GBROOS Data / Activity Report 2007/01

Heron and One-Tree Island Site Visits

September 2007

Executive Summary

The site visits were done to meet the following goals:

- To determine the suitability of a microwave link from the mainland (Mt. Larcom) to Heron Island and from Heron Island across to One-Tree Island;
- To test the reception and data rates for Telstra NextG connectivity at Heron and One-Tree Islands;
- To determine the suitability of installing on-reef networks at Heron and One-Tree Islands and in particular looking for suitable locations for base stations;
- To test the range of on-water wireless connections from the base station to the on-reef equipment;
- To determine the range of across-water wireless communications for the various types of equipment that will be deployed;
- To gather information for permitting such as suitable locations for equipment, number of deployed components, substrate and benthos types at the points of deployment and general ability to deploy and retrieve equipment;
- To better understand the logistics of deploying equipment and to get enough information to plan and resource the actual deployment planned for mid 2008;
- To get capability and environmental information to aid in designing the equipment.

The study found the following results:

- At both Heron and One-Tree Island Telstra NextG connectivity at 1Mb/s or greater (broadband speeds) was found using the test equipment, this opens up the possibility of using this technology if we are unable to implement faster microwave based systems;
- Heron Island has a currently unused 19m communications tower owned by Telstra which is ideal for both a microwave link back to the mainland and onto One-Tree Island and to locate the base station for the on-reef wireless network, however the issue of access and Telstra's future plans for the tower make the use of this tower potentially problematic;
- One-Tree Island has a couple of suitable sites for a microwave link back to Heron Island and from there to the mainland, these include the current water tower and the main accommodation block – no significant issues exist for using either of these;

- Base stations for the on-reef network were set up at both Heron and One-Tree Islands; for Heron Island, using the Telstra Tower (19m elevation), a distance of 5 km effective range was measured while for One-Tree Island, using the water tower (6m elevation), a range of 2.5 km was found - both are well within the expected range;
- A range of 1800 – 2000m was achieved for the on-water wireless network test that simulates a Relay-Spar talking to another Relay-Spar and so the on-reef network fixed units have a demonstrated range of around 2 km or 1 nautical mile;
- A range of 1200m was found for the test that simulated a Relay-Spar talking to a Multi-Float and so Multi-Floats must be positioned within 1.0 to 1.2 km of a Relay Spar to get effective communication;
- A range of 600m to 800m was found for the communication from a long-range µNode to a Relay-Spar and so all long-range µNode Floats need to be within this range of a Relay-Spar or Multi-Float;
- All of the proposed locations are on shallow sandy bottoms which make it easy to design equipment that will have minimum environmental impact and which will be easy to remove when the project has finished;
- A much better understanding of the deployment issues (such as tidal access to One-Tree) has been obtained along with some initial designs for the equipment and the resources and timing required for the deployments.

A number of issues were identified:

- We need to know the future of the Telstra tower on Heron-Island including any future Telstra plans for the tower and the ability for the project to locate / co-locate equipment on the tower or to find an alternative;
- We need to involve AARNet in developing the microwave link if this route is taken as this simplifies a number of logistical aspects as well as ownership and management of the link;
- Access to One-Tree Island is a major issue as tides limit the timing of work that can be done;
- The Wistari Multi-Float could be problematic in that to get 20m of depth you need to be some 70-150 metres off the reef crest and so it is difficult to get a deep water profile <u>and</u> a crest-to-slope profile with the one location and so it may be better to have two Multi-Floats for this location, one in near the reef crest and one further out in the channel;
- The deployment of the full sensor network mid 2008 will take more resources than initially thought and this needs to be planned and resourced.

The project met all of the initial goals and a better understanding of the logistics and operational parameters has been obtained. The testing of the equipment confirmed that the basic design is sound and in fact the real-world testing delivered better results that anticipated and so the technical basis of the work has been confirmed. A quotation for the microwave link to Heron and One-Tree Islands is due by the end of September and this will be important in moving this part of the project ahead.

Scott Bainbridge

<u>GBROOS Project Manager.</u>

Introduction

The site visits to Heron and One-Tree Islands were done to investigate the existing communications infra-structure on each of the islands, to look at potential use of the Telstra NextG network for data communications and to look at the feasibility and cost of a direct microwave link from the mainland (Mt. Larcom) to Heron Island and then across to One-Tree Island. To meet this last need a microwave consultant (Mr. Shannon Klose) was brought in from National Wireless Limited to do a site survey and develop a feasibility study and subsequent quotation for the work.

The second major part of the work was to test the on-water wireless communications both from a land-based base station and between the on-reef equipment. To do this a base station was set up on each island and the signal strength measured while doing boat transects away from the base station. The on-reef tests were done using a point fixed on the edge of the water and then doing transects away from this in various configurations to mimic the designs under consideration.

The third component was to look at where equipment could be deployed and to gain an understanding of the immediate environment to develop deployment designs that would meet the operational requirements. A correlated activity was to describe and photograph each intended deployment area to help with the permitting process with GBRMPA.

The final component was to gain a better understanding of the logistical and operational factors that will need to be considered when doing the designs and the actual deployments. The experience gained while in the field is invaluable in ensuring that the designs are robust and that we have the resources and time to do the deployments.

The site visits are an important way of field testing the equipment and design ideas, in understanding the logistics and realities of working in the field, in gaining local knowledge of the area and in being able to better plan and deliver outcomes.

Goals

The particular goals of the site visits to Heron and One-Tree Islands were:

1. Assess the feasibility and cost of putting in a high-speed microwave communications link between the mainland and Heron Island (>100Mb/s) and then Heron Island and One-Tree Island (>10Mb/s) to give broadband speeds or greater communications to the two island stations both for the GBROOS work and as infrastructure to support future work;
2. Assess the likely Telstra NextG connectivity at each of the islands to see if this is one way of doing live data from the remote island stations;
3. Find a location for the base-station to support the on-reef wireless network including power and equipment storage;
4. Test the across-water signal strength from the base station to the Relay-Spar (RS) type of device that will form the backbone of the on-reef wireless network;

5. Test the across-water signal strength from each of the planned devices back to the Relay-Spar type of device, this will dictate the range that the on-reef wireless network has and what can be done to improve this and where equipment can be placed to get connectivity;
6. To assess a number of potential designs for the on-reef equipment and how these can be constructed and deployed;
7. To look for potential sites for the on-reef equipment and what immediate environment these are in so as to help with the design and permitting process (in particular the impact each unit will have and the ability to recover and service the equipment);
8. To plan the deployment of the equipment due for mid 2008.

Locations

The two study locations are Heron Island and One-Tree Island in the southern part of the Great Barrier Reef off Gladstone in central Queensland. The sites were chosen because they are co-located with two research stations; that of Heron Island Research Station (HIRS) run by the University of Queensland and the One-Tree Island Research Station (OTIRS) run by the University of Sydney, additionally Heron Island has a resort run by Voyages.

This means that both locations have extensive infra-structure and are widely used by the research community making them well understood and suitable for the sensor net application. As well it is possible for some maintenance to be done by the local station staff again making it easier to support infrastructure. Finally Heron Island is serviced by ferry and barge making it easy to gain access no matter what the weather.

Scientifically the two areas are important as they sit at the southern end of the Great Barrier Reef (GBR) and so represent the southern or 'coldest' extent of the main GBR matrix. They are also close to where the East Australian Current comes out of the main GBR lagoon and so are important in looking at the outflow of water from the main current flowing through the lagoon of the GBR matrix.

