Operation Wittenoom VH-MDX Research

Introduction

To understand why aircraft do what they do (and why they crash), it is vital to understand the systems behind it, and, how the pilot interacts with the airplane. I have written this using a ‘zero assumed knowledge’ approach.

There are many things to consider when attempting to plot a “best chance of success” search area for MDX.

This include -

1 – Basic flight theory

2 – Limitations of research material

3 – Human factors and performance

4 – Limitations of technology of the day

5 – Reliability of witness statements

6 – Collating all available information and cross checking it for accuracy

In preparing this submission, I have tried to take into consideration of every variable I can think of. I have deliberately not included witness statement references in this, relying only on what I can prove to a reasonable degree with mathematics, science and verifiable data. Unfortunately, some assumptions will need to be made, as it is an incomplete ‘bigger picture’. I have not used some of the theories put forward by Operation Phoenix, but have included a section on that book at the end.

I have an extensive background in aviation, and have studied many of the underlying principles related to aviation in an effort to better understand the aviation environment and make it a safer environment to operate in. Specifically to this investigation, I have questioned people that are authorities in their respective fields, and read instructional books relating to those aspects. Almost all of these publications are available to use on the internet, and for those unavailable, I have e-copies that I would be able to email.

A list of material and persons referred to is below –

Cessna 210 Pilots operating handbook (Source – VH-MDZ, a ‘sister ship of MDX)

Fundamentals of Air traffic control, 5th edition by M. S Nolan (no relation)

National Archives of Australia file S1/812/1036

ATSB investigation into C210M VH-WBZ

http://www.atsb.gov.au/publications/investigation_reports/2011/aair/ao-2011-160.aspx

ATSB Investigation into PA-31 VH-PYN

http://www.atsb.gov.au/publications/investigation_reports/2005/aair/aair200506266.aspx

ATSB Publication “VFR Flight into IMC”

http://www.atsb.gov.au/publications/2011/avoidable-4-ar-2011-050.aspx

ATSB Publication “An overview of spatial disorientation as a factor in aviation incidents”

http://www.atsb.gov.au/publications/2007/b20070063.aspx

ATSB Publication “Mountain wave turbulence”

http://www.atsb.gov.au/publications/2005/mountain_wave_turbulence.aspx

Wikipedia entry – “Lee Waves”

http://en.wikipedia.org/wiki/Lee_wave

Operation Phoenix by D A Readford

Squadron Leader Ian Harrower, RAAF (ATC/RADAR operator)

Ron Griffin, FSO Sector operator Sydney – 1974 – 1976 West Australia 1976 - 2000

Particularly useful was Fundamentals of air traffic control, chapter 8, as that contains instructions, operating principles and design limitations of radar installations that were in use at both RAAF Williamtown and Sydney in 1981. SQNLDR Harrower was also very informative providing a ‘human factors’ insight into the operation of the radar, and giving his opinion on what may have transpired. This aspect is of particular importance, as any location that a search may be based around will more than likely rely heavily on radar data.

Basic flight navigation theory

Flying an aircraft has many similar features with other modes of transport, such as driving a car, but there are many more considerations to be taken into account when thinking about the operation of an aircraft. Where a car moves in 2 planes, relative to the ground, an aircraft moves in three. In a car, you are largely restricted to using the predetermined road network, and whilst navigation is a consideration, being able to move in all three planes in space, at much larger speeds, unconfined by an inflexible grid for movement, being unable to stop unless reaching a suitable destination and only having fixed resources at your disposal adds to the level of complexity.

Aircraft navigation can be boiled down to 4 simple building blocks, of which the rest of the operation can be built on. Speed, Distance, Time and Direction. This is known as 'deduced reckoning' (DR or dead reckoning). That is to say, if you leave point A, on a certain compass bearing, for a certain amount of time, at a certain speed and cover a certain distance, there is only one place that you will be able to be. That is the simplest principle behind air navigation. In reality, there are many other factors involved in this matter. I will endeavor to only address the factors relevant to this particular scenario.

The first will be wind strength and direction. When standing on the ground, and the wind is blowing around you, the air mass is moving relative to you and the ground. If you were to release a balloon, it would float away. In nil wind, it would float straight up, but if the air mass is moving, it will not only float up, but away from you in a horizontal plane. This affects anything that leaves the ground. Speed is measured in two ways when navigating an aircraft, AIRSPEED and GROUNDSPEED. If you are in an aircraft heading due east at 090 degrees, doing 100 knots, and there is nil wind, you will be moving across the ground at 100 knots. This is because the mass of air is not moving relative to the ground. Now if the wind picks up and is blowing 10 knots from the west, your airspeed is still 100 knots, but your groundspeed would have decreased by 10 knots to 90 knots, as you are 'swimming upstream'. Bearing that concept in mind, your airspeed and aircraft configuration has not changed in any way, but you are now moving 10 knots slower, and will not cover the same amount of distance across the ground in one hour as you would in a nil wind condition. The reverse of this is also true, if the wind was blowing from 090 degrees (behind you, or, a tailwind), your airspeed would still be 100 knots, but you would now be doing 110 knots across the ground.

In the previous examples, the wind was either directly opposing or directly assisting the aircrafts movement over the ground. If the wind is blowing at an angle relative to the movement of the aircraft, the speed difference across the ground will affected by an appropriate amount. For example, on the same aircraft flying due west, and the wind now coming from due south, 180 degrees, the wind is blowing at a right angle to the aircrafts movement, so the speed would now be 100 knots airspeed and 100 knots ground speed. This is known as a crosswind component.

This last example now adds another element in aircraft navigation. The aircraft in the example above would have gone 100 nm but it would not end up at its intended point (point B for simplicity). It would actually end up some distance to the north, as the air mass would have blown it north, if it maintained its compass heading of due west (270 degrees). The aircraft TRACK across the ground (Track made good, or TGM) would actually be measured, if you were drawing the flight path on a map as 276 degrees.

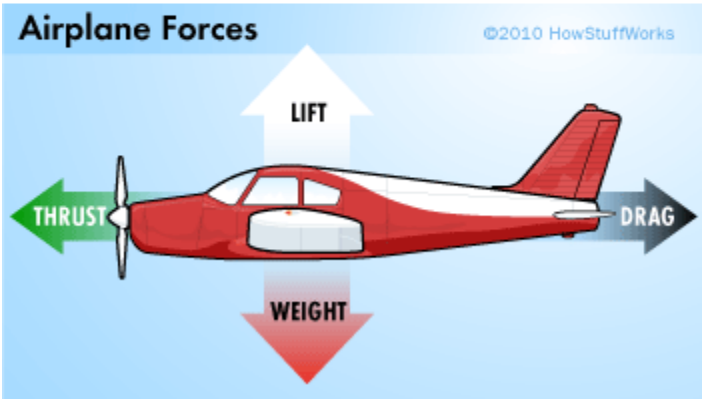
To have the aircraft track across the ground at the planned track of 270 degrees, the pilot would have to apply a course correction, and would steer a compass heading of 264 degree to end up at point B. And now that the aircraft is turned ever so slightly into wind, it also has a small headwind component of 0.5 knots!

When viewed by a third party, like a radar operator on a screen, they don't see the aircraft heading, (the direction on the compass the pilot is steering to arrive at his destination, corrected for wind) they only see the track made good across the ground/radar display. They also only see the aircraft groundspeed.

Aircraft performance

The aircraft in question is moved through the air by the use of an engine/propeller combination power plant. The engine turns the propeller at a ratio of 1:1, that is, every rotation of the engine crankshaft equals one rotation of the propeller. The amount of power the engine develops is governed by the use of the throttle, measured by the manifold pressure gauge, and the propeller pitch control, measured by engine RPM. Altering these two settings results in different combinations of engine power, to best suit the phase of flight the aircraft is engaged in (Climb/Cruise/Descent). These are usually expressed as percentages of the engines rated power. The engine fitted to MDX was rated to develop 300 BHP at maximum power (full throttle, 2850RPM) and 285 BHP at maximum continuous power (2700 RPM). As stated, different phases of flight require different power settings. At take off, and engine is usually developing maximum rated power, referred to as take off power. Shortly after that, power is reduced to either maximum continuous power, or if applicable, a climb power setting. Depending on the requirements, a cruise/climb power setting may be adopted. When climbing, the aircraft performance is referenced to a particular airspeed. In the case of MDX, the absolute best climb performance that may be expected in still air would be an indicated airspeed (IAS) of 78 knots, using full power. As aircraft weight increases, and height increases during the climb, the climb performance correspondingly decreases. Climb performance is measured in Feet per Minute (FPM) on takeoff, at maximum takeoff weight, at sea level, MDX could reasonably expect a climb performance in the order of 700-800 FPM. Climbing at maximum power is hard on the engine, uses a large amount of fuel and slows the aircraft ground speed. Typically, when terrain clearance and airspace clearance allows, pilots will use a cruise/climb power setting and IAS. This enables a higher ground speed at the cost of a higher rate of climb, and is easier on the engine, allowing a higher airflow for engine cooling. On the flight plan filed by the pilot of MDX, he has written that he will be using a cruise climb IAS of 110 knots, in the field marked CLIAS. This would be an IAS used by the pilot during normal operations on climb to the cruise altitude of 8000 feet. The use of this setting would not provide the best ROC that the aircraft was capable of.

As the aircraft moves through the air, there are 4 forces at work on the plane. Lift, Weight, Thrust and Drag.



The pilot is able to manage these forces with various inputs into the aircrafts configuration, using the control surfaces and power. To climb the aircraft, the wing needs to produce more lift than weight. The pilot does that by increasing power and raising the nose of the aircraft, which increases the amount of lift it produces by changing the wings angle of attack. This also increases drag and decreases the airspeed. There is a ratio, called the best lift to drag ratio, where the most amount of lift is produced for the least amount of drag, and is different for every wing. This ratio will correspond with a particular airspeed, and will provide the best climb performance possible. In cases where terrain clearance is the primary concern, or the aircraft is caught in a strong downdraught, the pilot is expected to apply maximum continuous power and elevate the nose of the aircraft and maintain this speed. In the case of MDX, this is 78 knots airspeed. At 78 knots airspeed, the wind still needs to be factored in to obtain the ground speed. The airspeed indicator on the 210 has a marking at 80 knots, and most pilots will use this, as it is 'close enough' for sake of convenience whilst in flight for an aircraft of that type.

As the pilot is trying to climb, as indicated by the transcript, it would be more reasonable to expect that any DR calculations would take into account speeds closer to this speed, rather than cruise airspeed.

As the flight progressed, and at the point where the situation became dire, the pilot would have selected a power setting and IAS that would result in the maximum rate of climb that the aircraft was capable of. The reasons for setting this are as follows

- Downdraughts
- Turbulence
- Terrain clearance
- Ice accretion
- Height above MSL

In a downdraught, the air mass the aircraft is in is being pushed down to the ground. To overcome this, a 210 at close to MTOW (as MDX was, established by it was 26kg below MTOW when leaving YBCG, and had only burned 109 minutes of fuel) would require significant, if not maximum, power to overcome and the IAS that the maximum ROC can be expected, depending on the strength of the downdraught. The pilot reported he was in downdraughts of 1000 FPM. A normal descent for an aircraft of that type would only be half that (500 FPM). As the pilot knew he was over high terrain, and experiencing aircraft performance problems, it is reasonable to presume that he would set maximum power and “best rate” IAS of 78 knots. The use of this speed would also put the aircraft below the maximum speed for turbulence penetration.

When and if the aircraft encountered an up draught, the power would be reduced and the nose of the aircraft pushed into a descent profile, but the airspeed would only increase slightly due to the reduction in power

Anecdotal evidence provided by other pilots that operate C210 aircraft indicate that in a situation that required slowing the aircraft down in abnormal situation, landing gear extension is a common practice, as it increases drag and slows the aircraft. The use of flap for this method is not recommended as it adds extra aerodynamic stress to the wing structure which may compromise it in moderate to severe turbulence.

Turbulence penetration

Turbulence penetration is particularly important in the case of MDX. At speeds greater than the rated turbulence penetration speed, the aircraft runs a very real and imminent danger of in-flight breakup. This speed varies as a function of aircraft weight. The C210M Pilots Operating Handbook (POH) list that for MTOW (1723kg) the maximum Va is 119 knots IAS down to 95 knots at 1134kg. The speeds for weights between these two point are linear and may be plotted as such. The Va for MDX at the time was around 110 knots. The cruise speed for MDX would be around the order of 140 knots, 30 knots higher that the speed that restricts full or abrupt control movements, such as those required in turbulence.

As can be seen, the speeds required to cause an in-flight breakup are not very high for a C210M and the typical cruise speed for MDX is well above this IAS. To not reduce power and airspeed in a C210 during periods of severe and sustained turbulence would surely result in the loss, with little or no warning, of the aircraft at a much earlier point. This can be evidenced by the attached ATSB report into the in-flight breakup of an identical make and model (Cessna 210M, serial number 21061846, DoM 1977, MDX was Serial 21061678) aircraft that was destroyed by flying through a storm and associated turbulence. VH-WBZ, 7 Dec 2011, left Roma in Queensland and was found destroyed the following morning. The advanced after market data monitors installed on that aircraft showed it had cruise power set right up until electrical power was lost, the electrical power loss being caused by the in-flight break up.

It is important that any search areas put forward are carefully scrutinized for validity, bearing in mind the wind direction, wind velocity, and IAS with reference to Vno/Vne/Va to see if it is even possible for the aircraft to transit from one point to the next given the properties of the aircraft and flight path.

The reason I believe that “best rate” climb configuration would have been used by the pilot of MDX, and that calculated aircraft speeds should be based with this in mind, is as follows –

- The pilot repeatedly states that he is trying to climb, and would be well aware of the aircrafts performance limitations at that height AMSL and that aircraft weight.
- The pilot states that he is in cloud, with suspect instrumentation, with clear air above him, the primary concern will be to re enter VMC as quickly as possible, and at a lower ROC, that could take some time, if at all.
- Terrain clearance would also be of primary concern, and maximum ROC would be the only hope of assuring terrain clearance.
- Turbulence/downdraughts would also degrade climb performance, and without full power and “best rate” climb speed, the aircraft may lack the performance to ensure a positive ROC. Depending on the strength of the downdraught, even in the “best rate” climb configuration, the aircraft still may lack the ability to climb.
- With all this going on, there is no reason to initiate a descent. The aircraft may have descended in a downdraught, but the pilot would have been trying to counter that by using the above methods. There would be little, if any, increase in IAS.
- From the time where he says he is going to climb to 10000, the pilot is trying to climb. At no point does he say he has leveled off, or will be deliberately descending for any reason, and in fact makes reference to his attempts to climb throughout the transcript.

