Initial Plant Assessment Report

(Public Release Version)

RATCH-Australia Corporation

RATCH-Australia

Collinsville Solar Thermal Power Station

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Introduction

RATCH-Australia Corporation Limited (RAC), in partnership Transfield Infrastructure Pty Limited, and The University of Queensland (UQ), is undertaking all the preparatory development work to assess the viability of converting an existing 180MW coal fired power station to a 30MW hybrid solar thermal / gas power station at the existing Collinsville Power Station (CPS) in Queensland (the Project).

As a part of the project, RAC will also examine the feasibility of using Novatec's Supernova Linear Fresnel Solar Thermal technology to generate superheated steam to be supplied to steam turbine/s to provide grid connected electricity. The dual-fuel boiler will also be designed to use natural gas to enhance grid reliability from the Project.

The Australian Government, through an Australian Renewable Energy Agency's (ARENA) Emerging Renewables Program Funding Agreement, is providing the funding for the completion of the feasibility study.

One of the key deliverables for Milestone 2 is this **Initial Plant Assessment Report for Public Release**, which contains a summary of the non-commercially sensitive information from the following sections:

- **Technical-Initial Plant Assessment Report**: RAC's technical advisors have completed an initial assessment of the Project which includes:
  - Reviewing the condition of the existing equipment and identifying the refurbishment requirements.
  - Preparing preliminary solar field design
  - Compare the installation of a new steam turbine with the reuse of the existing steam turbine.
- **Gas Supply Concept Study**: The aim of this study is to identify the processes involved and alternatives available to provide commercial quantities of gas to support the Project.
- **Preliminary Environment Assessment Report:** RAC engaged an environmental consultant to undertake an Environmental Opportunities and Constraints Assessment, to determine the potential environmental constraints to the proposed development of the site.

Technical-Initial Plant Assessment Report

RAC engaged technical advisors to provide the initial technical assessment of the Project. This report provides a detailed assessment of the existing plant with respect to refurbishment requirements for the proposed Project scope, culminating in:

- a detailed assessment of existing plant with respect to refurbishment requirements for the proposed Project scope
- a technical, cost and risk comparison of:
  - the installation of a new steam turbine, compared to
  - the reuse of the existing steam turbine
- the preliminary solar field design; and
- Identification of any technical fatal flaws.

Overview

This initial technical assessment indicates there is the potential for repowering and life extension of a selected unit at CPS for operation as a solar thermal power plant for the next 25 years. In addition, there is the potential to use some of the existing equipment, supporting infrastructure and services at the CPS for the proposed Project to reduce the overall Project costs.

The detailed refurbishment program, including the power-block, existing equipment, supporting infrastructure and services and dual fuelled fossil fired boiler, represents a significant investment. However, no fatal flaws with the refurbishment option were identified.

CPS's specific historic installation, maintenance and operating regime results in a substantial portion of the power-block requiring replacement and refurbishment. This results in only a moderate capital cost saving when compared to the installation of a new power-block.

A new power-block provides a technically superior, more reliable and lower risk option, along with the added benefits of increased solar generation yields and reduced fossil fuel cost due the higher efficiency of the new plant. Another major benefit of the installation of a new power-block is the ability to use traditional lower risk Project delivery mechanisms supported by warranties, such as a traditional engineer procure and construct (EPC) wrap contract, and the expected associated improved funding conditions.

Assessment of existing equipment and unit selection

An assessment of the four existing 30 MW power blocks and supporting equipment at CPS was completed to establish which components should be retained for the Project.

This assessment evaluated the plant under three disciplines; mechanical, electrical and instrumentation and control. The mechanical and electrical plant was assessed for its condition and suitability for continued reliable operation with recommendations of what, if any, changes or modifications should be made in order to ensure that it will provide continuous reliable operation during this future operational period. As the instrumentation and control system is currently over fourteen years it is expected that the entire control system would be replaced and as such no detailed assessment of the existing equipment was undertaken.

This initial assessment identified Unit 4, 30 MW unit commissioned in 1971, as the preferred power block for refurbishment for the solar power plant. This is primarily driven by the condition status of the major mechanical plant being the steam turbo-generator.