People

The diverse range of tasks undertaken required a range of skills and so four core people and one consultant were used to do the work. The main team from AIMS was Mr. Scott Bainbridge (GBROOS Project Manager), Mr. Gary Brinkman (head of AIMS' marine engineering area), Mr. Ray Boyes (fabrication specialist, rigger and diver) and Mr. Gavin Feather who is employed by GBROOS as a communications technician and data programmer. To do the microwave feasibility study a microwave technician, Mr. Shannon Klose from National Wireless Limited, was brought in as a consultant (under a commercial contract).

Methodology / Equipment

Introduction

This section briefly describes the equipment and methods used for the study. Where possible the equipment chosen reflects that which we expect to deploy. For most of the over-water tests we did not set up buoys but rather taped the aerial to the boat at a hight to replicate that expected for the scenario under test. Issues such as buoy movement and the impacts this has on signal strength and reliability will be investigated using trials at AIMS.

The main set of equipment used included a Garmin GPS*map* 76CSx GPS unit, maps and locations were plotted using Google Earth, the base stations and reef equipment were Campbell Scientific CR211 units using in-built spread-spectrum 922 MHz radios or external RF411 radios. The aerials used included a 5dB whip aerial to simulate the aerial to be used on the long-range µNodes and 1.0m 6dB co-linear aerials for the base station, relay-spars and multi-floats. The Campbell Scientific software was used to measure signal strength as Relative Signal Strength (RSS) which ranges from 80 or full signal down to 0 or no signal. For all of the signal strength readings a value of 40 or more is considered to be operationally reliable by the equipment manufacturer and this is what was aimed for.

Proposed types of reef-based equipment

This document will refer to four types of equipment; base stations, relay-spars, multi-floats and µNodes floats. These are quickly described here for clarity.

Base Station: The base station receives data from the on-reef wireless network and does some processing and then packages the data for transferral back to the mainland and then back to the Data Centre at AIMS. Typically the on-reef network will consist of a number of Relay-Spars that in turn talk to the floats and buoys containing the sensors although some Relay-Spars may contain sensors themselves. The base station will typically be mounted high up on the Island with a clear view out to sea. For Heron Island this was done off the Telstra tower (Figure One), for One-Tree Island this was mounted on a pole on the Water Tower (Figure Two).

The base station consisted of one 6dB 1.0 metre aerial; a Campbell Scientific CR211 logger, a 922 MHz spread-spectrum radio and a gel-cell lead acid battery. The output of the radio was around 100 milliwatts.

Figure One: Telstra tower on Heron Island showing the base station aerial (circled).

Relay-Spar (RS): This will be a pole mounted set of equipment that will provide the on-reef wireless network that the sensor buoys and packages will use to transmit their data back to the base station.

For these test a Relay-Spar was simulated by using the boat with a 1.0m 6dB aerial mounted 2m above the water, the aerial was connected to another Campbell Scientific CR211 logger and 922 MHz spread-spectrum radio. The Campbell software and a water proof laptop were used to measure signal strength.

Multi-Float: This is the main buoy used to deploy the sensors and it will consist of a Campbell Scientific CR211 logger, RF411 radio with a set of sensor strings running down with depth or across the reef flat as required. For these tests this was simulated by using the boat with a 1.0m 6dB aerial mounted 1m above the water surface.

Figure Two: Water tower on One-Tree Island showing the base station aerial.

µNode Float: This will be a small 50cm foam float using a small integrated electronics packaged from Adaptive Systems in the Netherlands. The standard units use 802.11b wireless communications but these will be coupled with a Campbell Scientific RF411 spread-spectrum radio using a 30cm 5dB whip aerial to increase the range making them a long-range µNode. This was simulated by using a Campbell Scientific CR211 logger and RF411 radio and the smaller 30cm 5dB aerial.

Microwave Feasibility Study

Both Heron Island and One-Tree Island were surveyed for suitable sites noting height above sea-level and clear line of sight access in the required direction. Other factors were access to power and the ability to get the in-coming communications to the systems already on the Island. A spectrum analyser was used to look for potential interference and issues such as access, cyclone ratings and general maintenance were investigated.

On-reef Base Station

At Heron Island a 1.0m 6dB co-linear aerial was set up inverted at the top of the Telstra tower (see Figure. One), this was attached to a Campbell Scientific CR211 logger and 922 MHz spread-spectrum radio generating 100 milliwatts of transmission power. The height of the aerial was around 19m.

At One-Tree Island the same set up was deployed from the top of the water tower using a pole for additional height to around 8m (Figure Two).

Range testing for on-water equipment

The range testing for the on-water equipment was done using a fixed station, either located on the beach (see Figure Three) or in a separate boat (small Zodiac, see Figure Four), and a mobile station on the boat (Figures Five and Six). The various equipment was simulated by changing the heights and types of the various aerials.

Figure Three: Beach mounted fixed station

Figure Four: Boat mounted fixed station (anchored)

Figure Six: Boat mounted mobile station, aerial is the black unit to the top left of the photograph.

Figure Seven: Boat mounted computer, GPS and logger/radios.

Outcomes

Microwave feasibility study

There seem to be no technical or logistical issues with getting a high speed microwave link from the mainland to Heron Island and then across to One-Tree Island. There are other issues that may be problematic and these need to be addressed.

The link to Mt. Larcom would be done using two 1200mm microwave dishes mounted on the Telstra tower powered from the existing Telstra power. The dishes would be mounted facing the mainland, one at the top at 19 metres and one just above the first platform at around 12 meters. This is slightly less than the optimum 10 metre separation but the tree line interferes with any dish located below 12 metres.

The link to One-Tree Island would use two 300mm square microwave panels mounted on the Telstra tower at the Heron Island end and on the accommodation block at the One-Tree Island end. There are no issues with the location of One-Tree Island and in fact there are a number of suitable locations.

The anticipated bandwidth that could be delivered is over 50Mb/s to Heron Island and over 10Mb/s on to One-Tree Island. This is more than enough for the sensor network project and also represents a significant increase in what is currently installed on both islands.

There are a number of potential issues:

- Getting access to the Telstra tower – if we are unable to locate our equipment on the (currently) unused Telstra tower then the microwave link is no longer feasible as there are no other current suitable sites. There may be opportunities with the current refurbishment of HIRS to build a suitable tower and so this idea needs to be further investigated.
- Telstra’s future plans for Heron Island – while Telstra have just installed a satellite communication system there is talk of Telstra putting a NextG base station at Heron Island which will need to be fed by a microwave link to the mainland in effect duplicating what is being proposed for the sensor project. This has obvious implications in that we may end up with duplication or Telstra may revoke any access rights in order to install their own equipment. In the long run a NextG base station would be good for the project but any duplication needs to be avoided.
- If the microwave link is installed on Heron Island we still need to get the communication across to the Research Station, this should be straight forward but again needs to be investigated further.
- The link will terminate at Mt. Larcom and then use the University of Central Queensland’s link back up to Rockhampton and then into the main AARNet 2.5 Gb/s backbone. The link from Mt. Larcom to Rockhampton is currently slow (34Mb/s from memory) and this will act as a major bottleneck to what bandwidth can be delivered but there are plans to upgrade this in the next few years.

- It would be best of the link is installed, commissioned and maintained by AARNet and so we need to approach AARNet to look at how they can work with us on this project.
- Management of the use of the link needs to be clarified before the link is in place as there are three potential users of the same link – the GBROOS project, HIRS and OTIRS.

Telstra NextG Connectivity

The Telstra NextG wireless data network provides potential for getting data back from the Islands to the mainland and if the microwave solution is not affordable or feasible then we can potentially use the NextG network to provide back-haul for data.

