NSW Public Safety Network (PSN) Indoor Radio Services Design Specifications

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Revision record

Please note significant document changes with a version increment of 1.0. Minor administrative changes, where the meaning or intention of the document is not altered should increase by an increment of 0.1.

Version	Date	Author	Summary of changes
0.1	August 2013	RF Industries	Internal RFI review.
0.2	October 2013	RF Industries	Submitted for review.
0.3	November 2013	TA	Customer updates.
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0.4A	December 2013	RF Industries	Updates based on customer input.
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2.3	January 2015	Phillip King	Released to the TPRG for Comment
2.4	March 2015	Phillip King	Incorporated TPRG Feedback
3.0	June 2019	Chris Brooks	Updated to align with refreshed IBC Strategy Renamed to "Specification"

Version	Date	Author	Summary of changes
3.3	July 2020	Sangeetha Satchithanantham	Reviewed with few modifications.
3.4	September 2020	Minoru Hirai	Peer reviewed for release.
3.5	August 2020	Minoru Hirai	Added 4.3/10 DIN option for connectors

Related Policies and Documents

Report Reference Number	Issuer	Reference	Document Name
[1]	NSW Telco Authority	TA-SPEC-001 CAD Specification Issue 005	Radio Communications - CAD Specification
[2]	NSW Telco Authority	TA -TBD	Radio Communications Safety Guideline 2A – RF_EME Compliance OF Radio Site
[3]	MCF	DAS Design Specification	DAS Design Specification
[4]	NPSC	Best Practices for In-Building Communications	Best Practices for In-Building Communications
[5]	NSW Telco Authority	DOC20/419518	IBC Verification Specification
[6]	NSW Telco Authority	DOC20/419515	IBC Prediction Specification

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1 Introduction

The NSW Telco Authority (the NSWTA) are responsible for the strategic direction of wireless operational voice and data telecommunications in NSW. This includes determining a whole-of-Government telecommunications strategy, prioritising investment decisions, and developing and implementing state-wide policy affecting planning development, operations and maintenance.

This document focuses on areas broadly classified as indoor or in-building. These are usually public spaces whereby;

- existing Government networks provide limited service
- future coverage will be poor based on construction of new infrastructure (such as a tunnel or building).

The driver for such coverage is a need for emergency service organisations (the Police, Fire, SES and Ambulance) to attend these spaces in order to deal with incidents. When attending, public safety officers must be able to use their radios on site for their own safety as well as for the safety of members of the public.

This specification has been established to encourage repeatable, upgradeable and quality deployments of in-building coverage for operational telecommunications networks.

2 Objective

The purpose of this document is to provide an Indoor Radio Service Design Specification for the NSWTA, NSWTA Agencies, building developers, system design service providers and equipment suppliers.

Indoor radio service areas include shopping centres, health and education campuses, pedestrian/road/rail tunnels, airport terminals, multi-storey buildings and Agency buildings. Coverage and capacity requirements associated with special events are not included in this specification.

The specification will achieve indoor radio service designs which are engineered to meet NSW Telco Authority requirements for:

- Site specific coverage and capacity objectives,
- Radio network performance,
- Design documentation,
- Future requirements,
- Integration to the greater whole of government shared networks such as the PSN,
- Design safety,
- Operational resiliency,
- User experience,
- EME compliance,
- EMC compliance*,
- ACMA licence condition compliance, and
- Cost effective all-of-government radio solutions.

* EMC compliance will be specified on a site-by-site basis.

3 Responsibilities

3.1 NSW Telco Authority

In addition to the specification set out in this document the NSW Telco Authority shall provide a project statement of work which will include a site specific Engineering Brief (see appendix A) which will be dependent on the information provided by the Supplier

3.2 Supplier

It is the responsibility of the Supplier to follow the process and provide the deliverables as defined in this document. Deviation from this will lead to potential delays from incorrect data.

Based on this specification and the Engineering Brief, the supplier shall provide to the NSW Telco Authority a detailed site-specific design (see Section 5 Deliverables) along with those deliverables as highlighted in appendix B.

4 Design Requirements

Prior to accepting a request for In-building Coverage (IBC), the NSW Telco Authority will have considered other possibilities to provide in-building coverage without the need for a dedicated IBC solution. This decision will be dependent on the accuracy of information provided by the Supplier.

The NSW Telco Authority will review the existing macro network coverage in and around the target IBC requirement to determine:

- What level of macro site coverage exists in the area,
- Whether a solution can be found using the existing macro network without the provision of a Distributed Antenna System (DAS), and
- Whether a new macro site is warranted to solve both the IBC deficiencies and wider area coverage deficiencies.

The NSW Telco Authority will make an assessment based on coverage prediction modelling, data gathered through the In-Building Coverage Verification Specification (provided by the Supplier where applicable) and where necessary field measurements. Once the IBC requirement has been established the NSW Telco Authority will create an Engineering Brief which will capture the high-level requirements for the IBC design.

The supplier's team preparing the design must consist of personnel suitability skilled in the relevant areas of engineering, deployment and project management.

4.1 Design Principles

The design will achieve the following based on the supplier's own expertise, this specification and information provided by the NSW Telco Authority:

- A cost-effective design,
- A design that satisfies all aspects of the Engineering Brief and this specification including coverage and performance requirements,
- A design that complies with ACMA, EME, and WHS regulatory requirements, and

- A design that meets NSW Telco Authority and industry standards in relation to component, build and performance standards.
- A solution that offers good access to the base station / repeater and battery equipment for maintenance and repair without requiring road/rail closures or other restricted access wherever possible
- A solution that offers a means to access the whole DAS for maintenance and repair, noting in some situations restricted/special access will be required.

4.2 Design Options

The supplier will be briefed (Engineering Brief – appendix A) as to whether the DAS will be fed with:

- a new base station (i.e. new network capacity); or
- a repeater (i.e. shared network capacity)

Where capacity is to be shared the donor site, method of sharing (translating repeater, non-translating repeater, fibre system etc.) will be specified in the Engineering Brief.

In general the NSW Telco Authority prefers passive DAS infrastructure. This is because:

- Passive systems tend to be easier to upgrade should new requirements emerge in the future,
- Passive systems do not require the provision of power supplies throughout the DAS infrastructure,
- Passive systems tend to be more reliable and require less maintenance and reduced spares holdings over active systems, and
- Passive systems are generally easier to design and have fewer constraints with respect to uplink path loss, intermodulation and noise.

The NSW Telco Authority recognises that passive DAS infrastructure is not appropriate in all situations. The supplier will make a decision on what form the final DAS solution will take.

The supplier will clearly articulate why a particular solution has been selected and will address:

- Cost,
- Feasibility,
- Future expansion,
- Product support and lifecycle considerations,
- Maintenance,
- Site specific constraints, and
- RF performance.

The proposed design may include, but is not limited to the following:

a) Passive DAS,

This would contain coaxial cable plus antennas and may also include the use of radiating cable. Typical applications include situations where losses due to cable runs result in acceptable system performance.

b) Passive + Active DAS,

This would contain a passive DAS with active components including bi-directional amplifiers, fibre fed RF units, category 6 data cabling based systems and in-line or broadband amplifiers. Typical applications include situations where system gain is required for the passive DAS to meet coverage requirements, or whether installation constraints limit the use of large diameter coaxial cable.

c) Existing DAS.

Consideration should be given to the integration, expansion and/or upgrading of existing third party networks (for example Telecommunication Carriers) to provide a cost effective means of providing the required coverage provided availability requirements can be met. Later sections of this document provide more information on the criteria that must be met when proposing to use an existing DAS.

4.3 Hardware

The supplier shall deploy components that are compatible with the UHF bands being used to deliver in-building coverage and Its preferred DAS to be compatible with up to 900MHz to support the future PSMB capabilities (defined in Engineering Brief - appendix A) There

is no requirement for the DAS components to be compatible with any other bands and these should not be catered for unless explicitly called for in the Engineering Brief.

The design will consider future expansion (coverage and capacity) and provide a description explaining how this will be realised.

The design will use only components that meet or exceed the standards specified in this specification. Overarching requirements for hardware specified in IBC designs are listed below:

- Downlink Passive Intermodulation (PIM) at RF combiner and antennas. Typically -150dBC at the combiner input, and - 130dBc at antennas (where typical downlink power does not exceed +20dBm/RF carrier),
- Return loss at the RF TX and RX input ports to the DAS combiner must not be worse than 15dB. The return loss in all other parts of the DAS including at couplers, antennas and active devices must also not be worse than 15dB,
- RF connector types. The supplier must specify 7/16th DIN or 4.3/10 DIN in RF backbone parts of the DAS. Type-N connectors are permissible for the final connection to antennas. Type N connectors are permissible in RF combining equipment, however the final duplexed connection to the DAS shall use 7/16th or 4.3/10 DIN connectors,
- All unused ports, both inputs and outputs, are to be terminated with suitable dummy loads, using values specified in the manufacturer's recommendation (usually 50 ohms).
- Optical connectors used for RF over OF systems should be appropriate for the high linearity requirement of analogue systems. Typically APC style connectors will be used in this application.

The design will meet the above standards in relation to intermodulation specifications for both active and passive components including amplifiers, antennas, filters, connectors, masts and clamps by ensuring the use of use of high quality components rated appropriately for the application. RF connectors will use gold, silver or ternary alloy plating. RF connectors containing steel, nickel, aluminium, or any plating using these metals, will not be used as these are potential intermodulation sources. [5]

Cables will meet the requirements of relevant building codes, fire authorities and building owners/ managers in respect of fire retardant and smoke emission properties. Some

buildings or locations may require particular cable specifications. The supplier will determine this by consultation with facility owner or manager.

If an existing DAS installation contains cabling without appropriate fire retardant and low smoke emission ratings, identification of these should be made and the cost of upgrading included in the proposal as an option.

With the exception of radiating cable, cables will have solid outer conductor as a minimum requirement when used between individual feeder cables, radio equipment, combiners, cross band couplers, antennas and all other network components. With the possible exception of interconnecting cables used in RF multi-coupling, no braided cable is to be used in the DAS design.

All DAS components proposed as part of a solution should be from the approved equipment list which will be provided by NSWTA upon request. The DAS designer must verify the suitability of all materials and equipment proposed to be used on the DAS with NSW Telco Authority prior to incorporation in the DAS design.

The approved equipment list will be used to ensure:

- Quality. Parts on the list meet various NSW Telco Authority requirements and have been tested accordingly with NSW Telco Authority
- Consistency. Designs will largely use the same parts which assists in maintenance and support; and
- Ease of Build. Designs using standard components are easier to build because part sourcing and procurement difficulties have been considered and largely eliminated.

The NSW Telco Authority accepts that there will be occasions where design solutions require parts not on the approved equipment list. When this occurs, the supplier is to note the design's departure from standard parts and justify the proposal.