Refurbishment plan

The minimum refurbishment plan involves a total replacement of most equipment except for a refurbishment of the main mechanical plant including the steam turbine generator, condenser and low pressure side of the feed heating plant.

A summary of the proposed refurbishment plan for based on a Unit 4 rehabilitation would be as follows:

- full mechanical refit of the steam turbine and associated systems
- re-tubing of the condenser
- refurbishment of the condensate extraction pumps and LP heaters
- replacement with new equipment for HP heaters, boiler feed pumps, de-aerator, a majority of valves, turbine governing system and monitoring, cooling tower and water treatment system
- refurbishment of the remaining station plant systems including water, fire and air compressors
- full electrical and mechanical refit of turbine generator and associated systems
- replacement with new excitation and AVR system
- replacement with new equipment for all transformers (except for four smaller units), switchboards, cabling, DC systems, UPS and electrical protection systems
- Replacement with new equipment for all instrumentation and control equipment including the ICMS.

A possible extension to the base case for the steam turbine refurbishment process that would significantly increase long term performance and reliability is a full refit or modular turbine upgrade. However this undertaking results in a substantial increase in the rehabilitation price. For the purposes of the comparison between refurbishment of the existing steam turbine and the installation of a new steam turbine the base case pricing has been used.

New plant alternative

Adopting a 'new' power block approach located in near vicinity to the existing CPS provides substantial benefits although will be more expensive from an initial capital expenditure perspective.

The advanced design incorporated in the steam turbine generator and integrated equipment provides various benefits, including:

- significantly improved levels of overall cycle efficiency can be obtained by use of a two cylinder reheat turbine with a moisture separator reheater (MSR) specifically designed and engineered for solar applications
- fast start up capability and improved loading cycling performance which again improves the generation yield; and
- the solar to electrical conversion efficiency is very high with limited use of the fossil fuel.

Finally all new equipment will be compliant with the latest and more onerous standards and safety requirements thereby helping to reduce the risk to operational and maintenance personnel.

Comparison of alternatives

CPS's specific historic installation, maintenance and operating regime results in a substantial portion of the power-block requiring replacement and refurbishment, resulting in only a moderate cost savings when compared to the installation of a new power-block.

An initial estimate for the refurbishment is includes one (1) new gas-fired superheater (and associated equipment) with a base case refit to the steam turbine. A full steam turbine upgrade could increase the capital cost significantly.

The energy yield modelling based on the configuration for both the existing refurbished power block and new power block has predicted the electricity production and fuel consumption figures given in Table 1. Both these configurations include the fossil fuelled boiler and are based on same size solar field.

The major difference between the two plants relates to the cycle efficiency and corresponding generation yields. The substantial increase in cycle efficiency of greater than 6% which represents nearly a 20% improvement on the refurbished plant equates to higher levels of solar generation yield (~14.4%) and reduced fossil fuel consumption (~21.4%).

Table 1: Key plant parameters

	Existing Power Block	New Power Block
Steam conditions	4.24 MPa & 454°C	12 MPa & 500°C
Maximum solar cycle efficiency	32%	38.5%
Maximum fossil fuel cycle efficiency	30.4% (LHV basis)	36.6% (LHV basis)
Total mirror area	202,230 m^2	202,230 m^2
Full load thermal input (approx.)	93.8 MW	77.9 MW
Maximum solar output	30 MWe	33 MWe
Maximum hybrid output	30 MWe	30 MWe
Annual solar electricity production	61.62 GWh	70.49 GWh
Annual fossil fuel electricity production	70.52 GWh	66.66 GWh
Total annual electricity production	132.14 GWh	137.15 GWh
Annual Water Consumption	371 Ml	253 Ml

Solar layouts

The solar field layout can have an aperture area in the range of 200,000 m^2–260,000 m^2 dependent on final optimisation and incorporates an initial preheating and evaporation stage and superheating section. Minimising the distance between the steam turbine with its associated balance of plant (the 'power block') and solar field has a significant impact on the overall solar power plant cost and operating efficiency.