The intent was to see what connectivity could be found at each of the Islands. The basic set-up was a 1.0m 5dB aerial and a NextG modem with a Telstra supplied program to measure connection speed. The modem has a potential speed of around 4Mb/s (and up to 7 Mb/s with a firmware upgrade with a future expansion to 14Mb/s) and so the NextG network could provide connections at a speed that will support most of the activities of the Sensor network project for very reasonable cost.

The connection speeds obtained are shown in Appendix A but at both sites greater than 1 Mb/s was obtained which is enough for the initial set of deployments. As such NextG is suitable for the work we are proposing at least in the initial stages. Note that to convert from Kilo**bytes** / second to Mega**bits** /second multiply by eight so the speed at Heron Island of 157 Kilobytes/sec is the same as 1.256 Megabits/sec.

Across Water Wireless Network Range – Heron Island

The intention of this part of the project was to test the range of the proposed on-water wireless network components. This was one of the main unknown technical components of the Sensor Network project and it was important to be able to test what range we could get with the types of equipment proposed. If we were not able to get the distances we needed then parts of the project may need to be significantly changed so it was important to be able to test the equipment in real conditions.

1. **Base Station to Relay-Spar**

The on-reef network will be implemented through a series of fixed Relay-Spars, these will talk to each other to create the on-reef wireless network and in turn these will talk back to the base station to send the data back to the mainland.

This test was to determine the range from the established base stations to a Relay-Spar located in the lagoon of the reef. The aim for the base-station is to get it as high as possible to give a longer line-of-sight signal path and so for each site the base station will be positioned differently. The results will be site dependant. The path taken for the test is shown in Figure Eight. For scale the distance from the tower to RS1 is 3,690m, from the tower to RS3 is 5,430m and from the tower to RS5 is 7,320m.

The graph of signal strength versus distance from the base station for Heron Island is shown in Graph One. The position of the base station and the geography of the island give a lee effect where the signal strength is less in the immediate lee of the island but increases once line of sight is established and then declines as expected with distance.

A signal strength of 40 or greater gives a reliable signal and is set as the minimum operational value for the sensor network on-reef communications. The graph shows that distances around 5000m were obtained with the signal strength still at or above the 40 mark which is excellent. Graph Two shows the data with the initial points removed to reduce the island lee effect. A second order polynomial describes the signal strength with distance with an r^2 value of 0.98.

2. **Relay-Spar to Relay-Spar**

In order to create the on-reef network the Relay-Spars need to be able to communicate with each other so that a device that talks to one can get its data back to the base station via the network of Spars. This test looks at the maximum distance that a Relay-Spar can talk to another Spar and, in theory, should be reasonably constant regardless of site.

The results are shown in Graph Three and show that a reliable (signal strength >= 40) link could be established with the Spars 2000m apart and so a distance of around a nautical mile (1800m) seems to be workable. This is important as it sets the number and placement of the Relay-Spars required to provide a network to the area of interest.

3. **Relay-Spar to Multi-Float**

The Relay-Spars form the on-water wireless network and they will in turn talk to the various floats. The first test was to look at the distance that a reliable signal could be sent between a Relay-Spar which is a fixed component with the aerial at 2 metres above the water to a Multi-Float that floats and which has an aerial 1 metre above the water but which uses the larger 1.0m aerial used on the Relay-Spar and base station.

The results of this test are shown in Graph Four. The results show that reliable communications (signal strength >= 40) are established to around 1200 – 1400 metres from the Relay-Spar to the Multi-Float. This means that all Multi-Floats need to be positioned within 1.2 kilometres of the Relay-Spar in order to get good connectivity.

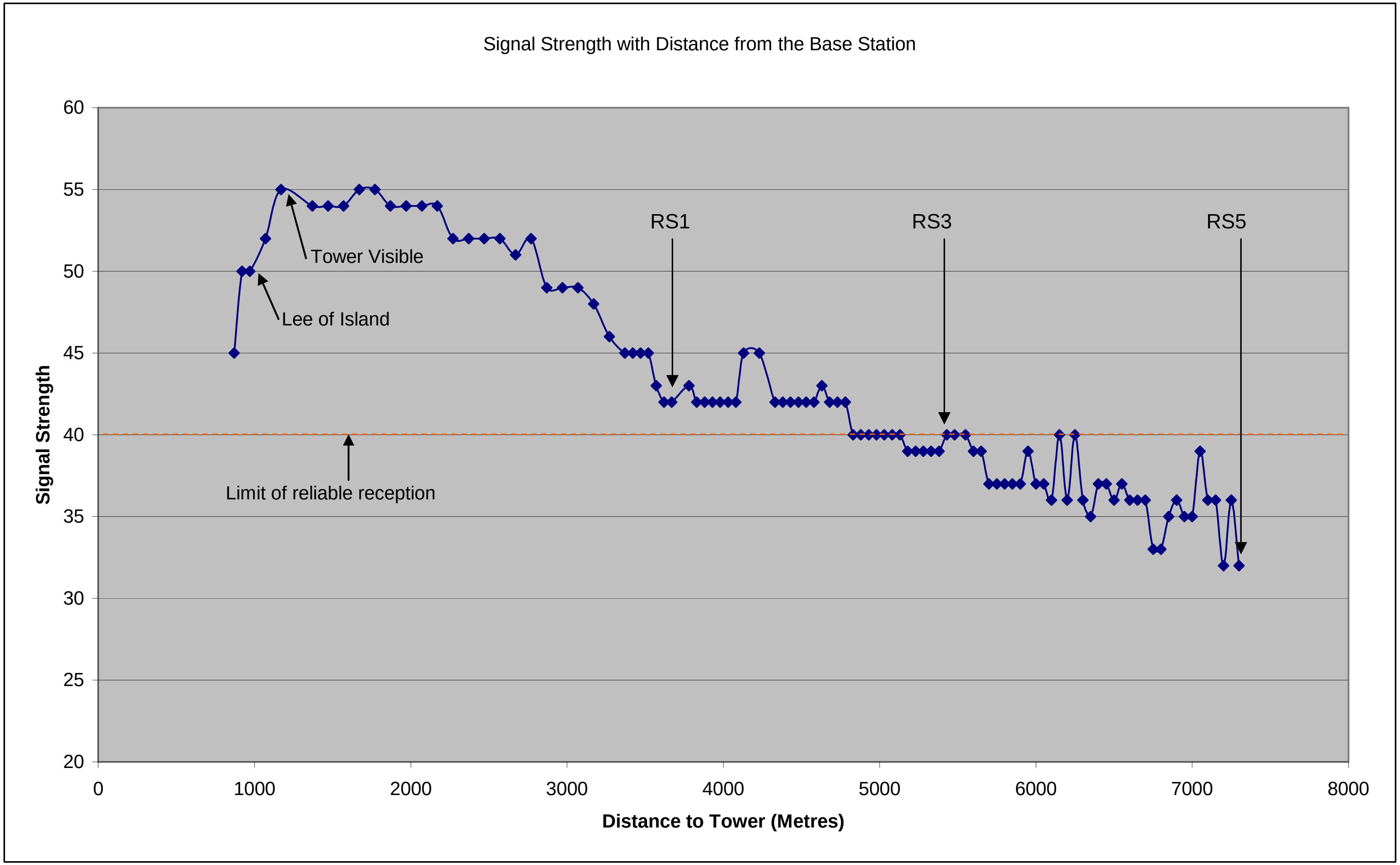
4. **Relay-Spar to long-range µNode Float**

The smallest float that will be used are the foam long-range µNode Floats that will use a smaller 30cm 5dB whip aerial. These will potentially suffer from the greatest signal strength issues as they are near to the water and use a smaller aerial. It may be possible to use a larger aerial mounted up higher but this will affect the stability of the unit and the visual impact.