4.4 Existing Systems

Where an existing DAS is present, a plug-in solution should be the first option considered to avoid duplicating DAS infrastructure. The supplier shall undertake a technical assessment of the suitability of the DAS and will address:

- Current coverage achieved by the DAS,
- Current DAS design provision for UHF services and frequency bands,

- EME constraints now and in the future, and
- Whether swap out of a number of components (eg to support a wider band) would make the DAS suitable and if the level of changes needed is practical and cost-effective,
- Whether the existing DAS could also be extended to cover areas important to emergency services organizations, and whether this work would be practical and cost-effective,

The likelihood that owner of the DAS will allow co-location and minor changes (if required).

Where there is an existing radio communications network, the supplier must not materially degrade the performance of the existing networks. The supplier shall pay attention to degradation in the following areas:

- Intermodulation,
- System losses impacting downlink and uplink path loss and hence achieved coverage,
- Physical placement of equipment impacting access and serviceability of pre-existing installations,
- Receiver desensitization,
- Noise floor degradation,
- Changes in system configuration that may impact exiting users, and
- Changes in downlink radiated power that may compromise pre-existing EME and/or EMC constraints.

The supplier must understand the limitations of the existing system and ensure associated risk is communicated to the NSW Telco Authority in the design proposal. The owner of the existing system must be consulted by the supplier in order to ensure that any risks associated with co-location are understood.

It is prudent to conduct a PIM test of the existing DAS prior to making any changes or plugging in of a new system so that any existing issues can be brought to the attention of the DAS owner for their rectification.

4.5 Coverage and Capacity

The supplier shall design the indoor coverage network to ensure that 95% of locations within the defined coverage area will be at a minimum of -90dBm signal level based on the wearing of a portable radio at waist height i.e. one (1) meter from the surface being walked. Considerations must be made to specific key locations as defined below (4.5.1 Target Coverage Areas) which would be of importance to specific agency coverage requirements. -90dBm is the worst-case received power level allowed in either the up or downlink. In the case of systems that add significant uplink noise, the C/ N must not be worse than 25dB at -90dBm. The supplier must demonstrate these criteria are met through predicted levels (generally by calculation) and link budget calculations.

Where the -90dBm/ 95% location criteria are not achievable, the supplier must explicitly indicate on a floor plan or map exclusion areas. The supplier must give reasons why an exclusion is sought. NSW Telco Authority also expects the supplier to report as exclusions areas of a system which will be cost prohibitive to achieve the -90dBm/ 95% location criteria.

The supplier will advise NSW Telco Authority of options to sectorise the system. The supplier will also advise NSW Telco Authority where additional capacity due to high traffic areas might be required.

4.5.1 Target Coverage Areas

Key Locations for coverage may include but not limited to;

- Buildings
    - Building Core
    - Common accessible areas
    - Back of house areas (staff and authorized access areas)
    - Inside lift cars*
    - Plant rooms
    - Fire stairs*
    - Basement car parks
- Tunnels
    - Contiguous coverage throughout tunnel
    - Underground stations and platforms

- Inside lift cars*
- Common accessible areas
- Fire stairs*
- Back of house areas
- Basement carparks
- Plant and equipment rooms

* It may not be permissible to mount infrastructure in the fire stairwells due to fire-prevention regulations. In this case, a DAS antenna should be positioned near the doors leading to the fire stairs so that coverage can penetrate. A similar approach should be taken for lift coverage.

4.6 Design Constraints

In addition to the constraints for minimum coverage described above, the IBC system design must comply with a number of constraints to ensure an acceptable quality of the delivered service. These include:

- The maximum downlink received RF power at a portable or mobile radio at the closest approach point to any RF radiating element cannot exceed -10dBm,
- The maximum allowed uplink received RF power at the BTS receivers (or at the RX multi-coupler if present) at the closest approach point to any RF radiating element cannot exceed -10dBm,
- The maximum uplink RF power present at the input to any RF to optical conversion module must be at least 10dB below its maximum rated input power when,
  - In the downlink all carriers are active,
  - In the uplink a single portable unit is at the closest approach point to a radiating element,
- Maximum permissible thermal noise floor degradation due to in-band noise contributions from active components cannot exceed 6dB when measured at the receiver input;
- DC Power requirements for standalone system autonomy is a minimum of 10 hours reserve for BTS and all active elements of the system for the life of the installed system; and

- Where radiating cable is used in high speed applications, length should be limited to 150m per segment for good performance.

Deviation from any of the above must justified and agreed by the NSWTA.

4.7 System Performance

The IBC system must not be designed in isolation of the surrounding macro network. The supplier must ensure that:

- The air interface RF link must not be downlink limited. Ideally the link will be balanced for portable terminals, subject to other RF design constraints in this specification,
- The design must ensure there is sufficient coverage overlap for effective and reliable cell re-selection at the interface between the new IBC system and the surrounding macro network, and that desirable serving patterns are achieved. Careful antenna placement, antenna selection and setting of downlink RF power levels will assist in minimising overshoot and interference,
- The design must ensure that it is appropriate for the anticipated speed of terminals. Fast moving terminals must have sufficient time when entering and exiting the new IBC coverage to facilitate cell re-selection. Conversely, slow moving terminals must not be served by new IBC coverage outside of the intended coverage footprint,
- Ensure co-channel interference is considered and does not occur,
- The design must consider existing co-sited RF systems that may through noise, fundamental overload, spurious signals or providing a mixing site for IMD products degrade the performance of the proposed system,
- Ensure antennas are not located close to known or suspected sources of RF noise, spurious signals or potential RF mixing sites. Some commercial building illuminated signage (for example exit signage) is known to generate wideband RF noise, and can impact the accuracy of PIM measurements, and

Where RF links to donor sites are used, the performance of RF links must be quantified. Link paths must be modelled, and an expected availability derived. The annual worst case availability of RF links shall exceed 99.99%. Exemption can be sought from NSWTA for occurrences where this cannot be achieved.

The supplier will provide an RF link path profile using terrain resolution of 3 arc seconds or better. The supplier will verify the link path visually if possible, and will present images showing the view towards the proposed donor site at the proposed antenna location.

4.8 EME Requirements

The supplier shall ensure that the design complies with all relevant Australian regulations for construction and cabling requirements including occupational and non-occupational safety limits in terms of RF exposure.

The supplier must be familiar with Radiation Protection Standard for Maximum Exposure Levels to Radio Frequency Fields -3 kHz to 300 GHz (2002) as issued by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

The cumulative radiated power from any individual antenna must be designed to not exceed +30dBm EiRP. This limit applies to PSN only systems. Shared IBC systems will have pre-existing EME limitations that the supplier must not exceed.

If the supplier proposes that the EiRP limit stated here will be exceeded the supplier must justify this approach and include:

- The downlink RF power proposed,
- The reasons for the higher power requirement,
- The suppliers strategy to mitigate EME exposure risk, and
- What other alternatives exist and why they cannot be implemented.

For all antennas in a system design, the supplier must state how each is compliant with EME regulations. Where the antennas are within normal design limits, this can be satisfied by supplying a table of output power calculations per antenna. In general, where there is a non-occupational exclusion zone around a radiating point, the design must demonstrate how access to the exclusion zone will be managed to achieve compliance.

4.8.1 RFNSA

EME compliance also requires the site data to be entered into the RFNSA. It is the responsibility of the contractor/supplier to enter valid data into the RFNSA representing the site configuration.

4.9 Electromagnetic Compatibility (EMC)

Depending on the environment within which the system will be installed, consideration may need to be made that ensure EMC levels are within those which would ensure no issues are created.

4.10 RF Multi-Coupling and Combining

The supplier is responsible for providing a design for RF multi-coupling and combining for both BTS and repeater solutions.

In general a standard multi-coupling design will be used which will consist of a cascade coaxial cavity style TX combiner and RX pre-select filter and distribution amplifier. Hybrid combiners shall also be considered in the design for future flexibility. The final duplexed RF connection to the DAS will be with a 7/16th or 4.3/10 DIN connector.

Where a repeater solution is deployed the supplier will provide the multi-coupler design. The final duplexed RF connection to the DAS will be with a 7/16th DIN or 4.3/10 DIN connector.

5 Deliverables

The design shall be delivered in the form of reports, assessments, drawings and certificates provided in formats to suit the project requirements including stakeholder needs.

5.1 Design Report

The design report shall be a single document encapsulating all elements of the design requirements as specified in the project statement of work or with reference to other information supplied by the NSW Telco Authority.

The design report shall refer to all supporting documentation, which will include drawings, standards, specifications, certifications and supplementary reports. As a minimum, the design report shall include sections as outlined below and further described in this section.

5.1.1 Introduction

The introduction will contain a description of the project, nature of the report and the customer.

5.1.2 Overview

The overview will contain a description of the coverage site, a brief discussion addressing the existing macro network coverage establishing the need for the new IBC system and a high level description of the proposed solution.

5.1.3 Assumptions and Limitations

All assumptions made in preparation of the report including any limitations will be clearly stated.

5.1.4 System Design

a) Design Proposal

Describe the proposed design, including the technology, equipment type and the configuration including antennas and donor site information (if a repeater is proposed).

The proposal should include reference to the following:

- Location and layout of existing and proposed equipment, including radio and power systems, feeder cabling (including length) and antennas,

- Elements which may have restricted access
- Transmission equipment including repeaters where capacity is shared or dedicated optical or radio equipment where new capacity (i.e. dedicated BTS) is being provisioned,
- Power system. This will define all aspects of the power system including AC mains dimensioning, rectifier dimensioning and redundancy, battery dimensioning and autonomy, alarms and standard equipment types, and
- Existing and planned cooling / ventilation, fire detection / suppression, door alarms and temperature monitoring for the room where equipment is to be located, and detail any changes required for the proposed design.

b) **Design Options**

The report will provide a description of options considered in preparation of the proposed design. Where coverage exclusions are proposed, the supplier will provide an explanation of why the exclusions are necessary.

c) **Design Rationale and Methodology**

The report will detail the high-level process followed in producing the design. This may include:

- Issues and updates to the Engineering Brief,
- Information gathering via the NSW Telco Authority including briefings,
- Information gathering via external parties, including site visits and surveys,
- Consultation regarding requirements,
- Risk reviews and minimisation,
- Design decisions driven by non-technical criteria, for example user requirements and WHS considerations,
- Design decisions driven by technical criteria, for example minimising RF overshoot, and
- Stages of the design process and decision points.

5.2 Bill of Materials

A detailed bill of materials (BOM) including part numbers, descriptions, quantities and vendors will be provided by NSW Telco Authority. For any parts that are not on NSW Telco Authority's standard parts list, the supplier will provide a copy of the manufacturer's specification sheets. The parts in the BOM will be referenced to the drawing packages as specified in section 5.5.3 (a). This will allow NSW Telco Authority to keep an accurate record of equipment in the network.

