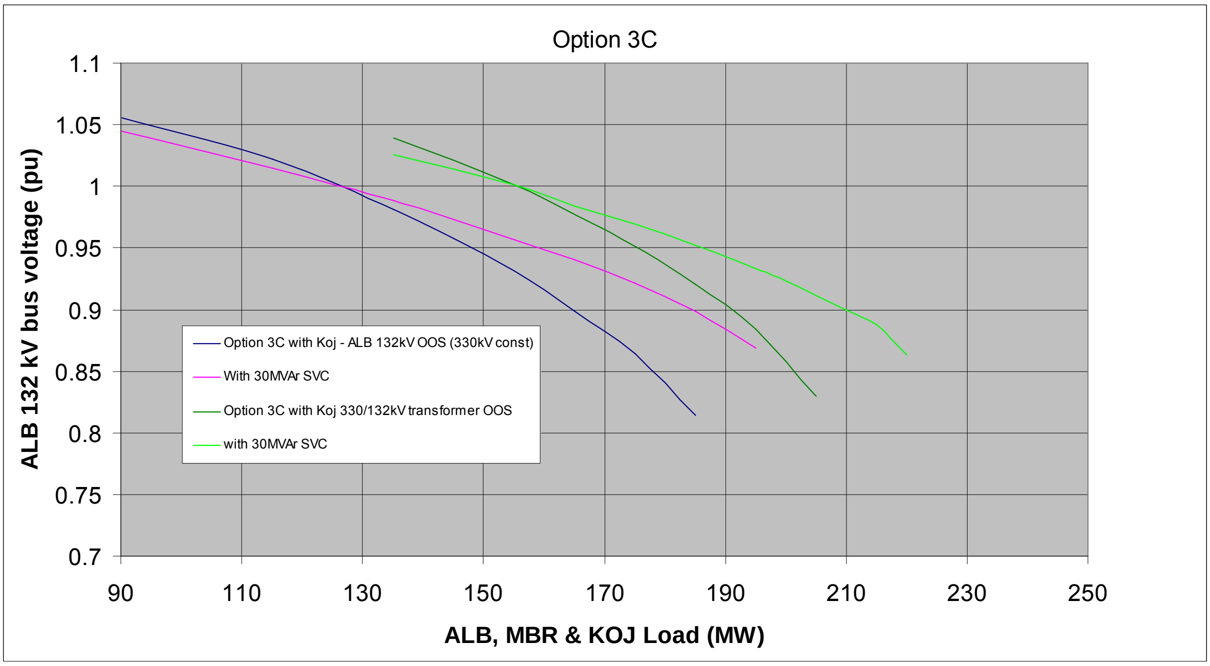


Figure 24: Option 3c - Double circuit 330 kV option post 2017 with new 330 kV line (132 kV operation) from Kojonup to Albany – voltage performance

The voltage limitations are the most binding, as shown graphically in Figure 24 (the maximum power is at 0.9 pu voltage).

Augmentation driven by voltage performance is required in 2032, and a SVC was considered to enable further augmentation to be deferred until 2037. The deferral is 5 years however given the cost of an SVC ($21.45 million) compared with the upgrade cost to 330 kV ($53.2 million), a NPC analysis indicates that the SVC would result in a NPC which is $1.1 million higher than the 330 kV upgrade.

Consequently, a SVC has not been used and the upgrade to 330 kV operation thus occurs in 2032 as follows.

Part B: In 2032, upgrade Albany to 330 kV supply.

(i) The project involves:

- At Muja construct and install a new 330 kV bay and connect to the MU-KOJ 81 circuit.
- At Kojonup connect the MU-KOJ 81 circuit to the KOJ-ALB 81 circuit to form a MU-ALB circuit at 330 kV, bypassing Kojonup.
- At Kojonup create a single 330 kV bus with two new bays and connect the KOJ-ALB 82 circuit to form a KOJ-ALB 91 circuit at 330 kV. The existing 330/132 kV transformer is reconnected to a new bay and the existing bay is reused for the MU-KOJ-SDN circuit.

- At Albany establish a 330 kV switchyard, construct and install two 330/132 kV transformers and two 330 kV circuit breaker and a half bays, to connect the two 330 kV transmission circuits and the two 330/132 kV transformers.

The 330 kV bus at Kojonup is intended to be a single bus arrangement with three connections. A contingency of MUJ-KOJ-SDN will result in 330 kV supply to the KOJ 330/132 kV transformer being maintained via the KOJ-ALB 330 kV circuit from the 330 kV bus at Albany.

The network performance for the post-2032 arrangement (as shown in Figure 25) is:

- for an outage of one of the ALB 330/132 kV transformers, the other transformer overloads, with a thermal limit of 290 MW which adequate to beyond winter 2060 based on the load forecast; and
- for an outage of one of the ALB 330/132 kV transformers the voltage limit is greater than 300 MW which is adequate to beyond winter 2060 based on the load forecast.

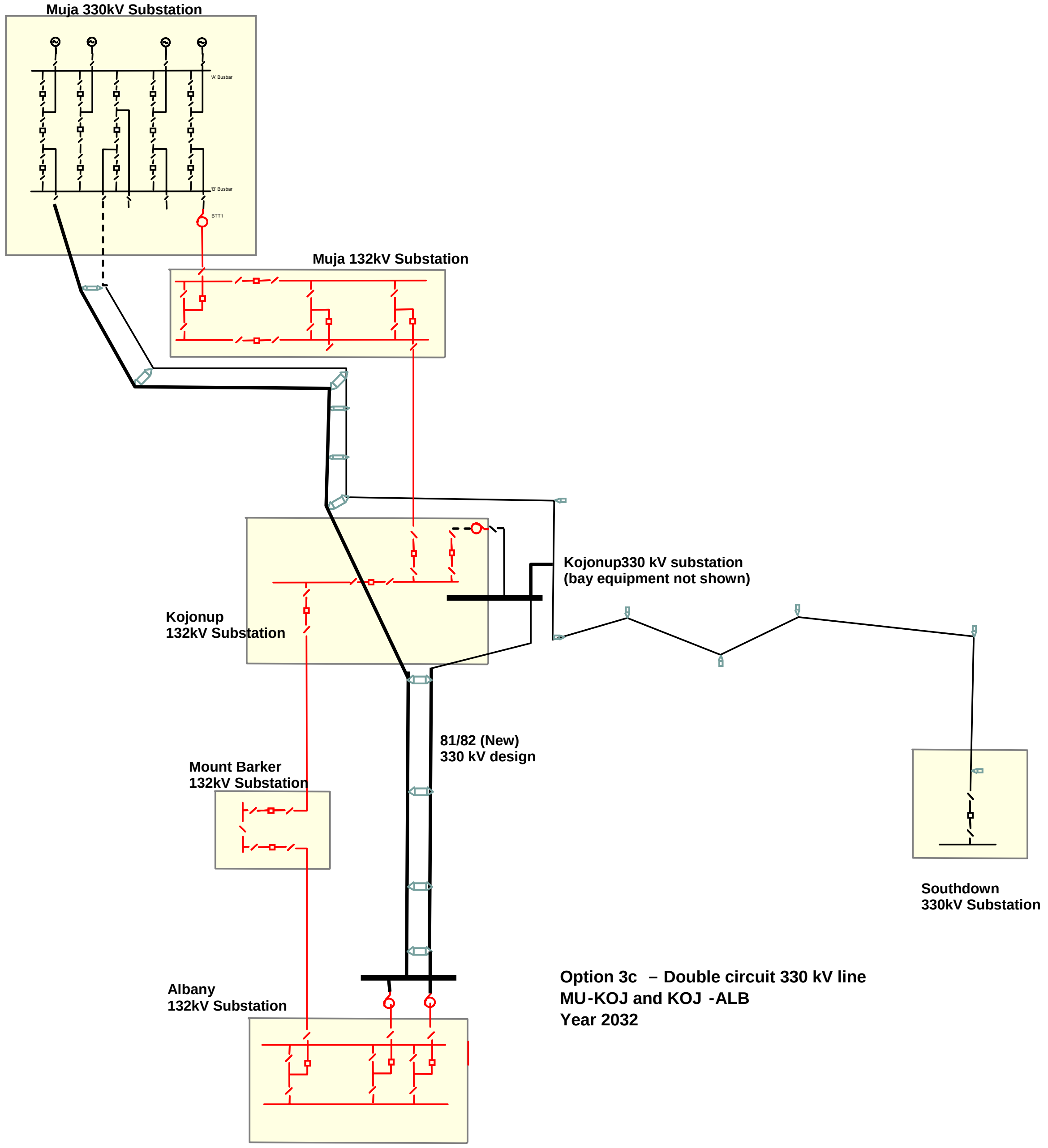


Figure 25: Option 3c – Upgrade Albany to 330 kV in 2032

There are further 132 kV asset replacement works in this option as set out below.

Part C: In 2038 MU-KOJ 82 circuit would be 60 years old, so in the analysis presented here it is assumed that it will be replaced or removed. In this case it can be removed with no replacement required as the KOJ transformer and the KOJ-MBR circuit provide sufficient network performance and security requirements.

Part D: In 2052 the MBR-ALB circuit would be 60 years old, so in the analysis presented here it is assumed that it will be replaced or removed. In this case replacement with a double circuit 132 kV line is assumed (this allows the future decommissioning and removal of the KOJ-MBR line).

In 2061 the KOJ-MBR line will be 60 years old. Rather than replacement it would likely be decommissioned and a second 330/132kV transformer installed at Kojonup. This is however beyond the 2060 horizon of this study and has therefore not been included in the analysis.

It is noted that, under this arrangement, the Kojonup 132 kV switchyard is essentially no longer required. The existing 330/132 kV transformer (installed in 2016), can therefore either:

- Remain in situ, to facilitate a possible upgrade of the 66 kV network out of Kojonup; or
- Be reused elsewhere and replaced with a 330/66 kV transformer, with the complete removal of the Kojonup 132 kV switchyard.

4.5.3.1 Summary

A major environmental advantage of this option is that no new line route between Muja and Kojonup is required due to the configuration of the major augmentation for the Southdown Mine, and ultimately the number of line routes or easements is reduced to just one. The MU-KOJ 82 line is effectively redundant from 2032 once Albany is upgraded to 330 kV, and can be decommissioned and removed at any time after this.

This option maximises the economic life of the KOJ-MBR-ALB line route, and results in a more optimal configuration than the options where KOJ-ALB is built as double circuit 132 kV.

Between Kojonup and Albany, the KOJ-MBR 81 easement (approx 100 km) can be eventually decommissioned and removed.

After the works in 2017, further augmentation works are required within 15 years (2032), then within a further 6 years (2038), and then within a further 14 years (2052).

4.5.4 Project and net present cost

The development phases, project base cost, and net present cost are summarised in Table 8, Table 9, and Table 10 for Options 3a, 3b, and 3c respectively.

Table 8: Option 3a project costs and NPC

Project	Project Description	Base 2011 Costs ($m)	Delivery Year	Net Present Cost ($m)
1	**SDJV Southdown Mine Major Augmentation**			
1.1	Design and construction of MU-KOJ section 87.5 km of 330 kV double circuit, steel tower construction line (one side operates at 132 kV as MU-KOJ 81 circuit), and KOJ-SDN section 188 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja and Southdown.	379.5	2014	
1.2	Removal of the MU-KOJ 81 line and revegetation of route corridor	8.0	2016	
2	**Existing Network Augmentation: Albany Reinforcement – Stage 1**			
2.1	Design and Construction of a 250 MVA 330/132kV transformer at Kojonup, including 330 kV circuit breaker.	12.3	2017	
2.2	Design and construction of 157 km of double circuit 132 kV overhead Line, steel pole construction, including removal of existing Kojonup-Albany 81 overhead line and revegetation of route corridor	102	2017	
2.3	Design and construct series capacitors for each of the two new KOJ-ALB circuits at Kojonup.	12.0	2017	
2.4	Additional 132 kV bay at Kojonup and Albany for the 3rd 132 kV KOJ-ALB circuit	3.2	2017	
3	**Existing Network Augmentation: Upgrade Kojonup to 2nd 330 kV circuit**			
3.1	Upgrade MU-KOJ 81 circuit to 330 kV operation, including: - New 330 kV line bay infrastructure at Muja	8.8	2038	
3.2	Establish a 330 kV switchyard at Kojonup and install a 2nd transformer at Kojonup	18.6	2038	
3.3	Remove of existing Muja to Kojonup 82 overhead line and revegetation of existing route corridor.	7.9	2040	
4	**Existing Network Augmentation: Albany SVC**			
4.1	Install a +/-30 MVAr SVC at Albany	21.5	2047	
5	**Existing Network Augmentation: Upgrade Albany to 330 kV supply**			
	Design and construction of 103 km (KOJ-MBR section) and 49 km (MBR-ALB section) of double circuit 330 kV overhead Line, and operating one circuit at 132 kV, including removal of existing line.	149.8	2052	
6.1	Establish a 330 kV switchyard at Albany, and install one 330/132 kV, 250 MVA transformer.	18.8	2052	
	TOTAL	742		**435**