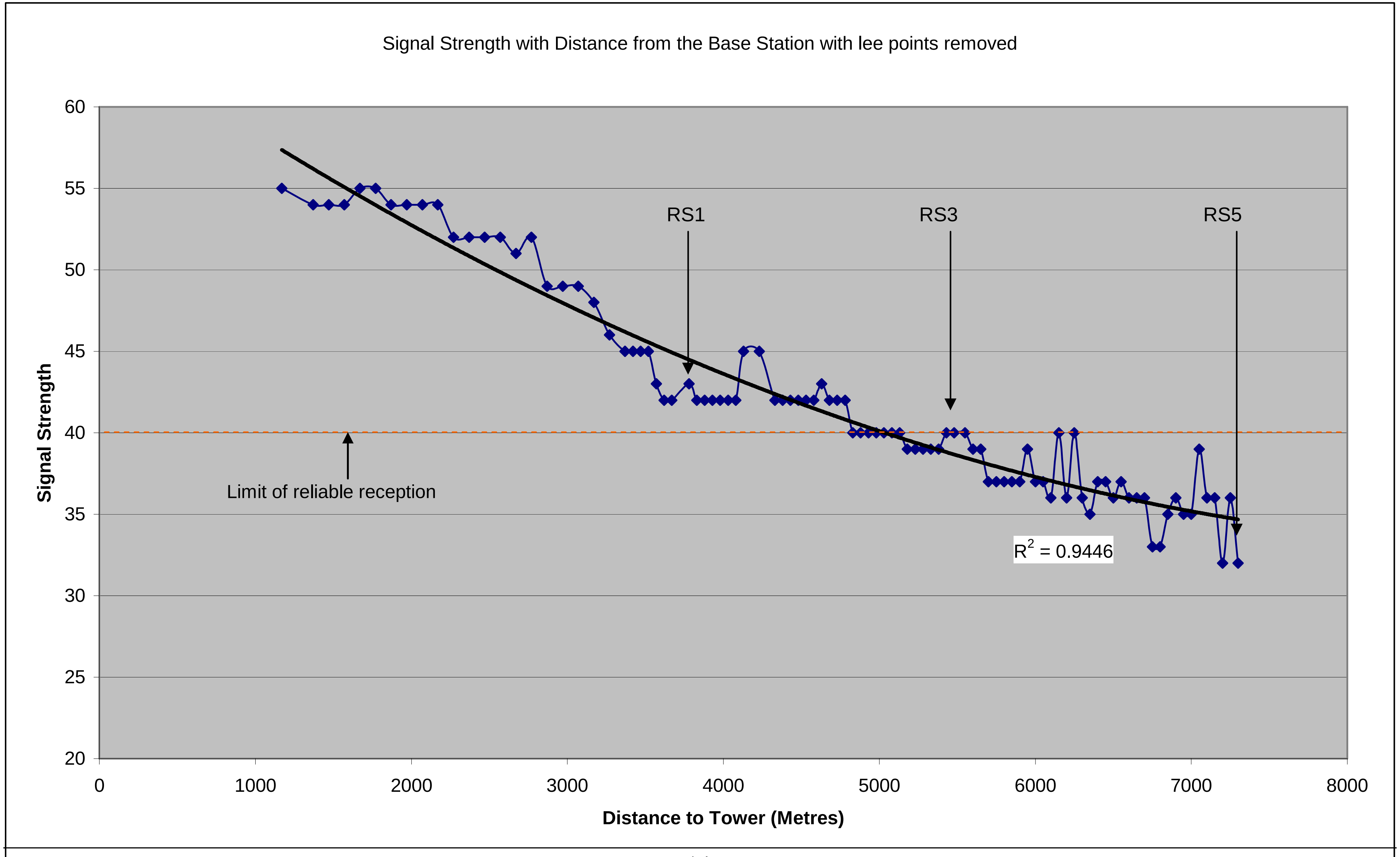
The distance that the long-range µNodes could talk back to a Relay-Spar was tested with the results a shown in Graph Five. The results show a distance of 600-800 metres depending on the polarity and movement of the float and so this is one design that needs further field testing as it is sensitive to the movement and deployment of the float. The results are within the anticipated range of 300 metres so there are no substantial issues just a need to better understand how the signal strength varies with the environmental conditions.

Figure Eight: Track of readings from the Heron Island Base Tower to RS5 (Orange Line).

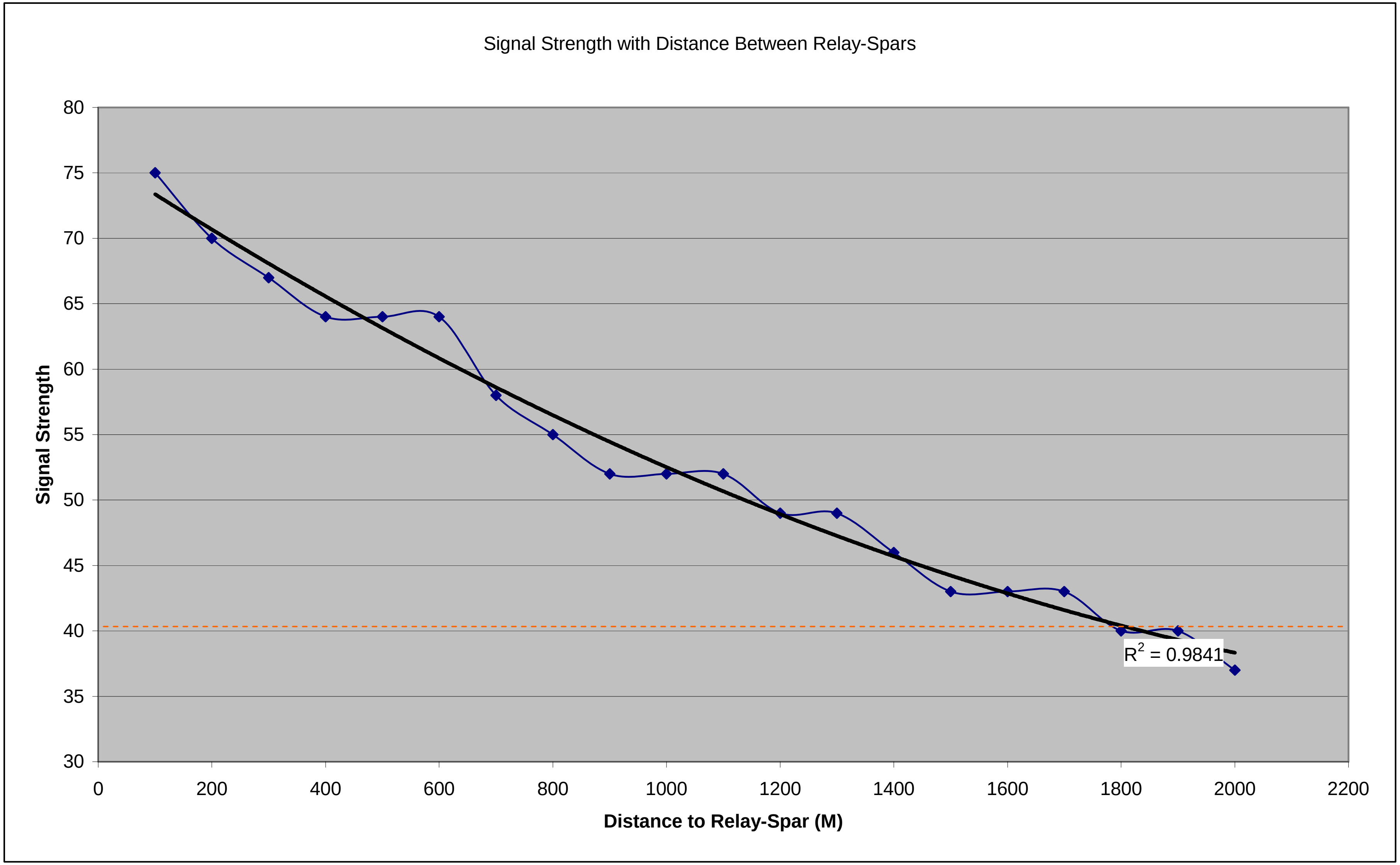
Graph One: **Graph of Signal Strength versus distance from the Heron Island Base Tower along the line Tower to RS1 to RS3 to RS5, minimum reliable signal strength is 40.**