5.3 Construction, Operation and WHS

5.3.1 Construction Risk

The supplier will provide a description of the steps that will be taken to identify and minimise risk during construction of the proposed design.

Where feasible the design should minimise construction risk through:

- Having a clear understanding of all system requirements including coverage, performance and operations,
- Having a clear understanding of site specific constraints that may limit or preclude particular construction approaches. This would include drilling holes in walls and penetrating floors for cable installation, fire prevention requirements, installing cable in conduit, and installation of external cabling etc., and
- Understanding operational constraints that may be faced when construction activities are occurring on site. These may include hours/days on week when construction access is permitted, security limitations in accessing parts of buildings and the requirement not to impeded existing communications systems in the facility.

Where the supplier has been unable to find key information relating to construction risk, the uncertainty will be identified in the report.

5.3.2 Design Safety Report

The supplier will provide a high level safety report which addresses all aspects of the design. It will include but not be limited to:

- Operation, storage and handling of potentially hazardous materials which includes batteries, chemicals, flammable material, gases etc. that will be used in the system installation and operation,
- Access to antennas requiring involving work-at-height using a ladder, EWP or other methods,
- EME. Signage and access protocols need to be documented. If isolation switches or other mitigation techniques are proposed fitted, the correct operation of these is to be explained,
- Manual handling issues associated with large components,
- Low clearance areas under antennas and near cables,
- Narrow isle and limited clearance around equipment racks, and
- Activities or locations where PPE is a required.

Where possible the designer should consider WHS at the time of installation and for people maintaining the system after commissioning and handover. The design shall ensure WHS risk to all parties is minimised or where feasible eliminated.

5.3.3 Operational Risk Assessment

The supplier will consider the operational risk associated with the introduction of an IBC system. As a guide, the supplier should consider the following areas in this assessment:

- Correct use of the system by staff. This includes normal use, use in site trunking mode (where relevant), and use when neighbouring sites fail. Channel/vote group selection for various user groups will be addresses. Enhancing the user experience through an understanding the radio environment and the coverage design should be a goal,
- The possibility of system congestion at peak use times,
- EME considerations including approach distances to radiating elements (antennas and radiating cable),
- Consequences of loss of transmission link to site,
- Consequences of loss of power to base station and transmission equipment. Restoration time, alarms, site trunking (where relevant),

- Consequences of loss of power to active components in the DAS, and
- Care that needs to be taken with respect to equipment including cabling that has been installed as part of the system. For example avoid moving or damaging cat 5 cables, RF cables and antennas.

The supplier will also reference equipment serviceability, technology life-cycle and any other support elements that the supplier considers relevant.

5.4 Engineering Brief

The Engineering Brief will be provided by the NSW Telco Authority to the supplier. It is a requirement that the Engineering Brief is included in the design deliverables package for reference. The supplier will include the most recently issued revision of Engineering Brief. Appendix A details the content of the Engineering Brief.

5.5 Drawing Package

The drawing package will be supplied in AutoCAD 2012 format providing a schedule of all drawings included in the design package. A copy is also to be supplied in pdf format. See appendix D for an example of a drawing package.

The drawings schedule shall include the following details:

- Drawing reference or number,
- Drawing title,
- Drawing revision,
- Drawing issue date,
- Drawing issue status (preliminary, concept design, detailed design, for construction, as-built),
- Drawing legend defining all symbology used in the drawing sets, and
- Notes where applicable detailing construction requirements, materials standards and workmanship.

Drawing format and naming must adhere to NSW Telco Authority's CAD specification.

5.5.1 Site Access and Locality

Both drawings and notes will be included to provide the following information. Refer to examples in Appendix D.

a) **Location Map**

Maps of the site showing the location and a high-level view in Google format or similar shall be included.

b) **Site Specific Notes**

Details shall include but not limited to the following:

- Building name,
- Site address,
- Location of the base station including floor number where relevant
- Site contact Names,
- Site contact phone numbers, plus one general phone number for that team/facility that is not tied to an individual
- Site contact email addresses, plus one group mailbox for that team/facility that is not tied to an individual
- Site induction details and WHS requirements, if pertaining to a construction site.
- Special conditions,
- Security arrangements and contact details, and
- Parking.

5.5.2 System Diagrams

Single line drawings detailing the following components of the proposed design shall be included. Refer to examples in Appendix D.

a) **Distributed Antenna System (DAS)**

Details of the antenna system, including all active and passive components with reference to their physical location within the designated building shall be documented.

Note: Dependant on the size of the DAS, this information may appear on a number of drawings.

b) **Macro network BTS and Rebroadcast Equipment**

For all components of the BTS/rebroadcast system, drawings will be provided to detail the configuration.

While these components may be referenced in the DAS diagrams, these drawing(s) will show further detail of the components and their connections and include radio, power supply, alarm monitoring, cabinets and antenna(s).

This diagram will be used to determine operate and maintain delineation.

c) **RF Multi-Coupling Equipment**

Detailed drawings associated with RF multi-coupling for both BTS and repeater solutions will be provided. This drawing will identify all parts used in the RF combining arrangement and will show the configuration including connections between components, losses and gains, typical levels and provision for expansion (if relevant).

5.5.3 System Layouts

For each building floor, road tunnel etc. the supplier will provide CAD floor plans, facility plans and/or maps showing the location of DAS equipment components. The supplier will use additional commentary where information is not clearly discernible from the layouts. Refer to examples in Appendix D.

a) **Distributed Antenna Locations**

A drawing showing the locations of all cabling, couplers and antenna components of the DAS shall be included in the system layouts. Individual components will be uniquely identified in the drawing. The identifiers will be referenced in the BOM – see section 5.2.

b) **BTS/Rebroadcast Equipment**

A drawing showing the layout of areas where BTS/rebroadcast components are to be located shall be included. The layout shall be to scale, and shall indicate:

- Rack arrangements for main equipment area(s) and for equipment remotely located in the DAS,
- Transmission and ancillary equipment location,
- RF multi-coupling equipment location, and

5.5.4 Power Systems

A single line drawing of the proposed power system will be provided by the supplier. The drawing will include all aspects of the AC and DC power systems related to the DAS including:

- Battery – indicate capacity and operating, and monitoring,

- Rectifiers – indicate number, monitoring, redundancy and capacity,
- DC power distribution indicating circuit breaker quantity, ratings and allocations,
- Indicate connection to AC supply including circuit breaker quantities, ratings and allocations

Where active devices are located in the DAS, single line drawings for power systems will be included for these locations. All active devices in the DAS must have battery back-up which results in a battery autonomy not less than the BTS or repeater battery autonomy.

Power system details shall include a table indicating DAS component power consumption, rectifier ratings and battery autonomy for the system configuration (for all locations).

5.5.5 RF Coverage

The following calculations should be based on the proposed design and will be used as part of system acceptance on completion of the radio site build.

For further detail on coverage prediction, refer to examples in Appendix C.

a) Distributed Antenna System RF Calculations

A comprehensive table detailing downlink path loss calculations for each antenna based on cable lengths, cable / connector losses and coupler losses. The table should also include gain from any active devices based on the expected levels from network donors including antenna system gains and losses, cables and connectors.

The table should include:

- Downlink path loss and expected received RF power level (at terminal) given a nominal distance from the antenna, including expected clutter losses and all other downlink path losses/gains. A maximum downlink level will be calculated given the minimum approach distance for each antenna. The design must satisfy the maximum and minimum received level requirements (see section 4.4 and section 4.5),
- Uplink pathloss and expected received RF power level (at BTS or repeater) given a nominal terminal (portable and/or mobile) distance from the antenna, including expected clutter loss and all other uplink path losses/gains. A maximum uplink level will be calculated given the minimum approach distance for each antenna. The design must satisfy the maximum and minimum received level requirements (see section 4.4 and section 4.5), and

- Cumulative maximum downlink radiated power from each antenna is to be stated explicitly and compared to the maximum allowable EME radiated power (see section – 4.7). Levels will be flagged in or out of specification. The supplier will address the EME compliance of each antenna individually – see section 4.7.

The data in this section will be presented in an Excel spreadsheet. The spreadsheet will have no restrictions applied to it and all calculations will be accessible.

b) Rebroadcast Link

Where an RF link is required, the supplier shall provide a link path profile showing the geographical terrain, system gains and losses. A detailed link analysis will be included with the profile, and the final link availability will be stated.

c) Coverage Area

The supplier shall provide commentary of the coverage solution offered including:

- Original coverage objectives,
- Subsequent discussions and agreements made with the NSW Telco Authority and/or DAS owner regarding coverage extensions or reductions,
- Any assumptions used to arrive at the final coverage design – for example additional outside coverage required to facilitate effective cell reselection for fast moving terminals in a tunnel, and
- A summary of the coverage achieved, highlighted deficiencies and enhancements with respect to the original coverage objectives.

The supplier shall show the proposed area of coverage on maps or plans of the coverage location. The intended coverage area shall include areas inside the building or tunnel but shall also show the intended coverage at the interface to the macro network, for example at building entry points and tunnel portals. At these locations, the serving pattern of the macro network should also be indicated through identification of the top 3 serving cells and their downlink RF levels referenced to the same antenna as was used for the DAS downlink levels (typically unity gain omni-direction antenna).

The coverage area will be clearly shown by shading an area around each antenna. If possible the supplier should show modelled coverage, however if this is not practical it is acceptable to indicate coverage using nominal cells based on antenna pattern and the building clutter.

Adjacent antennas should use different colours so the intended antenna serving pattern can be seen. The coloured coverage area should be compared to the coverage area originally requested in the brief from the Government.

Coverage deficiencies in achieved coverage (in comparison to that originally specified) should be highlight and an explanation given. A coverage deficiency is a deviation from the coverage criteria defined in section 4 within the defined coverage footprint (as defined in the Engineering Brief).

6 Definitions

Term	Definition
ACMA	The Australian Communications and Media Authority (ACMA) in the context of RF system design is the spectrum regulator. Note that the NSW Telco Authority Spectrum Management Office is responsible for management of the harmonised Government spectrum in the UHF band in NSW
APC	Angled Physical Contact connector used for optical fibre
BER	The Bit Error Rate (BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. BER is often expressed as a percentage.
BTS	Base Transceiver Station. This is a macro network base station, sometimes also called a repeater.
Carrier	A Carrier is define in this document as a Telecommunications Company providing a wireless service
Customer	Party who has requested radio advice via the Master Supply Agreement for ITS 2573, who unless stated otherwise can be considered to be the NSW Telco Authority.
C/N	Carrier to Noise Ratio. This is a reference to the quality of the signal.
DAS	A Distributed Antenna System (DAS) is a network of antenna nodes, connected to a common source that provides radio communications within a geographic area or structure.