Table 9: Option 3b Project and NPC

Project	Project Description	Base 2011 Costs ($m)	Delivery Year	Net Present Cost ($m)
1	**SDJV Southdown Mine Major Augmentation**			
1.1	Design and construction of MU-KOJ section 87.5 km of 330 kV double circuit, steel tower construction line (one side operates at 132 kV as MU-KOJ 81 circuit), and KOJ-SDN section 188 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja and Southdown.	379.5	2014	
1.2	Removal of the MU-KOJ 81 line and revegetation of route corridor	8.0	2016	
2	**Existing Network Augmentation: Albany Reinforcement – Stage 1**			
2.1	Design and construction of SDN-ALB section 90 km of single circuit 330 kV overhead Line	58.5	2017	
2.1	330 kV bay infrastructure at Southdown	3.61	2017	
2.3	Establish 330 kV terminal station at Albany, with 330 kV bay, 330/132 kV transformer and new 132 kV bay at Albany	18.8	2017	
2.4	Design and construct series capacitors for the KOJ-MBR 81 circuit to get proportional sharing with existing KOJ-ALB circuit.	4.5	2017	
3	**Existing Network Augmentation: Albany Reinforcement – Stage 2**			
3.1	Design and construction of 157 km of single circuit 330 kV overhead Line (operate at 132 kV), including removal of existing Kojonup – Albany 81 overhead line and revegetation of route corridor.	102	2018	
4	**Existing Network Augmentation: Albany Reinforcement – Stage 3**			
4.1	Upgrade MU-KOJ 81 and KOJ-ALB 81 circuits to 330 kV operation and configure to a MU-ALB 91 circuit (bypasses Kojonup). Includes: - New 330 kV line bay infrastructure at Muja - New 330 kV & 132 kV bay infrastructure at Albany - 330/132 kV transformer at Albany	21.6	2027	
5	**Existing Network Augmentation: Kojonup supply capacity upgrade**			
5.1	Establish a 330 kV switchyard at Kojonup, and install one 330/66 kV, 75 MVA transformer.	16.7	2038	
5.2	Remove of existing Muja to Kojonup 82 overhead line and revegetation of existing route corridor.	7.9	2040	
6	**Existing Network Augmentation: Mount Barker/Kojonup upgrade**			
6.1	Replace MBR-ALB with double circuit 132 kV line	33.4	2052	
	TOTAL	655		**467**

Table 10: Option 3c Project and NPC

Project	Project Description	Base 2011 Costs ($m)	Delivery Year	Net Present Cost ($m)
1	**SDJV Southdown Mine Major Augmentation**			
1.1	Design and construction of MU-KOJ section 87.5 km of 330 kV double circuit, steel tower construction line (one side operates at 132 kV as MU-KOJ 81 circuit), and KOJ-SDN section 188 km of 330 kV single circuit, steel tower construction, including 330 kV substation infrastructure at Muja and Southdown.	379.5	2014	
1.2	Removal of the MU-KOJ 81 line and revegetation of route corridor	8.0	2016	
2	**Existing Network Augmentation: Albany Reinforcement – Stage 1**			
2.1	Design and construction of 157 km of double circuit 330 kV overhead Line, steel tower construction, including removal of existing Kojonup-Albany 81 overhead line and revegetation of route corridor. Initial operation is at 132 kV	155	2017	
2.2	Additional 132 kV bay at Kojonup and Albany for the 3rd 132 kV KOJ-ALB circuit	3.61	2017	
3	**Existing Network Augmentation: Albany Reinforcement – Stage 2**			
3.1	Establish 330 kV terminal station at Albany, with two 330 kV circuit breaker and half bays, and two 330/132 kV transformer at Albany	31.4	2032	
3.2	At Kojonup connect the MU-KOJ 81 circuit to the KOJ-ALB 81 circuit to form a MU-ALB circuit at 330 kV, bypassing Kojonup. At Kojonup create a single 330 kV bus with two new bays and connect the KOJ-ALB 82 circuit to form a KOJ-ALB 91 circuit at 330 kV. The existing 330/132 kV transformer is reconnected to a new bay and the existing bay is reused for the MU-KOJ-SDN circuit.	13.1	2032	
3.3	Muja works for 2nd 330 kV circuit to Kojonup (Albany).	8.8	2032	
4	**Existing Network Augmentation: Decommission and remove MU-KOJ 82**			
4.1	Remove of existing Muja to Kojonup 82 overhead line and revegetation of existing route corridor.	7.9	2040	
5	**Existing Network Augmentation: Mount Barker upgrade**			
5.1	Design and construction of 49 km (MBR-ALB section) of double circuit 132 kV overhead Line (mango), plus additional line bay at Albany. Decommission and remove existing and MBR-ALB line.	33.4	2052	
	TOTAL	652		**463**

5 Discussion

5.1 Economic analysis

Table 11 summarises the net present cost of each option, ranked in order from lowest to highest with the benefit compared to the base case Option 0. All options require significant up-front investment within the next five years.

All options commence with the Southdown Mine major augmentation comprising the construction of a 330 kV connection between Muja and Southdown via or near Kojonup and result in the eventual development of 330 kV assets between Muja and Albany which give effect to the required augmentation to the existing network to meet capacity, thermal and voltage requirements.

Table 11: Summary of NPC and base costs for each option ranked in order

Scenario	Description	NPC ($M)	Base 2011 Cost ($M)	Rank	Benefit c/w Option 0
Option 3a	Southdown Mine major augmentation: 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and rebuild KOJ-ALB 81 as 132 kV double circuit	$435	$742	**1**	$19.9
Option 1	Southdown Mine major augmentation: 330 kV Single circuit MU-KOJ section (indirect new route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and replace MU-KOJ 81 with new 330 kV single circuit line	$447	$779	**2**	$8.2
Option 0 (Base Case)	Southdown Mine major augmentation: 330 kV Single circuit MU-KOJ section (indirect new route), 330 kV single circuit KOJ-SDN Existing network augmentation: undertaken independently	$455	$770	**3**	
Option 3c	Southdown Mine major augmentation: 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and rebuild KOJ-ALB 81 as 330 kV double circuit	$463	$652	**4**	-$7.9
Option 2	Southdown Mine major augmentation: 330 kV Single circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and replace MU-KOJ 82 with 330 kV single circuit line	$467	$769	**5**	-$11.2
Option 3b	Southdown Mine major augmentation: 330 kV double circuit MU-KOJ section (in existing MU-KOJ 81 route), 330 kV single circuit KOJ-SDN Existing network augmentation: a KOJ 330/132 kV transformer, and build 330 kV single circuit triangle KOJ-SDN-ALB	$467	$655	**6**	-$11.9

As shown above, Option 3a is the most cost effective option in NPC terms to achieve both SDJV's requirements and those of the existing network. Option 3a $19.9 million (5%) less expensive in NPC terms than Option 0 (the base case) and $11.7 million less expensive than Option 1.

This indicates there is an economic benefit to integrating the SDJV connection with the existing system of up to $19.9 million compared with the base case.

Thus, if the proposed Southdown Mine does proceed, integrating the major augmentation to meet its requirements with existing network upgrades would be the most prudent choice on an economic basis, as would the utilisation of a double circuit line between Muja and Kojonup to replace the 81 route as part of the Southdown Mine major augmentation.

The adoption of any of Options 3a, 3b or 3c achieves SDJV's capacity and timing requirements while allowing Western Power the greatest flexibility to further analyse and conclude the subsequent steps of the broader development plan for the existing network as and when load growth or asset performance deems it appropriate or most economically efficient.

Both Options 3b and 3c have additional potential deferral benefits depending on the asset condition of the KOJ-MBR and MBR-ALB lines, as extending the life of these assets can defer the replacement of the MBR-ALB line with a new 132 kV double circuit line. This does not however make a significant difference to the NPC in the table above. All options are within 10% of one another in terms of NPC. As a result, and given the accuracy of the cost estimates (+/- 30-50%), selection of a preferred option on an economic basis alone is not definitive.

Sensitivity to Discount Rate

Table 12 below shown shows the sensitivity of the ranking to changes in the discount rate. The lowest ranked options are shown highlighted to indicate how the ranking changes with hurdle rate.

Table 12: Sensitivity of Option to Hurdle (Discount) Rate

	7.50%			10.65%			12.50%			15%		
Option	**NPC ($M)**	**Rank**	**Benefit c/w Option 0**	**NPC ($M)**	**Rank**	**Benefit c/w Option 0**	**NPC ($M)**	**Rank**	**Benefit c/w Option 0**	**NPC ($M)**	**Rank**	**Benefit c/w Option 0**
Option 3a	$497	1	$27.2	$435	1	$19.9	$411	1	$16.3	$384	2	$12.3
Option 1	$525	5	-$1.4	$447	2	$8.2	$415	2	$12.0	$381	1	$15.1
Option 0	$524	4		$455	3		$427	3		$396	3	
Option 3c	$516	2	$7.9	$463	4	-$7.9	$438	4	-$11.4	$409	4	-$13.4
Option 2	$530	6	-$6.4	$467	5	-$11.2	$440	5	-$12.7	$410	5	-$13.6
Option 3b	$521	3	$3.3	$467	6	-$11.9	$442	6	-$14.8	$412	6	-$15.9

Option 3a is the least cost for three of the four hurdle rates examined with decreasing benefit as the rate is increased, with Option 1 becoming the least cost at a hurdle rate of 15%.

Overall the three lowest ranked options (0, 1, or 3a) are the same, apart from order, for three of the four rates, but for the lowest hurdle rate of 7.5% the least cost NPC are Options 3a, 3c, and 3b. The preferred development path based on a least-cost economic analysis is still Option 3a.

Losses

It should be noted that no quantitative assessment of the impact of network losses on each of the options has been made. It is taken as given that the upgrade to 330 kV reduces line losses but these have not been factored into the NPC calculations.

A transition to 330 kV from 132 kV will result in a significant decrease in network losses which will result in an economic benefit. Typically a 330 kV circuit will have approximately 8%-16% of the losses of a 132 kV circuit. This will result in a higher benefit for the options with an early transition to (or early construction of) 330 kV lines. Option 3b and 3c supply Albany – which is the major load centre – directly at 330 kV, starting from 2017 and 2033 respectively as opposed to the other options which all involve maintaining supply at 132 kV over 157 km from Kojonup in some form at least until 2039 (Option 1) and 2053 (Options 2 & 3a), and >2060 (Option 0).

The relative impact of network losses is to provide an (unquantified) benefit to option 3c and 3d. If this benefit is small then Option 3a remains the preferred option, however if the benefit is large this could result Option 3c or 3d becoming the least cost option. In each case the first investment in 2014 is the same, a 330 kV double circuit being constructed between Muja and Kojonup.

5.2 Non-economic analysis

Environmental

On an environmental basis the number of existing and future easements required for each option is different and the following table ranks these in order.

Option	Description	Existing line routes / easements relinquished	New line routes/easements required	Total	Rank
Option 0	330 kV Single circuit MU-KOJ section (squiggly route), independent from MU-KOJ network development		MUJ-KOJ(SDN line)	+1	4
Option 1	- 330 kV Single circuit MU-KOJ section (squiggly route), KOJ transformer, and replace MU-KOJ 81	MU-KOJ 82	MUJ-KOJ(SDN line)	Neutral	3
Option 3a	- 330 kV Double circuit MU-KOJ section (MU-KOJ 81 route), and KOJ transformer	MU-KOJ 82		-1	2
Option 3c	- 330 kV Double circuit MU-KOJ section (MU-KOJ 81 route), KOJ transformer, and 330 kV line to Albany	MU-KOJ 82 KOJ-MBR 81		-2	1
Option 3b	- 330 kV Double circuit MU-KOJ section (MU-KOJ 81 route), and KOJ transformer	MU-KOJ 82 KOJ-MBR 81	SDN-ALB	-1	2
Option 2	- 330 kV Single circuit MU-KOJ section (MU-KOJ 81 route), KOJ transformer, and replace MU-KOJ 82			Neutral	3

Option 3c has the greatest benefit with eventual relinquishment of two easements, whereas Option 0 is the worst outcome with one additional easement required.

Options 1 and 2 are both neutral, and Options 3a and 3b result in the relinquishment of one easement.

Works Program

Option 2 is the most advantageous in terms of work programming in that, after the initial investments in 2017, no other works are required for 30 years.

Options 0 and 3a require further works after 21 years from 2017, with the remaining options requiring further works within between 1 and 15 years.

Asset utilisation

Option 3c has the most optimised (minimum amount of transmission infrastructure for capacity derived) and efficient transmission asset configuration and utilisation since it avoids (unlike Options 0, 1, 2, and 3a) having new 132 kV lines in parallel with new 330 kV lines. Apart from a replacement of the MBR-ALB line with a 132 kV line, no other 132 kV line replacement or upgrades are required, and in fact, all are removed.

Conversely, Option 0 results in the least optimised asset utilisation with a 330 kV double circuit line being built in parallel with relatively new 132 kV lines. This has the disadvantage of potential underutilisation of both the 330 kV and 132 kV lines for many years as Option 0 results in four parallel circuits between Muja and Kojonup and also between Kojonup and Albany.

If rationalisation were to occur to effectively remove redundant capacity, significant costs would be incurred due to the early retirement of what would be relatively new assets.

Options 0, 1, 2, and 3a, all result in the eventual upgrade of the route from Kojonup to Albany via Mount Barker to 330 kV double circuit configuration. As shown in Figure 12, the simplest outcome is to have a single 330/132 kV transformer at both Albany and Kojonup, enabling the utilisation of the KOJ-ALB series compensated circuits to be extended by providing the N-1 backup capacity. However, the final upgrade of the second circuit to 330 kV would require a replacement of the Mount Barker substation with new 330/22 kV transformers and 330 kV switchgear. This is a non-optimal outcome as these transformers would be unique on the SWIN. The load is also very low with low growth potential as the bulk of the load growth occurs at Albany. In contrast, the other options maintain a 132 kV supply indefinitely and avoid any works at Mount Barker.

Future expansion

Options 1, 2, and 3(a, b, c) all result in two 330 kV circuits between Muja and Kojonup, which effectively provide unconstrained capacity (645 MVA) for the foreseeable future. All of the identified options also include a single circuit 330 kV overhead line from Kojonup to Southdown in 2014. This 330 kV overhead line infrastructure provides opportunities for future connection points to be established along the proposed corridor to support the existing distribution system or future generation projects.

Options 3b and 3c provide the highest amount of capacity to Albany and have the highest capability to absorb major load increases or the development of large scale generation without significant expansion of the grid required between Albany and Muja.

The augmentation path of the other options is largely driven by thermal or voltage issues so any new load or major generation development would tend to accelerate augmentations (and therefore result in a higher NPC).

From 2017, for options 3c and 3b there is available capacity for in excess of 600 MW of generation at Albany with no new transmission lines required (two 330 kV circuits available) and only substation works required. Other options would require additional (or brought forward) augmentations to enable the upgrade of Albany to 330 kV (utilising a 330 kV double circuit line via Mount Barker).

The 3b option has a potential advantage in that it also provides N-1 transmission security to Southdown. While this is not required at Southdown it may facilitate development of new load or generation connections to the east of Wellstead.

