# SUBMISSION HIGHLIGHTING TECHNICAL IMPOSSIBILITY OF ACHIEVING ACCURATE SPLIT ZONINGS BASED ON ENVIRONMENTAL MAPPING.

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## EXECUTIVE SUMMARY

*I am writing this submission as a person with 20 years' experience in using Geographic Information Systems (GIS) for both mapping and analysis in a planning context, and with post graduate qualifications and field experience in land resource mapping.*

*My experience ranges from:*

*(a) GIS data collation for 4 major regional planning studies while consulting to the Department of Housing and Local Government and the Premiers Department in Queensland,*
*(b) cartographic production of 3 Shire zoning schemes,*
*(c) GIS management for numerous large environmental impact statements for an international environmental consulting firm and in my own consultancy,*
*(d) the scientist doing soils and vegetation surveys in the field.*

*I deal with issues of lack of consistency between spatially accurate topographic information and property (cadastral) data on a daily basis in my current role of providing GIS systems to the agricultural sector.*

I wish to state very succinctly that the concept of using natural features mapped from aerial photography to split zonings on a parcel of land is technically flawed, and CANNOT be achieved accurately without spending **millions** of dollars on either:

(a) on ground surveys to define areas of vegetation *relative to survey reference points* on EVERY land parcel affected by the zonings, OR
(b) overcoming inherent sources of error from the process of transferring the data from the aerial photography into a GIS to include it in a planning scheme, INCLUDING marking areas of protected vegetation on using high-quality orthorectified aerial imagery such as NearMap, AND improving the spatial accuracy of the NSW cadastral (property) database.

Those calling simply to *"identify any mapping inaccuracies and outlines appropriate means of rectifying them"* are displaying a naivety based on "you don't know what you don't know".

Errors in getting vegetation mapping aligned with the cadastral information used as a base for the zoning scheme include:

1. Basic mis-interpretation of vegetation communities by those doing the mapping

2. Errors in transferring lines marked on aerial photography to the GIS, due to:
    a. sloppiness,
    b. scale (a 2mm line on a 1:25,000 photo is 50 meters)
    c. parallax errors due to the height of vegetation or hills and valleys.
3. Inaccuracies in the digital cadastral database that is used for the zoning scheme when compared to the topographical information (known to be up to 100m in rural areas)

This cost required to prepare spatially accurate zoning maps cannot be justified, which will mean that should land properties be split in the proposed LEP based on the interpreted locations of vegetation communities from aerial photography, the definition of the split zonings will be inherently inaccurate, and property owners will have to apply for a rezoning application to get them corrected once the LEP is accepted.

Failure to undertake this level of process to define areas accurately on the mapping will result in a never-ending bureaucratic nightmare sorting out where people can undertake currently allowable activities on their properties. This will waste Council time and probably legal costs that myself and other ratepayers are ultimately paying for.

There are better and more socially just options available that can protect the vegetation such as covenants and Vegetation Protection Orders that do not require the vegetation to be designated spatially, and protect the vegetation rather than the supposed area that the vegetation is supposed to exist on. Enhancement of vegetation communities and wildlife corridors can be enhanced through landholder agreements which may entitle landholders to rates compensation in exchange for creating a vegetation covenant over areas of a property.

The mapping done to date can be used to identify areas of vegetation that need to be protected, but to take the further step of splitting zonings on a land property will create major practical issues in the future.

The rest of the submission is aimed at providing the background information to explain the technical justification for my original statements.

Should you wish to discuss any of these matters or opinions, please contact me at robert@wotzhere.com , or 0419718642.

Yours Sincerely

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## WHY VEGETATION WILL NEVER MATCH THE CADASTRAL DATABASE THAT IS USED AS A BASIS FOR ZONING SCHEMES.

The fundamental issue is that vegetation communities are mapped from aerial photography, and the process of getting that information into a property based zoning scheme is fundamentally impossible to do accurately without a massive effort to overcome inherent technical issues in the process. Planners and earth scientists are typically unaware of the issues, as "You don't know what you don't know".

If a person doing a vegetation survey is experienced, they will use stereo pairs of aerial photography when doing the initial interpretation of mapping. This means that they will use a stereoscope and overlapping aerial photos to view the images in 3D. This allows the viewer to see the texture of the vegetation communities and enable them to map vegetation more effectively. The boundaries are then marked upon one of the photos.

In some cases stereo pairs of photographs are not available, and the mapping is done in 2-D. Nevertheless the boundaries are marked onto an air photo. These areas are then field checked and adjustments made to the location of those boundaries on the photos.

These boundaries are then transferred to a base topographical base with a variety of means, but generally by tracing to a topographic base first or directly into a Geographic Information System (GIS) by digitising the line work.

The issue is that the process of transferring the data from the air photo to the GIS, however diligent the operator is, is usually inaccurate. Then, even if it was perfect, it would not correspond to the cadastral boundaries that the zoning scheme is based.