Term	Definition
DIN	Deutsches Institut für Normung, or German Institute for Standardization, which is a German manufacturing industry standards group.
DL	Downlink. The RF downlink is the radio link from the BTS to the terminal equipment.
Donor Site	A remote site that is used to rebroadcast channels indoors.
EiRP	Effective radiated power with respect to an isotropic radiator (dBm)
EMC	Electromagnetic Compatibility. This term relates to whether RF fields are likely to compromise the functionality of potentially susceptible equipment
EME	Electromagnetic Energy
IBC	In-Building Coverage. This is a generic term which refers to specialised coverage for buildings, tunnels, campuses etc.
IMD	Intermodulation Distortion. This is a form of spurious interferer generated when two or more RF signals mix to produce an unwanted product
Indoor Coverage Verification	Document provided by the TA that defines a methodology for determining current coverage within the target building, tunnel campus etc.

Term	Definition
Indoor Coverage Report	Document provided by the TA that contains outcomes from coverage testing as defined by the 'Indoor Coverage Verification' document.
NSW Telco Authority	The NSW Telco Authority (TA) is responsible for the strategic direction of wireless operational voice and data telecommunications in NSW.
OF	Optical Fibre
PIM	Passive Intermodulation. A source of interference caused by the combining of signals in a system. Sources may include antennas, cables, and dirty or loose connectors, damaged RF equipment
PSMB	Public Safety Mobile Broadband. It's a future capability intended to deliver high speed data network for public safety agencies.
RF	A Radio Frequency (RF) field is an electromagnetic field used to transmit voice or data wirelessly.
RFNSA	Radio Frequency National Site Archive. A database referencing Australian Mobile Network base stations, and including information such as Electromagnetic Energy (EME) Reports, site locations, carrier contact details for existing sites and community consultation information for new sites.
Supplier	Party contracted by the NSW Telco Authority to perform indoor radio services design works on their behalf.
UL	Uplink. The RF uplink is the link from the terminal equipment to the BTS.

7 Appendix A – Engineering Brief (definition)

The Engineering Brief will be provided by NSW Telco Authority and is specific to each indoor Radio Services Design Proposal. The Engineering Brief should contain the following:

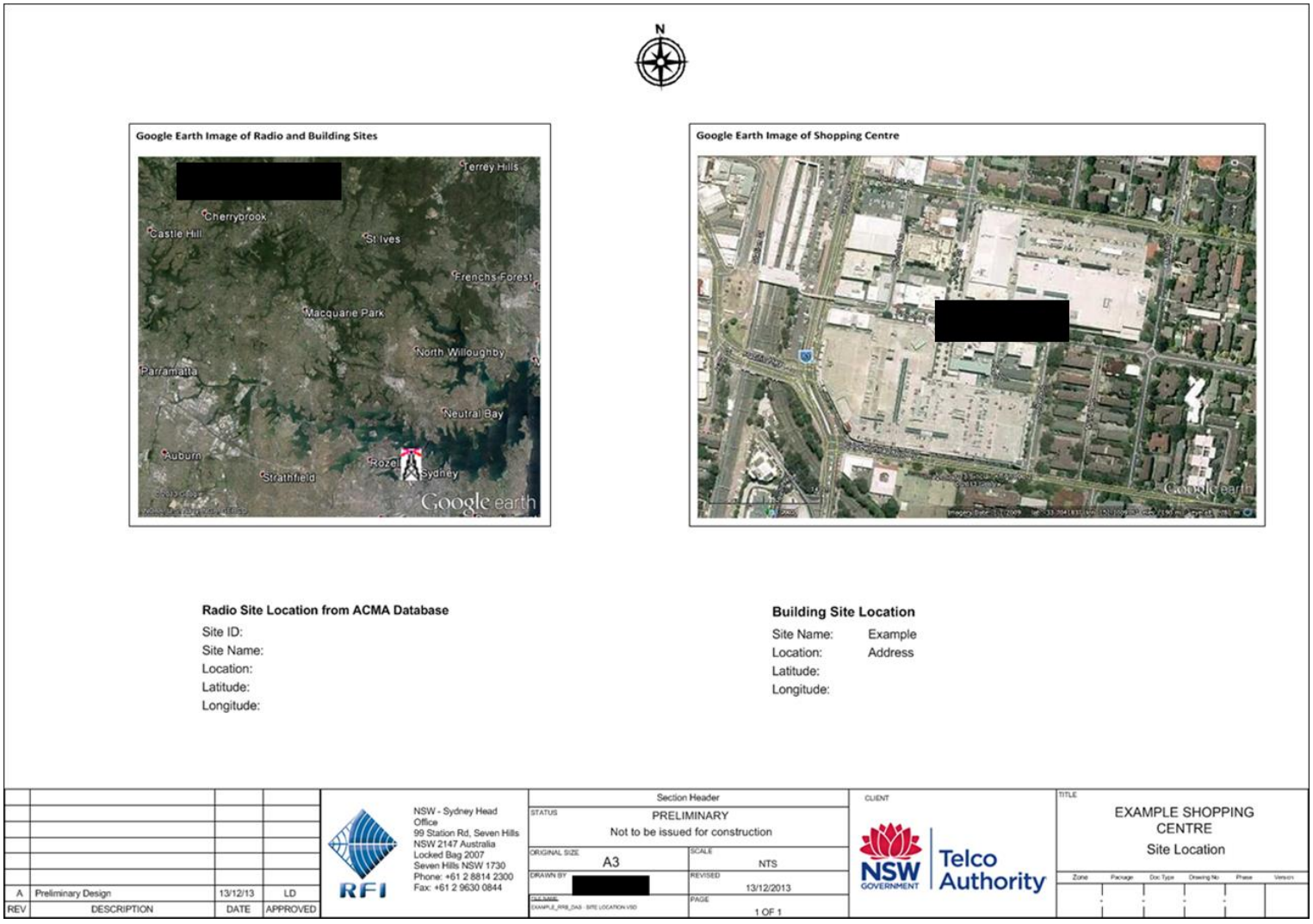
- Known operational requirements which require particular design effort (i.e. PSN customer tenancy)
- Whether the DAS will be fed with a dedicated BTS (new capacity) or a repeater (shared capacity). If repeaters are to be used the repeater solution type (i.e. translating, non-translating, fibre fed) and donor site will be given,
- Required equipment rack space for the BTS or repeater equipment and associated transmission equipment,
- Number of RF channels to be deployed,
- Required services and bands to be catered for by the IBC system, and
- Required AC feeds to power the PSN system
- Battery requirements and associated rack

8 Appendix B – Engineering Design Pack (definition)

The Engineering Design Pack, which is to be provided by the designer/developer/owner will contain the following:

- Contact details for the site; i.e. building management and / or security;
- Coverage survey results based on the Indoor Coverage Verification Guideline (TA01-GEN1-DOC-0011),
- Any known building access restrictions that might impact site design or construction access,
- A complete set of floor plans / maps marked-up to indicate the areas where indoor coverage is provided,
- Agency specific operational requirements within the building,
- Known operational requirements which require particular design effort (i.e. PSN customer tenancy

9 Appendix C Drawing Package Examples



BUILDING DESCRIPTION:

- Name -
- Address -
- Description of building location, layout, size and construction.

SITE CONTACTS (Position / name / phone / email):

- Main Phone / Fax -
- Centre Manager -
- Operations Manager -
- Risk & Security Manager –
- Security -
- Medical Centre -

BUILDING ACCESS (location description and hours):

- Docks -
- Access to lifts -
- Lift size / capacity -

SITE HOURS OF WORK:

- Some shops operate 24 hours.
- Noise works close to cinema only between 12 pm and 8 am
- For work performed out of normal business hours notify security providing 48 hours notice.

PARKING:

- Trade vehicles must only be parked at level 3M or above.

REV	DESCRIPTION	DATE	APPROVED
A	Preliminary Design	16/12/13	GA

RFI

NSW - Sydney Head Office
99 Station Rd, Seven Hills
NSW 2147 Australia
Locked Bag 2007
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Phone: +61 2 8814 2300
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Section Header

STATUS: PRELIMINARY
Not to be issued for construction

ORIGINAL SIZE: A3
SCALE: NTS
DRAWN BY: [redacted]
REVISED: 13/12/2013
FILE NAME: EXAMPLE_RRB_DAS - SITE SPECIFIC NOTES.VSD
PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority RK