Refurbishment option (Solar Field Option 1)

The preferred option in this case would be Figure 1: Solar Field Option 1, with the solar field separated into two subfields. This option requires re-location of an existing Powerlink transmission line and construction works over the existing ash dam, both of which may be time consuming and cost-prohibitive. Even in this case the more remote field would require some 900 m of steam piping which for superheated steam is significant. These piping costs have been included in the refurbishment estimate.

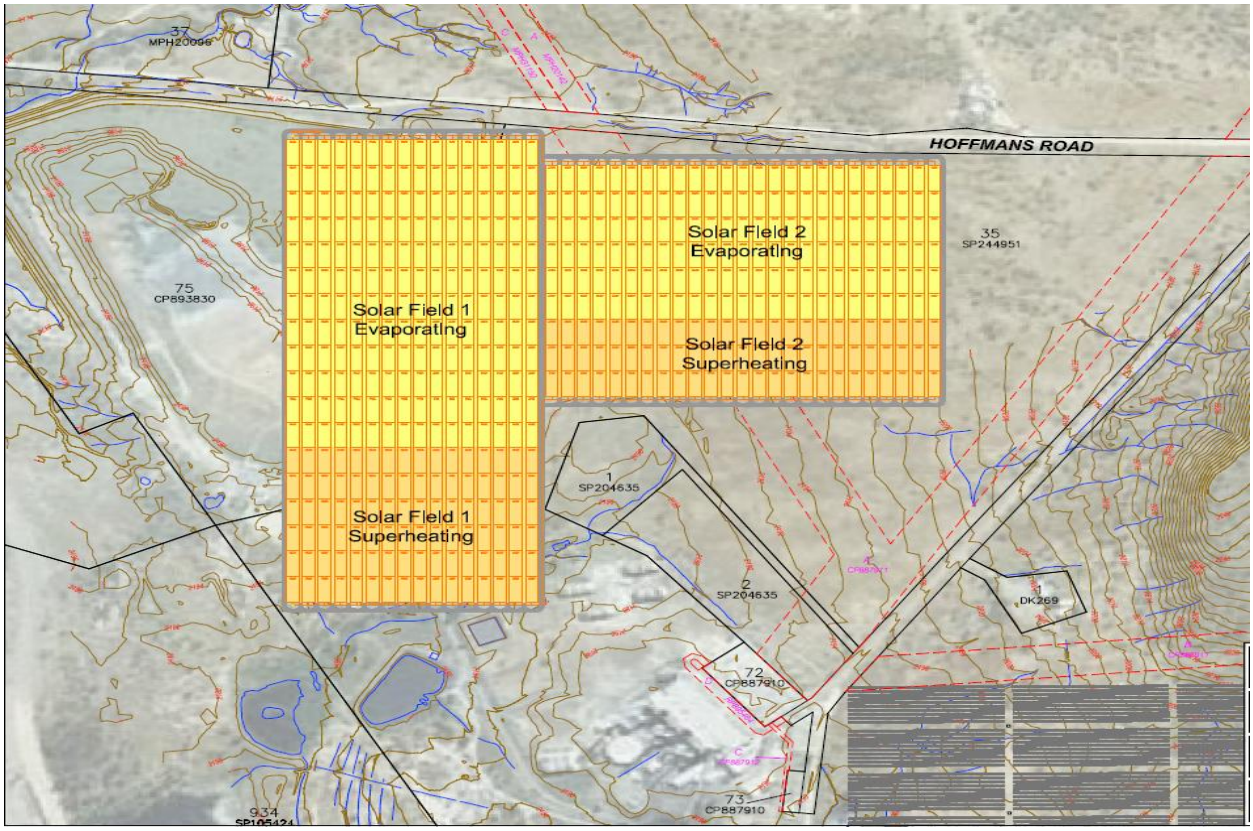

Figure 1: Solar Field Option 1

New equipment alternative (Solar Field Option 2)

A potential location of a green field option is shown in the layout Figure 2: Solar Field Option 2Figure 2below where the solar field lies in the area between the two transmission line routes and to the north of the existing power station. The power block would be immediately adjacent to the southern end of the solar field. The cooling tower and evaporation pond would be located in the same area surrounded by the existing transmission line routes and the solar field.