An investigation carried [6] out by Western Power indicated the existence of potential loads east of Wellstead (Southdown Mine location) totalling approximately 70 MW, excluding SDJV's load, that had the potential to be supplied from the Southdown substation.

Asset rationalisation

Options 3b and 3c provide the greatest scope for rationalisation of the existing assets as both could result in eventual decommissioning and removal of the 132 kV switchyard at Kojonup with direct 330/66 kV conversion (assuming the 66 kV network is maintained in its present form).

The line between Kojonup and Mount Barker is eventually decommissioned and removed in these options.

Deferral options

For the future augmentations beyond the initial augmentation to 2017, there is further scope for deferring investment by using NCS, However, this analysis would be impractical to consider given the accuracy of the cost estimates used (+/- 30-50%), the timescales (≈40 years), and the unknown cost of NCS. This is common to all options and does not change the outcome of the comparison.

However, options to defer investment in transmission augmentation should only be viewed as temporary and not as a permanent solution. Ultimately, load growth and asset condition will combine to require significant investment in the transmission system supplying the Albany and Mount Barker substations.

Load forecast sensitivity

All of the options require major up-front investment in new lines between Muja-Kojonup and Kojonup-Albany by 2017.

In the case of Muja-Kojonup, this investment rapidly becomes insensitive to the load forecast due to the need for commitment to a major augmentation within the next year to enable the 330 kV transmission line to connect the SDJV.

In the case of Kojonup-Albany this investment also rapidly becomes insensitive to the load forecast due to the need for commitment within the next two to three years to enable sufficient time for the rebuilding of the Kojonup – Albany line.

Subsequent investments will have a higher sensitivity to load growth, although the impact on NPC is considerably less due to the timescale.

Options 3b and 3c become largely insensitive to load growth within the 50 year time scale due to the up-front investment in the 330 kV transmission lines. Options 0, 1, 2, and 3a, have the advantage that if the load growth fails to materialise or grows at a rate slower than forecast, some of the future investments can be deferred. While many of these investments are also driven by asset age and condition, which is unrelated to load growth, there remains a significant opportunity to defer future investment.

Taking a 50-year view of system needs illustrates the prudence of making a strategic investment in transmission capacity that ensures the initially commissioned assets are adequate to meet system demand for their entire service and economic lives.

Asset condition based replacement

Options 3b and 3c both have a potential advantage in terms of asset condition based replacement in that the upgrade of the Mount Barker supply and decommissioning of the MU-KOJ 82 and KOJ-MBR lines can be deferred if asset condition is still acceptable since their replacement and decommissioning is not driven by thermal or voltage constraints.

Also, supplying Mount Barker from Albany is more reliable since it is only 49 km from Albany as opposed to 103 km from Kojonup. Mount Barker is also not expected to grow significantly based on current forecasts.

Reactive support equipment

The upgrade to 330 kV is largely driven by voltage performance, however can be delayed by additional equipment, such as a 30 MVAr SVC at Albany, by as much as 5 to 7 years. This can have the potential to defer the upgrade to 330 kV for certain options, however, once the upgrade occurs the SVC will effectively become redundant but it can in some instances result in an overall saving in NPC terms.

5.3 Summary

The Option 3 scenarios offer the highest non-economic benefits and, of these, 3c would be the preferred option.

However, on an economic basis, 3c is ranked 4th, at $27.8 million higher in NPC than Option 3a, which was the lowest in NPC terms. Option 3b was the highest in NPC terms of all the options.

All of these options incorporate the same initial major augmentation to connect the Southdown Mine comprising SDJV, that of a 330 kV double circuit line between Muja and Kojonup (in the existing MU-KOJ 81 easement), with the remainder of the line constructed as 330 kV single circuit.

Given the timing of the Southdown Mine project, it is necessary to resolve the form of the major augmentation that will enable the most efficient development of the existing network to meet mid- to long-term capacity, thermal and voltage requirements, which this analysis achieves. The remainder of the works required to upgrade the existing network in the Option 3 scenarios does not need to be resolved at this time and will require further analysis.

Therefore the selection of any of the Option 3 scenarios is somewhat arbitrary in determining the initial investment path for integrating SDJV with the existing system.

6 Recommendation

SDJV is developing a magnetite mine (Southdown) near Wellstead approximately 90 km north east of Albany. The customer has requested a Contract Maximum Demand of 180 MW with a connection/commissioning date of March 2014. The most technically and economically prudent manner in which to supply the requested connection is via an overhead 330 kV transmission line.

It is recommended that Option 3 (options 3a, 3b and 3c are identical in their proposal for the major augmentation to supply the Southdown Mine) be progressed since it provides the underlying transmission backbone required to implement any of the variations of Option 3 (a, b and c) as system augmentation requirements become clearer over time.

Taking the 50-year view outlined, Option 3a is the preferred option on an economic basis being $19.9 million less NPC than the base case Option 0.

On the strength of this comparison, it is recommended that option 3a be adopted as the ultimate solution for the broader supply requirements of the Southdown Mine and the Kojonup, Albany, and Mount Barker load area.

The benefits of this course of action are:

- meeting SDJV's capacity and timing requirements for the Southdown Mine;
- meeting mandated service standards as stipulated by the Technical Rules at the lowest NPC,
- Achieving SDJV's requirement to have the infrastructure available by March 2014.
- Realising a $19.9 million dollar benefit in net present cost compared to a wholly independent SDJV connection from Muja.
- utilising the existing MU-KOJ 81 line easement for construction of a new 330 kV double circuit line, not requiring a new easement between Muja and Kojonup for subsequent reinforcement works.
- facilitating the eventual upgrade of Western Power's network to 330 kV, but with an added benefit of the eventual relinquishment of the MU-KOJ 82 line easement.

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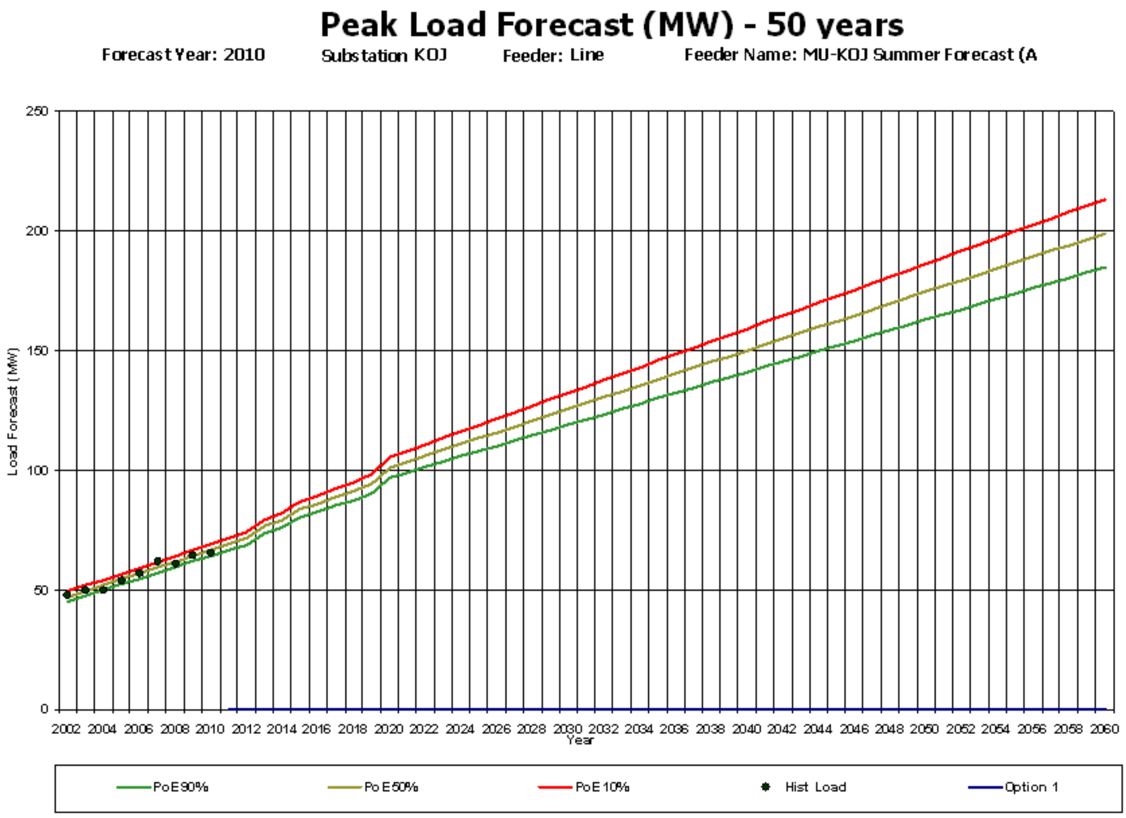
Grange Resources project	7444611v1
Template unit costs	7426252
Technical Rules	3605551

Appendix A – Forecast load at Kojonup, Albany and Mount Barker substations

A.1 Summer

Summer forecast load at Kojonup, Albany and Mount Barker substations, for the next 50 years, extracted from OPAL



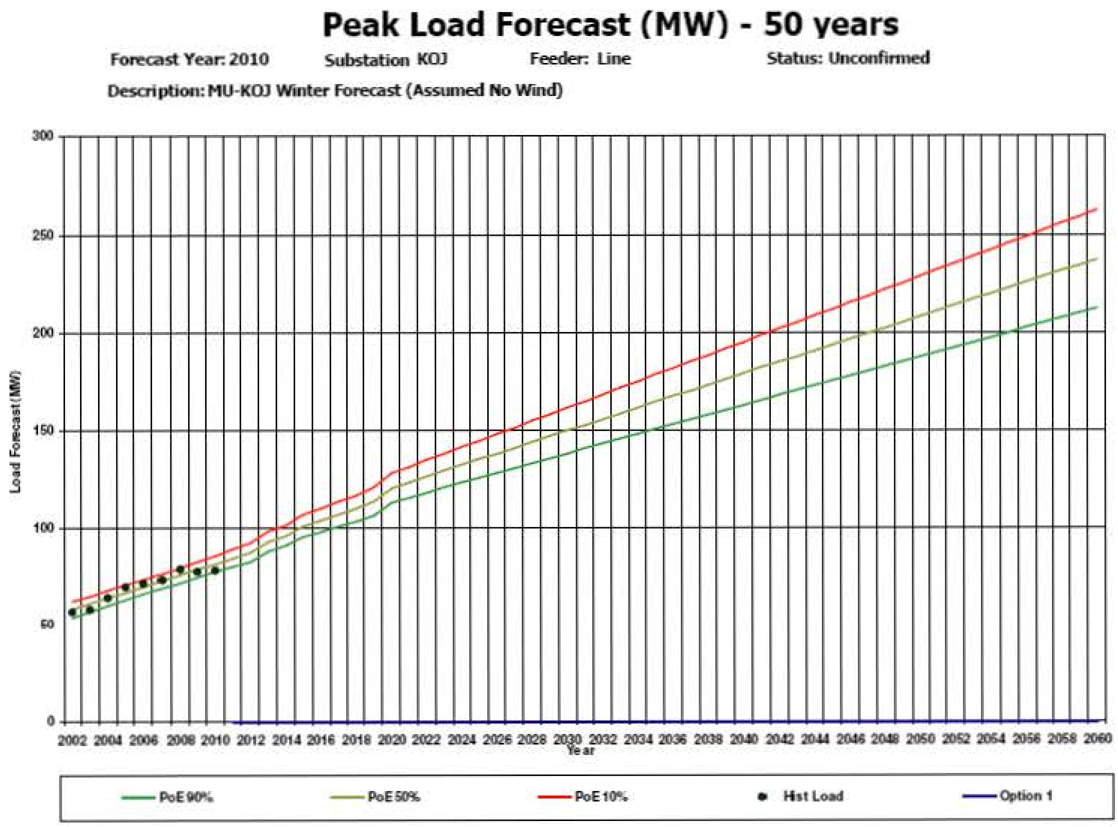
Peak Load Forecast (MW) - 50 years

Forecast Year: 2010 **Subtation:** KOJ **Feeder:** Line **Feeder Name:** MU-KOJ Summer Forecast (A