TITLE
EXAMPLE SHOPPING CENTRE
RRB – DAS – Site Specific Notes

Zone	Package	Doc Type	Drawing No	Phase	Version
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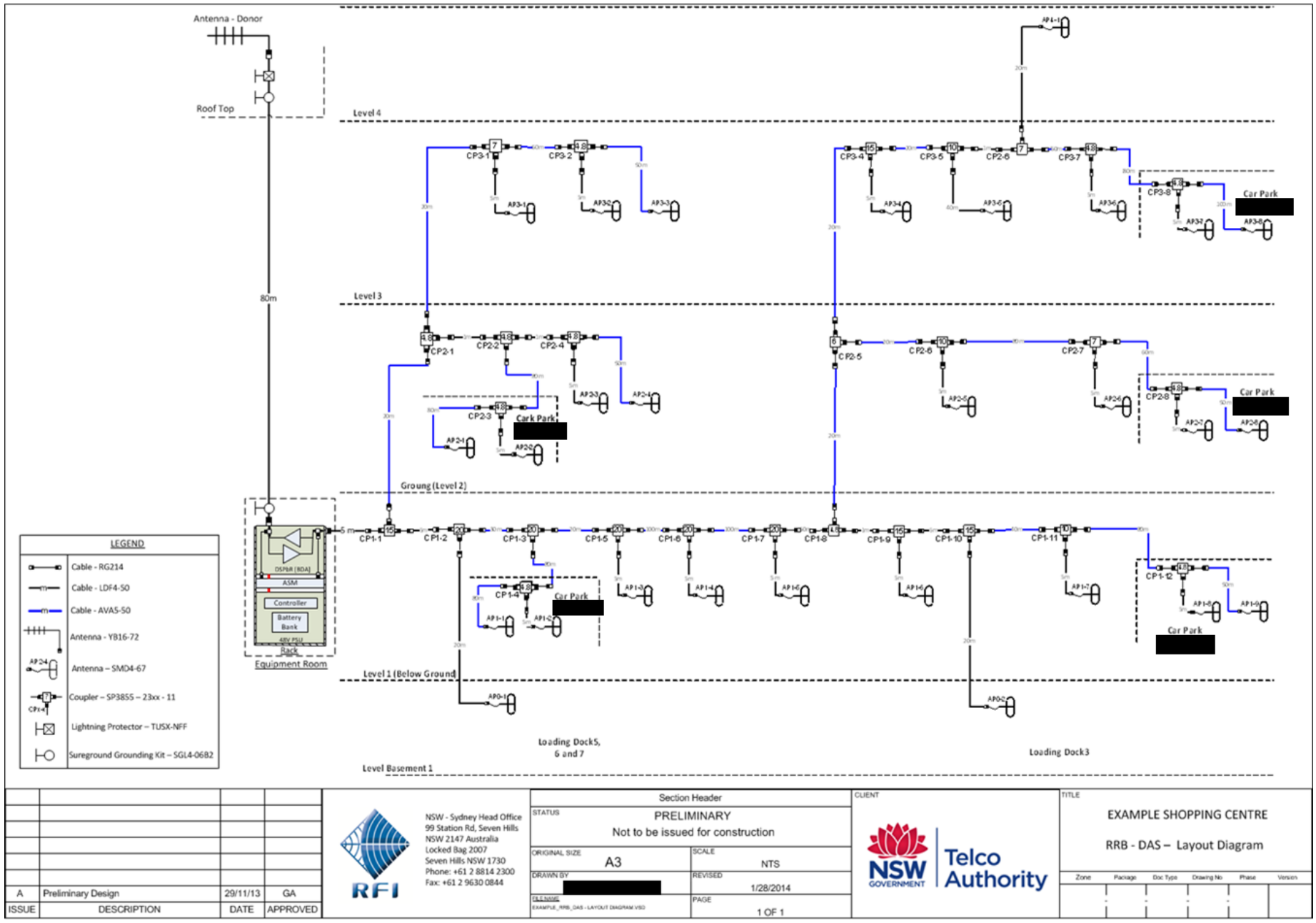
Antenna - Donor
Roof Top
80m
Level 4
Level 3
Groung (Level 2)
Level 1 (Below Ground)
Level Basement 1
Equipment Room
Rack
OSPBR (80A)
ASM
Controller
Battery Bank
48V PSU
Car Park
Loading Dock5, 6 and 7
Loading Dock3
LEGEND
Cable - RG214
Cable - LDF4-50
Cable - AVA5-50
Antenna - YB16-72
Antenna – SMD4-67
Coupler – SP3855 – 23xx - 11
Lightning Protector – TUSX-NFF
Sureground Grounding Kit – SGL4-0682
A | Preliminary Design | 29/11/13 | GA
ISSUE | DESCRIPTION | DATE | APPROVED
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Section Header
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PRELIMINARY
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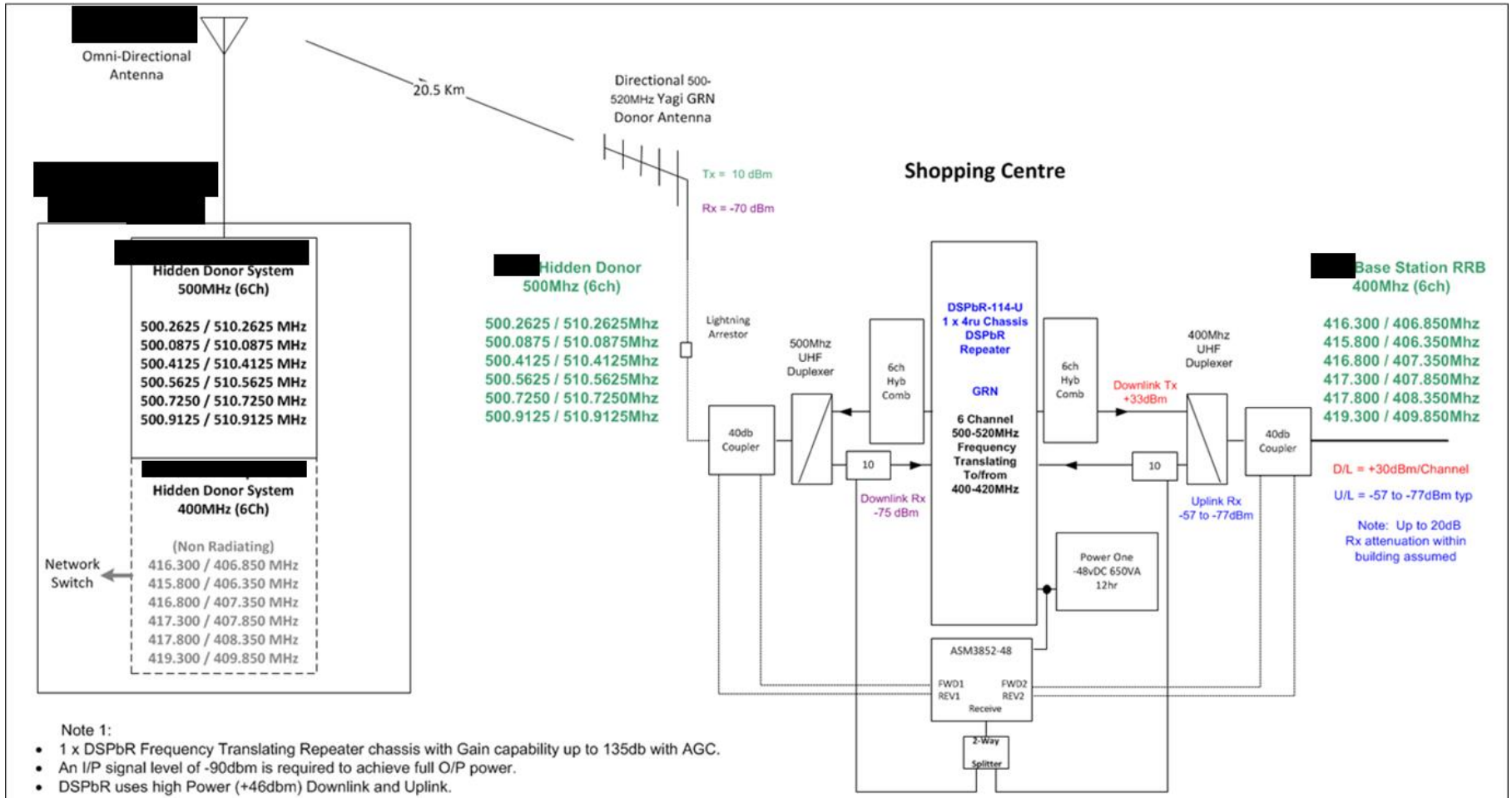
ORIGINAL SIZE
A3
SCALE
NTS
DRAWN BY
REVISED
1/28/2014
FILE NAME
EXAMPLE_RRB_DAS - LAYOUT DIAGRAM.VSD
PAGE
1 OF 1
CLIENT
NSW GOVERNMENT
Telco Authority
TITLE
EXAMPLE SHOPPING CENTRE
RRB - DAS – Layout Diagram
Zone
Package
Doc Type
Drawing No
Phase
Version



Note 1:

- 1 x DSPbR Frequency Translating Repeater chassis with Gain capability up to 135db with AGC.
- An I/P signal level of -90dbm is required to achieve full O/P power.
- DSPbR uses high Power (+46dbm) Downlink and Uplink.

Note 2:

- Antenna System Monitor (ASM3852-48) has Couplers fitted to both Donor and Rebroadcast path to Monitor Forward and Reflected Power and 10dB couplers with receive splitter to monitor receive level in both directions.

REV	DESCRIPTION	DATE	APPROVED
A	Preliminary Design	13/01/2014	GA

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Section Header

STATUS: PRELIMINARY
Not to be issued for construction

ORIGINAL SIZE: A3
SCALE: NTS
DRAWN BY: [redacted]
REVISED: 13/12/2013
FILE NAME: EXAMPLE_RRB_DAS – RF RRB SYSTEM V3D
PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority RK