There are 3 sources of errors that this process will encounter:

4. Basic mis-interpretation of vegetation communities by those doing the mapping
5. Errors in transferring lines marked on aerial photography to the GIS, due to:
    a. sloppiness,
    b. scale (a 2mm line on a 1:25,000 photo is 50 meters)
    c. parallax errors due to the height of vegetation or hills and valleys.
6. Inaccuracies in the digital cadastral database that is used for the zoning scheme when compared to the topographical information.

### BASIC MIS-INTERPRETATION OF VEGETATION COMMUNITIES

Mistakes happen, this is human. We expect that. These can easily be rectified over time. However, when these mistakes are fixed into a zoning scheme, it takes a development application to fix it. There are many examples in the current mapping where this is so. The Shire does not need to impose even more load on its staff dealing with an issue such as this. Even if it gets a lot of the errors corrected after the draft LEP is accepted, there will still be some embarrassing errors found later.

Who will be responsible for the costs involved in correcting the errors - the property owner, the Shire or the State planning department that has approved the zoning scheme? It is unfair for the property owner to bear the burden of someone else's mistake, but the other options cost me, as a rate and tax payer.

## ERRORS IN TRANSFERRING LINES MARKED ON AIR PHOTOS TO A GIS

Transferring data from an air photo at a particular scale to a base that can be used in a GIS is not a straightforward process, and unfortunately is often undertaken by people who have little understanding of the inaccuracies in the process.

### SLOPPINESS

Generally the process of transferring the data marked on aerial photographs to a GIS is a manual process. This is prone to errors such as any manual process, but is accentuated by how involved the process is and the number of steps involved.

To get the data into a GIS, you must first register the image so that it fits into its right place in the world. Aerial imagery is generally distorted and skewed, and any registration of raw aerial photography is only an approximation (refer for example: http://www.geog.ucsb.edu/~jeff/115a/lectures/geometry_of_aerial_photographs_notes.html)

This can be minimised if the aerial imagery used is orthorectified, where detailed photo-registration and terrain modelling have been used to take many of these distortions out. Alternatively, some modern technologies such as that used by NearMap take account of topography when generating their imagery. This type of imagery is available at selected times and parts of the shire, but it is only available in 2-D, making it less useful for the scientists mapping the vegetation communities.

The most correct method of capturing interpreted information into a GIS is to:

(a) capture data on aerial imagery in a photo series, marking primarily the middle section of each photo.
(b) Once field verified, transfer this line work to orthorectified imagery, manually taking into account any distortions from the original,
(c) Digitise the line work marked on the orthorectified image into a GIS.

Each step in this process is subject to quality control issues regarding accurate placement of the original locations that the surveying scientist intended.

### SCALE

Further to this, the scale of the mapping needs to be commensurate to its intended purpose. If the photography was mapped on aerial imagery at a scale of 1:25000, a 2mm line marked with a chinagraph pencil often used for this purpose would be 50m wide on the

ground.  And yet the GIS will show the boundary as one pixel thick no matter how close you zoom in.  Small unintended errors become quite significant.

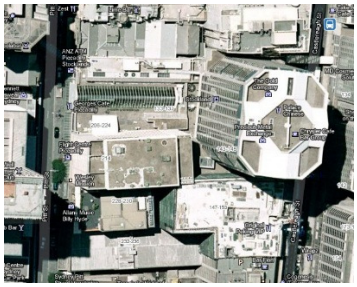
Vegetation mapping used for splitting properties should be done at much scales closer to that used for property planning, namely 1:5000 or better on rural lands, and 1:2000 on more densely subdivided areas.

The mapping provided as part of the planning scheme was published at 1:42000 (where a 2mm pencil line is equivalent to 84 m), and I have not seen any evidence that the mapping was done to an adequate scale and just published at a more convenient scale.

## PARALLAX ERRORS

Consider the photo below.  It would appear that the top of this building is not over its bottom.  This obviously is not true, and is easy to comprehend when we are looking at buildings.

This distortion is caused by parallax, and the fact that all points on an aerial photograph will exhibit some degree of parallax error except for the point perpendicular to the camera. http://en.wikipedia.org/wiki/Parallax .



When we are looking at natural landscapes, the effects of parallax are not as apparent.  It does exist whenever there is variation in topography (tops of hills will be displaced to the gullies), or features with height are viewed (such a trees).  The amount of distortion will vary depending on a whole range of factors (see previous article).  This will mean that mapping that typically defines the tops of the trees will be displaced compared to where it exists on the ground, and that you cannot accurately locate markings on an aerial photography in undulating topography.

To demonstrate this, I constructed a simple experiment to demonstrate the effect of parallax on the location of a vegetation community marked on aerial photography and transferred to a Geographic Information System.