Effect of Vacuum pump failure on the aircraft and flight path

The stated loss by the pilot of the Artificial Horizon (AH) and Directional Gyro (DG), was communicated to the controller at quite a late stage in the flight, 09:24:37, well after two hours from leaving the Gold Coast. These two very important instruments, in MDX, are powered by the engine driven vacuum pump.

The way the DG (also referred to as the Heading indicator, or HI) works like this –

- The primary means of establishing the heading in most small aircraft is the magnetic compass, which, however, suffers from several types of errors, including that created by the "dip" or downward slope of the Earth's magnetic field.
- Dip error causes the magnetic compass to read incorrectly whenever the aircraft is in a bank, or during acceleration, making it difficult to use in any flight condition other than perfectly straight and level.
- To remedy this, the pilot will typically maneuver the airplane with reference to the heading indicator, as the gyroscopic heading indicator is unaffected by dip and acceleration errors.
- The pilot will periodically reset the heading indicator to the heading shown on the magnetic compass.
- The heading indicator is arranged so that only the horizontal axis is used to drive the display, which consists of a circular compass card calibrated in degrees. The gyroscope is spun either electrically, or using filtered air from a vacuum pump (sometimes a pressure pump in high altitude aircraft) driven from the aircraft's engine.
- Because the Earth rotates (ω, 15° per hour), and because of small accumulated errors caused by friction and imperfect balancing of the gyro, the heading indicator will drift over time, and must be reset from the compass periodically.
- Normal procedure is to realign the direction indicator once each ten to fifteen minutes during routine in-flight checks. Failure to do this is a common source of navigation errors among new pilots

As they are gyroscopic instruments, small weighted wheels inside them are made to spin by the flow of air created by the vacuum pump. If the vacuum pump fails, these 2 instruments will no longer work.

But, when the vacuum pump fails, the instruments don’t just suddenly stop working like a light bulb. The spinning gyroscope weights inside them slowly wind to a stop due to the spinning inertia. Sometimes, especially during high pilot workload, this failure may go some time before being noticed. If the failure is a result of the vacuum pump, that failure also may go un-noticed. The vacuum pressure is monitored by the vacuum gauge, more often than not, a small gauge not directly in view of the pilot. Some aircraft have a warning light that illuminates at low suction pressure, some, like MDX, do not.

After the actual failure of the vacuum pump, unless the pilot looks at suction gauge, the instruments will initially continue to function, but their performance and reliability and function will degrade from the point in time of failure. As previously stated, this may be some time, as much as 15 minutes! During this time, the gyros are spinning down and slowing down. As the aircraft turns, as DG is no longer as reactive as required. Every time the aircraft turns onto a new heading, it will not be on the correct heading, it will be under-reading. That is to say, if the aircraft turns from 180 degrees to 220 degrees, a heading change of 40 degrees, the actual heading will be closer to 250-260 degrees. The aircraft is now turning faster than the DG is indicating. If the failure is not noticed, the pilot may wish to take up the heading of 240, but as the DG is not reacting as fast as required, by the time the DG reads 240 degrees, the actual aircraft heading will be closer to 250-260 degrees.

There are many reasons why this is relevant to MDX and tracking its flightpath. One of those is being able to track the aircraft with the use of DR. The point of failure can most likely be attributed to sometime shortly after passing Taree. The aircraft was successfully navigated to Taree from the Gold Coast on time and on track. MDX then continued towards Williamtown for a short time, before turning to resume the flight as planned, via Craven. I suspect it was during this time between Taree and about Nabiac that the vacuum pump failed. The pilot indicated he wanted to turn to go to Singleton via Craven, but somehow ended up approximately 36nm north of the expected position (Singleton). This also leads me to believe that when he reported at Craven at 1918, I suspect that he was in fact, not at Craven, but to the north of that. Factoring in the prevailing wind and the reaction of the DG to the vacuum pump failure, the course actually flown would have been to the north of Craven, with a turn to the south west to bring it to the point where it was radar identified 36nm north of Singleton on the Singleton – Mount Sandon track. The reason for the dog leg, is that the pilot, thinking that he is at Craven, would have initiated a turn to go to Singleton, and that turn being affected by the same problem with the DG. Shortly after that, the failure would have become apparent, as by that stage, the artificial horizon (AH) would have become unusable and highly noticeable in cloud. This passage from an AOPA (Aircraft Owners and Pilots Association) study on vacuum pump failures –

- "… the slow death routine of most Attitude Indicators is at first very difficult to identify. Attitude Indicators die like bad actors in early western movies, taking forever to draw out the scene."

The internet is littered with stories and studies related to pilots flying into Instrument Meteorological Conditions (IMC, ie, cloud, rain snow etc) with a failed vacuum pump and crashing.

Limitations of research material

The accident occurred in 1981. Since that time, our technology, and our understanding of that technology has been somewhat improved. Unfortunately, we must rely on records and devices conceived and built in the 70's to try and deduce what reliable information may be used in the search today.

Tandberg Tapes and timings

All transcripts were based on the automatic voice recording equipment housed in the air traffic control center in Sydney. These were large "reel to reel" Tandberg tapes that recorded everything that went on at the centre on a 5 channel tape. One of those channels was the calibrated time stamp, where a voice automatically called out a time at a predetermined interval, usually each minute. This automatic track was underlying all other recordings made on the AVR. Also captured was any air to air communications, any air to ground communications, ground to ground communications and any communications made by controllers between themselves.

A specialist was then engaged by the Air Safety Investigations Branch (ASIB) to make a typed, time stamped transcript of all communications about the incident. This also included a sound spectrographic analysis of sound transmitted without voice modulation, to aid in identifying any factors in the accident.

These were timed down to the second, by calibrated machines, and there is no reason to suspect that the accident and the events preceding the loss of radar have been timed inaccurately. The spectrographical analysis also supports this. Further, the recordings made at Williamtown and the recording made in Sydney share identical time stamps. To suggest that both of these are wrong is unlikely in the extreme. Unless it can be proven otherwise, I believe the assumed timings used in Operation Phoenix are not correct. The reason he gives for adding his timings are that there was a difference between the playback and record speed, the time stamps being missed due to transmitting aircraft, tape edits and tape gaps.

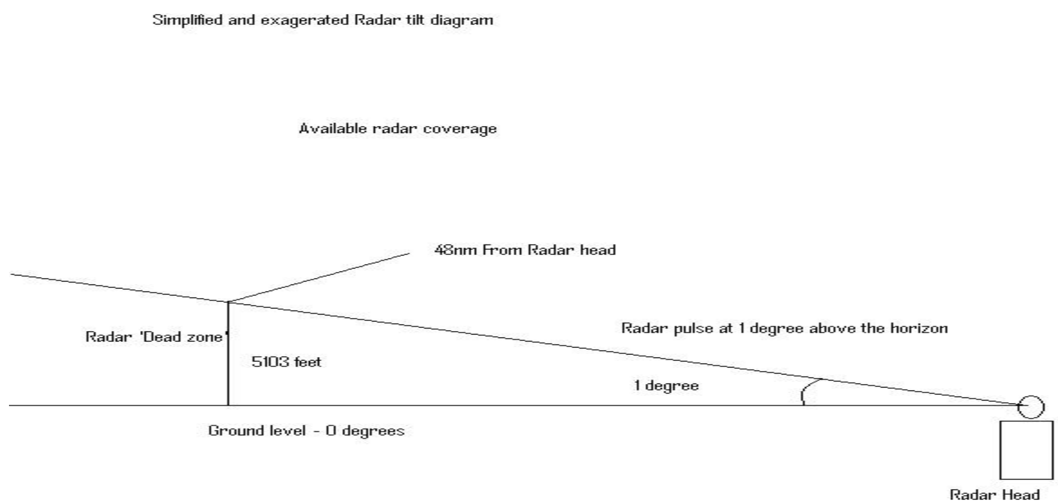
These errors are actually quite simple to explain. The original AVR was the 5 channel Tandberg tape described above. These were taken and recorded by Air Safety Investigation Branch (ASIB) onto a different format of ¼ inch magnetic tape that isolates each channel. The audio was then shared by various agencies involved with the investigation and search. But it wasn't shared in its original form. Reel to reel tapes where difficult to share, but had the advantage that they could hold the entire recording in one contiguous format, without breaks or the need to change tapes. When it was shared, it was shared by the use of cassette tapes, which hold half their lengths on opposite sides, requiring a tape change when it ran out. These also didn't record at exactly 1:1. I am in possession of one of those original tapes. What is heard on those tapes that is referred to a time stamp is not the timestamp put on there by the machine, but just some guy in the room when the transfer recording (not at the time of the AVR recording on the 9^{th} of August, 1981) was taking place and just simply calling out the time as he estimated.

Radar position fixes

Having spoken at length to a senior air traffic controller who used the equipment that much of our information is based on, a number of limitations have been explained in detail. The phrase used by this ATC was ‘more art than science’ back then. Radar back then came in 2 forms, primary radar and SSR. SSR (Secondary surveillance radar) is a radar system used in air traffic control (ATC), that not only detects and measures the position of aircraft i.e. range and bearing, but also requests additional information from the aircraft itself such as its identity and altitude. Both these information sources were integrated and displayed on the same screen. Unlike primary radar systems that measure only the range and bearing of targets by detecting reflected radio signals, SSR relies on targets equipped with a radar transponder that replies to each interrogation signal by transmitting a response containing encoded data.

Primary radar can see anything that reflects a signal back to it, but SSR can only ‘see’ the transponder. Whilst 2 primary radars could see the same target at the same time, SSR could only be interrogated by one radar station at once. Also, radar stations located in different locations would see the same target in different locations! But the most important information to take from that is that only one radar (Sydney OR Williamtown) could see the SSR ‘squawk’ at any time, not both. The time that Sydney ceased interrogating the transponder on MDX, and Williamtown started was the time when the transponder code was requested to turn to ‘squawk 3000’, slightly before 09:35:41.

The radar screens of that era were the archetypal green screens with a clockwise moving sweep seen in movies. The radar updates are dependent on the speed the radar head rotates at. In the case of Williamtown in 1981, a sweep took 4 seconds and went clockwise. Therefore, once a target was interrogated by the beam, the target would move and next be interrogated 4 seconds later. In order to reduce clutter close to the radar head, the transmitter was angled up above the horizon by 1 degree. This was so reflections at a close range on the ground would not provide clutter around the radar head. This also had the issue of preventing the radar picking up any targets below this azimuth. As the range from the radar increased, the ‘dead area’ below the line created by drawing a line from the radar head upwards by 1 degree to the horizon forms a triangle. Using simple mathematics, any given distance along this line will give an altitude below which, a target will not be able to be detected by radar.



Using the simplified (not to scale and exaggerated) radar diagram above you can see that as an angle continues, it subtends to cover a greater distance. Therefore the area not covered by radar below this line gets larger the further from the radar. Interestingly, with the 1 degree tilt found on the radar head at Williamtown in 1981, using simple trigonometry, we find that at a distance of 45nm from Williamtown, the altitude where it a target will do longer be detected is 4800 feet. If you recall, the last reported altitude by MDX was 5000 feet, and the same time it faded from radar and radio contact was lost.

There is also a number of other limitations that radar had then (and even now). Moving target indicator circuitry (MTI) was built into the radar, which eliminated slow moving or stationary targets from the radar screen. It was set at a pre-determined speed, called the MTI gate. Anything below this threshold, the radar screen would not display. This included buildings, road traffic and most weather patterns. On the night of August 9, 1981, a very strong westerly wind was blowing heavy cloud, rain, sleet and snow in an easterly direction, at a speed above the MTI gate, enabling the radar to pick up the weather patterns, increasing the clutter on the primary radar. Without the SSR interrogation integrated by the radar into the primary return, it would be very difficult for the controller to identify MDX. There are other ways that affect if a radar displays a return. One is how the aircraft is moving, relative to the radar. If the aircraft is moving directly toward or away from the radar, it has quite a high speed, and will not be filtered out by the MTI. If it is moving at roughly right angles, the radar may filter out the return with the MTI circuitry, as there is no or very little phase shift between successive returns. The Williamtown controller does mention the use of his MTI control twice.

Further research has revealed that the Williamtown Radar was set to a range of 48nm on that night, and the MTI Boundary was fixed at 44nm. Beyond 44nm permanent echoes were visible on the radar screen, and a primary paint would have been indistinguishable from the PE ground clutter.