TITLE
EXAMPLE SHOPPING CENTRE
RRB - DAS – RF RRB System

Zone	Package	Doc Type	Drawing No	Phase	Version
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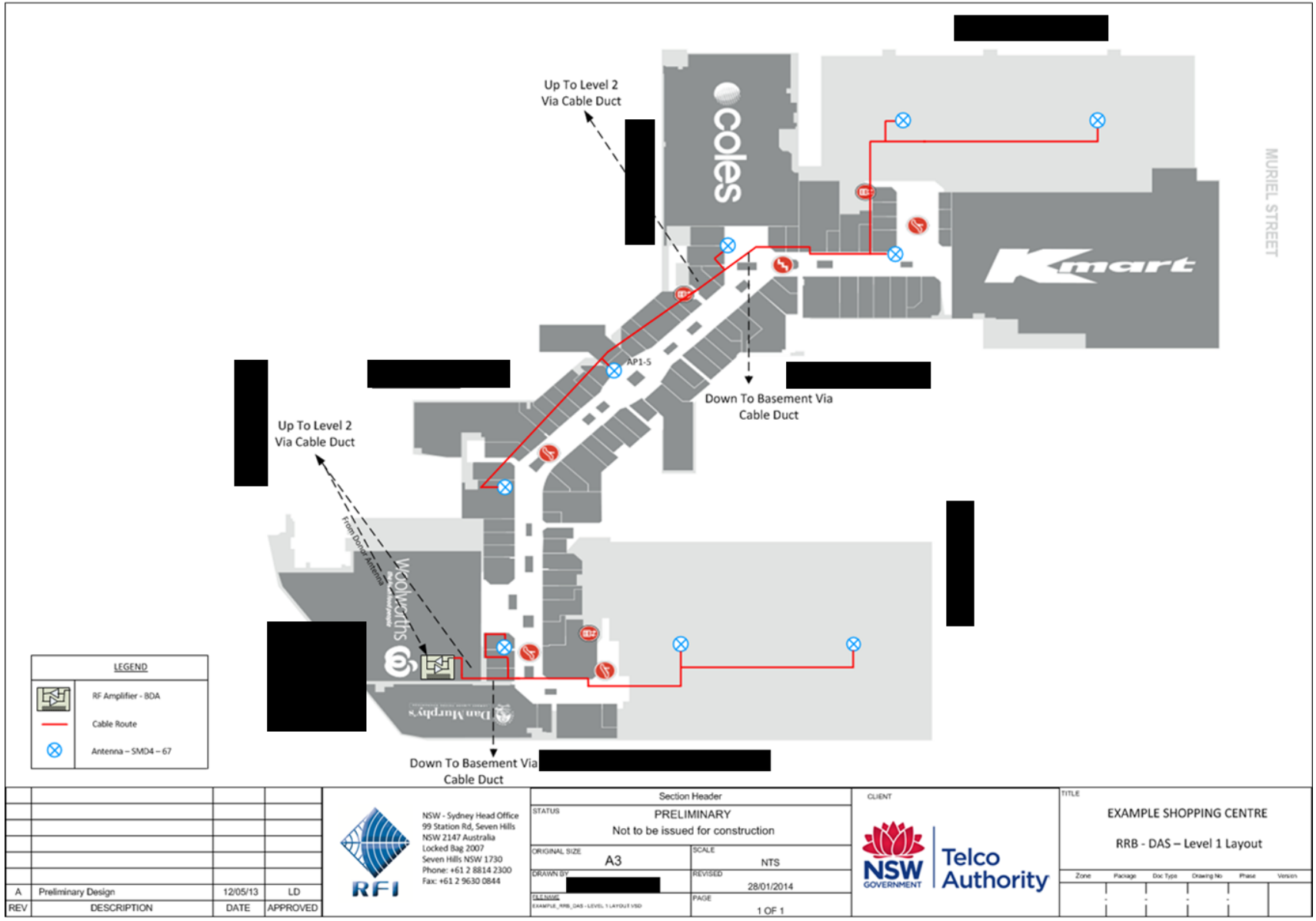
Up To Level 2
Via Cable Duct
coles
Kmart
MURIEL STREET
AP1-5
Down To Basement Via
Cable Duct
Up To Level 2
Via Cable Duct
From Donor Antenna
Woolworths
Dan Murphy's
Down To Basement Via
Cable Duct
LEGEND
RF Amplifier - BDA
Cable Route
Antenna – SMD4 – 67
A
Preliminary Design
12/05/13
LD
REV
DESCRIPTION
DATE
APPROVED
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Section Header
STATUS
PRELIMINARY
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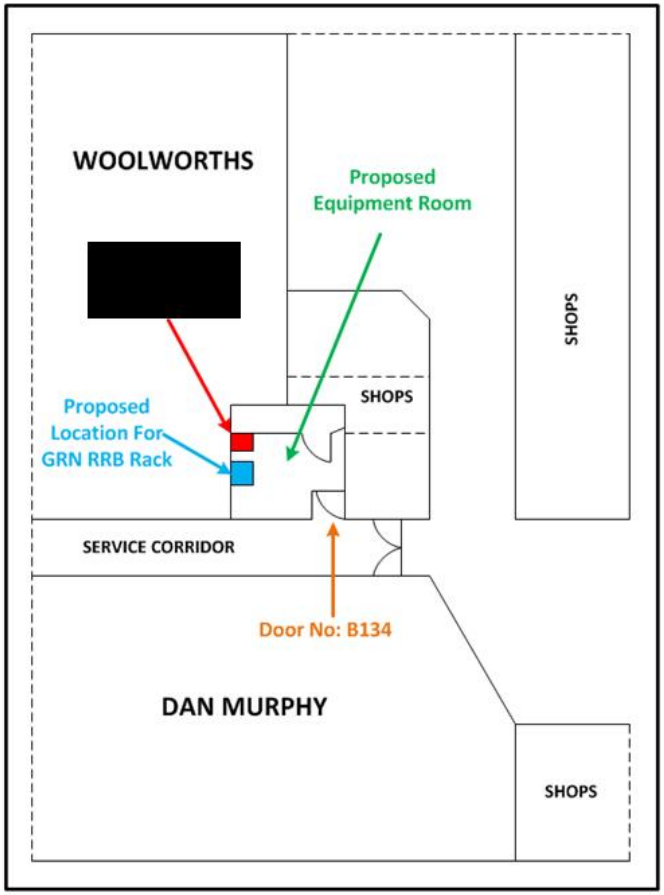
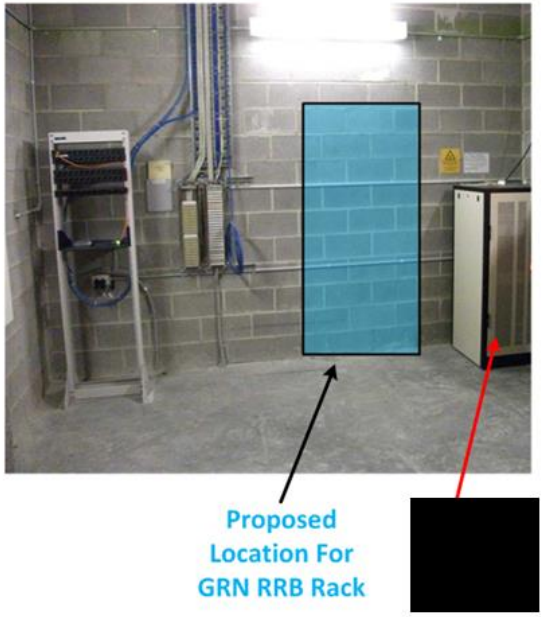
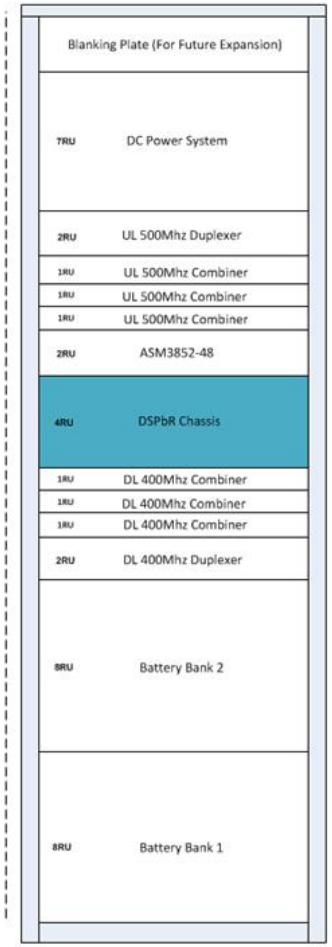
ORIGINAL SIZE
A3
SCALE
NTS
DRAWN BY
REVISED
28/01/2014
FILE NAME
PAGE
1 OF 1
CLIENT
NSW GOVERNMENT
Telco Authority
TITLE
EXAMPLE SHOPPING CENTRE
RRB - DAS – Level 1 Layout
Zone
Package
Doc Type
Drawing No
Phase
Version



LEVEL 1





REV	DESCRIPTION	DATE	APPROVED
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ORIGINAL SIZE: A3
SCALE: NTS
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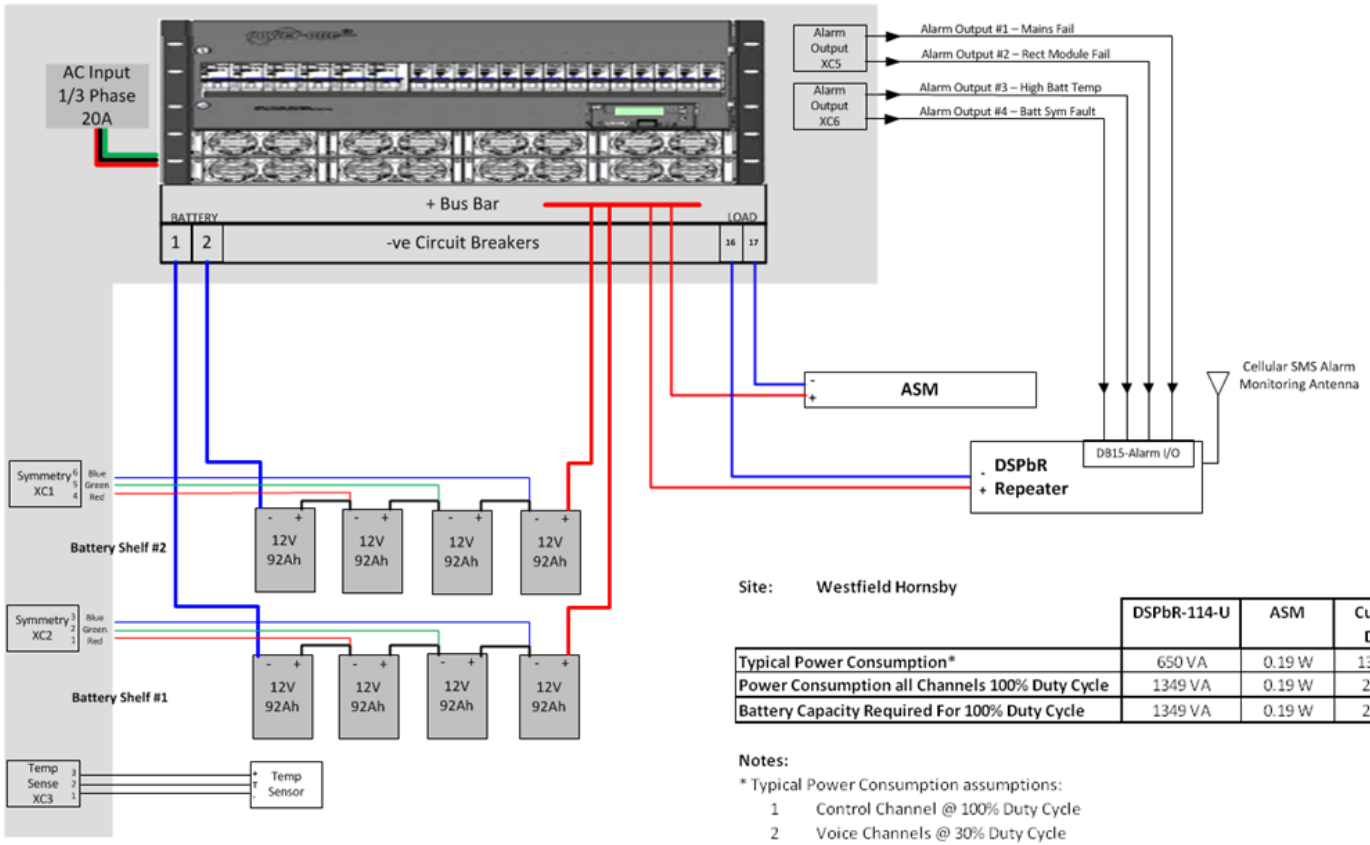
REVISED: 1/28/2014
FILE NAME: EXAMPLE_RRB_DAS - FLOOR PLAN_RACK LAYOUT.VSD
PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority

TITLE
EXAMPLE SHOPPING CENTRE
DAS – Floor Plan & Rack Layout

Zone	Package	Doc Type	Drawing No	Phase	Version
-	-	-	-	-	

48V UPS
Wiring Schematic



Site: Westfield Hornsby

	DSPbR-114-U	ASM	Current Draw	System Voltage	Battery Capacity	Est Battery Time
Typical Power Consumption*	650 VA	0.19 W	13.54 A	48V	184 Ahr	13.6 Hrs
Power Consumption all Channels 100% Duty Cycle	1349 VA	0.19 W	28.1 A	48V	184 Ahr	6.55 Hrs
Battery Capacity Required For 100% Duty Cycle	1349 VA	0.19 W	28.1 A	48V	368 Ahr	13.1 Hrs

Notes:

* Typical Power Consumption assumptions:
  1. Control Channel @ 100% Duty Cycle
  2. Voice Channels @ 30% Duty Cycle
  3. Duty Cycle is based on previous system experience

System quoting is based on Typical Power Consumption values.
For 12 hour coverage on battery back up with all channels at 100% duty cycle, 2x additional 92Ahr battery shelves, 2x additional rectifiers plus additional 19" rack and associated equipment will be needed at a much greater cost of design and supply.