Graph Two: **Graph of Signal Strength versus distance from the Heron Island Base Tower along the line Tower to RS1 to RS3 to RS5 with the points in the lee is the Island removed, R^2 is 0.9446.**



Graph Three: **Graph of Signal Strength versus distance between two Relay-Spars with 1.0m aerials set at 2m above the water on Heron Island, R2 is 0.984**



Graph Four: Graph of Signal Strength versus distance between a Multi-Float and Relay Spar, R^2 is 0.986

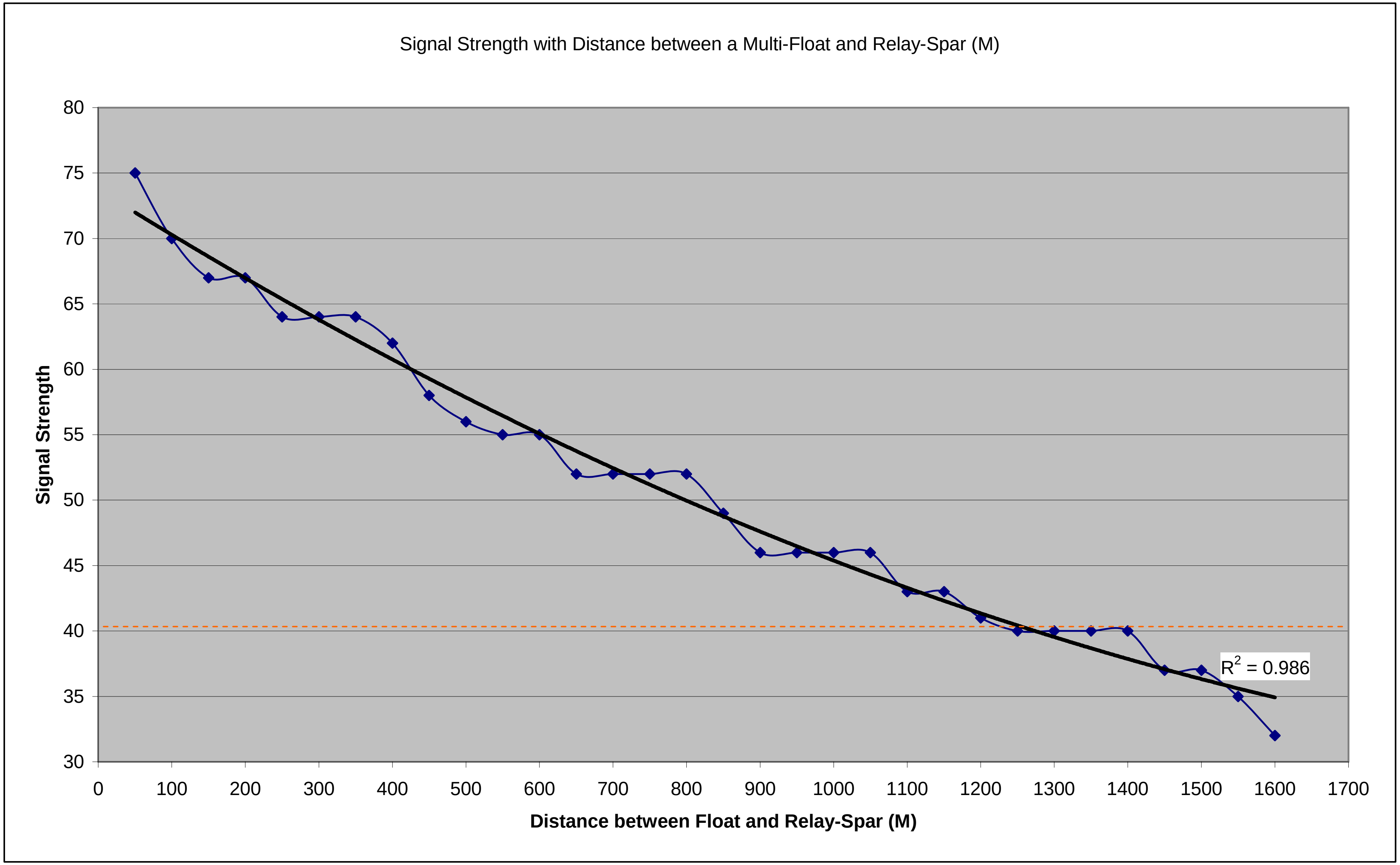
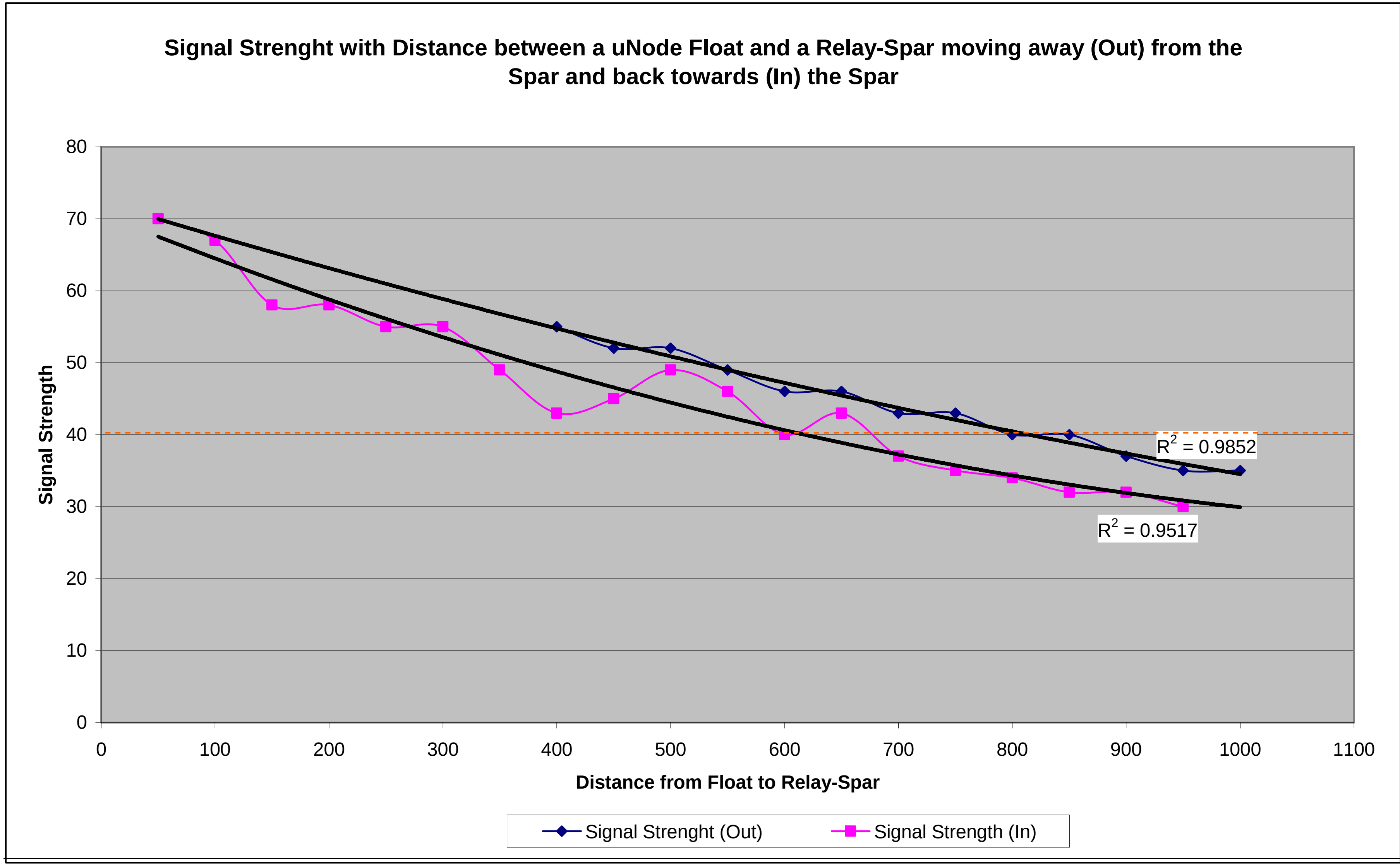