Some existing equipment for CPS would be retained such as the raw supply systems, liquid fuel storage, administration buildings and major maintenance workshops. Low cost small bore piping would connect the raw water and fuel systems to the new power block.

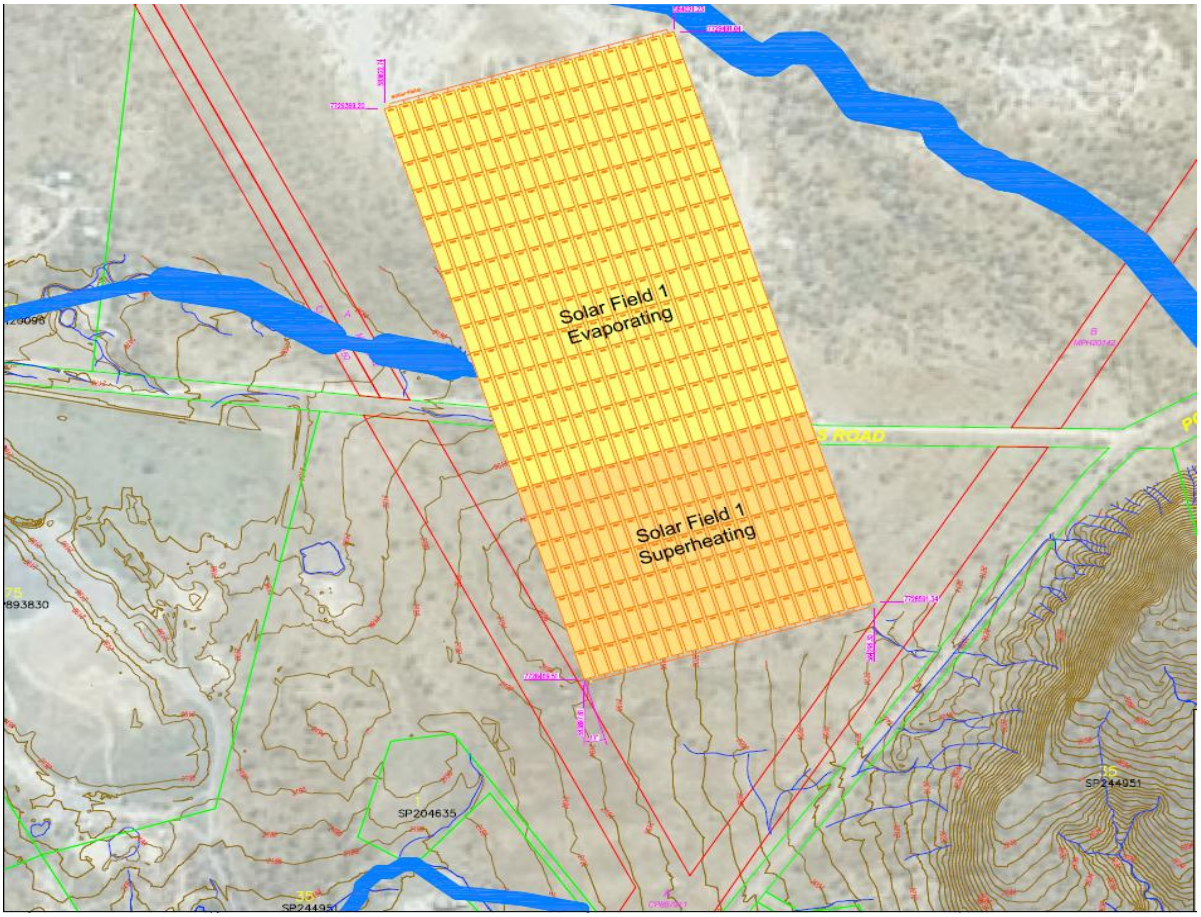

Figure 2: Solar Field Option 2

Gas Supply Concept Study:

RAC engaged with local gas suppliers to prepare a concept study, with the aim of identifying the processes involved and alternatives available to provide commercial quantities of gas to the Project. The concept study proposal is based on the installation of a pipeline to supply gas from nearby tenements to the Project.