UPS

REV	DESCRIPTION	DATE	APPROVED
A	Preliminary Design	9/12/13	GA

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Section Header
STATUS: PRELIMINARY
Not to be issued for construction
ORIGINAL SIZE: A3
SCALE: NTS
DRAWN BY: [redacted]
REVISED: 28/01/2014
DLE NAME: EXAMPLE_RRB_ DAS - AC DC DISTRIBUTION.VSD
PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority

TITLE
EXAMPLE SHOPPING CENTRE
RRB - DAS – AC DC Distribution

Zone	Package	Doc Type	Drawing No	Phase	Version
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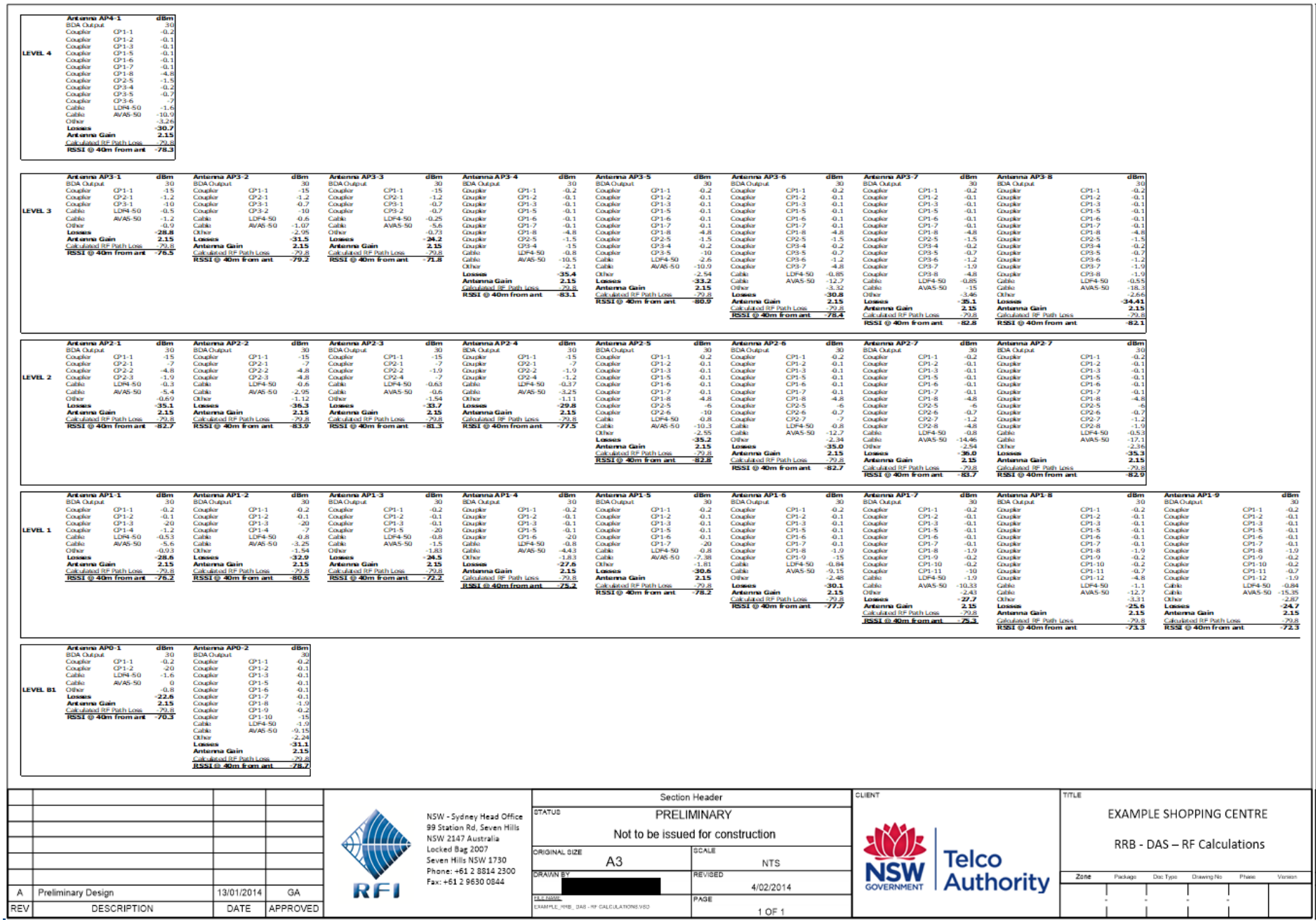

LEVEL 4	Antenna AP4-1		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-1.5
	Coupler	CP3-4	-0.2
	Coupler	CP3-5	-0.7
	Coupler	CP3-6	-7
	Cable	LDF4-50	-1.6
	Cable	AVA5-50	-10.9
	Other		-3.26
	Losses		**-30.7**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-78.3**

LEVEL 3	Antenna AP3-1		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-1.2
	Coupler	CP3-1	-10
	Cable	LDF4-50	-0.5
	Cable	AVA5-50	-1.2
	Other		-0.9
	Losses		**-28.8**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-76.5**

	Antenna AP3-2		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-1.2
	Coupler	CP3-1	-0.7
	Coupler	CP3-2	-10
	Cable	LDF4-50	-0.6
	Cable	AVA5-50	-1.07
	Other		-2.95
	Losses		**-31.5**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-79.2**

	Antenna AP3-3		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-1.2
	Coupler	CP3-1	-0.7
	Coupler	CP3-2	-0.7
	Cable	LDF4-50	-0.25
	Cable	AVA5-50	-5.6
	Other		-0.73
	Losses		**-24.2**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-71.8**

	Antenna AP3-4		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-1.5
	Coupler	CP3-4	-15
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-10.5
	Other		-2.1
	Losses		**-35.4**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-83.1**

	Antenna AP3-5		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-1.5
	Coupler	CP3-4	-0.2
	Coupler	CP3-5	-10
	Cable	LDF4-50	-2.6
	Cable	AVA5-50	-10.9
	Other		-2.54
	Losses		**-33.2**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-80.9**

	Antenna AP3-6		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-1.5
	Coupler	CP3-4	-0.2
	Coupler	CP3-5	-0.7
	Coupler	CP3-6	-1.2
	Coupler	CP3-7	-4.8
	Cable	LDF4-50	-0.85
	Cable	AVA5-50	-12.7
	Other		-3.32
	Losses		**-30.8**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-78.4**

	Antenna AP3-7		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-1.5
	Coupler	CP3-4	-0.2
	Coupler	CP3-5	-0.7
	Coupler	CP3-6	-1.2
	Coupler	CP3-7	-1.9
	Coupler	CP3-8	-4.8
	Cable	LDF4-50	-0.85
	Cable	AVA5-50	-15
	Other		-3.46
	Losses		**-35.1**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-82.8**

	Antenna AP3-8		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-1.5
	Coupler	CP3-4	-0.2
	Coupler	CP3-5	-0.7
	Coupler	CP3-6	-1.2
	Coupler	CP3-7	-1.9
	Coupler	CP3-8	-1.9
	Cable	LDF4-50	-0.55
	Cable	AVA5-50	-18.3
	Other		-2.66
	Losses		**-34.41**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-82.1**

LEVEL 2	Antenna AP2-1		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-7
	Coupler	CP2-2	-4.8
	Coupler	CP2-3	-1.9
	Cable	LDF4-50	-0.3
	Cable	AVA5-50	-5.4
	Other		-0.69
	Losses		**-35.1**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-82.7**

	Antenna AP2-2		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-7
	Coupler	CP2-2	-4.8
	Coupler	CP2-3	-4.8
	Cable	LDF4-50	-0.6
	Cable	AVA5-50	-2.95
	Other		-1.12
	Losses		**-36.3**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-83.9**

	Antenna AP2-3		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-7
	Coupler	CP2-2	-1.9
	Coupler	CP2-4	-7
	Cable	LDF4-50	-0.63
	Cable	AVA5-50	-0.6
	Other		-1.54
	Losses		**-33.7**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-81.3**

	Antenna AP2-4		dBm
	BDA Output		30
	Coupler	CP1-1	-15
	Coupler	CP2-1	-7
	Coupler	CP2-2	-1.9
	Coupler	CP2-4	-1.2
	Cable	LDF4-50	-0.37
	Cable	AVA5-50	-3.25
	Other		-1.11
	Losses		**-29.8**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-77.5**

	Antenna AP2-5		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-6
	Coupler	CP2-6	-10
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-10.3
	Other		-2.55
	Losses		**-35.2**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-82.8**

	Antenna AP2-6		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-6
	Coupler	CP2-6	-0.7
	Coupler	CP2-7	-7
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-12.7
	Other		-2.34
	Losses		**-35.0**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-82.7**

	Antenna AP2-7		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-6
	Coupler	CP2-6	-0.7
	Coupler	CP2-7	-1.2
	Coupler	CP2-8	-1.9
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-14.46
	Other		-2.54
	Losses		**-36.0**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-83.7**

	Antenna AP2-7		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-4.8
	Coupler	CP2-5	-6
	Coupler	CP2-6	-0.7
	Coupler	CP2-7	-1.2
	Coupler	CP2-8	-1.9
	Cable	LDF4-50	-0.53
	Cable	AVA5-50	-17.1
	Other		-2.36
	Losses		**-35.3**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-82.9**

LEVEL 1	Antenna AP1-1		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-20
	Coupler	CP1-4	-1.2
	Cable	LDF4-50	-0.53
	Cable	AVA5-50	-5.6
	Other		-0.93
	Losses		**-28.6**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-76.2**

	Antenna AP1-2		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-20
	Coupler	CP1-4	-7
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-3.25
	Other		-1.54
	Losses		**-32.9**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-80.5**

	Antenna AP1-3		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-20
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-1.5
	Other		-1.83
	Losses		**-24.5**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-72.2**

	Antenna AP1-4		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-20
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-4.43
	Other		-1.83
	Losses		**-27.6**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-75.2**

	Antenna AP1-5		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-20
	Cable	LDF4-50	-0.8
	Cable	AVA5-50	-7.38
	Other		-1.81
	Losses		**-30.6**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-78.2**

	Antenna AP1-6		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-1.9
	Coupler	CP1-9	-15
	Cable	LDF4-50	-0.84
	Cable	AVA5-50	-9.15
	Other		-2.48
	Losses		**-30.1**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-77.7**

	Antenna AP1-7		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-1.9
	Coupler	CP1-9	-0.2
	Coupler	CP1-10	-0.2
	Coupler	CP1-11	-10
	Cable	LDF4-50	-1.9
	Cable	AVA5-50	-10.33
	Other		-2.43
	Losses		**-27.7**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-75.3**

	Antenna AP1-8		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-1.9
	Coupler	CP1-9	-0.2
	Coupler	CP1-10	-0.2
	Coupler	CP1-11	-0.7
	Coupler	CP1-12	-4.8
	Cable	LDF4-50	-1.1
	Cable	AVA5-50	-12.7
	Other		-3.31
	Losses		**-25.6**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-73.3**