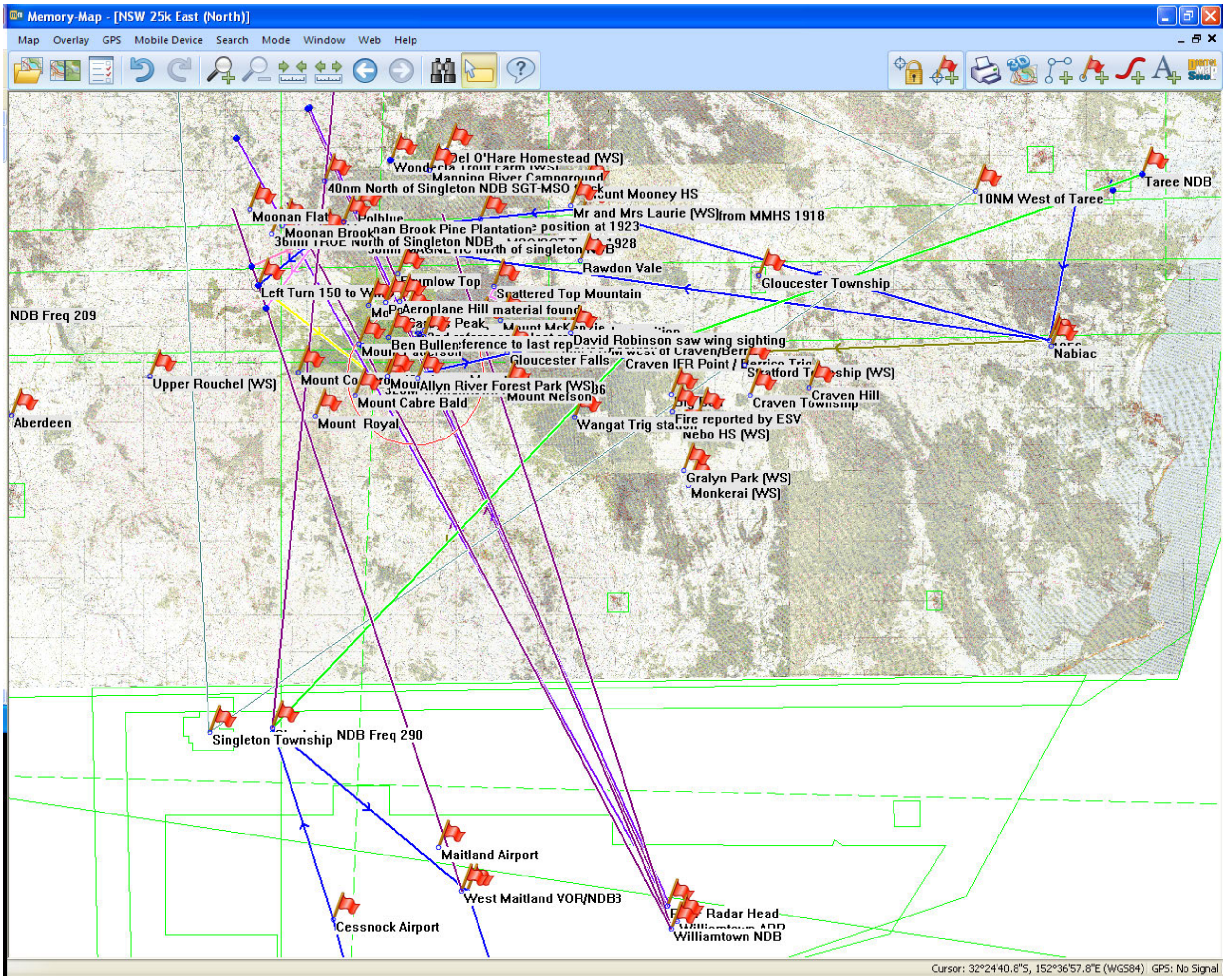
Another consideration is what is known as the radars blindspeed. This is a function of the radar frequency, and effective defences against this were in place, and therefore are not considered to be a factor.

Another difficulty with determining an aircrafts track was that if the target was stationary, or very slow, or moving round and round in a tight circle, there would be no perceived movement on the screen for some time, or at all, and it would appear to be at the same distance and bearing to the radar head. It would be difficult for the operator to ascertain the track the aircraft was flying on.

Both Primary and SSR were in operation on the evening of the 9th of August, 1981. Both these types of radar suffered from certain limitations. Things such as large trucks, buildings, clouds and even birds were able to be picked up by the radar. This had the effect of cluttering up the display.

MDX Barrington tops overview

Below is a large scale view of the Barrington tops. It has every geographical piece of information overlaid on it. This includes information contained in “Operation Phoenix” for comparison purposes. Further pictures will be less cluttered, as they will be zoomed into the relative area being discussed at the time.



The purple lines are ‘reference lines’. When parts of the transcript say that, for example, he is ‘36nm north of Singleton on the Mount Sandon / Singleton track’ there is a line drawn between the Singleton NDB navigation aid, and the Mount Sandon VOR navigation aid. Then, a point 36nm north of Singleton on that line is marked.

The Mount Sandon / Singleton track, like the Taree / Craven / Singleton track, are registered IFR airways. That is to say there is a set, surveyed route between those points, with published lowest safe altitudes, planned track headings and names. The Mount Sandon / Singleton route is called W180, and will be referred to as such from now on.

The other purple lines are magnetic bearings from West Maitland NDB/VOR (1 line) and 7 from RAAF Williamtown, on bearings of 320M, from the RAAF Radar head, NDB and ARP, 325M, from the RAAF Radar head, NDB and ARP and 330M, from the RAAF NDB.

The bright green lines are the track planned by the pilot of MDX as per his flight plan.

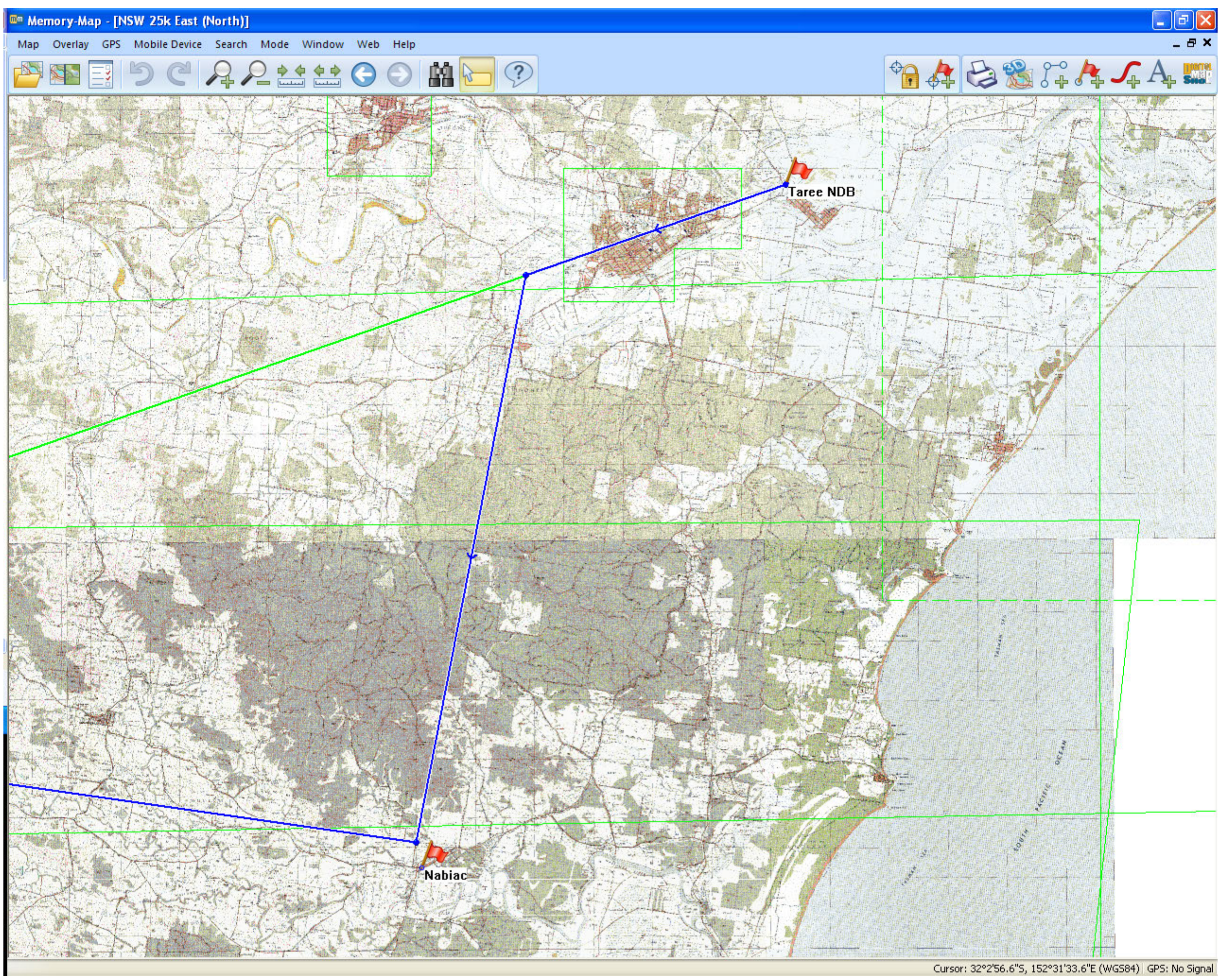
The mustard colored line indicated the flight path that the pilot thought he was taking when turning from Nabiac to go to Craven.

The orange and yellow and red lines are possible flight paths, where there is information that conflicts with other information.

The bright blue lines are the shortest distance between points that MDX was either observed by radar or deduced by 'listening' to the recording. These are not the actual flighpaths, as they may have variances in them from the straight line distance. They are just the quickest and most direct to route between two points.

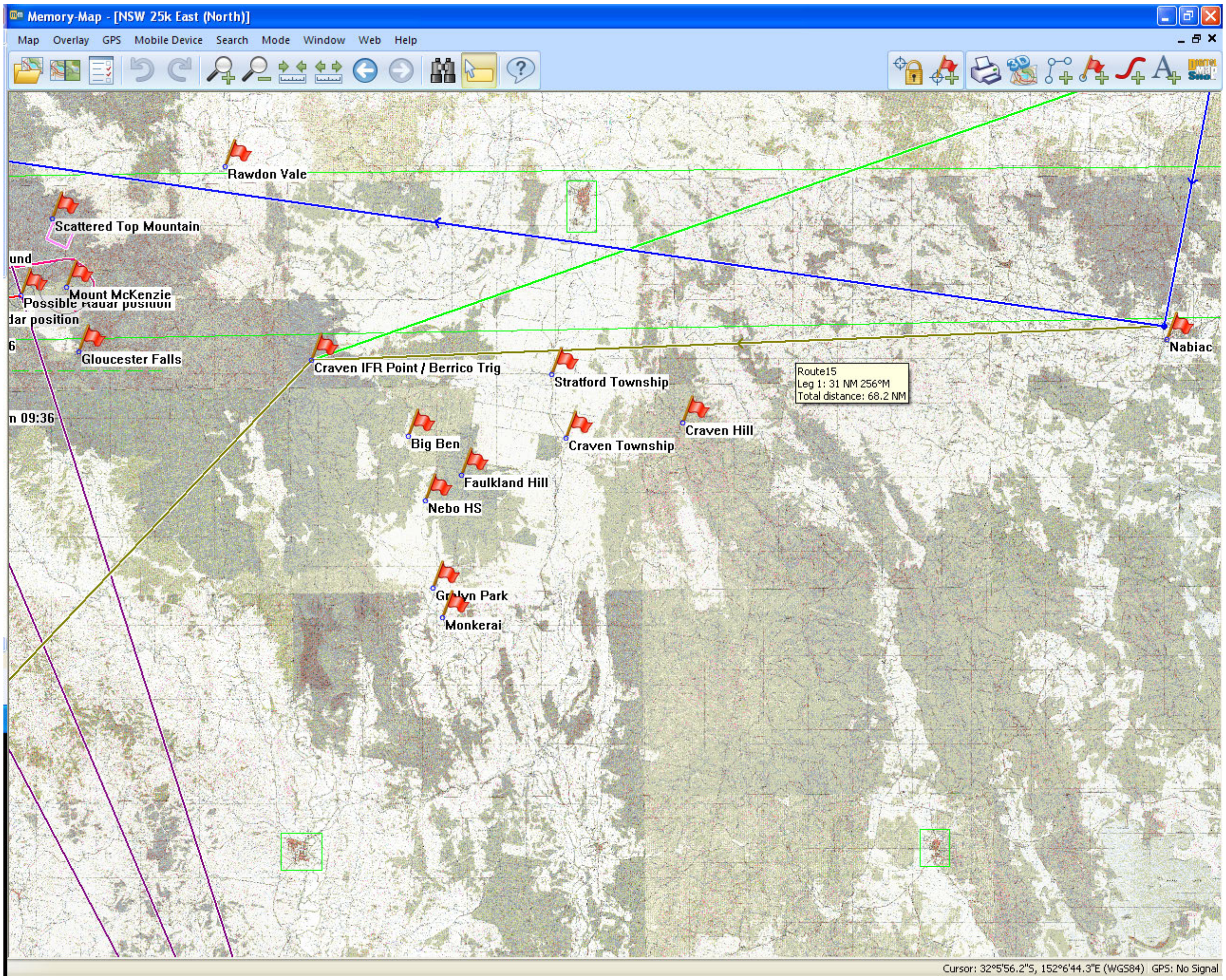
Taree to Nabiac

For example, he may have immediately turned for Craven over Taree, but then shortly turned again to track to Williamtown, as he was expecting a coastal clearance. When this was not forthcoming, the controller states that he is almost inside controlled airspace. The only way to correspond with the controllers' statement would be that MDX did in fact follow the flight path as mentioned earlier in this paragraph.



Nabiac to 1928

From this point, the next position that can be plotted with reasonable certainty is the point 36nm North of Singleton, that will be referred to as 1928 from this point on. From here, the pilot intended to fly to Craven, then Singleton, indicated by the mustard line.