Figure Five: **Graph of Signal Strength versus distance between a long-range µNode-Float and Relay Spar, R^2 is 0.985/0.951**



Across Water Wireless Network Range – One-Tree Island

1. Base Station to Relay-Spar

As the location of the base station was different on One-Tree Island (Water Tower – 10m) to that on Heron Island (Telstra Tower – 19m) the range from the One-Tree Island base station was tested in a similar manner to Heron Island.

Image Ten shows the track away from the base station along which signal readings were taken, the results are shown in Graph Six. The results show that for this set-up the distance of reliable communications is around 2500 metres which is enough to get to all of the proposed Relay-Spar locations.

2. Communications between other on-reef equipment

The conditions in the One-Tree Island lagoon are very similar to those on Heron Island and so the results obtained there will be transferable to One-Tree. For this reason coupled with the limited time available at One-Tree Island due to the tides no other testing was done.

Graph Five: **Graph of Signal Strength versus distance from the Base Tower for One-Tree Island, minimum reliable signal strength is 40.**

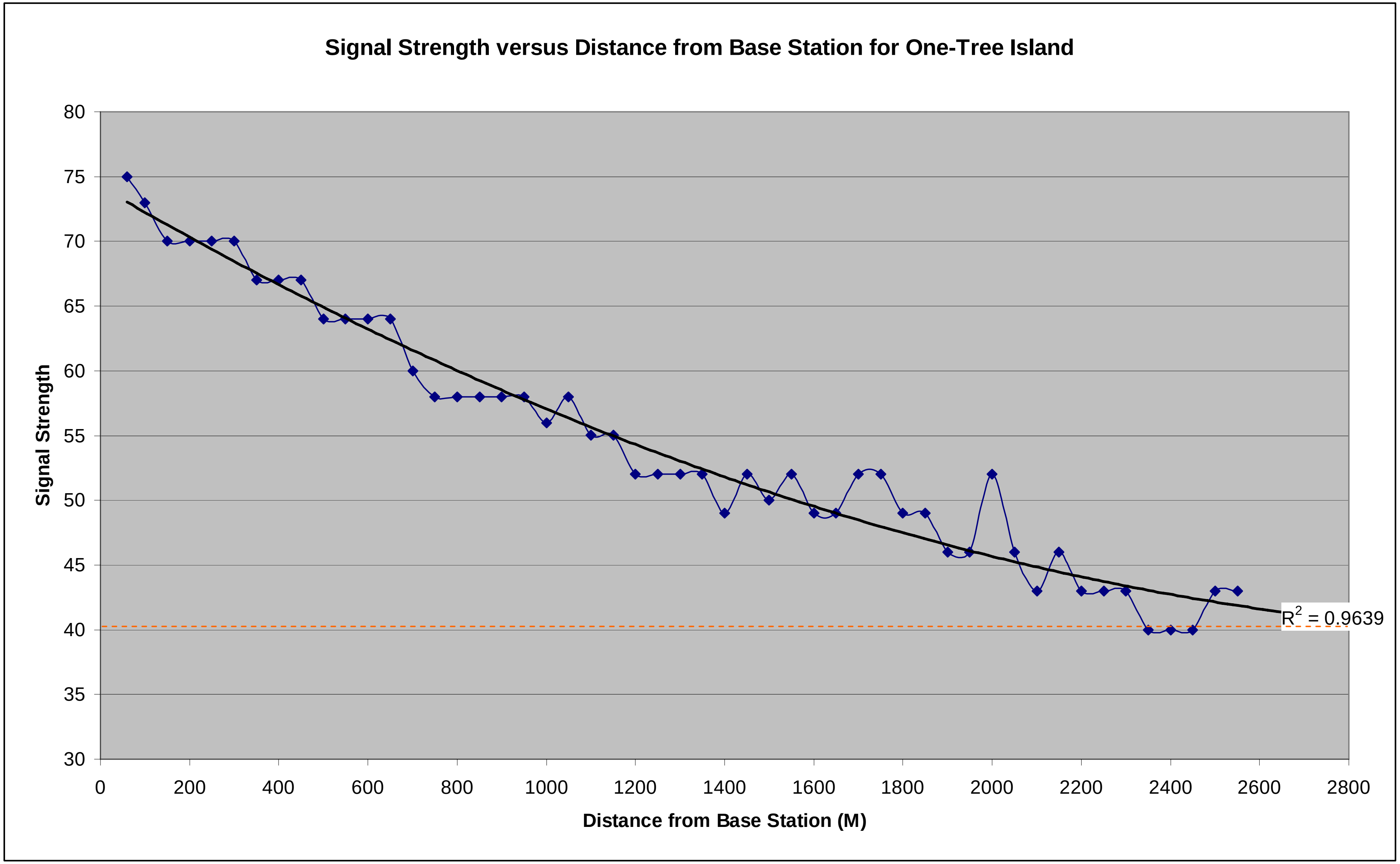


Figure Ten: Track of readings from the One-Tree Island Base Tower.

Proposed Locations of Equipment

For Heron Island the proposal is to have six (6) Relay-Spars forming the on-reef wireless network, a base station located on the Telstra Tower and five µNode Floats in the lagoon. This will be complimented by a Multi-Float located in the Wistari Channel and two on the northern edge of the reef. This is shown in Figure Twelve.

For One Tree the proposal is to have three (3) Relay-Spars which would be set up with instrumentation (effectively making them Multi-Floats), two additional Multi-Floats on the northern side of the reef and two µNode Floats as shown in Figure Thirteen.

Wistari Multi-Float

The initial idea was to measure a vertical profile in the channel from the surface to around 20 metres and also to run a profile from the reef crest down the reef slope into the channel. The geography of the area make this difficult as to get 20m depth to do a full profile you are 200-250 metres off the reef crest and so the one instrument cannot support the length of cable required to do the crest to slope profile and the surface to 20m profile.