Year	Peak Hist Load (A)	Peak Hist. Load (MW)	Block Ld. (MW)	Ld Tr. (MW)	Peak Load Forecast (MW)			Capacity (MW)					
					PoE 90%	PoE 50%	PoE 10%	Existing	PoE %	Option 1	PoE %	Option 2	PoE %
2002	233.0	47.9	0.0	0.0	44.8	47.1	49.5		0.0		0.0		0.0
2003	242.0	49.8	0.0	0.0	47.3	49.6	51.8		0.0		0.0		0.0
2004	242.0	49.8	0.0	0.0	49.8	52.0	54.2		0.0		0.0		0.0
2005	263.0	54.1	0.0	0.0	52.3	54.5	56.6		0.0		0.0		0.0
2006	277.0	57.0	0.0	0.0	54.8	56.9	59.0		0.0		0.0		0.0
2007	301.0	61.9	0.0	0.0	57.2	59.4	61.5		0.0		0.0		0.0
2008	296.0	60.9	0.0	0.0	59.6	61.8	64.0		0.0		0.0		0.0
2009	315.0	64.8	0.0	0.0	62.0	64.2	66.5		0.0		0.0		0.0
2010	320.0	65.8	0.0	0.0	64.3	66.7	69.1		0.0		0.0		0.0
2011			0.0	0.0	66.6	69.1	71.6	0.0	100.0	0.0	100.0	0.0	100.0
2012			0.0	0.0	68.9	71.6	74.2	0.0	100.0	0.0	100.0	0.0	100.0
2013			2.7	0.0	73.9	76.7	79.5	0.0	100.0	0.0	100.0	0.0	100.0
2014			0.0	0.0	76.2	79.2	82.2	0.0	100.0	0.0	100.0	0.0	100.0
2015			2.0	0.0	80.4	83.6	86.8	0.0	100.0	0.0	100.0	0.0	100.0
2016			0.0	0.0	82.7	86.1	89.4	0.0	100.0	0.0	100.0	0.0	100.0
2017			0.3	0.0	85.2	88.8	92.4	0.0	100.0	0.0	100.0	0.0	100.0
2018			0.0	0.0	87.5	91.2	95.0	0.0	100.0	0.0	100.0	0.0	100.0
2019			0.6	0.0	90.3	94.3	98.3	0.0	100.0	0.0	100.0	0.0	100.0
2020			4.5	0.0	97.0	101.2	105.5	0.0	100.0	0.0	100.0	0.0	100.0
2021			0.0	0.0	99.2	103.7	108.1	0.0	100.0	0.0	100.0	0.0	100.0
2022			0.0	0.0	101.4	106.1	110.8	0.0	100.0	0.0	100.0	0.0	100.0
2023			0.0	0.0	103.7	108.6	113.5	0.0	100.0	0.0	100.0	0.0	100.0
2024			0.0	0.0	105.9	111.0	116.2	0.0	100.0	0.0	100.0	0.0	100.0
2025			0.0	0.0	108.1	113.5	118.9	0.0	100.0	0.0	100.0	0.0	100.0
2026			0.0	0.0	110.3	115.9	121.5	0.0	100.0	0.0	100.0	0.0	100.0
2027			0.0	0.0	112.5	118.4	124.2	0.0	100.0	0.0	100.0	0.0	100.0
2028			0.0	0.0	114.7	120.8	126.9	0.0	100.0	0.0	100.0	0.0	100.0
2029			0.0	0.0	116.9	123.2	129.6	0.0	100.0	0.0	100.0	0.0	100.0
2030			0.0	0.0	119.1	125.7	132.3	0.0	100.0	0.0	100.0	0.0	100.0
2031			0.0	0.0	121.3	128.1	135.0	0.0	100.0	0.0	100.0	0.0	100.0
2032			0.0	0.0	123.5	130.6	137.7	0.0	100.0	0.0	100.0	0.0	100.0
2033			0.0	0.0	125.7	133.0	140.4	0.0	100.0	0.0	100.0	0.0	100.0
2034			0.0	0.0	127.9	135.5	143.1	0.0	100.0	0.0	100.0	0.0	100.0
2035			0.0	0.0	130.1	137.9	145.8	0.0	100.0	0.0	100.0	0.0	100.0
2036			0.0	0.0	132.2	140.4	148.5	0.0	100.0	0.0	100.0	0.0	100.0
2037			0.0	0.0	134.4	142.8	151.2	0.0	100.0	0.0	100.0	0.0	100.0
2038			0.0	0.0	136.6	145.3	153.9	0.0	100.0	0.0	100.0	0.0	100.0
2039			0.0	0.0	138.8	147.7	156.6	0.0	100.0	0.0	100.0	0.0	100.0
2040			0.0	0.0	141.0	150.1	159.3	0.0	100.0	0.0	100.0	0.0	100.0
2041			0.0	0.0	143.2	152.6	162.0	0.0	100.0	0.0	100.0	0.0	100.0
2042			0.0	0.0	145.4	155.0	164.7	0.0	100.0	0.0	100.0	0.0	100.0
2043			0.0	0.0	147.6	157.5	167.4	0.0	100.0	0.0	100.0	0.0	100.0
2044			0.0	0.0	149.8	159.9	170.1	0.0	100.0	0.0	100.0	0.0	100.0
2045			0.0	0.0	152.0	162.4	172.8	0.0	100.0	0.0	100.0	0.0	100.0
2046			0.0	0.0	154.2	164.8	175.5	0.0	100.0	0.0	100.0	0.0	100.0
2047			0.0	0.0	156.3	167.3	178.2	0.0	100.0	0.0	100.0	0.0	100.0
2048			0.0	0.0	158.5	169.7	180.9	0.0	100.0	0.0	100.0	0.0	100.0
2049			0.0	0.0	160.7	172.1	183.6	0.0	100.0	0.0	100.0	0.0	100.0
2050			0.0	0.0	162.9	174.6	186.3	0.0	100.0	0.0	100.0	0.0	100.0
2051			0.0	0.0	165.1	177.0	189.0	0.0	100.0	0.0	100.0	0.0	100.0
2052			0.0	0.0	167.3	179.5	191.7	0.0	100.0	0.0	100.0	0.0	100.0
2053			0.0	0.0	169.5	181.9	194.4	0.0	100.0	0.0	100.0	0.0	100.0
2054			0.0	0.0	171.7	184.4	197.1	0.0	100.0	0.0	100.0	0.0	100.0
2055			0.0	0.0	173.9	186.8	199.8	0.0	100.0	0.0	100.0	0.0	100.0
2056			0.0	0.0	176.0	189.3	202.5	0.0	100.0	0.0	100.0	0.0	100.0
2057			0.0	0.0	178.2	191.7	205.2	0.0	100.0	0.0	100.0	0.0	100.0
2058			0.0	0.0	180.4	194.2	207.9	0.0	100.0	0.0	100.0	0.0	100.0
2059			0.0	0.0	182.6	196.6	210.6	0.0	100.0	0.0	100.0	0.0	100.0
2060			0.0	0.0	184.8	199.0	213.3	0.0	100.0	0.0	100.0	0.0	100.0

A.2 Winter

Winter forecast load at Kojonup, Albany and Mount Barker substations, for the next 50 years, extracted from OPAL.



[

Peak Load Forecast (MW) - 50 years

Forecast Year: 2010 **Subtation:** KOJ **Feeder:** Line **Status:** Unconfirmed

Description: MU-KOJ Winter Forecast (Assumed No Wind)

Year	Peak Hist Load (A)	Peak Hist. Load (MW)	Block Ld. (MW)	Ld Tr. (MW)	Peak Load Forecast (MW)			Capacity (MW)					
					PoE 90%	PoE 50%	PoE 10%	Existing	PoE %	Option 1	PoE %	Option 2	PoE %
2002	276.0	56.8	0.0	0.0	54.0	58.1	62.3		0.0		0.0		0.0
2003	284.0	58.4	0.0	0.0	57.1	61.1	65.1		0.0		0.0		0.0
2004	311.0	64.0	0.0	0.0	60.1	64.0	67.8		0.0		0.0		0.0
2005	340.0	70.0	0.0	0.0	63.1	66.9	70.7		0.0		0.0		0.0
2006	347.0	71.4	0.0	0.0	66.1	69.8	73.6		0.0		0.0		0.0
2007	357.0	73.5	0.0	0.0	69.0	72.7	76.5		0.0		0.0		0.0
2008	383.0	78.8	0.0	0.0	71.8	75.7	79.5		0.0		0.0		0.0
2009	377.0	77.6	0.0	0.0	74.6	78.6	82.6		0.0		0.0		0.0
2010	379.0	78.0	0.0	0.0	77.3	81.5	85.7		0.0		0.0		0.0
2011			0.0	0.0	80.0	84.4	88.8	0.0	100.0	0.0	100.0	0.0	100.0
2012			0.0	0.0	82.7	87.4	92.0	0.0	100.0	0.0	100.0	0.0	100.0
2013			2.7	0.0	88.0	93.0	97.9	0.0	100.0	0.0	100.0	0.0	100.0
2014			0.0	0.0	90.6	95.9	101.2	0.0	100.0	0.0	100.0	0.0	100.0
2015			2.0	0.0	95.2	100.8	106.4	0.0	100.0	0.0	100.0	0.0	100.0
2016			0.0	0.0	97.8	103.7	109.7	0.0	100.0	0.0	100.0	0.0	100.0
2017			0.3	0.0	100.6	106.9	113.2	0.0	100.0	0.0	100.0	0.0	100.0
2018			0.0	0.0	103.2	109.8	116.5	0.0	100.0	0.0	100.0	0.0	100.0
2019			0.5	0.0	106.2	113.3	120.4	0.0	100.0	0.0	100.0	0.0	100.0
2020			4.0	0.0	112.8	120.3	127.7	0.0	100.0	0.0	100.0	0.0	100.0
2021			0.0	0.0	115.3	123.2	131.0	0.0	100.0	0.0	100.0	0.0	100.0
2022			0.0	0.0	117.9	126.1	134.4	0.0	100.0	0.0	100.0	0.0	100.0
2023			0.0	0.0	120.4	129.0	137.7	0.0	100.0	0.0	100.0	0.0	100.0
2024			0.0	0.0	122.9	132.0	141.0	0.0	100.0	0.0	100.0	0.0	100.0
2025			0.0	0.0	125.4	134.9	144.4	0.0	100.0	0.0	100.0	0.0	100.0
2026			0.0	0.0	127.9	137.8	147.7	0.0	100.0	0.0	100.0	0.0	100.0
2027			0.0	0.0	130.4	140.7	151.1	0.0	100.0	0.0	100.0	0.0	100.0
2028			0.0	0.0	132.9	143.6	154.4	0.0	100.0	0.0	100.0	0.0	100.0
2029			0.0	0.0	135.3	146.6	157.8	0.0	100.0	0.0	100.0	0.0	100.0
2030			0.0	0.0	137.8	149.5	161.1	0.0	100.0	0.0	100.0	0.0	100.0
2031			0.0	0.0	140.3	152.4	164.5	0.0	100.0	0.0	100.0	0.0	100.0
2032			0.0	0.0	142.8	155.3	167.9	0.0	100.0	0.0	100.0	0.0	100.0
2033			0.0	0.0	145.3	158.3	171.2	0.0	100.0	0.0	100.0	0.0	100.0
2034			0.0	0.0	147.8	161.2	174.6	0.0	100.0	0.0	100.0	0.0	100.0
2035			0.0	0.0	150.2	164.1	178.0	0.0	100.0	0.0	100.0	0.0	100.0
2036			0.0	0.0	152.7	167.0	181.3	0.0	100.0	0.0	100.0	0.0	100.0
2037			0.0	0.0	155.2	169.9	184.7	0.0	100.0	0.0	100.0	0.0	100.0
2038			0.0	0.0	157.7	172.9	188.1	0.0	100.0	0.0	100.0	0.0	100.0
2039			0.0	0.0	160.2	175.8	191.4	0.0	100.0	0.0	100.0	0.0	100.0
2040			0.0	0.0	162.6	178.7	194.8	0.0	100.0	0.0	100.0	0.0	100.0
2041			0.0	0.0	165.1	181.6	198.2	0.0	100.0	0.0	100.0	0.0	100.0
2042			0.0	0.0	167.6	184.6	201.5	0.0	100.0	0.0	100.0	0.0	100.0
2043			0.0	0.0	170.1	187.5	204.9	0.0	100.0	0.0	100.0	0.0	100.0
2044			0.0	0.0	172.5	190.4	208.3	0.0	100.0	0.0	100.0	0.0	100.0
2045			0.0	0.0	175.0	193.3	211.6	0.0	100.0	0.0	100.0	0.0	100.0
2046			0.0	0.0	177.5	196.2	215.0	0.0	100.0	0.0	100.0	0.0	100.0
2047			0.0	0.0	179.9	199.2	218.4	0.0	100.0	0.0	100.0	0.0	100.0
2048			0.0	0.0	182.4	202.1	221.8	0.0	100.0	0.0	100.0	0.0	100.0
2049			0.0	0.0	184.9	205.0	225.1	0.0	100.0	0.0	100.0	0.0	100.0
2050			0.0	0.0	187.4	207.9	228.5	0.0	100.0	0.0	100.0	0.0	100.0
2051			0.0	0.0	189.8	210.8	231.9	0.0	100.0	0.0	100.0	0.0	100.0
2052			0.0	0.0	192.3	213.8	235.3	0.0	100.0	0.0	100.0	0.0	100.0
2053			0.0	0.0	194.8	216.7	238.6	0.0	100.0	0.0	100.0	0.0	100.0
2054			0.0	0.0	197.2	219.6	242.0	0.0	100.0	0.0	100.0	0.0	100.0
2055			0.0	0.0	199.7	222.5	245.4	0.0	100.0	0.0	100.0	0.0	100.0
2056			0.0	0.0	202.2	225.5	248.8	0.0	100.0	0.0	100.0	0.0	100.0
2057			0.0	0.0	204.6	228.4	252.1	0.0	100.0	0.0	100.0	0.0	100.0
2058			0.0	0.0	207.1	231.3	255.5	0.0	100.0	0.0	100.0	0.0	100.0
2059			0.0	0.0	209.6	234.2	258.9	0.0	100.0	0.0	100.0	0.0	100.0
2060			0.0	0.0	212.0	237.1	262.3	0.0	100.0	0.0	100.0	0.0	100.0

Appendix B – Cost of losses

A.3 Derivation

The cost of losses for the transmission line voltage optimisation and the conductor optimisation exercise, was derived as follows:

The average short term energy market (STEM) price of energy 2006-09 was:

- $39.42 / MWhr off-peak
- $79.13 / MWhr peak

Obtained from Table 2 (pg 16) of the ERA document: "2009 Annual Wholesale Electricity Market report for the Minister of Energy - Public Version", available from the ERA website.

To get an average value for system losses the tariff information was used

- Off-peak: 10 hrs/day (weekday) + 24 hrs/day (weekend)
- Peak: 14 hrs/day (weekday)

Obtained from the "2010/11 Price List":
http://www.westernpower.com.au/documents/aboutus/accessarrangement/2010/2010_11_PRICE_LIST.pdf

The off-peak period is therefore 98/168 hours and the peak period is 70/168 hours, so multiplying by the prices listed above the average is **$56/MWhr**.