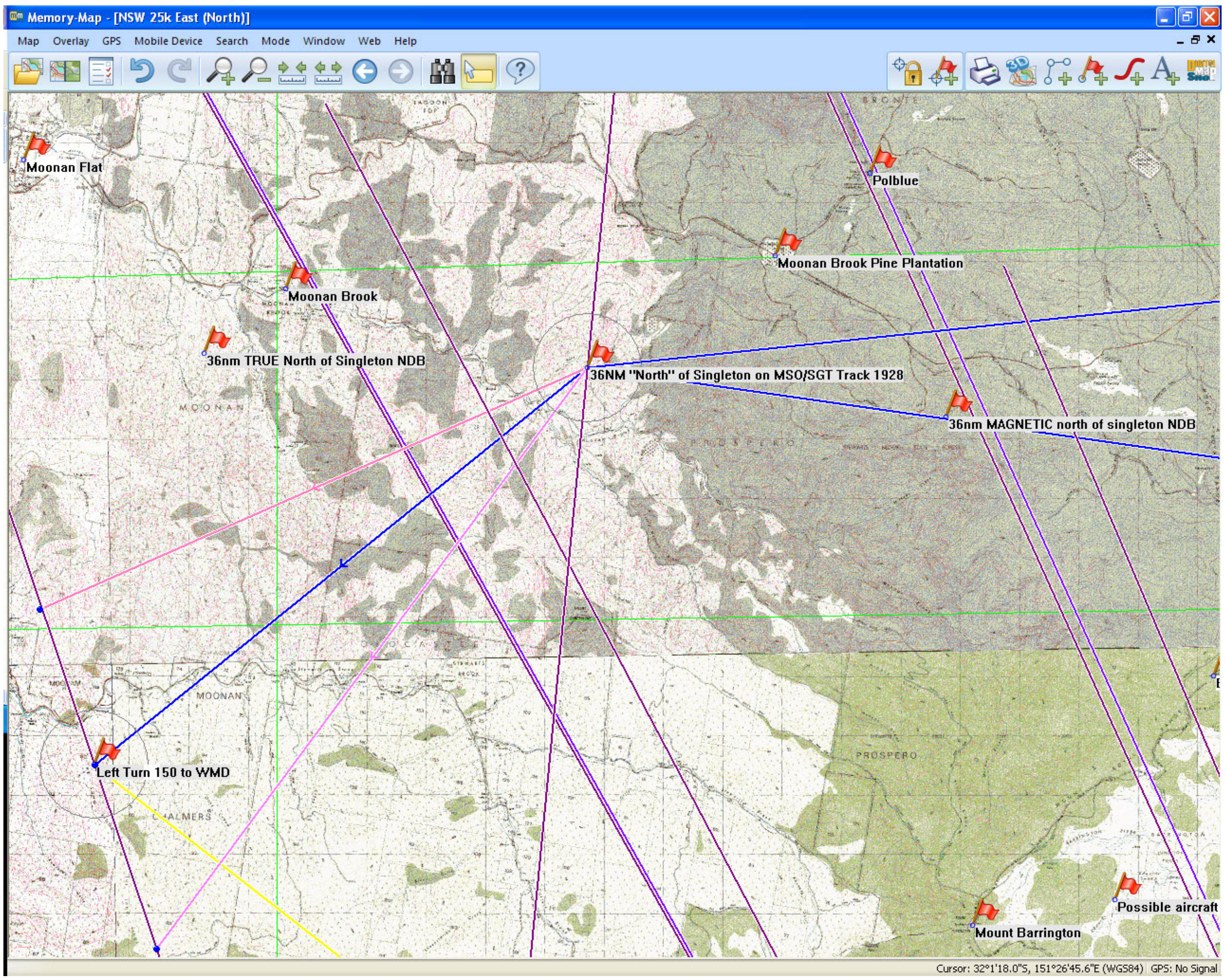


Although MDX did report that he was over Craven at 1918 there is some doubt as to him actually being overhead the reporting point when the report was made. The pilot reported that one of the primary navigation instruments, the ADF, which picks up the radio signal from the Singleton NDB was giving unreliable indications. To use this instrument to deduce his position overhead Craven would have been a relatively straight forward affair for a pilot of his experience.

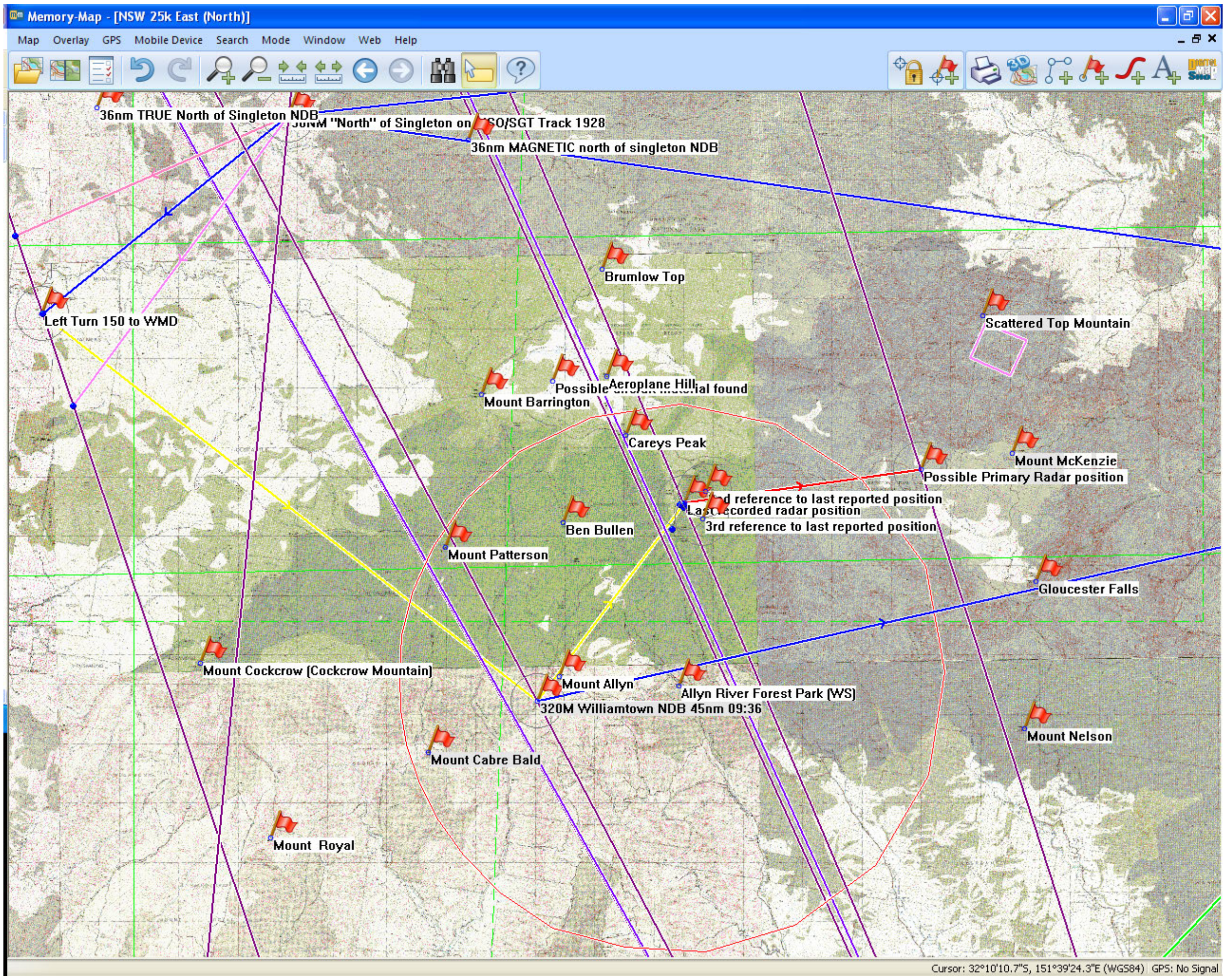
The blue line I have drawn, if it represented the actual flight path would have a slight dog leg in it, as when the pilot believed he was over Craven, he would have turned to Singleton. Establishing this actual path would be very difficult with the information we have today. Needless to say, any variance off this straight line would take longer to transit from Nabiac to 1928, which means to keep to the established times, the aircraft must have a higher groundspeed to achieve this.

Dotted to the south of that line are landmarks and places where operation phoenix uses witness statements.

1928 to 150 WMD

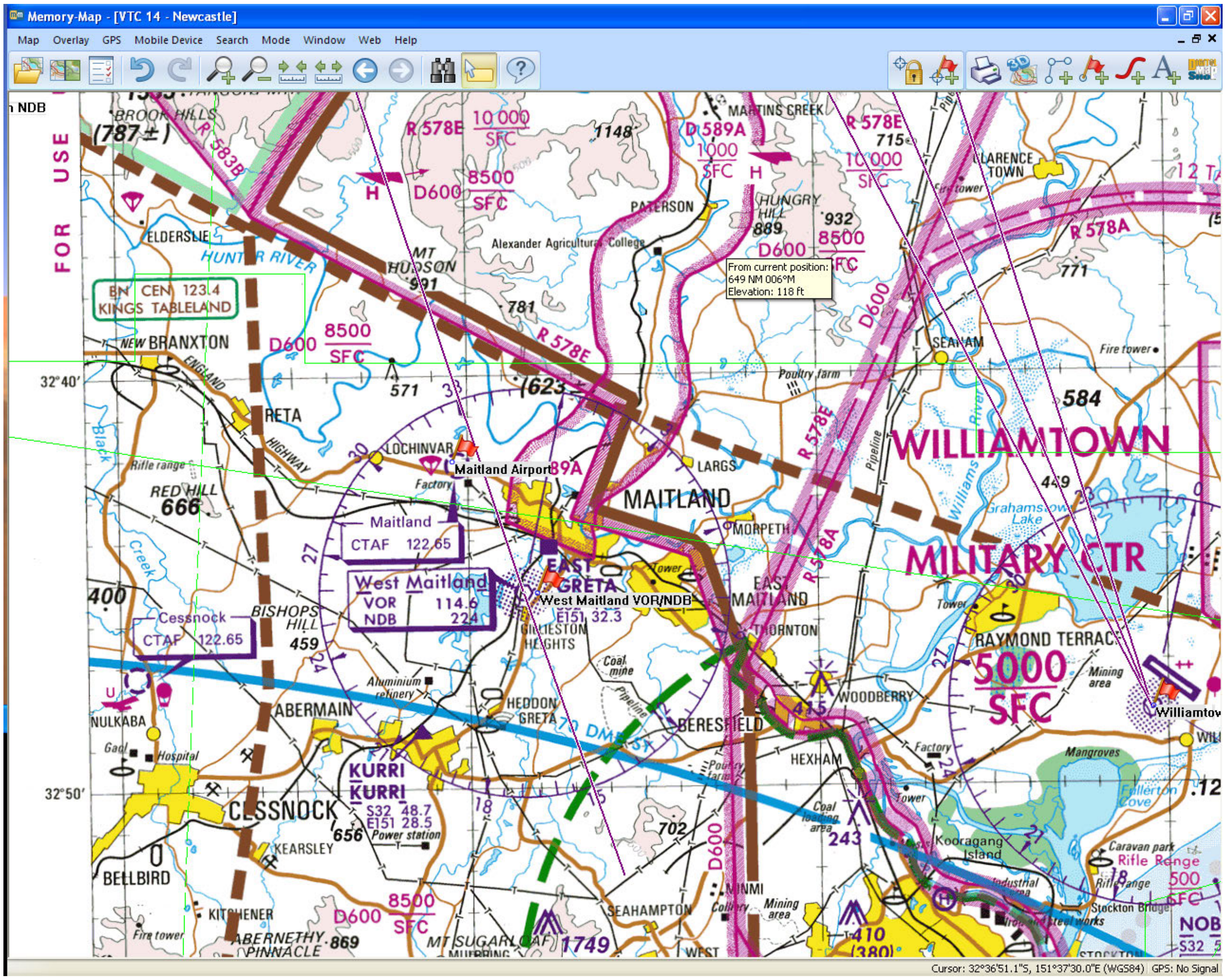


Following the blue line from Nabiac to 1928 where he is identified, the pilot requests further guidance from the radar controllers. To the north are flags indicating the places where witness statements are referred to in operation phoenix, as well as some geographic features to aid in orientation.



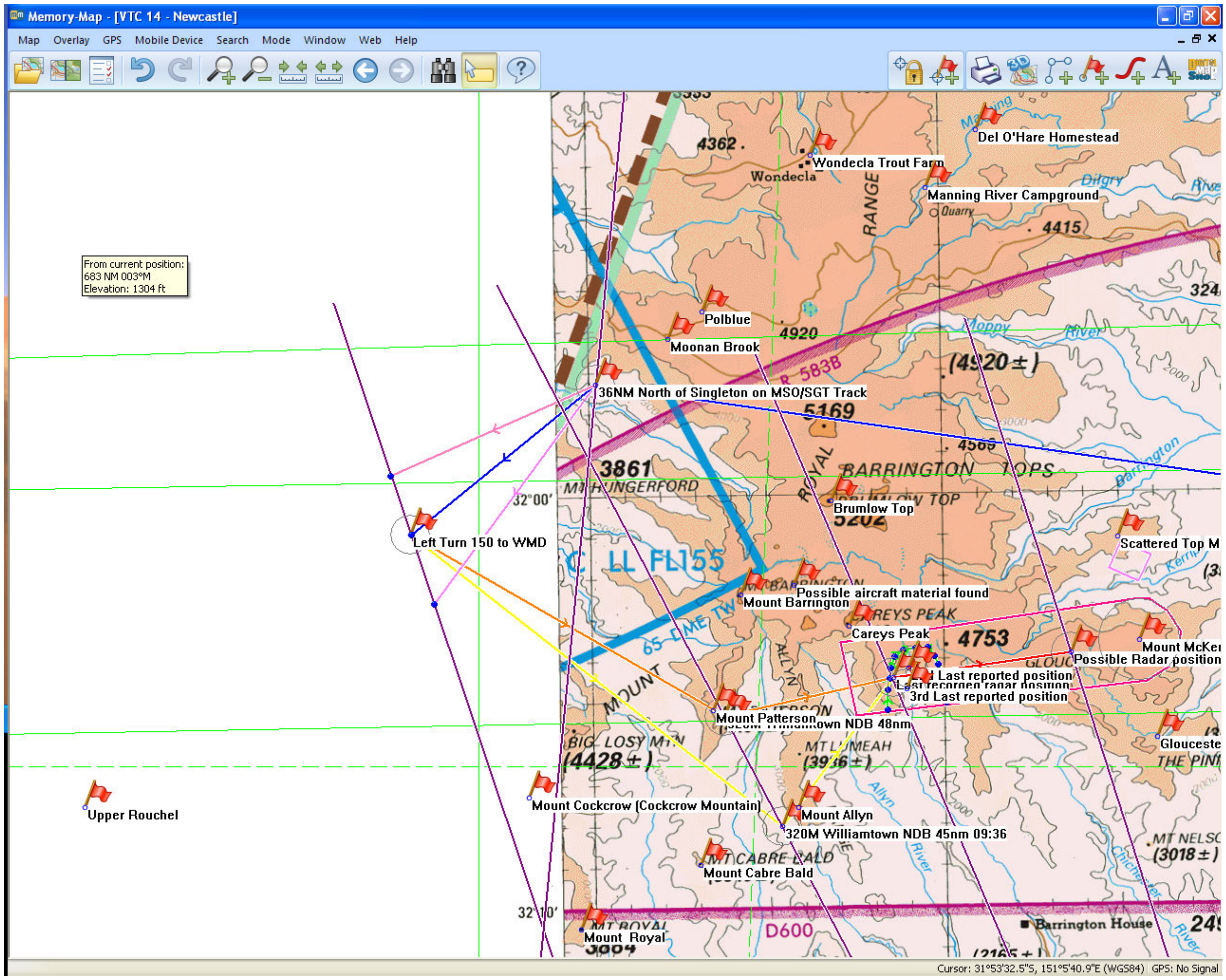
The controllers discuss between themselves the position and the pilot also reports that he is maintaining a magnetic heading somewhere around 220. The blue line from 1928 to 150 WMD is the 220M track, which would only be applicable to still air. The pink splay lines either side are the maximum possible variation given the wind speed and direction. For simplicity sake, I have used the middle point as the start for the next ‘leg’. The important point to take from this is that from 1928 to when the controller said that he needs to track 150 to get to West Maitland, he can only be somewhere along that purple line furthest west.