The solution maybe to have two floats deployed in this area. The first would be out in the channel and would have a vertical profile of instruments down to 20m. There are some existing floats and navigation markers that we could co-locate the float with to minimise the impact. The second float could be located in one of the ‘pockets’ or inlets along the reef crest where it would be slightly protected and would have a clear sandy run from the crest down the reef slope into the channel. Figure Fourteen later in this document shows example locations.

Conclusion

The site visits were very valuable in being able to field test some of the underlying technologies and to show that the basic design is sound. The visits also set us up for the deployments of the actual equipment in mid 2008 and give valuable information to aid in the design of the equipment.

The visit also allowed the testing of potential communications systems to get the data back in real time using either a microwave or Telstra NextG solution. The microwave link is the preferred solution although there are some potential issues with this (including cost) and so these issues need to be resolved.

The success of the trip was due very much to the help and support of the staff on the research stations on each of the Islands and so the trip was important in building those linkages and ensuring we better understand the needs of the stations and the conditions that we will be deploying into.

Figure Twelve: **Proposed locations of the Heron Island equipment – key: RS = Relay Spar, Multi-Float = Multi-Float Buoy, red squares are μNode floats. Wist = Wistari Channel Multi-Float(s), Tower is the base station on the Island.**

Figure Thirteen: Proposed locations of the One-Tree Island equipment – key: RS = Relay Spar, Multi-Float = Multi-Float Buoy, red squares are µNode floats. Water Tower is the base station on the Island.

Appendix A: Site Details for the Locations of the Relay-Spars

Introduction

This section gives some details about the environment around the proposed locations for the Relay-Spars remembering that this will be fixed structures. This information will be important for designing the equipment as well as for permits.

Heron Island Relay-Spar-1 (RS1)

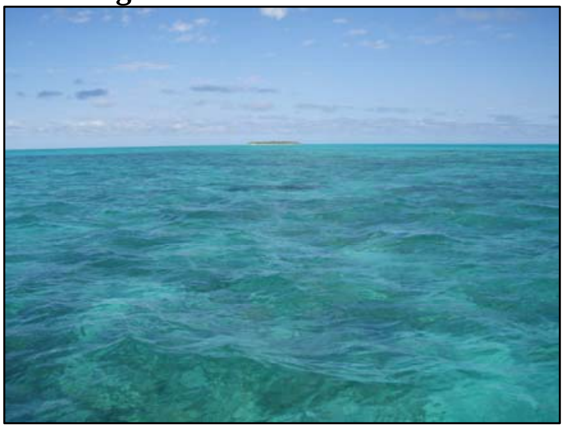
Location: 23° 26’ 43.17”S, 151° 56’ 54.19”E (see Figure Twelve)

Depth at LAT: 0.25m

Description: Flat sandy areas with occasional small coral outcrops, no real large bommies but just a number of smaller bommies.

Signal Strength: 45

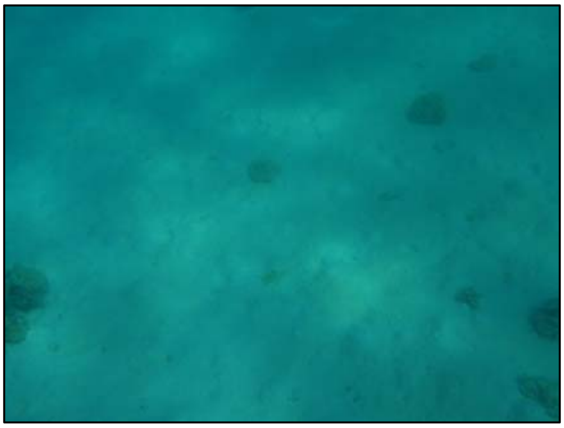
Looking back to Heron Island



View of the bottom

Typical benthos

Benthos



Notes: This area has large sandy areas that are suitable for deploying structures, at low tide it almost dries and so the structure needs to be self standing.

Heron Island Relay-Spar-2 (RS2)

Location: 23° 27' 11.52"S, 151° 56' 46.27"E (see Figure Twelve)

Depth at LAT: 0.1m

Description: Large numbers of small coral outcrops inter-dispersed with areas of sand, shallow and would almost dry on LAT.

Signal Strength: 45

Looking back to Heron Island

General area

General area

General area

Notes:

While this area has more coral cover there are significant areas of sand large enough to locate the equipment in and so there are no real issues with deploying equipment in this area.

Heron Island Relay-Spar 3 (RS3)

Location: 23° 26’ 58.76”S, 151° 57’ 55.74”E (see Figure Twelve)

Depth at LAT: 0.6m

Description: Mostly sand with again a few small coral outcrops and some larger bommies, deeper than some of the other sites.

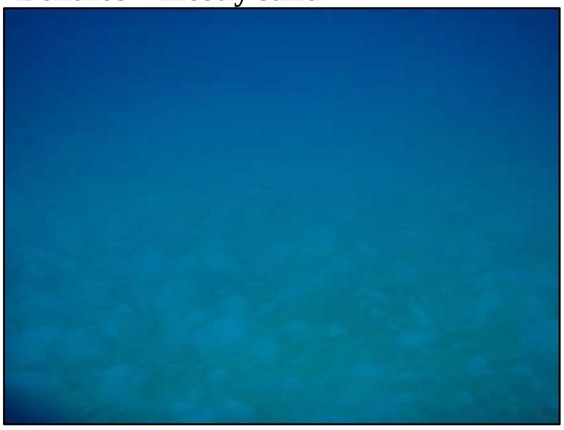
Signal Strength: 40

Looking back to Heron Island

General area

Benthos

Benthos – mostly sand



Notes:

This site is somewhat deeper than the other sites being around 3m deep at high tide and down to 0.5m at LAT. Mostly sand on the bottom.

Heron Island Relay-Spar-4 (RS4)

Location: 23° 27’ 28.74”S, 151° 57’ 38.82”E (see Figure Twelve)

Depth at LAT: 0.4m

Description: Almost all sand with a series of coral bommies forming larger structures.

Signal Strength: Not Recorded

General area showing bommies

General area with mostly sand

General area

Looking back to Heron Island

Notes:

The equipment could be located on the sandy areas between the coral bommies which would protect them and we could be close enough to do video work off the bommies.

Heron Island Relay-Spar-5 (RS5)

Location: 23° 26’ 53.62”S, 151° 59’ 1.89”E (see Figure Twelve)

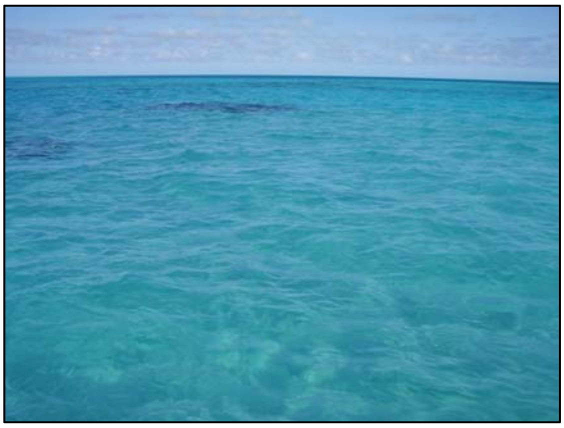
Depth at LAT: 0.2m

Description: Similar to the other sites in that it is mostly a sand bottom with a few smaller coral outcrops, no real bommies in the immediate area.