The objective of the gas facility installation is to meet the Project's gas ramp profile while minimising the pre investment in capital, and in particular, the sunk capital.

An engineering study is required to confirm these findings. This will be completed in the next stage of the project developments.

Preliminary Environment Assessment Report

Overview

RAC engaged environmental advisors to undertake an Environmental Opportunities and Constraints Assessment, to determine the potential environmental constraints to the proposed development of the site.

The objective of the Environmental Opportunity and Constraints Assessment is to identify potential

environmental constraints and opportunities to the future development of the Project site for the purposes a solar thermal power generating facility, involving a material change of use application.

No major constraints or fatal flaws were identified in this review. Some minor constraints to be considered during the detailed design phase of the Project were identified, as outlined in the following section.

Scope of Work

A desktop review of relevant ecological databases, mapping overlays, legislation and associated plans and policies was undertaken to identify mapped ecosystems and significant species and communities, as well as other ecological features that may occur on or within the vicinity of the site.

Following the desktop review, a site investigation including an assessment of flora, fauna and general environmental values was undertaken by two ecologists on 24 and 25 of October 2012. The sites of the proposed solar fields (i.e. Lot 35 on SP244951 and Lot 75 on CP893830) were assessed in their entirety. However the site for the proposed transmission line re-alignment (i.e. Lot 77 on CP903944) is currently privately owned and could not be accessed during the survey period. Observations of this parcel of land were made from the boundary fence and adjoining Hoffmans Road. The area of the proposed alignment within this lot was clearly visible from this location and the observations made were considered adequate to complete the necessary preliminary assessment of the site.

Summary of Findings

Findings of this investigation are summarised in Table 2 below. For ease of reference, a 'traffic light' system was used to indicate the following:

- Green – Conditions are unlikely to constrain future development for the purposes of industrial / power generation within the Project area;
- Yellow – Conditions may present a minor constraint to future development for the purposes of industrial / power generation within the Project area; and
- Red – Conditions are likely to present a significant constraint to future development for the purposes of industrial / power generation within the Project area.

Issue	Result	Implications and recommendations
Regional Ecosystems, Regrowth Vegetation and Essential Habitat		The site assessment determined that the heterogeneous polygon in the south-eastern portion of Lot 35 on SP244951 containing an 'of concern' regional ecosystem (5%), and the heterogeneous polygon mapped over the majority of Lot on 77 CP903944 containing an 'endangered' regional ecosystem (10%) were incorrectly mapped. RAC is currently in the process of amending the vegetation mapping via the Property Map of Assessable Vegetation instrument to reflect its true status, 'not of concern'. If the remnant vegetation is assessed at its current status ('of concern' and 'endangered'), the clearing of any vegetation will require an offset in accordance with the Policy for Vegetation Management Offsets – Version 3 (DERM 2011); Even where the remnant vegetation is confirmed as 'not of

		concern' regional ecosystem, general vegetation management criteria apply for the assessment of the development. Policy and code requirements for maintaining minimum areas of vegetation are being incorporated into the development of layout designs for the project.
Significant Flora		No significant flora species are likely to occur within the Project area. As such significant flora species would not pose a constraint to the development of the site.
Threatened Ecological Communities		From this assessment it was considered unlikely (low chance) that any threatened ecological communities would be significantly impacted by the Project. Whilst lot 77 CP903944 could not be accessed during the recent site assessment and may contain areas of Brigalow, these areas occur outside the proposed impact areas.
Significant Weed Species		Two Class 2 weeds were recorded on the site - *Parthenium hysterophorus* and *Zizyphus mauritiana.* One Class 3 weed was also recorded – *Lantana camara;* Landowners must take reasonable steps to keep land free of Class 2 pests; and Landholders are not required to control Class 3 plants unless their land is adjacent to an environmentally significant area. Targeted weed eradication programs are being undertaken on site by the existing Collinsville Power Station operations team. Future weed control programs will be considered in the proposed environmental management plan for the solar thermal project.
Significant Fauna		From the assessment it is considered that one species listed within schedules of the NCWR and the EPBC Act has a moderate likelihood of occurrence at times within the Project area, six species have a low to moderate likelihood of occurrence, and eight species have a low likelihood of occurring within the Project area; Additionally, one species listed as migratory under the EPBC Act has a moderate likelihood of occurrence at times within the Project area, eight species have a low to moderate likelihood, while three species have a low likelihood of occurring at some time within the Project area; and The assessment concludes that development within the Project area is unlikely to result in a significant impact on any significant fauna species. As such a permit under the NCA is not likely to be required, nor is a referral under the EPBC Act in relation to listed fauna species.
Introduced Fauna		Evidence of the presence of European rabbits (i.e. scats) was