The reason that MDX can only be positioned along this line is as follows. If a compass is superimposed on the West Maitland VOR/NDB, and a line is drawn through the center of the beacon that extends along the magnetic bearings of 150/330, then depending on what position you are relative to the beacon, will be what direction you will have to steer to go to that beacon. Aeronautical charts have compass roses printed over the VOR’s and the West Maitland VOR, with a line drawn through 150/330 is depicted below.



Close up of West Maitland with compass rose and line drawn through 150/330 extending North on the aeronautical map "Newcastle Visual Terminal Chart (VTC)"

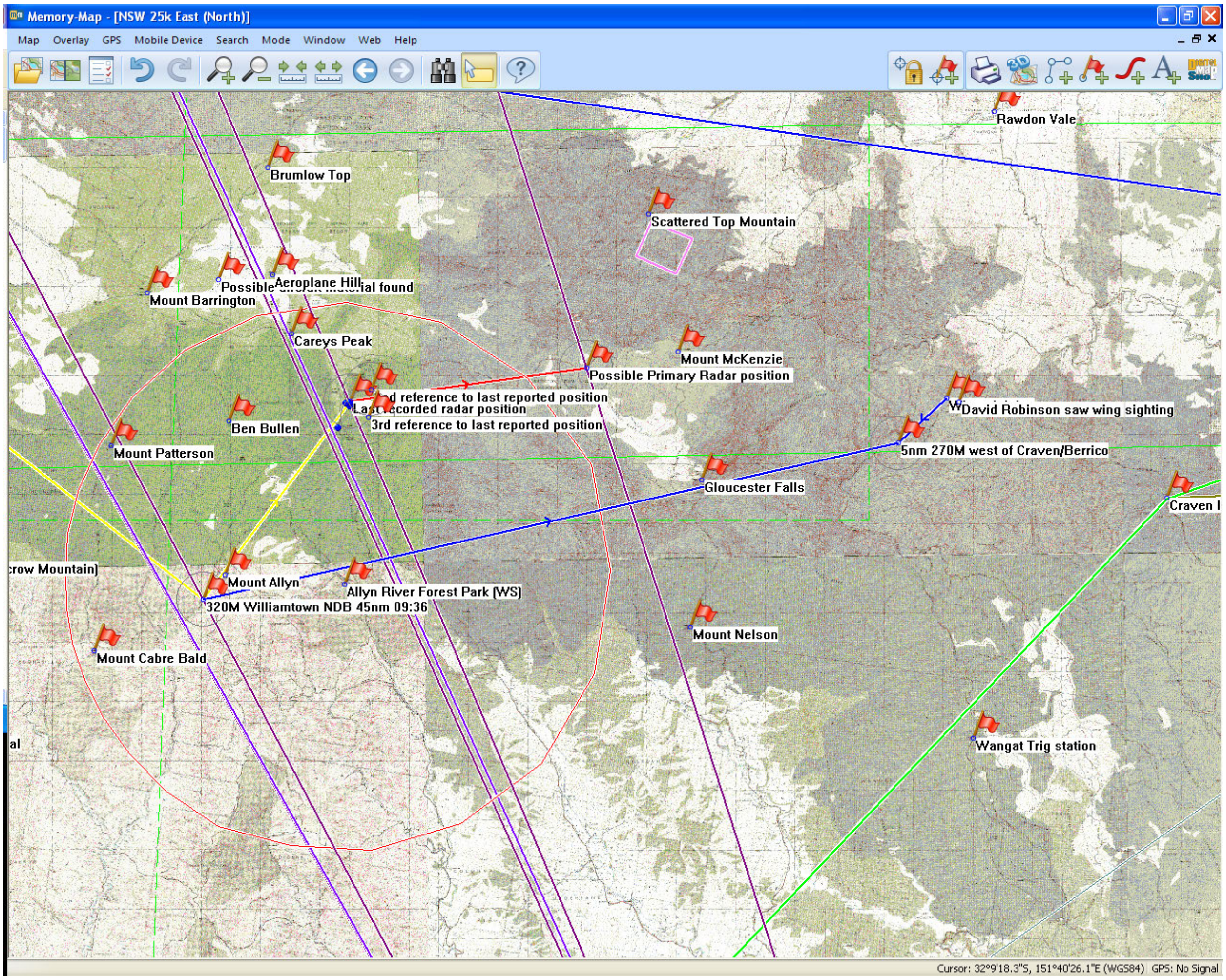
Continuing this line further north to the area in question, using the same map we can see the line extending through the approximate position of MDX.



Although this map coverage ceases just short of the approximate position, it is a scaled and geo-referenced map with the planning lines superimposed, scaled and geo-referenced to match. In summary, if you are anywhere north of the West Maitland VOR radio navigation aid, and need to steer 150 to go to it, you must be somewhere along that line. Conversely, if you are south of the beacon, you must steer 330 to go to it. If you are south of it, steering 150 will take you away from the beacon in a southerly direction. To find out where exactly along that line the aircraft is requires further information, for example, dead reckoning or a position line from another navigation aid, and where those two lines intersect, is where the position may be fixed. The information used to obtain an approximate position of MDX is the start position of 1928, and the pilot reporting his heading as “averaging 220” when queried about it from leaving 1928.

Owing to the accuracies in the radar at the time, up to a mile either side of that line is possible The grey circle centered on all these radar fixes is a 1 mile diameter circle, as that is the size of the paint an aircraft of that type would typically put on the controllers screen (see the section on radar limitations).

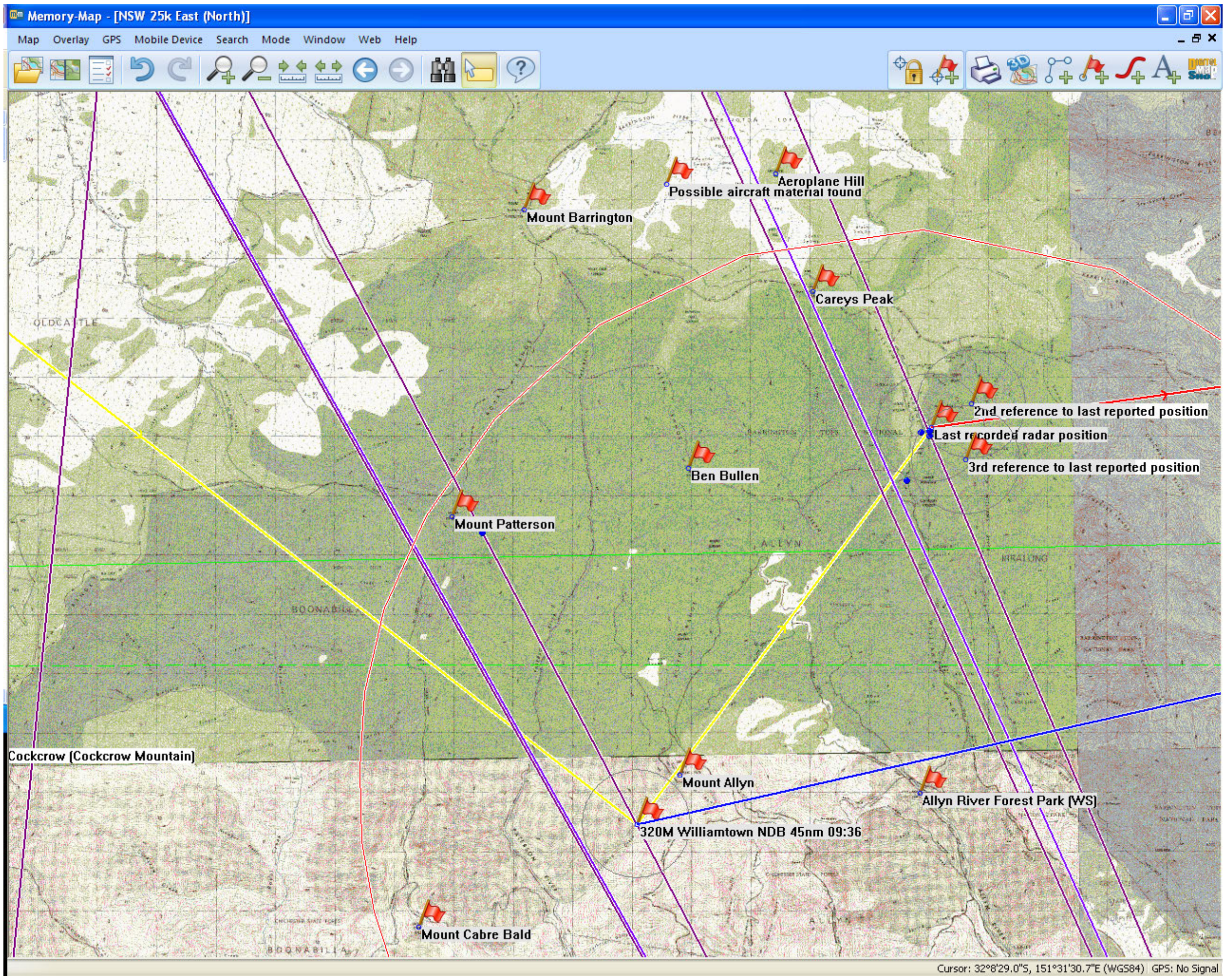
The point “Upper Rouchel” in the lower south west corner was the point mentioned in operation phoenix where a witness stated she saw the aircraft. This is completely at odds with every other piece of verifiable information available.



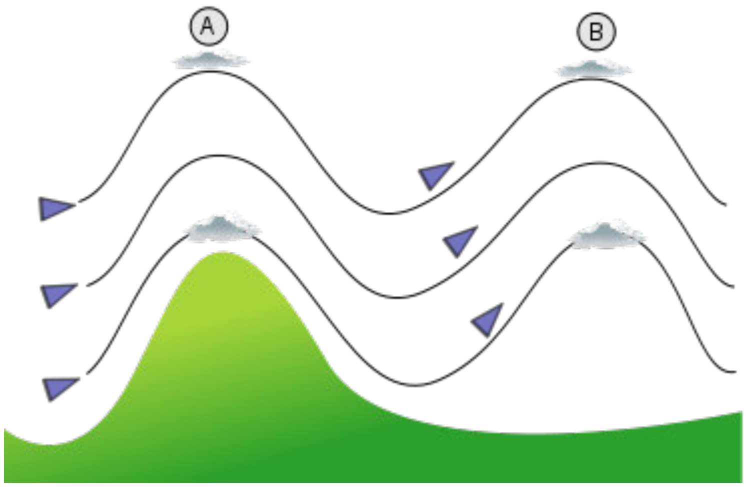
150 WMD to 320 Williamtown

Having now interviewed Peter Young, the controller on the night personally, he has said that the 45nm range originally in the transcript was the most accurate, and 48nm given to police later is to be ignored. When told to turn left to 150, if the pilot simply turned to 150 on his standby compass, without correcting for wind, the amount of drift experienced by the aircraft, given the aircrafts IAS and the wind strength and direction would be somewhere in the order of 38-40 degrees. On a heading of 150, the wind was blowing very strongly at almost 90 degrees relative to the aircraft, therefore there would not be a high headwind component but a very high crosswind component. This orange track line agrees almost to the degree with these calculations, and given the inherent inaccuracies embedded in the data, this is quite an encouraging sign. Further to this, if the yellow line was the track taken, the last leg to the last observed radar position would be almost NE, at a odds with statements made by controllers saying it had an ‘easterly’ track when contact was lost.