A.4 NPC calculation for SDJV's Southdown Mine connection options

Contract demand	180	MW	
Power Factor	0.9		
Load Factor	0.85	Average value for SWIS is 0.55	
Load loss factor	0.748	Kelvin's Law Load loss factor = 0.8(LF)^2+0.2(LF)	
Line length	288	km	
Loss cost	$ 56	/MWhr	
Escalation Factor	2.7%	p.a.	
Discount Factor	10.65%	p.a.	
	7.7%		Treasury Publication DM:# 7750614
Evaluation Period	50	Years	Based on Clause 7, page 27 of "Amended Proposed Revisions to the Access Arrangement for the South West Network owned by Western Power" DM #:6734262

		Option A 220 kV line	Option B 220 kV line	Option C 330 kV line	
Voltage (kV)		220	220	330	
Current (A)		524.86	524.86	349.91	
Conductor		Lacrosse	Lacrosse	Silicon	
No. cond per bundle		1	2	2	
Conductor R(ac), single		0.059	0.0716	0.063	ohm/km at 75 degC
Conductor R(ac), bundle		0.059	0.0358	0.0315	ohm/km
Line Losses (kW/km)		36.47	22.13	8.65	kW/km
Line Losses (kW)		10,504.15	6,373.70	2,492.51	kW
Line Losses (MW)		10.50	6.37	2.49	MW
Line Losses (MWh)		92,016	55,834	21,834	MWh per year
Cost of losses per year		**$ 5,152,914**	**$3,126,683**	**$ 1,222,725**	
NPC (30 years)		**$59,457,268**	**$36,077,461**	**$14,108,504**	Expected lifetime of Southdown Mine
	$Million	59.5	36.1	14.1	
NPC (50 years)		**$64,966,247**	**$39,420,197**	**$15,415,720**	
	$Million	65.0	39.4	15.4	

Appendix C – 330 kV Conductor Optimisation

A.5 330 kV Conductor options

A.1.1 Minimum conductor size for corona

To achieve the minimum corona requirement, twin bundle conductor is required, with a minimum conductor diameter of 29.3 mm. This requirement dictates the following conductors to be considered:

ACSR / GZ	AAAC 1120	Diameter (mm)
Orange	Selenium	29.3
Olive	Silicon	31.5
Paw Paw	Sulphur	33.8

A.1.2 Conductor Ratings

The table below shows the ratings that would be achieved with each conductor for different design operating temperatures.

	85 deg		75 deg		65 deg	
Suitable for 330kV	(A)	MVA	(A)	MVA	(A)	MVA
Paw Paw (twin)	2092	1194	1720	982	1212	692
Olive (twin)	1932	1103	1594	910	1132	646
Orange (twin)	1768	1009	1462	835	1048	598
Sulphur (twin)	2266	1294	1862	1063	1312	749
Silicon (twin)	2087	1191	1719	981	1221	697
Selinium (twin)	1908	1089	1576	900	1130	645

The incremental difference in capital cost between 65 and 85 degrees is minimal; however the thermal capacity provided by the 65 deg designs in the table above is well in excess of that required for the Southdown Mine demand. Therefore higher design operating temperatures are not warranted, so for the MU-SDN 330 kV line a design operating temperature of 65 deg will be used.

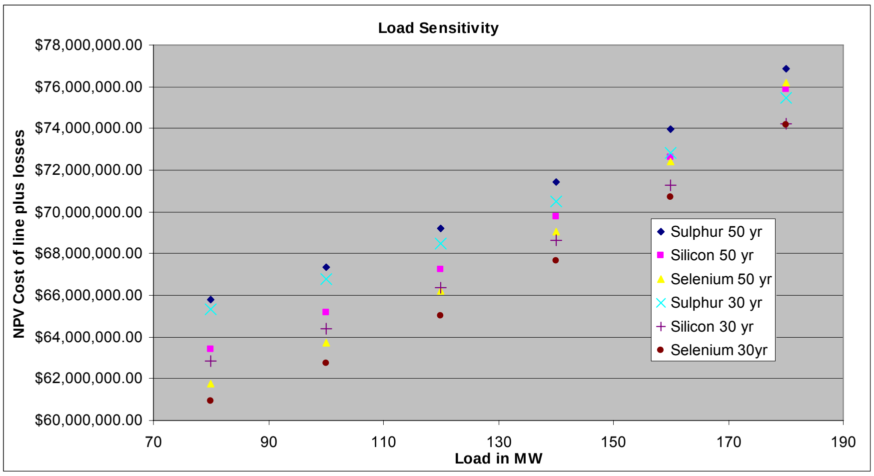
A.1.3 Conductor cost sensitivity

The costs for each conductor option have been estimated using a spreadsheet:

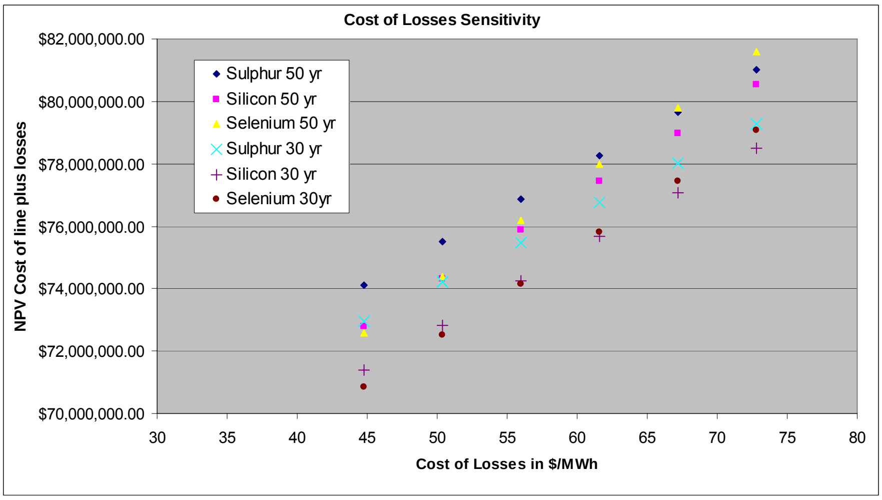
- Conductor Optimisation – Sensitivity Analysis (DM# 7815317)

For the 330kV single circuit structures, there is almost no difference in line cost between the ACSR conductor and the equivalent AAAC conductor (e.g. Paw Paw versus Sulphur). This is because to the tower tonnage due to the extra height required for AAAC appears to balance out the tower tonnage due to the extra tension requirements of ACSR.

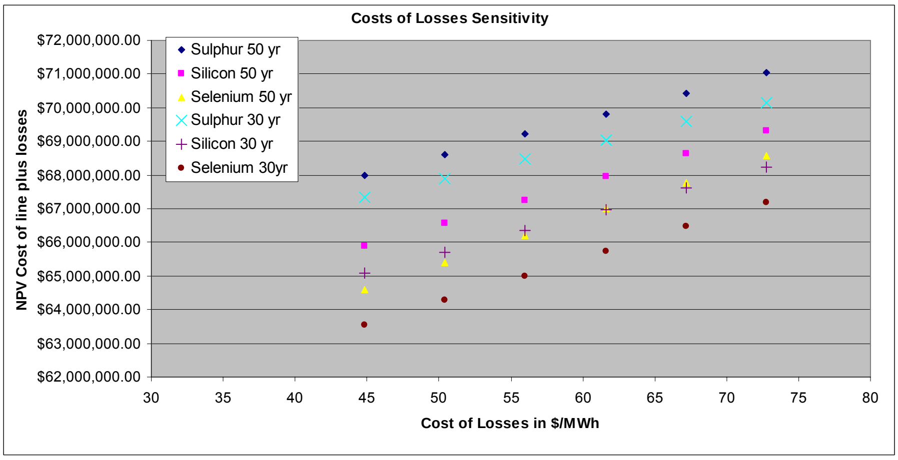
ACSR conductor is more expensive due to the steel core. Based on this the type of conductor is selected as AAAC as this has lower losses than the equivalent ACSR conductor.



Sensitivity of AAAC conductor with load - The above graph is based on 290 km line with fixed cost of losses at $56 per MWh, and the NPC as a function of the load. The least cost NPC changes at 170 MW from Selenium to Silicon.



Sensitivity of AAAC conductor to cost of losses - The above graph shows the 290 km line loaded to 180 MW and the NPC as a function of cost of losses. As can be see that Silicon is the least cost option if the cost of losses increases. This analysis was repeated with lesser load of 120 MW, and in this case Selenium has the lowest NPC.



Attachment 2 Summary of Community Consultation

SUMMARY OF COMMUNITY CONSULTATIONS FOR MAJOR AUGMENTATION TO SUPPLY SOUTHDOWN PROJECT

June 2011

1 Introduction

A joint venture of Grange Resources Limited and Sojitz Resources & Technology Limited (**SDJV**) is developing a magnetite mine (Southdown Mine) near Wellstead approximately 90 km north-east of Albany. The customer has requested access to the South West Interconnected Network to supply power to the Southdown Mine at a contract maximum demand of 180 MW and a connection/energisation date currently planned for March 2014.

Western Power identified that a 330 kV transmission line from Muja to Southdown would be required to connect the mine and be able to provide the requested demand. The SDJV's initial request was submitted in 2005 and was based on an in-service date of 3 to 4 years from request. Given the tight timeframe, Western Power developed a proposed new line route which followed an indirect route from Muja past Kojonup Substation and on to Southdown. This line route was established on the basis that the required in-service date could only be met through taking steps to minimise the time associated with obtaining environmental approval and community and property owner acceptance.

The Southdown Project was put on hold in 2008, and recommenced in May 2010 with a revised in-service date of March 2014. As part of the renewed discussions, it was decided to investigate a more direct line route between Muja and Kojonup following the existing 81 line route, while retaining the previously proposed line route from Kojonup to Southdown. Once again, this approach was taken to ensure that the in-service date could be met and environmental approvals and community acceptance secured.

Based on the above context and timing, this report provides an outline of the community consultations undertaken by Western Power in connection with securing the line route and community support for the development of its major augmentation proposal to supply power to the Southdown Project. It includes the outcome of those consultations and the impact those consultations had on the major augmentation proposal.

2 Engagement with key stakeholders

The consultations undertaken with key stakeholders included the following:

- Referral documents were provided to and consultations undertaken with the Department of Environment & Conservation and the Conservation Commission. No concerns were raised in relation to the major augmentation proposed or the documents provided. DM#8178242
- Consultations were undertaken with the Environmental Protection Authority and the Department of Sustainability, Environment, Water, Population and Communities. Referral documents are currently being prepared for both parties. No concerns have been raised in relation to the major augmentation proposed.
- Consultations were undertaken with all local government authorities (Shires of Collie, West Arthur, Kojonup, Gnowangerup, Broomehill-Tambellup and the City of Albany) and local members of Parliament. The Shire of West Arthur noted its support for replacing the existing line 81 from Muja to Kojonup rather than the indirect route as it would reduce the number of transmission line corridors which ultimately pass through their shire.

- Consultations were undertaken with hundreds of landowners potentially impacted by the line route options. This included:
    - visits by Western Power's field officers to discuss the project;
    - a Notice of Entry issued to 125 landowners impacted by the final line route to access their properties for technical and biological studies; and
    - 45 community information sessions held.

3 Issues

The following concerns were raised during consultations with key stakeholders:

- the potential negative impacts to the Stirling Ranges resulting from the line route as then proposed;
- the potential health impacts (EMFs);
- social, visual, environmental and tourism impacts associated with the location of the line route and materials used; and
- potential biosecurity issues associated with the spreading of diseases.

Each of these concerns has been addressed as noted in the subsequent section.

4 Outcomes

1. Stirling Ranges

A community group called SAVE (Stirling Area Visual Environment) was formed to protest the preliminary line route. Western Power engaged a specialist landscape architect to complete a visual impact study of the original proposed line route and the results of the study showed the transmission line would be barely visible from the Stirling Ranges. Western Power's Managing Director made a public commitment to the community that the proposed line route would not come within 10 km of the Stirling Ranges. The community group was satisfied with this outcome and this is reflected in each of the options which were subsequently assessed in the study presented with Western Power's submission to the ERA.

2. Environmental

Western Power has proposed an indirect line route to minimise environmental impacts where possible. These line deviations are for reasons that include, but are not limited to, nesting trees of the federally protected Carnaby's Cockatoo, Aboriginal heritage sites, airstrips, rivers and environmentally sensitive areas. While the indirect line route is reflected in the indirect single circuit proposal contained in the study annexed to Western Power's submission to the ERA, equivalent environmental benefits are also achieved through all other options assessed in the study.

3. Visual

During the community consultations process with landowners in 2006, concerns were raised in relation to the visual impact of the preliminary line route. The community put forward an alternative alignment for the transmission line along Tie Line Road. In response to this, Western Power engaged an independent consultant to conduct a sustainability assessment of the proposed alternative and the original 'southern' alignment. Following the completion of the sustainability assessments, information sessions were held to share the results of the survey and advise the community that the southern alignment was selected over the Tie Line Road option.

To mitigate the visual impact Western Power amended the design to include poles rather than lattice towers in a section south of Gnowangerup where the line intersects with a main road and through several properties. In addition the proposed line route has been planned to minimise the line's visual impact by locating the line through gullies and in low-lying areas of the landscape, wherever possible. This is reflected in each of the options which were subsequently assessed in the study presented with Western Power's submission to the ERA.

4. Tourism

The Borden community raised concerns of the line route spoiling the view from Louis' Lookout, a tourist site north of Borden. In response to their concerns, Western Power amended the line route to run behind Louis' Lookout, away from the view of visitors.

Chester Pass Road is a popular tourist drive. The line was moved to the other side of Borden to mitigate tourism and visual impacts from this busy road.

Visual impact assessments were conducted from Bluff Knoll and popular walking trails, such as the ridge top walk and these studies showed that the powerlines would be barely visible.

Once again, each of the above issues is addressed by all options contained in the study annexed to Western Power's submission to the ERA.

5. Health

Community members enquired about the health impacts of having the transmission lines cross their property, particularly with electromagnetic fields (EMFs). Where possible, Western Power tries as far as possible to maintain a 500m distance between powerlines and dwellings. Western Power's field officers advised concerned landowners that the powerlines are designed, constructed and operated in compliance with the recommended guidelines by the World Health Organisation and the National Healthy and Medical Research Council of Australia. This approach is reflected in each of the options which were subsequently assessed in the study presented with Western Power's submission to the ERA.

6. Biosecurity

Western Power is continuing to work with the Department of Agriculture, the Department of Environment and Conservation and impacted landowners to develop appropriate clean down strategies along the length of the line to minimise the risk of spreading diseases. These strategies will be incorporated into the ultimate approach taken in the construction of the transmission line as part of the major augmentation.

Further details in relation to the consultations undertaken by Western Power in connection with the major augmentation are annexed to this report.