Signal Strength: 30

Looking back to Heron Island

General area



Typical Benthos

General area

Notes:

Sandy bottom covering 90% of the substrate, a few scattered small coral outcrops, good place to deploy equipment but almost dries on very low tide.

Heron Island Relay-Spar-6 (RS6)

Location: 23° 27’ 46.73”S, 151° 58’ 37.97”E (see Figure Twelve)

Depth at LAT: 0.1m

Description: Almost all sand with just a few coral outcrops, quite shallow and is basically dry on LAT.

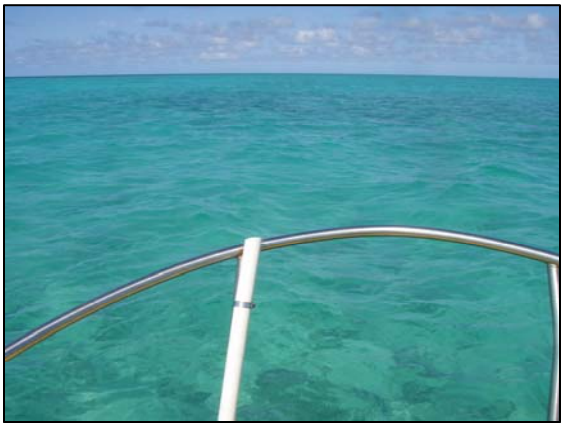
Signal Strength: 32

Looking back to Heron Island

General area

Benthos

General area



Notes:

Shallow sandy area with just a few small coral outcrops and no real bommies, will be dry at LAT and so the equipment needs to be self standing.

Heron Island Wistari Channel Mooring

Location: 23° 27' 24.67"S, 151° 55' 28.01"E (see Figure Twelve) (see notes below)

Depth at LAT: 13m

Description: This site is located in the Wistari Channel off the reef crest, the site is deeper at 13m above LAT and has good coral growth and so is an excellent site to do a deeper profile. See notes below. Note that this site is for a mooring NOT a fixed structure.

Signal Strength: 49

View back to Heron Island

View of benthos

Coral growth in the area

Coral

Notes:

The initial intention was to have a single mooring to do a vertical profile from surface to bottom (20m) and a second profile from reef crest down the reef slope. To get 20m of depth you need to be some 70-100 metres off the crest and so it is not possible to do both profiles with the one mooring.

One solution maybe to have two moorings. The first would be in deeper water in the channel itself (at location: 23° 27' 32.46"S, 151° 55' 38.38"E for example) and the other closer to the reef crest to do the crest to slope profile. The crest has a number of shallow 'inlets' that have mostly sand for the benthos and so would be good sites to run a cable down the reef slope from the crest into the channel. A mooring at location: 23° 27' 30.17"S, 151° 55' 41.75) for example could do this.

Figure Fourteen shows example locations for the two moorings with one near the reef crest located in one of the small inlets in the crest with the sensor string running down the slope and the other mooring further out in the channel with a simple vertical sensor string to give a channel profile reading.

Figure Fourteen: Example locations of two moorings in the Wistari Channel to give a vertical profile from the surface to 20m in the channel (WS2) and a profile from the reef crest down the slope into the channel (WS1).

One-Tree Island Relay-Spar-1 (RS1) (Central Bommie)

Location:	23° 29' 26.9"S, 152° 5' 30.0"E (see Figure Thirteen)
Depth at LAT:	0.5m
Description:	Mostly sand bottom with occasional coral bommies, area goes to 0.5m at low tide, good signal to Base Station. This is a well studied bommie
Signal Strength:	49

Surface view of the area around RS1

Underwater view showing coral bommie

Surface view

Underwater view

Notes:

This bommie is a well studied area and one that is used for other work and so it is a perfect place for the first relay-Spar. It is within easy communications range to the base station and so there will be few communication issues. The area is shallow and sandy and so the basic design of the relay spar can be used.

One-Tree Island Relay-Spar-2 (RS2)

Location: 23° 30’ 05”S, 152° 3’ 49.4”E (see Figure Thirteen)

Depth at LAT: 0.5m

Description: Large sets of circular bommies many with sandy parts in the centre, this would be ideal to locate the equipment in the centre of the bommies and drape the sensor strings over the bommie flat into the deeper water.

Signal Strength: 37

View showing the bommie

Another view showing sand patches

Coral areas in the Bommie

Sandy areas in the Bommie

Notes:

There are a number of large (10-30m) diameter bommies in this area that have large sandy patches in the middle. The ideal deployment would be to locate the Relay-Spar on one of these internal sandy areas and then optionally drape a sensor cable over the bommie into deeper water.

One-Tree Island Relay-Spar-3 (RS3)

Location: 23° 29’ 52.5”S, 152° 3’ 9.9”E (see Figure Thirteen)

Depth at LAT: 0.5m

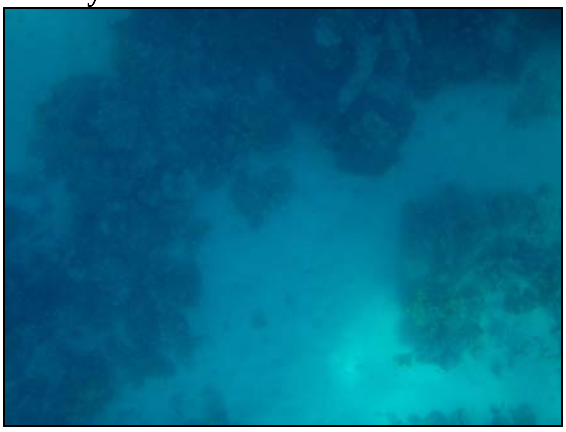
Description: Number of large circular bommies with sandy internal areas, some of these are in deeper water and would be suitable for running sensor strings down, a number form a wall or tongue of coral separating large sandy areas.

Signal Strength: 26

View showing the Bommie

View of the Bommie complex

Sandy area within the Bommie



Coral cover

Notes:

There are a number of suitable areas to choose from, we want one that has a large sandy area in the internal part of the Bommie suitable for deploying the instruments and preferably with deeper water around it over which we can run a sensor string. Overall this is a good place to locate equipment although getting equipment to the site at low tide will be problematic as there are shallow areas between this location and the main island.

Appendix B. Telstra NextG Connectivity Test

Heron Island – Base Station

Aerial:	1.2m 6dB Whip
Location:	23°26'30.06"S, 151°54'44.76"E
Height:	19m
Orientation:	Inverted

Test-1:
Download: 157 Kilobytes/s
Upload: 7 Kilobytes/s
QOS: 66%
RTT: 137 ms
MaxPause: 101 ms
Test location: Sydney

Test-2:
Download: 59 Kilobytes/s
Upload: 7.1 Kilobytes/s
QOS: 74%
RTT: 189 ms
MaxPause: 329 ms
Test location: Sydney

One-Tree Island – Base Station

Aerial:	1.2m 6dB Whip
Location:	23° 30’ 25.1”S, 152° 5’ 30.0”E
Height:	6m
Orientation:	Inverted

Test-1:
Download: 142 Kilobytes/s
Upload: 7 Kilobytes/s
QOS: 69%
RTT: 156 ms
MaxPause: 527 ms
Test location: Sydney

Test-2:
Download: 122 Kilobytes/s
Upload: 6.1 Kilobytes/s
QOS: 94%
RTT: 155 ms
MaxPause: 100 ms
Test location: Sydney

Appendix C. GPS Points

The following is a Google Earth KML file of the way points collected in the study, to use this copy the text below into a new file called ‘temp.kml’ and then open that file using Google Earth.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