	Antenna AP1-9		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-1.9
	Coupler	CP1-9	-0.2
	Coupler	CP1-10	-0.2
	Coupler	CP1-11	-0.7
	Coupler	CP1-12	-1.9
	Cable	LDF4-50	-0.84
	Cable	AVA5-50	-15.35
	Other		-2.87
	Losses		**-24.7**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-72.3**

LEVEL B1	Antenna AP0-1		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-20
	Cable	LDF4-50	-1.6
	Cable	AVA5-50	0
	Other		-0.8
	Losses		**-22.6**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-70.3**

	Antenna AP0-2		dBm
	BDA Output		30
	Coupler	CP1-1	-0.2
	Coupler	CP1-2	-0.1
	Coupler	CP1-3	-0.1
	Coupler	CP1-5	-0.1
	Coupler	CP1-6	-0.1
	Coupler	CP1-7	-0.1
	Coupler	CP1-8	-1.9
	Coupler	CP1-9	-0.2
	Coupler	CP1-10	-15
	Cable	LDF4-50	-1.9
	Cable	AVA5-50	-0.15
	Other		-2.24
	Losses		**-31.1**
	Antenna Gain		**2.15**
	Calculated RF Path Loss		-79.8
	RSSI @ 40m from ant		**-78.7**

REV	DESCRIPTION	DATE	APPROVED
A	Preliminary Design	13/01/2014	GA

RFI

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Section Header

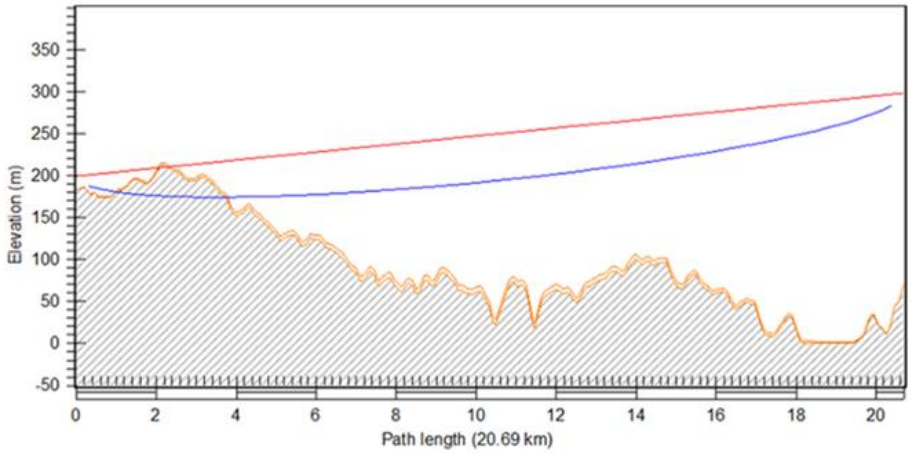
STATUS: PRELIMINARY
Not to be issued for construction

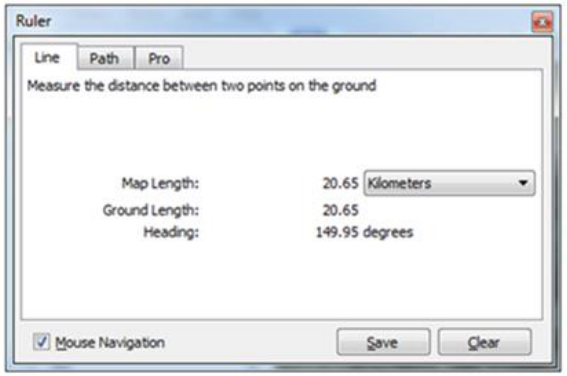
ORIGINAL SIZE: A3
SCALE: NTS
DRAWN BY: [redacted]
REVISED: 4/02/2014
FILE NAME: EXAMPLE_RRB_DAS - RF CALCULATIONS.VSD
PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority

TITLE
EXAMPLE SHOPPING CENTRE
RRB - DAS – RF Calculations

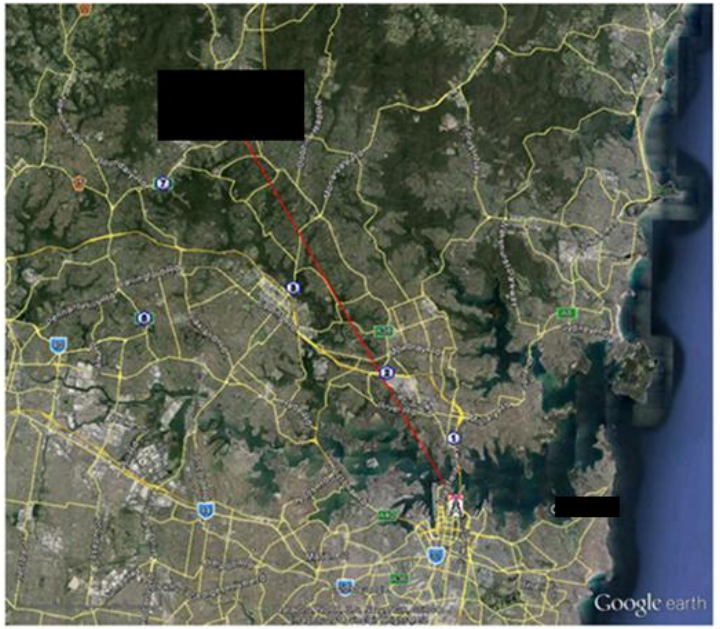
Zone	Package	Doc Type	Drawing No	Phase	Version





F = 500.00 MHz K = 1.33 %F1 = 100.0, 60.0

	[redacted]	[redacted]
Latitude		
Longitude		
True azimuth (°)	150.78	330.72
Vertical angle (°)	0.37	-0.32
Elevation (m)	182.34	71.00
Tower height (m)	10.00	70.00
Antenna model	YB16-71 (TR)	BA40-41 (TR)
Antenna gain (dBd)	12.00	3.00
Antenna height (m)	17.00	227.00
TX line model	LDF4-50A	LDF5-50A
TX line length (m)	25.00	60.00
TX loss (dB)	11.43	12.01
RX loss (dB)	1.43	2.01
Diffraction loss (dB)	9.86	
TX power (dBm)	40.00	43.98
ERP (dbm)	40.58	35.14
ERP (watts)	11.44	3.27
Receive signal (dBm)	-72.85	-76.83
Receive signal (uv)	50.92	32.20
Thermal fade margin (dB)	45.15	41.17
Annual location availability (%)	99.99968	99.99808
Annual multipath availability (%)	99.99694	99.99236



REV	DESCRIPTION	DATE	APPROVED
A	Preliminary Design	13/01/2014	GA

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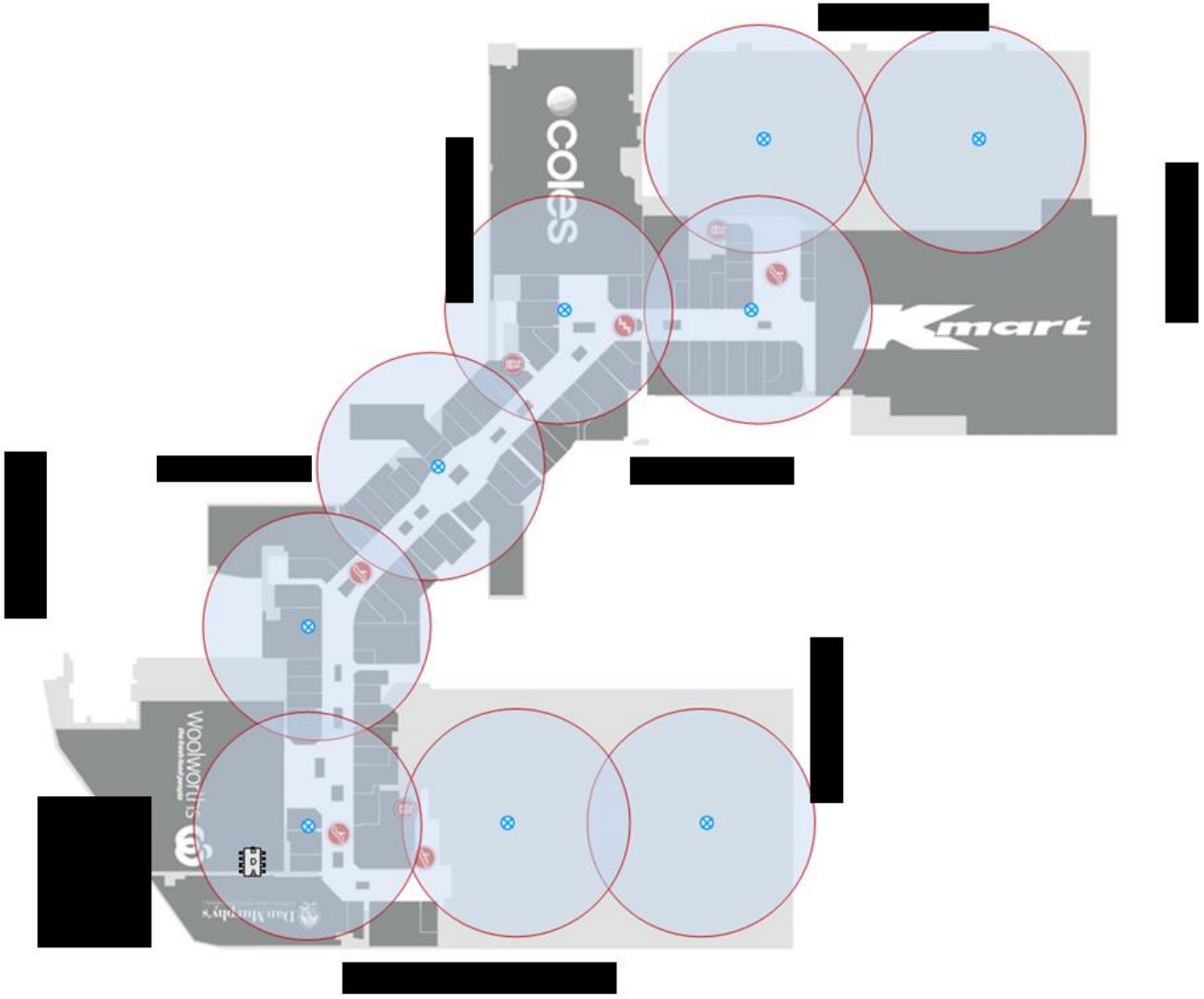
PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority

TITLE
EXAMPLE SHOPPING CENTRE
RRB - DAS – RF Link Path

Zone	Package	Doc Type	Drawing No	Phase	Version
-	-	-	-	-	



REV	DESCRIPTION	DATE	APPROVED
A	Preliminary Design	17/12/13	GA

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PAGE: 1 OF 1

CLIENT: NSW GOVERNMENT Telco Authority

TITLE
EXAMPLE SHOPPING CENTRE
DAS – Level 1 RF Prediction

Zone	Package	Doc Type	Drawing No	Phase	Version
	-	-	-	-	

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