5 Conclusion

As can be seen from the above discussion, Western Power has undertaken broad consultations with a range of stakeholders in relation to the major augmentation to supply power to the Southdown Project. Western Power has also demonstrated the use of feedback and information obtained in consultations to refine the major augmentation proposal, and the quality and extent of information provided to secure support for the project across the community. Each of the options assessed in the study annexed to Western Power's submission to the ERA concerning the major augmentation accommodate and address the concerns raised in the course of community consultations.

Summary of community engagement for Muja to Southdown Transmission Line Project

Part 1:

Since project recommencement (August 2010)

Activity	Date	Details
Ministerial briefing note	31 August 2010	Ministerial briefing note created and sent to Minister's office to highlight potentially contentious issues with project recommencing DM#7467707
Mailout	6 September 2010	Sent to stakeholders (local councils, politicians, government agencies) and landowners on both lines on Monday 6 September DM#7375498
Field visits	13 September 2010 onwards (ongoing)	Field visits – Field Officers, Mark Stevens and Allan Enright, contacted landowners from Friday 3 September, and went into the field from Monday 13 September.
New project contact details	3 September 2010	A new phone number (9326 4850) and email address (southdown@westernpower.com.au) set up for all project enquiries
Website	3 September 2010	Project website updated www.westernpower.com.au/grangeproject
Community information sessions	11-13 April 2011	Five community sessions held: • Moodiarrup • Kojonup • Broomehill • Gnowangerup • Borden
Communications	March/April 2011	Advertisements: • Albany Advertiser – 5 April and 7 April • Great Southern Herald – 6 April • Albany Great Southern Weekender - 7 April • Gnowangerup Roundup News – 7 April DM#089127 Mailout to 172 landholders (incl 16 Govt depts) – 31 March DM#082492 Phone call to all four Shires followed by email invitation (Shire of West Arthur, Gnowangerup, Tambellup-Broomehill & Kojonup)

Part 2:

2006 – 2008

Media Releases

2006

- 16 June: Announcement regarding the proposed Muja to Southdown transmission line project.
- 27 June: Commencement of consultation program on line route.
- 29 Aug: Community information sessions are being conducted in Borden, Kojonup and Albany
- Oct: A second transmission line route is to be investigated between Kojonup and Borden, in response to community to concern raised at the community consultation sessions in August 2006
- 16 Nov: Flora and fauna surveys are being conducted on the transmission line route options between Muja and Southdown.
- 4 Dec: Response to Paul Llewellyn's media release
- 19 Dec: Media release: Meeting of industry stakeholders, Western Power was convened by Paul Llewellyn to discuss Grange Resources power needs and options.

2007

- 4 May: Community consultation to start on new Kojonup to Albany and Albany to Wellstead transmission lines.

Community Information sessions and workshops

2006

- July: Maloney Field Services contracted for community consultation
- 29 – 31 Aug: Information sessions held in Borden, Kojonup and Broomehill to provide further details about the project.
- Nov: GHD contracted to conduct sustainability assessment of proposed line routes
- 29 - 30 Nov and 5 – 6 Dec: Community workshops held in Kojonup, Broomehill, Gnowangerup and Borden to assess the two corridor options between Kojonup and Borden.

2007

- March: GHD contracted to provide sustainability assessment on corridor options
- 3 – 5 April: Information sessions held at Kojonup, Borden, Gnowangerup and Broomehill to advise that the southern alignment has been selected over the Tie Line Road option.
- 9 – 18 May: 11 community information sessions held between Kojonup, Albany and Wellstead to explain the sustainability assessment process and invite nominations for the corridor selection panel
- 29 – 30 May: workshops held in Cranbrook and Albany with respective Corridor Selection Panels for each transmission line, with three potential corridors selected for each option
- 24 July – 16 Aug: 16 workshops held between Kojonup, Albany and Wellstead to gather weighting criteria

General letters to impacted stakeholders

2006

- 10 Jul: Letters sent to identified stakeholders advising of the project.
- 10 Oct: General update on project progress and the decision to assess two transmission line alignments between Kojonup and Borden is sent to identified stakeholders.
- 10 Oct: Notice of Entry is sent to property owners with regard to flora and fauna surveys along the line route options.
- 16 Nov: Invitations for a community workshop are sent to stakeholders in between Muja and Southdown, who are affected by one or more of the transmission line options.

2007

- 12 Mar: Affected stakeholders are advised of the outcome of the multi-criteria assessment and invited to attend an information session.
- 3 - 5 Apr: Information sessions held at Kojonup, Borden, Gnowangerup and Broomehill advising people that the southern alignment has been selected over the Tie Line Road option.
- Sep: Notice of Entry sent to impacted landowners along proposed line route

Attachment 3 Support letter from SDJV

9th June 2011

Grange Resources Limited
ABN 80 009 132 405
Level 11, 200 St Georges Terrace
Perth Western Australia 6000
PO Box 7025, Cloisters Square
Perth Western Australia 6850
T +61 8 9327 7901
F +61 8 9327 7932
info@grangeresources.com.au
www.grangeresources.com.au

Mr Lyndon Rowe
Chairman
Economic Regulation Authority
Level 6 197 St George's Terrace
Perth WA 6000

Dear Mr Rowe

RE: Request for Waiver of Regulatory Test

The Southdown Joint Venture (**SDJV**), being a joint venture between Grange Resources Limited (**Grange**) (70%) and Sojitz Resources & Technology Pty Limited (**Sojitz**) (30%) has prepared this letter in support of Western Power's (**WP**) request for a waiver of the regulatory test in relation to a major augmentation to its network required to supply power to SDJV's Southdown Magnetite Mine (**Southdown Mine**) by the scheduled date of March 2014.

The Southdown Mine forms the core component of the broader project (**Southdown Project**), which encompasses the mining and processing of magnetite into concentrate at the Southdown Mine, and pumping that concentrate as slurry approximately 100 km to a facility at the port of Albany, for shipment to Asia. The Southdown Project also includes an expansion of the Albany Port and the construction of a 100 km slurry pipeline and water return line, a concentrator plant and a desalination plant.

This supporting letter sets out:

(a) the background to the Southdown Project and its timing;

(b) the importance of the Southdown Project to the Western Australian community;

(c) the background to SDJV's request to connect to WP's network and consideration of alternative options;

(d) the commitments and assurances SDJV has made in relation to capital contributions for the major augmentation; and

(e) the impact that the application of the regulatory test to the proposed major augmentation will have on the Southdown Project.

As this supporting letter will demonstrate, the application of the regulatory test and its associated delay to the construction of the transmission line will, more than likely, have a severe impact on the Southdown Project and may even result in the Project not proceeding.

This letter and WP's submission also indicate that:

(a) in SDJV's view, there are no other commercially viable options for the supply of power to Southdown; and

(b) as SDJV has offered to make capital contributions towards the major augmentation in the manner set out in Section 4 of this letter, the proposed augmentation will not result in a net cost to users of the network.

For the foregoing reasons, SDJV considers that a waiver of the regulatory test by the Economic Regulation Authority is justified.

1. Background to Southdown Project

Southdown is a 650 million tonne magnetite deposit (with the potential to grow to over 1 billion tonnes) located approximately 90 kilometres north east of Albany on the south coast of Western Australia. The magnetite will be mined, processed into concentrate and pumped as slurry, approximately 100 km to a facility at the port of Albany from where it will shipped to ports in Asia.

The Project will include an expansion of the Albany Port, with the reclamation of a new berth to accommodate a concentrate storage facility and ship loading infrastructure and the widening, deepening and extension of the existing shipping channel to allow access by Capesize vessels.

The capital costs associated with the Southdown Project are estimated at approximately A$2.6 billion. Approximately A$600 million of this amount relates to the infrastructure costs of the proposed transmission line and the proposed development of the Albany Port. Other infrastructure associated with the Southdown Project includes a 100 km slurry pipeline and water return line, a concentrator plant, a desalination plant and the mine itself.

The resource is expected to support a mine life in excess of 19 years, with the potential to extend the mine life to 40 years if SDJV determines that the eastern extensions of the deposit are economic.

SDJV received approval to construct and operate the Southdown Project on 24 November 2009 under Ministerial Statement 816. Following the results of its prefeasibility study in 2010, SDJV is now seeking additional approvals to increase the annual production rate to 10 Mtpa of concentrate and to construct a desalination plant at Cape Riche. SDJV does not anticipate that these changes will impact on its current project schedule and expects to have all approvals in place by the end of 2011.

The target commencement date for power supply to the Southdown Mine of March 2014 is critical to the Project's success for the following reasons:

(a) The current iron ore concentrate price is ~US$190 per tonne. However, long term forecasts predict a significant reduction in the iron ore price to US$120 per tonne, as global production expansion projects come on line (including the Southdown Project).

(b) Given the estimated A$2.6 billion of capital required to develop the magnetite project, its success is driven by being able to take advantage of the current high iron ore price window, which will allow the owners to recover a large part of their capital investment in a reasonable time period.

(c) Not being able to take advantage of the favourable iron ore price window will greatly reduce Project cash flows and may make the Southdown Project uneconomic.

(d) Construction of the transmission line is on the critical path and WP's ability to construct a ~300 km transmission line in a little over two years will be a very demanding task.

2. Importance of Southdown Project

The Southdown Project will generate significant benefits to State of Western Australia, both financially and otherwise.

It will provide employment opportunities for a local workforce, with the Southdown Project expected to provide approximately 600 jobs in and around the Albany region. This will generate benefits for the wider community, with the development of other projects and enterprises connected with or proximate to the mine expected.

As noted above, the Southdown Project will generate investment of approximately A$2.6 billion. It will have annual running costs of $500 million. In addition to this, the State of Western Australia will benefit directly from the payment of annual royalties ($50 million p.a.), State taxes ($5 million p.a.) and regional rates ($3 million p.a.) associated with the Project. Annual salaries from the Project will total in excess of $60 million, which will create a cash injection into the local economy.

There will also be a number of enhancements to the region's infrastructure through the following:

- Power enhancement to the Great Southern region and the ability for third party users (such as wind farms) to join the network;
- Water enhancement to the local area through the desalination plant;
- Upgrades to the Albany Port, which will secure the Port as a commercial port for the State; and
- Provide an economic base load to the City of Albany.

Since 2005, the SDJV has engaged in extensive consultations with State and local governments, communities and other key stakeholders in relation to the Southdown Project, its content and the benefits that it will provide to the local, regional and Western Australian community. Extensive consultation has also been carried out through the negotiation of infrastructure access for the proposed transmission line and slurry pipeline. Other engagement with the Albany community (commercial and residential) has occurred and resulted in gaining environmental approval for the proposed Albany Port expansion. These and other numerous interactions have resulted in both subtle and substantial modification and design changes to the Southdown Project over time. As a result, the SDJV is confident that it has established a broad base of support from stakeholders for the Southdown Project.

SDJV has enclosed with this letter a recent presentation which provides further background in relation to the scope and value of the Southdown Project.

3. Request to Connect to Western Power's Network

In 2005, Grange submitted a request to WP to build a transmission line to supply power to the Southdown Project. Since then, the power requirements have increased so that the Southdown Project currently requires WP to supply 180 MW directly to Southdown and 11 MW at Albany.

After considering all available options, SDJV has reached the view that connecting to WP's network represents the only economical and operationally viable option for the supply of power to Southdown. Alternatives, including on-site generation, have been considered, but SDJV has found that these alternatives are either not financially viable, not able to supply the required loads or, most importantly, not able to meet the targeted project commencement date of March 2014.

WP has advised that the magnitude and location of the power supply required by SDJV cannot be supplied from the existing network (including through demand management), and may only be supplied through the construction of a major augmentation to the existing network.

WP's application for a waiver of the regulatory test in relation to such a major augmentation is based on its proposition that all future high voltage transmission in the Great Southern Region should be at 330 kV and 132 kV. SDJV supports that proposition.

WP initially proposed a single-circuit 330 kV line from Muja to Southdown which SDJV is satisfied will meet its operational and reliability objectives for the Southdown Project, and SDJV's scheduled March 2014 commencement date. However, following WP's consideration of its requirements to reinforce the Great Southern network, WP proposed an alternate route for the transmission line, a double circuit 330 kV line between Muja and Kojonup and a single circuit 330 kV line from Kojonup to Southdown. The details of the major augmentation are contained in Section 4 of this letter.

SDJV supports this alternative route and proposal because it will meet SDJV's operational and reliability requirements for the Southdown Project and SDJV's March 2014 commencement date.

4. Capital Contribution by SDJV

The major augmentation proposed in WP's submission to supply the Southdown Mine contemplates:

(a) Replacing the existing Muja to Kojonup 81 route with a 330 kV double circuit MUJ-KOJ section and rehabilitating the existing line route; and

(b) Building a single circuit 330 kV line from Kojonup to Southdown.

Subject to the Project proceeding, SDJV has undertaken to meet any capital contributions required under WP's Contributions Policy for those costs which do not subsequently meet the new facilities investment test (NFIT) under the Electricity Networks Access Code and accordingly we understand there will be no net cost to other users of the network resulting from the major augmentation.

5. Impact of Regulatory Test on Southdown Project

SDJV understands that the regulatory test, when applied to a proposed major augmentation, can take between 6 and 12 months to be completed, assuming the test is satisfied. This delay will negatively impact on the Southdown Project, as it will push back the timing window for WP to procure and construct the proposed major augmentation, with the result being that WP will be unable to commence construction in early 2012 (as required to meet the Project's scheduled March 2014 commencement date).

Given the transmission line is on the Southdown Project's critical path, this delay will impact on the scheduling of all of the Southdown Project activities and will result in the Boards of Grange and Sojitz being unable to make a financial investment decision to proceed with the Southdown Project until after the regulatory test decision has been made.

This delay to the Project will result in SDJV being unable to take advantage of favourable iron ore prices, which will reduce project revenues and may jeopardise the future of the Southdown Project.

The discussion in Section 3 also confirms that there would be nothing gained in the application of the regulatory test in terms of generating viable alternative options for the supply of power for the Southdown Project within the timeframe required. Rather, based on the matters raised in Sections 1 and 2 above, the delay associated with the regulatory test could have far-reaching negative consequences for the Project and its viability.