Species		observed at a number of locations within the Project site. A number of additional species are considered likely to occur: Pig (Sus *scrofa);* Red fox (Vulpes *vulpes);* Cane toad (Rhinella *marina);* and Cat (Felis *catus).* Control of all Class 2 Pests, with the exception of the Dingo (Canis *lupus dingo)* should be undertaken where effective control is feasible and effective. Control of feral cats should be a priority. Although Dingos are also classified as Class 2 Pest under the LPA, and as such all land owners are required to control them (due no doubt to their predation of stock), recent research suggests that the presence of dingos may actually have a beneficial effect on native mammal populations by excluding or reducing the populations of smaller feral Cats and Red foxes (Johnson & Van DerWal 2009). Future control programs of Class 2 Pests will be considered in the proposed environmental management plan for the solar thermal project.
Aquatic Ecosystems, Wetlands and Watercourses		The *Water Act 2000* (Water Act) regulates the destruction/disturbance of freshwater riverine vegetation in the bed and banks of DNRM watercourses. In accordance with the Water Act, watercourses are determined as watercourses by the DNRM through topographical mapping, aerial imagery and a possible onsite assessment. Liaison with DNRM is required to determine if the watercourses present on site are watercourses in accordance with the Water Act. Pre-lodgement meetings are currently being organised with the DEHP with regard to this aspect of the proposal.
Other Ecologically Significant Issues		In the context of the proposed development, the Queensland Biodiversity Offset Policy (QBOP) applies to the Sustainable Planning Act 2009 for activities under chapter 4 with an aggregate environmental score assessed under the Environmental Protection Act 1994. As the Project requires an ERA, liaison with DEHP is required to determine if the State Significant Biodiversity Value connectivity is present on site and the subsequent requirement of a biodiversity offset pursuant to the QBOP Pre-lodgement meetings are currently being organised with regard to this aspect of the proposal.
Good Quality Agricultural Land		As Land Suitability mapping classifies the site as 'non arable', which is suitable for grazing of native pastures and catchment protection due to the inherent soil types' unattractive agricultural properties, it is considered that the proposed development will not result in the loss of good quality agricultural land for cropping purposes.
Strategic Cropping Land		A review of the Strategic Cropping Land Trigger Map for the

		Coastal Queensland Zone and Western Cropping Zone determined that the proposed Project is not located within a Strategic Cropping Protection Area or a Strategic Cropping Management Area. As such, this draft SPP is not relevant to the Project.
Land Contamination		Lot 35 on SP244951 and Lot 75 on CP893830 have been included on the EMR. Amendments to the *Sustainable Planning Regulation 2009* which took effect on 15th March 2013 included changes to the assessment and referral triggers for contaminated land. Under these amendments the site is not a 'potentially affected premises', and thus referral for contaminated land matters is not required for this application.
Bushfire Hazard		As the Project area encompasses mapped medium bushfire hazard area, any future development of the Project area that requires a material change of use or reconfiguration of lot application will be assessed against the Bushfire Management Overlay Code. Liaison with Whitsunday Shire Council is required to confirm if the proposed development is required to be assess against the Bushfire Management Overlay Code; and If there is a requirement for the development to be assessed against the code, development design that considers the overlay code will be required. As such, it is recommended that following the finalisation of the development layout and the identification of the extent of vegetation to be removed, a detailed bushfire hazard assessment is undertaken to assess the bushfire hazard risk of the development and allow for adequate mitigation features.

Table 2: Summary of Findings