Mount Patterson to contact lost

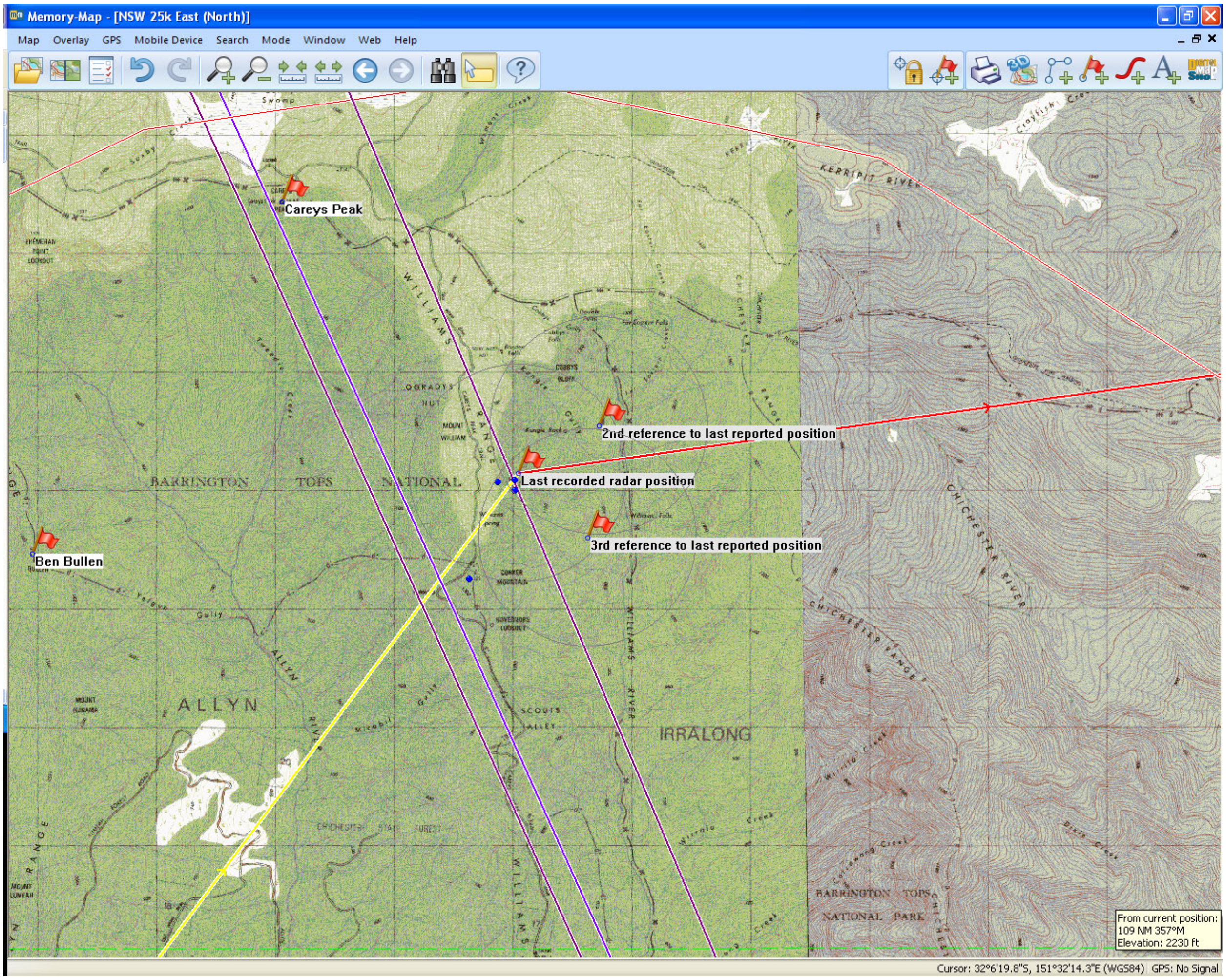


From here MDX was seen to be tracking easterly, and was descending at very high rates of descent. This here is some of the highest ground in the area (for example, Mount Patterson being about 4390 feet AMSL and Careys peak being about 4899 feet AMSL). There are several ridges and valleys parallel to each other that run roughly north/south. The aircraft was heading perpendicular to those and the wind was blowing from the west, also running roughly perpendicular to them. This would have created a phenomenon known as ‘lee waves’ which are a form of atmospheric standing wave. Below is a simplified diagram of a lee wave.



From wikipedia -

“In meteorology, **lee waves** are atmospheric standing waves. The most common form is **mountain waves**, which are atmospheric internal gravity waves. They are periodic changes of atmospheric pressure, temperature and orthometric height in a current of air caused by vertical displacement, for example orographic lift when the wind blows over a mountain or mountain range. They can also be caused by the surface wind blowing over an escarpment or plateau, or even by upper winds deflected over a thermal updraft or cloud street.”



As can be seen by the above map, the last recorded radar position is just slightly east of the highest point on Williams Range. There are three references to the 'last observed radar position' in the initial investigation, and as can be seen, they are all nearly centered on this point. The circles around each flag are 1nm in diameter, and this is the size of the plot on the radar controllers screen that they would have occupied, superimposed on the map. To clarify, the controller would have seen MDX as a plot about 1 mile in diameter, as the radar cross section of such an aircraft is substantially bigger than the actual aircraft. Therefore, every radar fix needs to contain a 'tolerance' of about 1nm. The red line indicates the projected flight path, as suggested by Operation Phoenix.

As I mentioned, these are all just east of the highest point on Williams range (about 4500 feet AMSL). The aircraft was only about 500-600 feet above the terrain at this point, and well in the grip of a very powerful downdraught associated with lee waves. The ATSB fact sheet on mountain waves says –

"In Australia, mountain waves are commonly experienced over and to the lee of mountain ranges in the south-east of the continent. They often appear in the strong westerly wind flows on the east coast in late winter and early spring.

Mountain waves are a different phenomena to the mechanical turbulence found in the lee of mountain ranges, and can exist as a smooth undulating airflow or may contain clear air turbulence in the form of breaking waves and 'rotors'. Mountain waves are defined as 'severe' when the associated downdrafts exceed 600 ft/min and/or severe turbulence is observed or forecast.

Glider pilots learn to use these mountain waves to their advantage; typically to gain altitude. However, some aircraft have come to grief in those conditions. Encounters have been described as similar to hitting a wall. In 1966, clear air turbulence associated with a mountain wave ripped apart a BOAC Boeing 707 while it flew near Mt. Fuji in Japan. In 1968, a Fairchild F-27B lost parts of its wings and empennage, and in 1992 a Douglas DC-8 lost an engine and wingtip in mountain wave encounters.

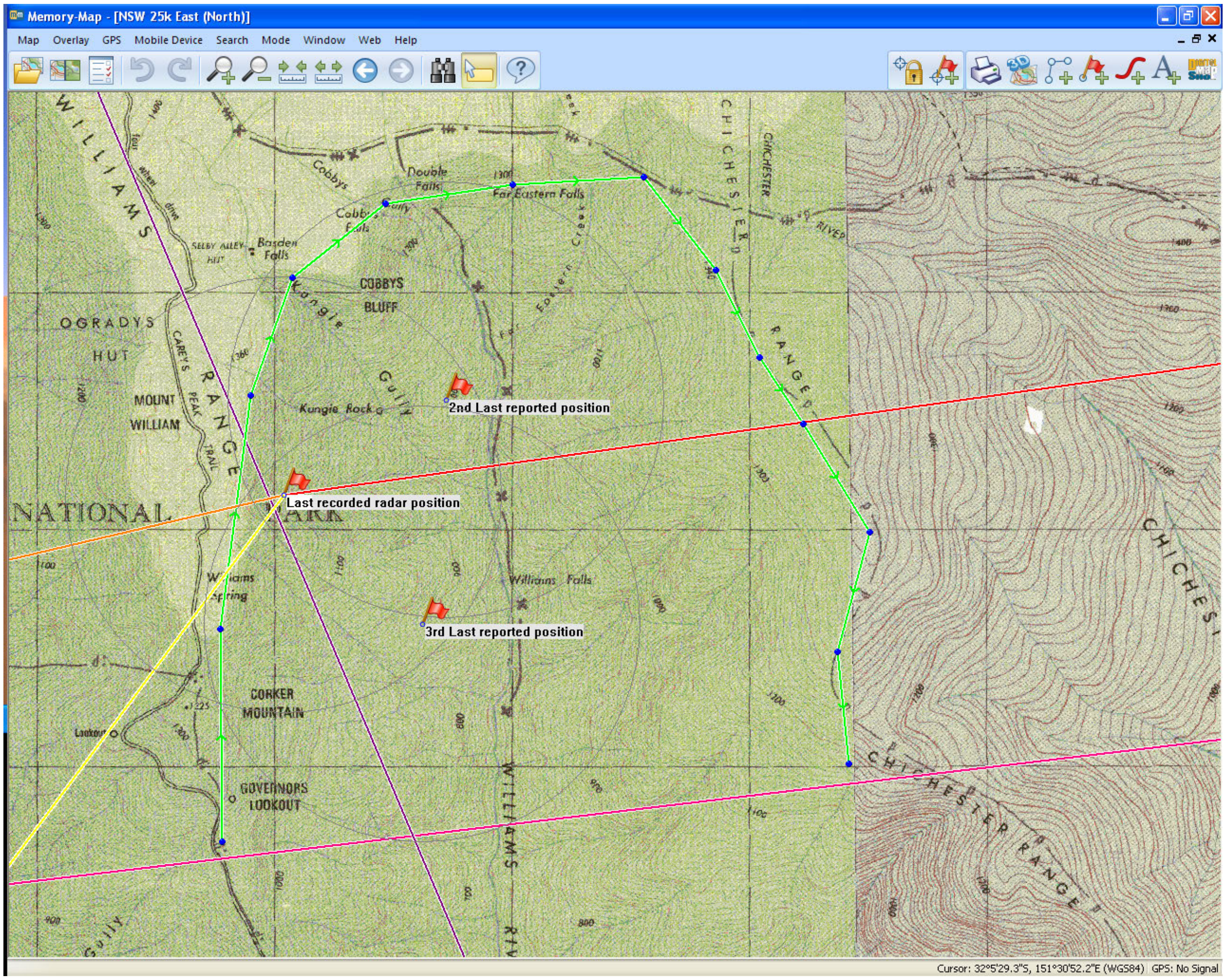
Mountain waves are the result of flowing air being forced to rise up the windward side of a mountain barrier, then as a result of certain atmospheric conditions, sinking down the leeward side. This perturbation develops into a series of standing waves downstream from the barrier, and may extend for hundreds of kilometres over clear areas of land and open water.

Mountain waves are likely to form when the following atmospheric conditions are present:
- the wind flow at around ridge height is nearly perpendicular to the ridge line and at least 25 kts
- the wind speed increases with height
- there is a stable layer at around ridge height.

Many dangers lie in the effects of mountain waves and associated turbulence on aircraft performance and control. In addition to generating turbulence that has demonstrated sufficient ferocity to significantly damage aircraft or lead to loss of aircraft control, the more prevailing danger to aircraft in the lower levels in Australia seems to be the effect on the climb rate of an aircraft. <u>General aviation aircraft rarely have performance capability sufficient to enable the pilot to overcome the effects of a severe downdraft generated by a mountain wave or the turbulence or windshear generated by a rotor.</u> In 1996, three people were fatally injured when a Cessna 206 encountered lee (mountain) waves. The investigation report concluded, "It is probable that the maximum climb performance of the aircraft was not capable of overcoming the strong downdrafts in the area at the time".

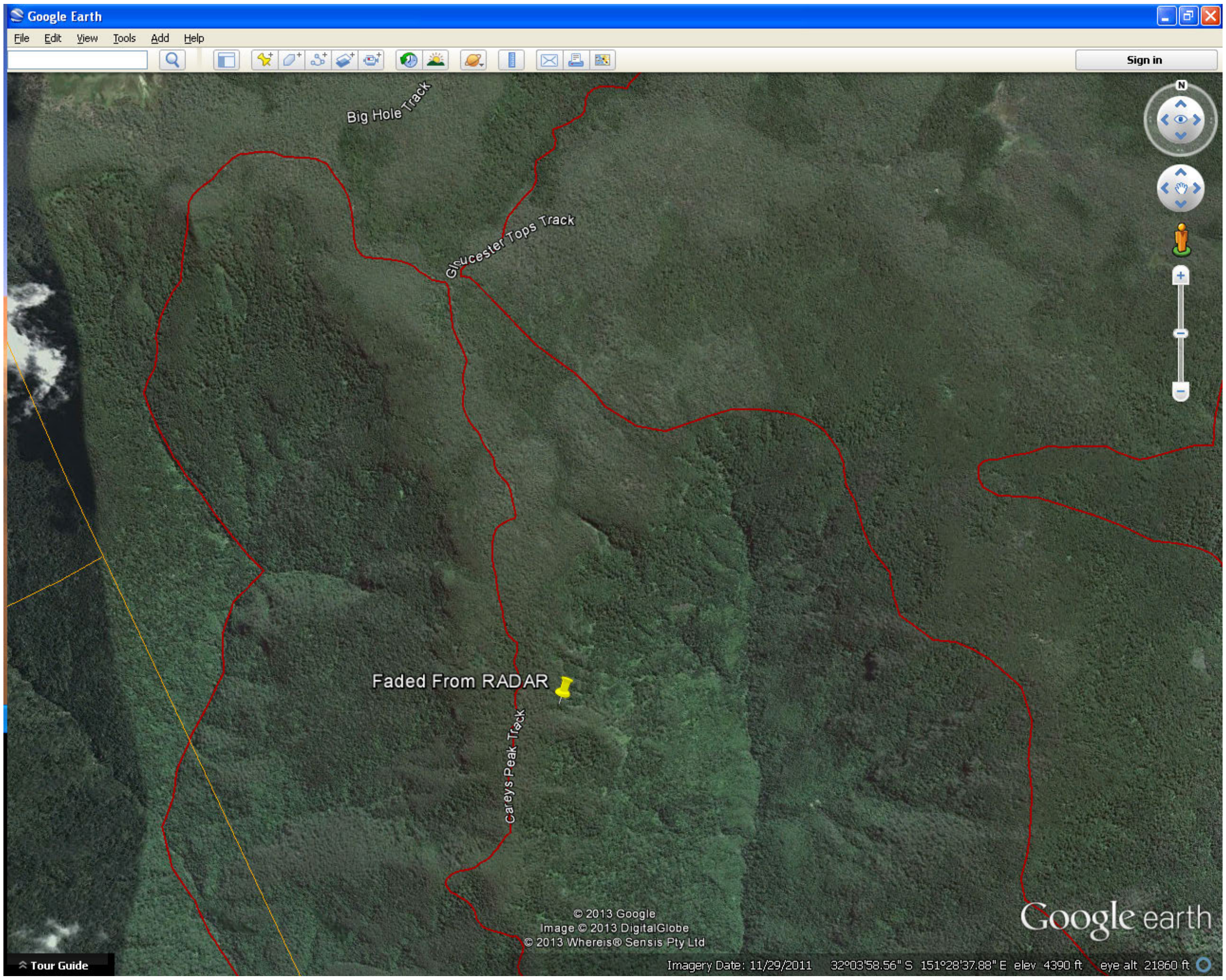
Crossing a mountain barrier into wind also <u>reduces the groundspeed</u> of an aircraft and has the effect of keeping the aircraft in the area of downdraft for longer."