Conclusion

The Southdown Project will generate significant benefits for the people of Western Australia and, in particular, the people in the Great Southern region. Construction of the ~300 km transmission line to the Southdown Mine by March 2014 is critical to the success of the Project.

SDJV has been unable to identify any other economically viable power alternatives that can deliver the required power or meet SDJV's targeted commencement date of March 2014. In addition, SDJV's willingness to fund any capital contributions required under WP's Contributions Policy associated with the major augmentation will mean that there is no net cost to users of the network.

In light of the above, SDJV firmly believes that a regulatory test waiver is both necessary and justifiable and we trust the Authority will grant the waiver.

SDJV confirms that this letter and its annexures may be made public.

Yours sincerely

Russell Clark
Managing Director and CEO

Cc: Doug Aberle (Western Power)

Enc:

Attachment 4 Project presentation from SDJV

GRANGE RESOURCES

Australia’s leading magnetite producer

Southdown Magnetite Project Pre-feasibility Study

May 2011

Disclaimer

The material in this presentation ("material") is not and does not constitute an offer, invitation or recommendation to subscribe for, or purchase, any security in Grange Resources Limited ("GRR") nor does it form the basis of any contract or commitment. GRR makes no representation or warranty, express or implied, as to the accuracy, reliability or completeness of this material. GRR, its directors, employees, agents and consultants, shall have no liability, including liability to any person by reason of negligence or negligent misstatement, for any statements, opinions, information or matters, express or implied, arising out of, contained in or derived from, or for any omissions from this material except liability under statute that cannot be excluded.

Statements contained in this material, particularly those regarding possible or assumed future performance, costs, dividends, production levels or rates, prices, resources, reserves or potential growth of GRR or, industry growth or other trend projections are, or may be, forward looking statements. Such statements relate to future events and expectations and, as such, involve known and unknown risks and uncertainties. Actual results and developments may differ materially from those expressed or implied by these forward looking statements depending on a variety of factors.

Overview

- Australia’s leading magnetite producer
- ASX 300 index company
- Strong balance sheet, no net debt
- Proven operational performance – tonnes and cashflow
- Quality product, high margins – iron ore pellets
- Large integrated mine, concentrator, pellet plant and port facilities
- Major magnetite development project in Western Australia
- Long term off take agreements
- Strong management team with extensive operating expertise

Magnetite – The premium iron ore

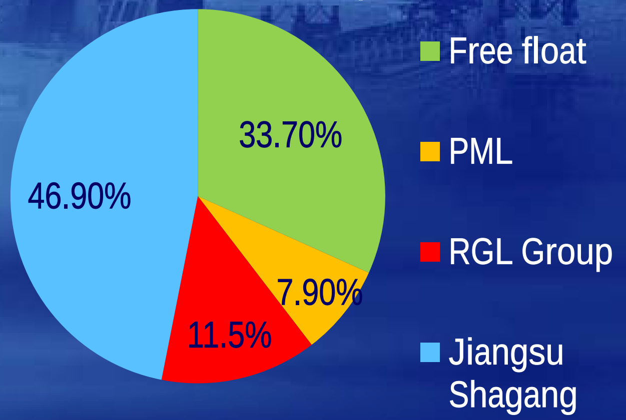
Company Snapshot

Current key statistics (A$)

Ordinary shares on issue	2 April 2011	1,153m
Last share price	2 April 2011	$0.655
Market capitalization	2 April 2011	$755m
Cash & Receivables	31 March 2011	$156.2m

Grange joined the ASX 300 in September 2010

Current Ownership Structure



Board of Directors	
Mr Zhiqiang Xi	Chairman
Mr Neil Chatfield	Deputy Chairman
Mr Russell Clark	Managing Director, CEO
Mr Honglin Zhao	Executive Director
Mr Clement Ko	Non Executive Director
Mr John Hoon	Non Executive Director

Research
Citi
Macquarie
Merrill Lynch
Patersons
Petra Capital
Southern Cross Equities
RBS
RBS Morgans

Grange's position is supported by quality assets in Tasmania and Western Australia.

Southdown Project (70%)

- JV with Japanese Trading Company, Sojitz (30%)
- 90km northeast of the Port of Albany
- 650 million tonnes of premium quality magnetite resource in southern Western Australia
- Targeting 10Mtpa concentrate, to produce high quality pellets for over 30 years
- Infrastructure solutions in place (power, port, water)
- Advanced permitting
- Potential to increase resources and reserves

Savage River (100%)

- Northwest Tasmania
- Annualised production rate of 2.0 Mtpa premium blast furnace pellets and concentrate
- Mine life to 2026
- 118Mt reserves at 51% DTR
- Owner-operated open pit mine, 83km slurry pipeline, coastal pellet plant and port
- Dedicated infrastructure – no third party charges
- Extensive operating experience applicable to Southdown development

Large Scale Operations

Grange Downstream Infrastructure

Grange Port & Shiploading Infrastructure

Southdown Magnetite Project *Key Facts*

Ownership	▪ Grange 70%, Sojitz Corporation 30%
Resources and Reserves[1]	▪ Mineral Resource of 654Mt magnetite at 36.5% DTR[1,2] ▪ Ore Reserve of 388Mt magnetite at 35.5% DTR[1,3]
Production[1]	▪ Targeting 10Mtpa magnetite concentrate for premium blast furnace pellets
Capital Costs	▪ Southdown Mine – A$2,575 million ▪ Kemaman Pellet Plant – A$941 million
Operating Costs	▪ <A$60/t of concentrate ▪ <A$75/t of pellet
Mine Life	▪ >19 years
Infrastructure	▪ Established port, pipeline route, power easements, pellet plant site and deep water port in Malaysia
Project Status	▪ Pre feasibility study (+/- 20%) completed ▪ Metallurgical testwork largely complete ▪ Processing flow sheet finalised ▪ Mining Permit issued, will be amended during 2011 for 10Mtpa; Port permit issued ▪ Water Permit for desalination plant expected during 2011

1. All figures presented on a 100% project basis 2. Southdown Magnetite Project Resource Upgrade (ASX 3 July 09) 3. July 2008 Southdown Reserve estimate

Southdown Magnetite Project *Location Plan*

Southdown Magnetite Project **_Regional Benefits_**

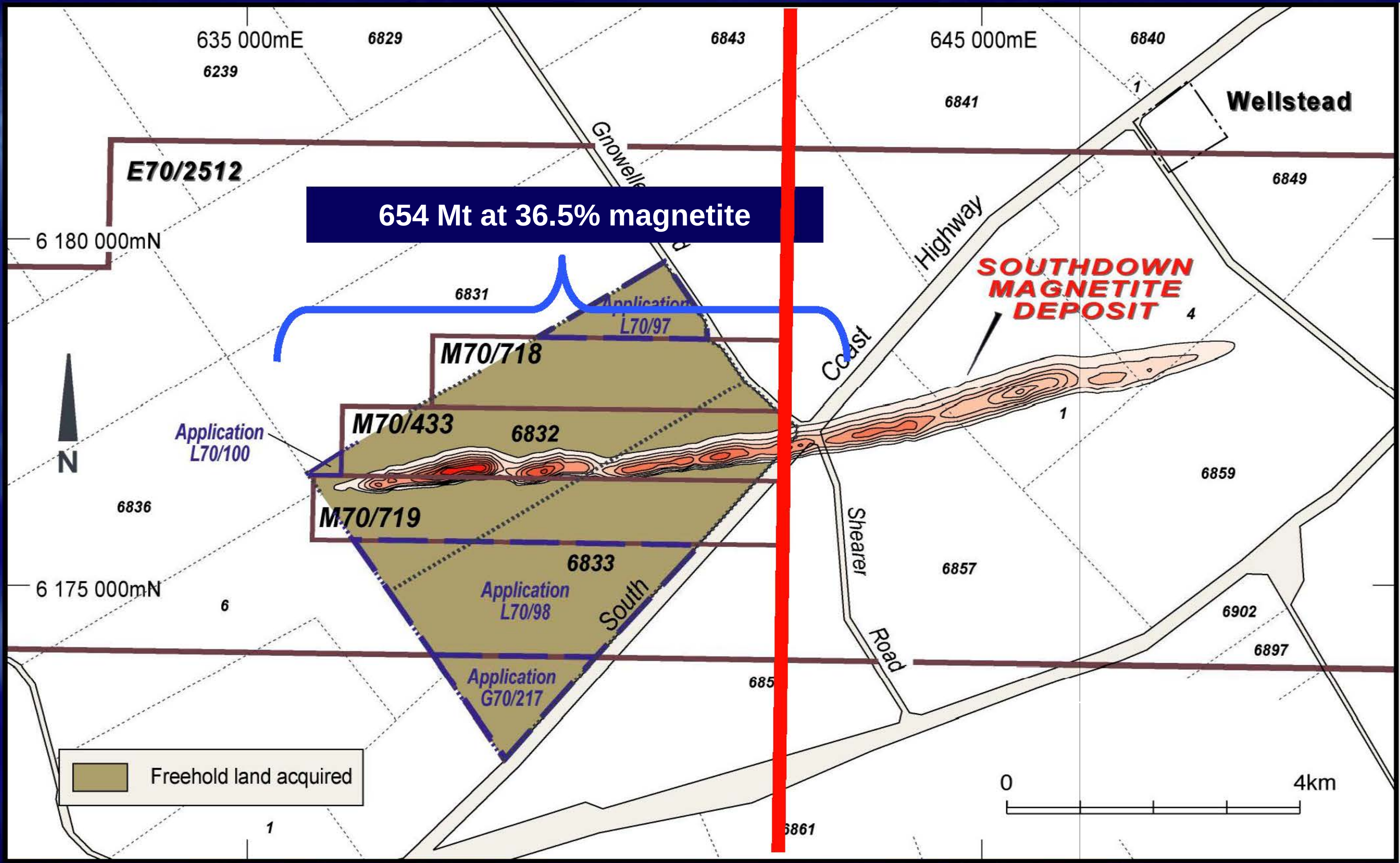
A long-term (30 to 50 years) sustainable industry in the Great Southern.

- A local workforce (not FIFO)
- Over 600 long-term jobs directly created
- Work for local contractors and businesses
- Injection of ~ $500M annually into local economy
- Regional rates ~ $3M per annum
- Support for local community groups and events
- Significant population and economic growth for City of Albany, Bremmer Bay

Southdown Magnetite Project *PFS Highlights*

- Mine Capex, including infrastructure A$2.57 billion;
- Operating costs per tonne of concentrate produced <$60 per tonne;
- Positive NPV with favourable IRR;
- Mine life of 19-40 years @10mtpa of concentrate;
- Definitive Feasibility Study (“DFS”) completion forecast for 1st quarter of 2012;
- Initial production forecast for 2014;
- Pellet plant Capex of A$941 million;
- Total cost of pellets produced <A$75 per tonne ;

Southdown Magnetite Project *Orebody*

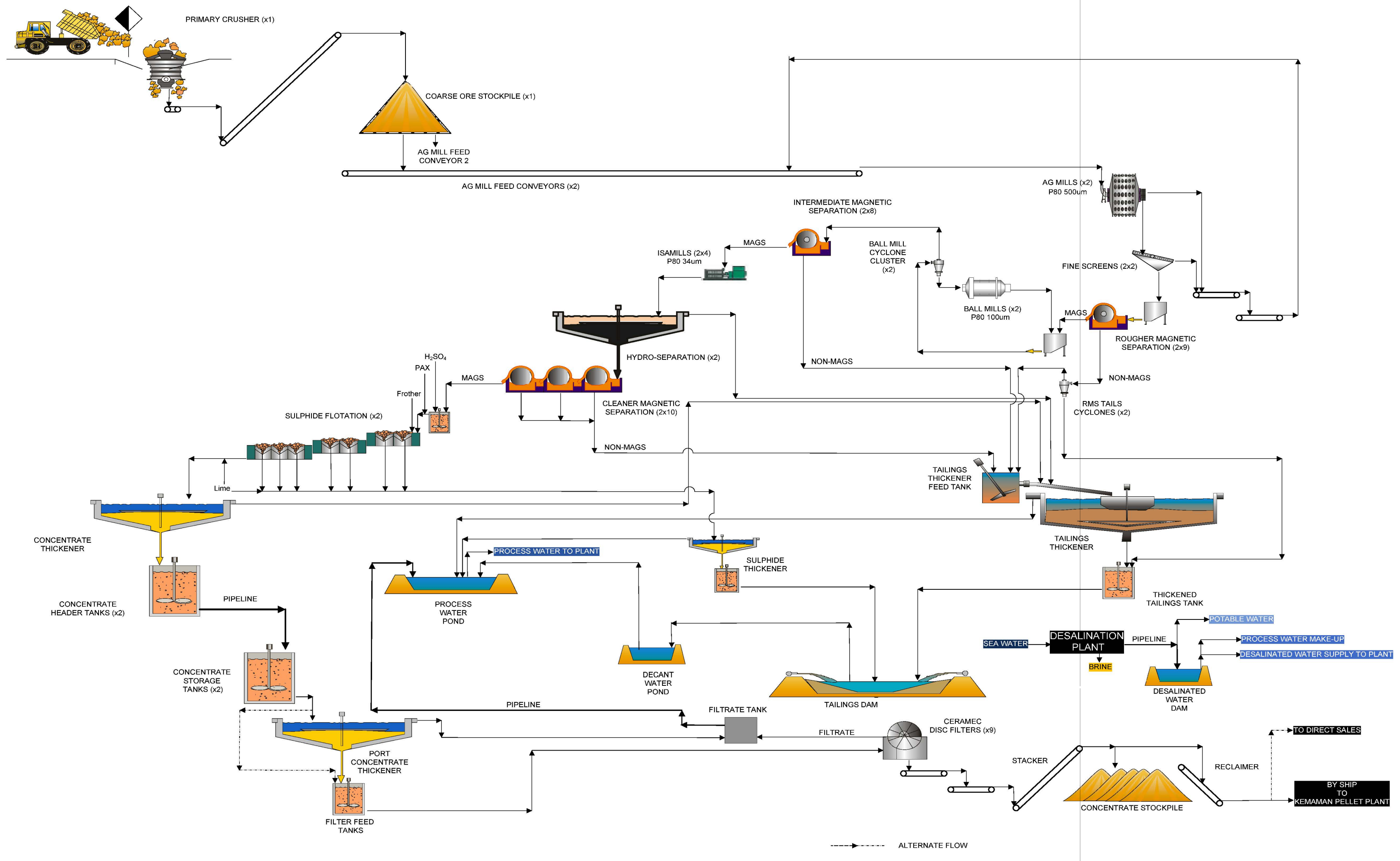


Southdown Magnetite Project *Orebody Potential*

Details	PFS Case Western Resource	Short Term Potential Full Western Resource	Long Term Potential Western/Eastern Resource
Mine Life	19 years	21 years	40 years
Ore (million tonnes)	430	~575	~1,200
Ore Grade %DTR	37.7%	36.8%	36.5%
Concentrate (million tonnes)	158	~199	~375