The Cessna C206 is a very similar aircraft to a 210 in terms of performance and build structure. It is therefore my opinion that the aircraft crashed somewhere in the Williams river valley, very close to where it originates.



This site, shown above on the map in bright green, has many properties appropriate to the possible crash site of MDX.

- It has high terrain on all sides, just below the last reported height of MDX.
- It would have had very strong lee waves blowing as a tailwind on MDX, pushing it down into the valley.
- It was observed to fade from radar over this point
- This area was never searched in the original foot search for the aircraft. See the GE image below which has the original search areas superimposed on it.
- It is heavily vegetated, with triple canopy forest and very steep terrain.

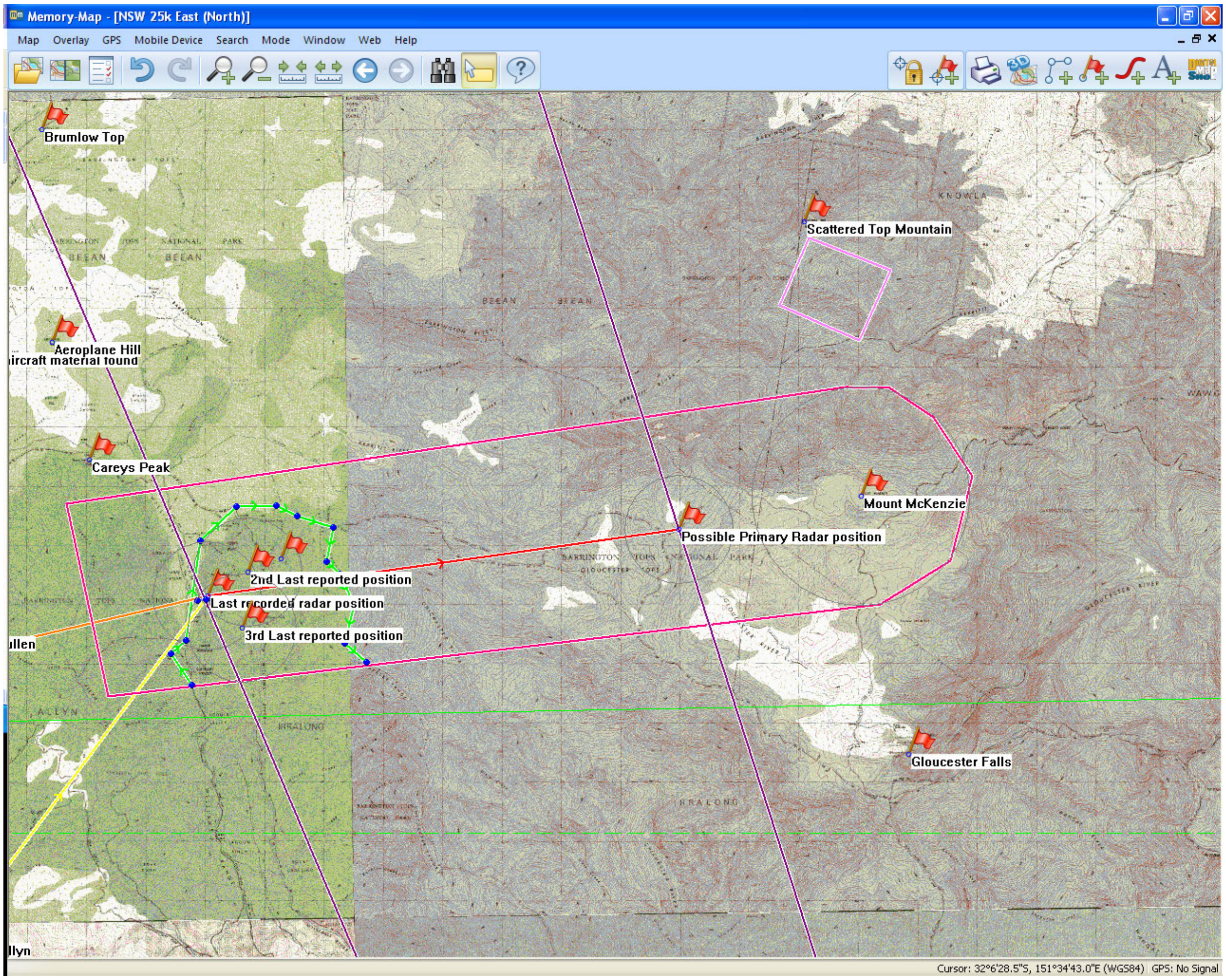


The lines in red indicate search areas searched in 1981.

Operation Phoenix issues

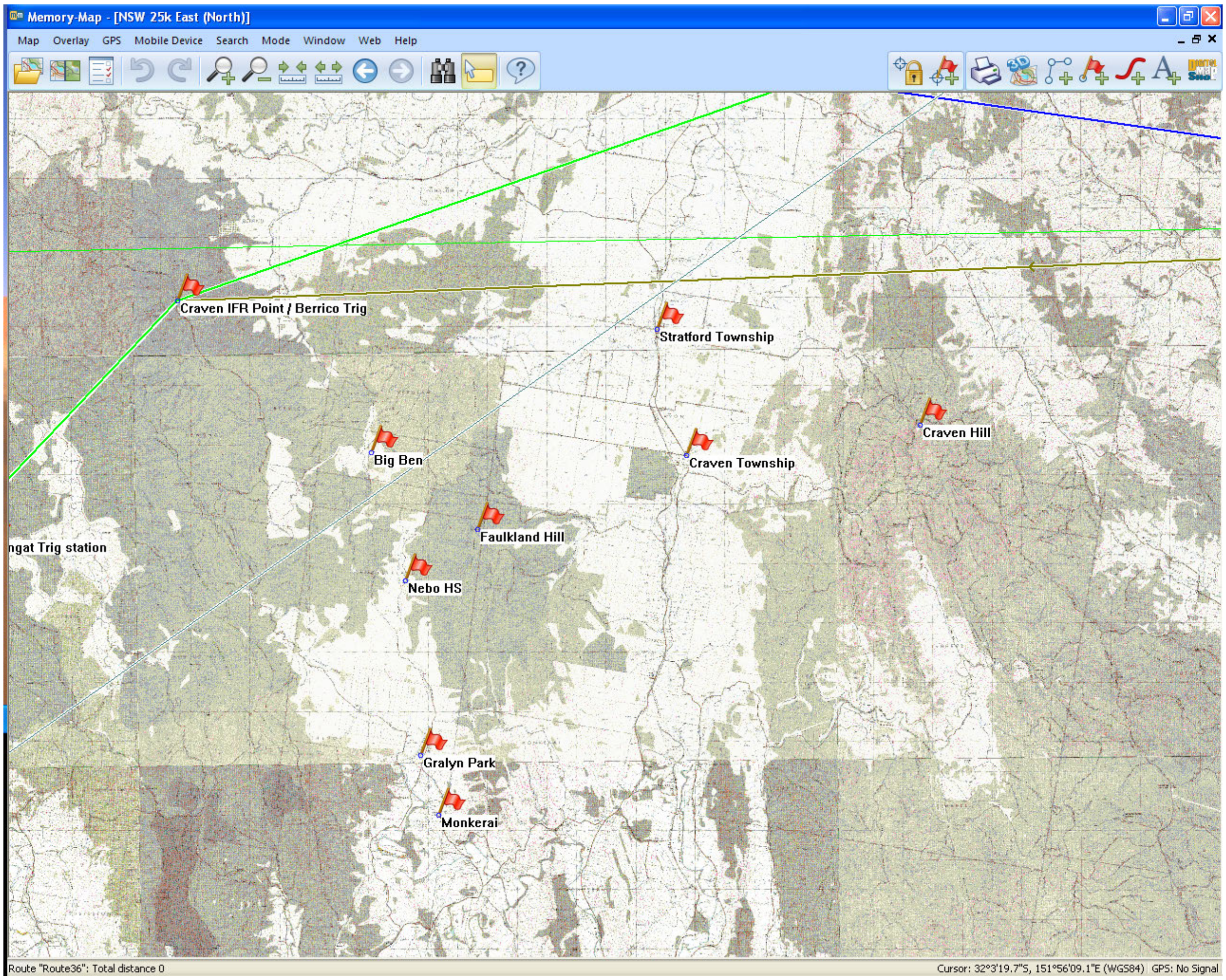
Operation Phoenix was written largely based on witness statements, some calculated assumptions, other assumptions to 'fill in the gaps' and a few references to some known research materials. On the surface, it seems very well researched, but after an in depth analysis by myself and several experienced industry peers, it does not hold up to scientific scrutiny. I have included points throughout this document that relate to specific sections.

Below is a continuation beyond the final radar position that is posited by Don.



He is using a few words on the last page of the transcript where the Williamtown controller makes reference to a bearing of 330, without a range included. Before this, the controller mentions his MTI gate twice, meaning he no longer has MDX's SSR paint (which requires the transponder), but may still have the primary paint, which he mentions. As explained in the radar section, this would have been very difficult for even an experienced controller to discern from the atmospheric clutter (clouds/rain/snow/sleet) and ground clutter. It is more than likely it was this that the radar operator was seeing. There is not enough time from the final place he was identified to get to the 330 radial, and certainly not enough time to get to Scattered Top mountain. Further to this, the aircraft was descending at roughly 1700 feet per minute. Even if the final paint were accurate, MDX would not have had the required terrain clearance to go from that position to Scattered Top, as there is the high ground of Mount McKenzie to the north and east in between.

Other issues with Don's assumption are the sighting at Upper Rouchel. He says that the aircraft was sighted by an elderly lady who was inside at night watching TV. The height difference between her home, and the altitude MDX was at, would have made hearing the aircraft difficult at the best of times. Couple this with the weather conditions present according to her statement, which identified high wind, low cloud (a cloud base of 100ft, 30 metres!), rain and sleet. If she were facing the airplane as it travelled towards her, the wind would have been blowing (strongly) from behind her towards MDX. This would have carried what little sound that was carried from an aircraft, away from her. Also, nobody else in the small settlement reported anything similar. Earlier alleged sightings such as the one around the area of Craven Township had as many as 5 alleged sights, in a 10 nm diameter.



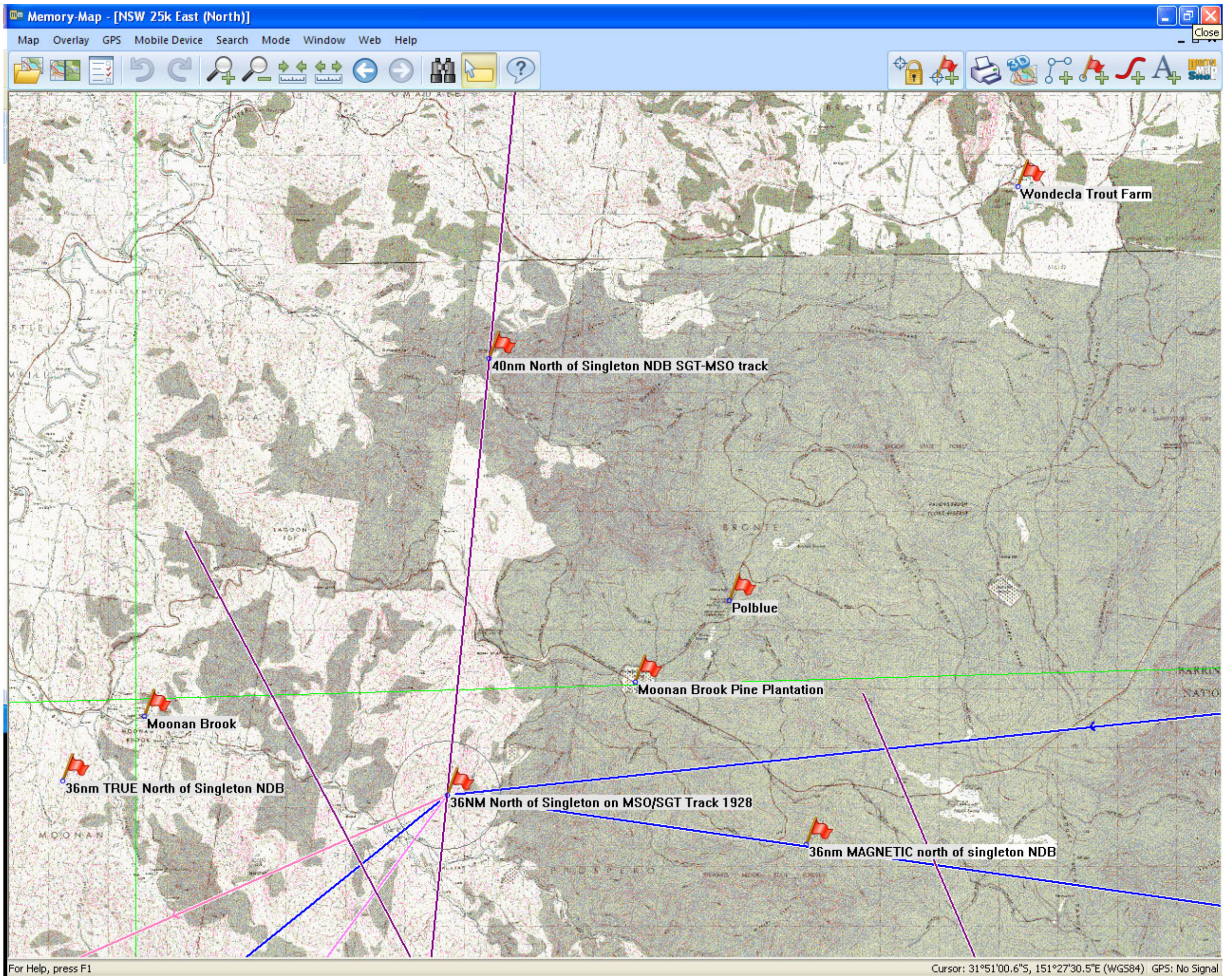
Don suggests that the aircraft was seen 5 people at flagged points on the above picture, yet no more than one person saw an aircraft in a region no more than 300 meters across and populated by 5 times that amount of people?