Note	
Note	▪ Short Term Potential Full Western Resource assumes that further drilling will move inferred resources to indicated resource and also add tonnage through deeper drilling. ▪ Long Term Potential Western/Eastern Resource assumes that further drilling in the eastern side of the magnetic anomaly will establish inferred resource which, following in fill drilling, will add indicated and measures resource

Southdown Magnetite Project *Concentrator Flow Sheet*



GRANGE RESOURCES

Southdown Magnetite Project *Product Quality*

Southdown Magnetite Concentrate	%
Total Fe	68.9
SiO_2	1.56
Al_2O_3	1.45
CaO	0.11
MgO	0.16
TiO_2	0.38
P	0.04
S	0.08
LOI (Loss of ignition)	-3.18

Southdown Iron Ore Pellets	%
Total Fe	67
B2	0.54
SiO2+Al2O3+TiO2	3.31
P	<0.01
S	0.01

Southdown Magnetite Project *Location Plan*

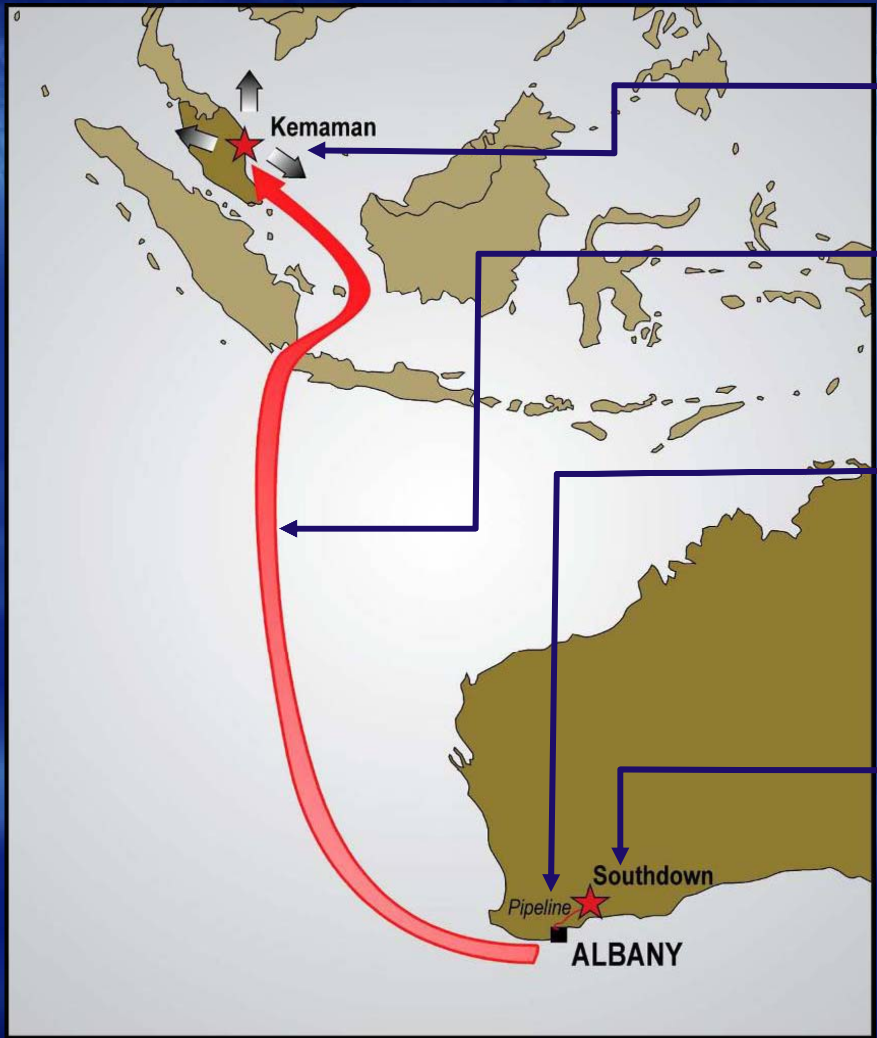
Water

Port of Albany

Southdown Magnetite Project *Environmental Permits*

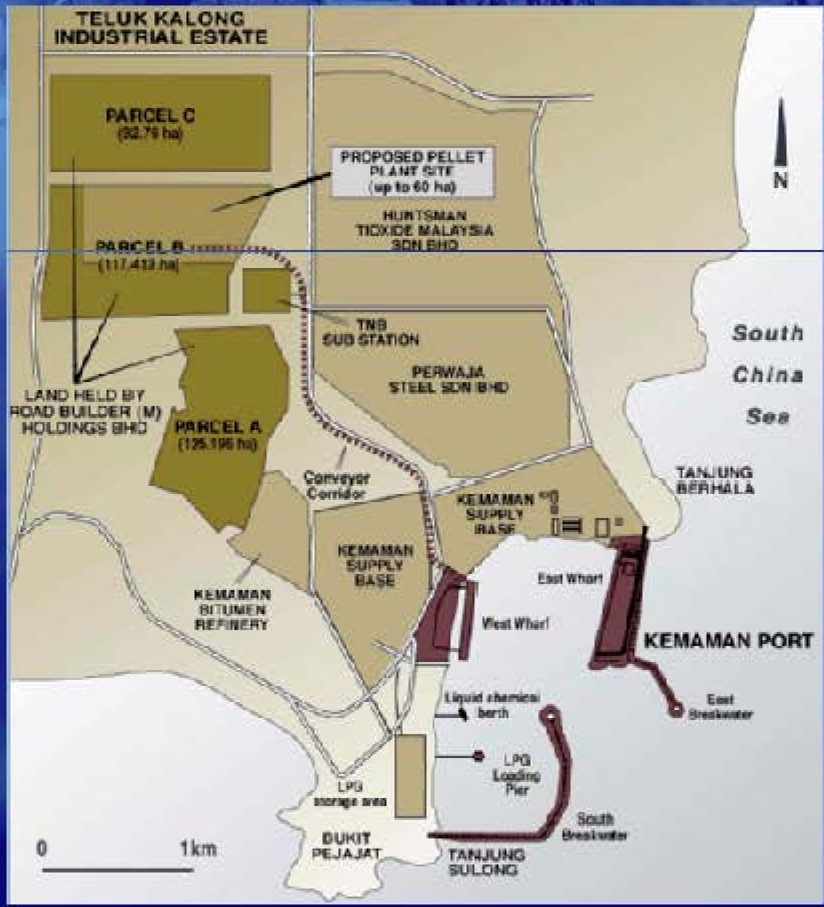
☑ Mine Environmental permit	Granted November 2009, amendment required in 2011 for 10mtpa
☑ Port permits	Granted November 2010
☐ Water permit	Desalination permit expected in 2011

Southdown Project *Australia - Malaysia*

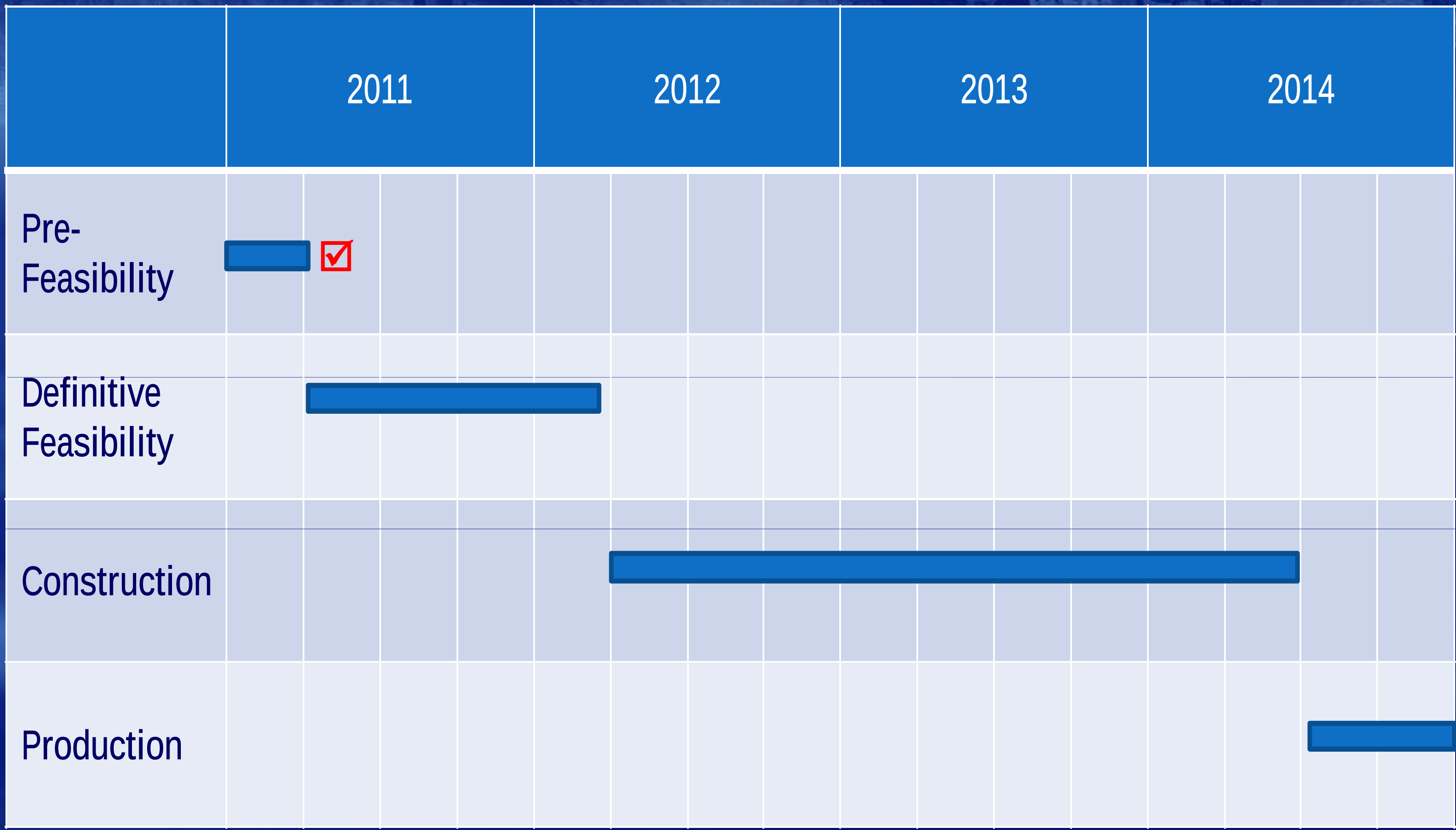


4. Pellet Plant (7Mtpa)
3. Concentrate shipped (10Mtpa)
2. 100km slurry pipeline to Albany Port
1. Mine and concentrator targeting 10Mtpa of concentrate production for over 25 years

The Kemaman Pellet Plant *Location Plan*



Southdown Magnetite Project *Timetable*



Southdown Magnetite Project *PFS Highlights*

Why is this project different to other magnetite projects being built?

- Grange's extensive operating experience and existing IP dramatically reduces execution risk,
- The project is well advanced:
  - ➢ Major permits for the mine and port are in place;
  - ➢ Land tenure is largely secure;
  - ➢ Metallurgical test work is well advanced;
  - ➢ Power line easements are established and permitted;

An Opportunity for WA

The Southdown Magnetite Project will deliver
a new long-term industry for Western Australia
and the Great Southern Region.
It will improve local infrastructure,
create regional employment
and further develop the City of Albany
as a regional economic centre.

Positive Outcomes for WA

- A new industry in southern Western Australia
- State Royalties of ~$50M per annum
- State taxes ~ $5M per annum
- Port enhancements secure Albany as a commercial port
- Better infrastructure for water & power
- Partnerships that benefit the State & region
    - training
    - community – non FIFO
    - tourism
    - environmental eg Commersonia species

Regional Benefits

A long-term (30 to 50 years) sustainable industry in the Great Southern.

- A local workforce (not FIFO)
- Over 600 long-term jobs directly created
- Work for local contractors and businesses
- Injection of ~ $500M annually into local economy
- Regional rates ~ $3M per annum
- Support for local community groups and events
- Significant population and economic growth for City of Albany, Bremmer Bay

Key Contacts

Primary contact:

Russell Clark

Managing Director & Chief Executive Officer

+61 8 9327 7901

managingdirector@grangeresources.com.au

Competent Person Statement

Southdown Project

The information in this presentation which relates to the Mineral Resources of the Southdown Project is based on information compiled by James Farrell who is a full-time employee of Golder Associates Pty Ltd and a Member of the Australasian Institute of Mining and Metallurgy. James Farrell has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity for which he is undertaking to qualify as a Competent Person as defined in the JORC Code (2004). James Farrell consents to the inclusion of this information in this presentation in the form and context in which it appears.

The information in this presentation which relates to the Ore Reserves of the Southdown Project is based on information compiled by Mr Ross Bertinshaw who is a full-time employee of Golder Associates Pty Ltd and a Fellow of the Australasian Institute of Mining and Metallurgy. Mr Bertinshaw has sufficient experience in Ore Reserve estimation relevant to the style of mineralisation and type of deposit under consideration and to the activity for which he is undertaking to qualify as a Competent Person as defined in the JORC Code (2004). Mr Bertinshaw consents to the inclusion in this presentation of the matters based on his information in the form and context in which it appears.