Add the strong wind degrading anyone’s ability to hear sound makes me skeptical of that part. Don also posits a situation where the pilot of MDX, unsure of his position in relation to high and rising terrain, with failed instruments and icing, descending in cloud, below minimum lowest safe altitude to less than 100ft above ground level, then turning and climbing away again?!

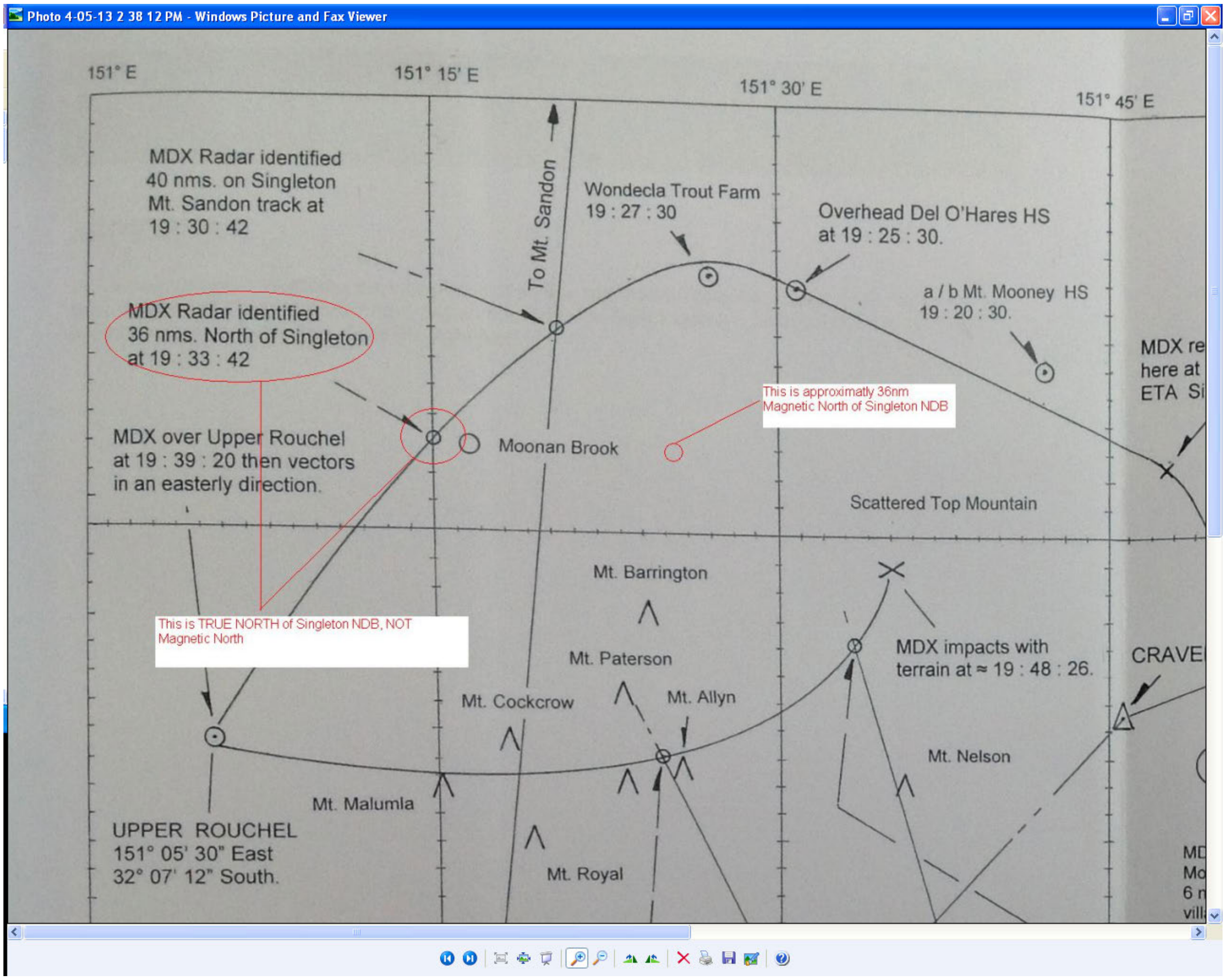
The human factors in this scenario are unlikely in the extreme, given the pilots reluctance to enter bad weather (see the material in the NAA file). The pilot also at no time does he make an announcement that he is willingly descending, and in fact, says that he is trying to climb at all times. What makes it even further unlikely is the aircraft climb performance. Having descended 5500 feet to just above ground level and then climbed back to roughly the same altitude would have taken 11 minutes longer than if it just flew there at the same altitude and then flew back.

Don also suggests that MDX was identified at 40nm, on the Singleton – Mount Sandon Track, then again at 36nm due north of Singleton. This is incorrect, as the radar operator was making a more accurate estimate of the distance he first suggested of 40nm, not a second position report. Radar operators give their bearings in degrees magnetic. Radar displays are orientated magnetically, not grid or true. The point 36nm due magnetic north of Singleton, which the radar would display, and the operator would be aware of is in fact to the east of the Singleton – Mount Sandon track, not the west, as Don suggests.

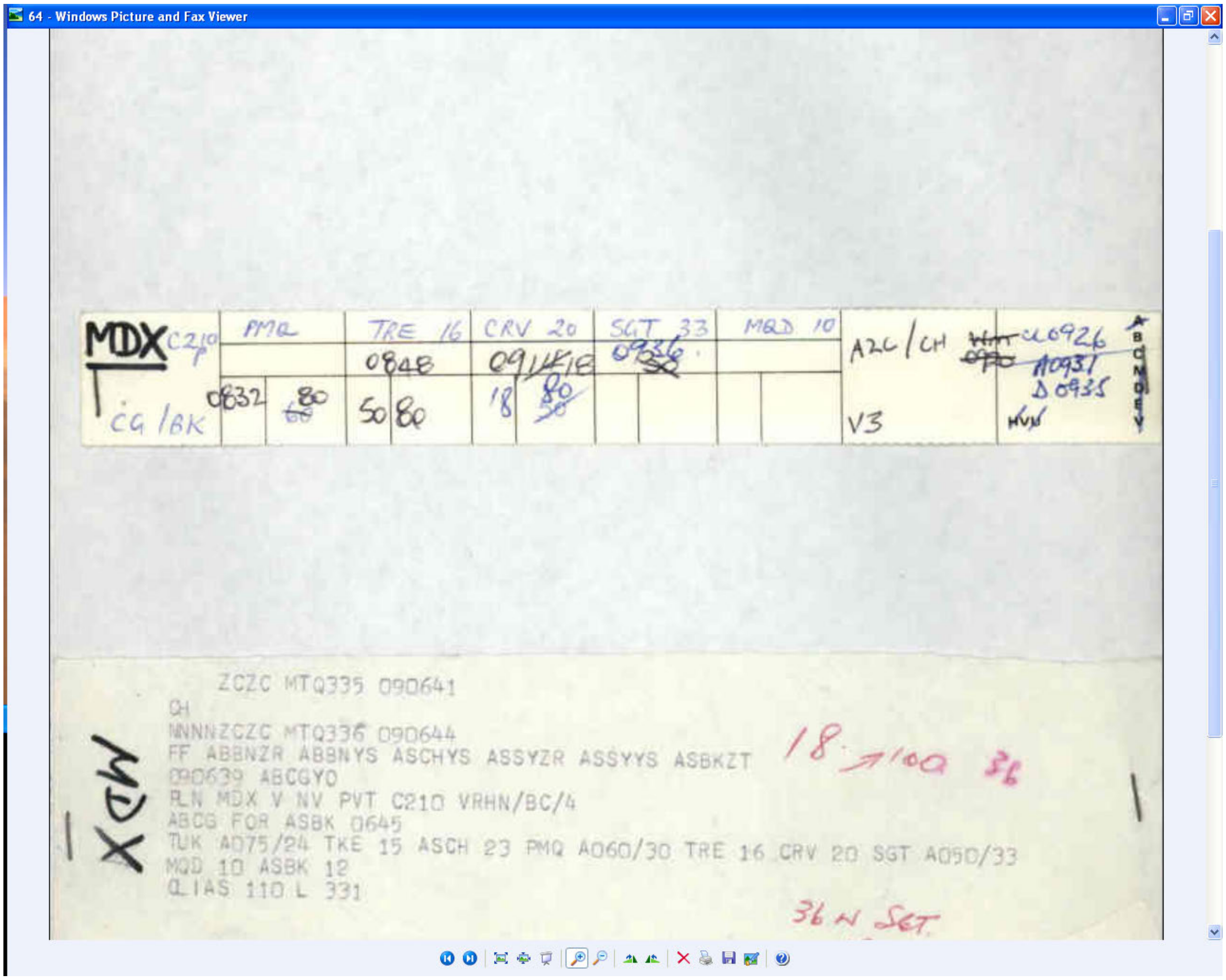
This fault is illustrated below, having those two points overlayed on the map, and Don's simplified map.



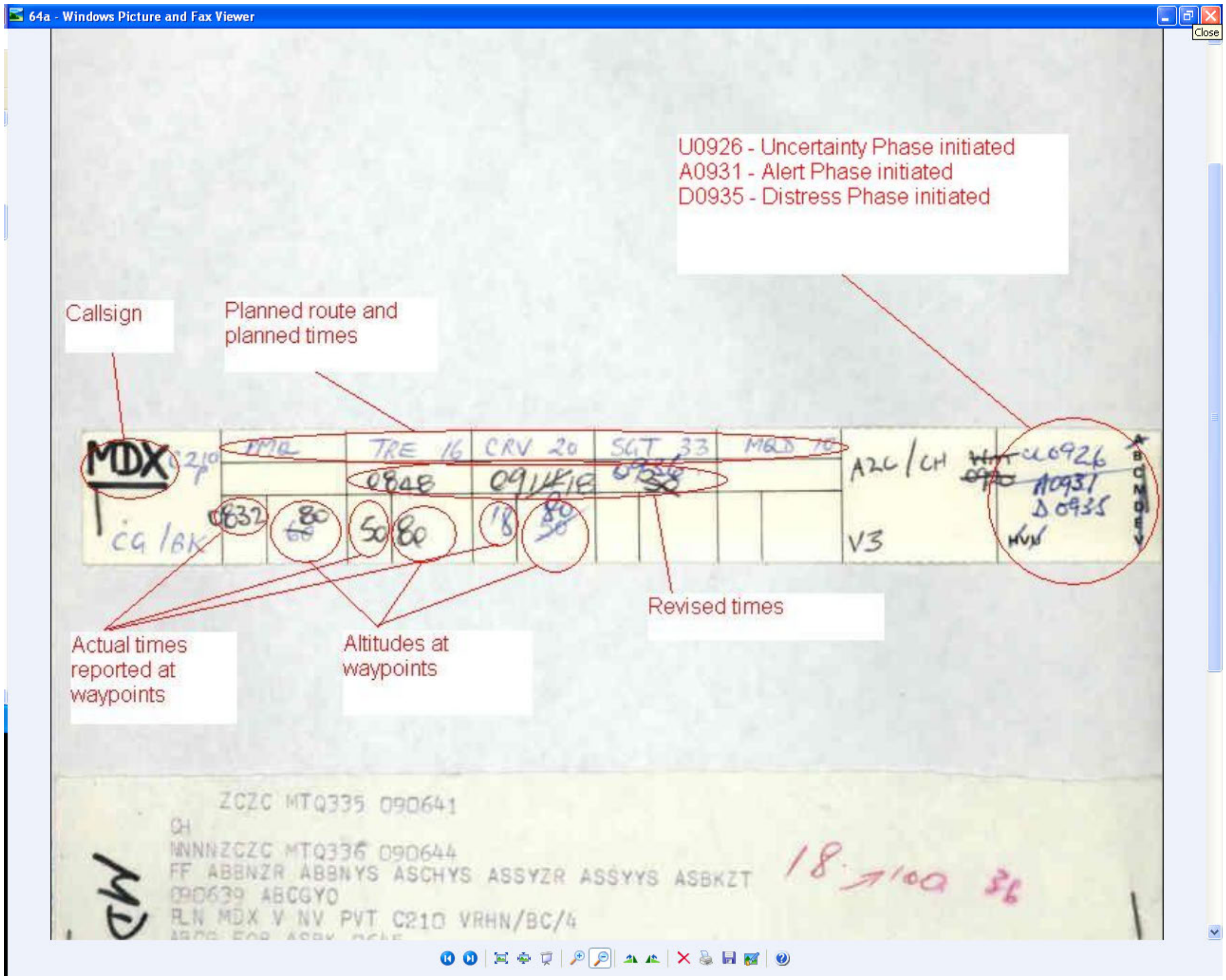
Using Don's map in his book, this fault is illustrated here –



Don goes on to suggest that there was a 6 minute interval where the radar operator tries to determine MDX's track. This is highly unlikely, as it would not take that long to derive this information. There is also no radio traffic from ANY aircraft during this 6 minute period, when there was clearly other traffic. To also suggest that there was no communication with MDX in this time period is also extremely unlikely. Another issue to add to the question of timings, and that his assertion that the timings on the transcripts are incorrect, is that there are available, all the ATC flight strips, little bits of paper used by controllers to keep track of aircraft in their sector. All these have times written on them when the controller logs various radio calls, and they also all agree with the times set out, and would require several controllers to all be using the wrong time for Don to be correct.



Above is the flight strip written by FIS5. Below is a version with explanations of the writing. Both these files can be found in the dropbox file repository.



As this can be plainly seen, the controller was writing on the flight strips, as the event was unfolding, and would have been looking at the master clock to write the times as events occurred.

Some of the witness statements Don refers to contradict other things he says. For example, he maintains that the aircraft was in cloud, but then uses a witness statement that says they saw an aircraft at treetop height. If MDX was at that height, and could be seen by someone in that position, it's unlikely flight would have gone any further, as the high rate of descent would have meant it would have came out of the cloud and immediately hit the ground.

He also says that anyone is unlikely to have heard the crash, due to the high wind velocity, but maintains that other people heard it in a similar fashion?! Also, unless someone was standing in a sizeable clearing, on top of a mountain, they would not have been able to see an airplane on a dark stormy night through triple canopy bush, as is found on either side of the Allyn River, high up in the valley where it originates.