## PARALLAX ERROR EXPERIMENT

The model on the left was simply a modelling clay "hill" with an area of orange "vegetation" on the top. While simplistic, the use of the model provides a demonstration of the principle without the complexity of a real landscape that make this effect more difficult to separate the effects of parallax from other distortions.

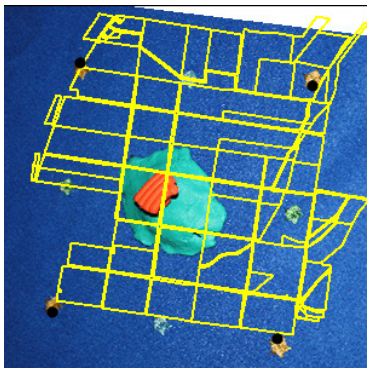
The “hill” was placed on a blue blanket that had dots embroided, which formed a reference grid to be able to register the images to common reference, and to show that the hill itself was not moved in the photography.

Three photos were taken with the "hill", with the camera positioned so the "hill" was positioned:

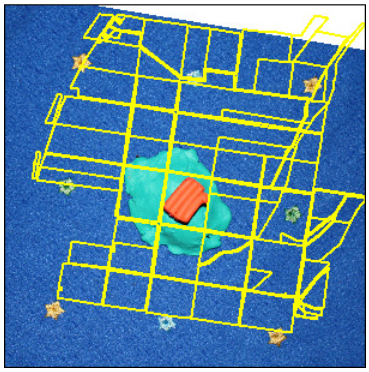
(1) to the western (left) side of the photo,
(2) in the centre of the photo and
(3) to the eastern (right) side of the photo.

The 3 photos were then registered to a location on the earth in a Geographic Information System (GIS), with the dots on the blanket used as reference points. The cadastral database was overlain onto the three photos.

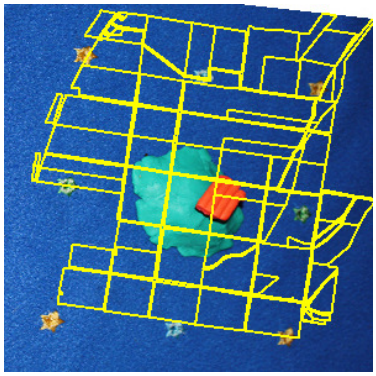
Note that the position of the orange "vegetation" shifted dramatically depending on the position of the "hill" in the photo, compared to the green stars adjacent to the "hill". The cause of this shift was mostly due to parallax (displacement or difference in the apparent position of an object viewed long two different lines of sight), and the difference in height of the top of the “hill” and vegetation to the surrounding “landscape”.



**Hill located on western side of photo**



**Hill located in centre of photo**



**Hill located on eastern side of photo**

The consequence of this in a real world situation would be that the vegetation, which is in the centre of one allotment if the hill happens to be located in the centre of an air photo (where there is no parallax), would appear in neighbouring allotments if the hill happened to be located on an edge of the photograph used to map the vegetation. Thus the aerial photography that the lines are marked is ortho-rectified, the quantity of shift will be random and unaccounted for.

Better alignment of the vegetation boundaries to its true position on earth could be done by carefully transferring all the line work marked on aerial photographs to an orthorectified

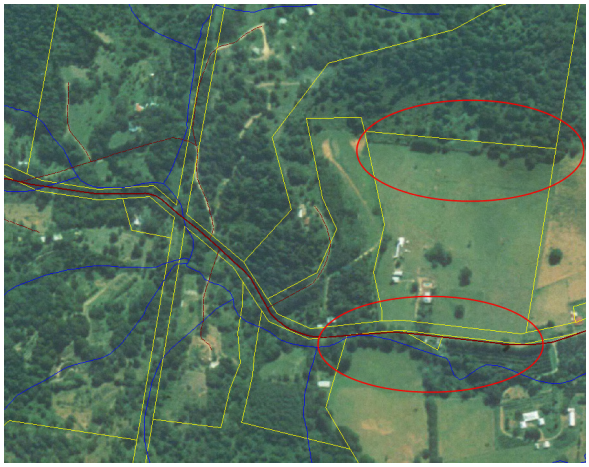
image where photo distortions have been largely removed. This would still be subject to human error and scale issues, but could theoretically be done reasonably accurately. This would result with the vegetation being placed more accurately to the topographic data, but would still not be accurate to the property information as discussed below.

## ISSUES WITH TOPOGRAPHIC MAPS VERSUS PROPERTY CADASTRAL DATABASE.

Assuming that the mapping was perfectly aligned to the topographic information, which theoretically could happen if it was the data transfer was done by first transferring any line work to orthorectified aerial photography, it still could not be used as a basis for zoning mapping.

However, this would not remedy the inaccuracies in the property boundary or cadastral data used as a basis for the zoning scheme. This inaccuracy was caused by the process used to transfer the cadastral data from the old survey plans to the digital cadastral database used as a basis for the zoning plans. These inaccuracies represents errors of between 0.5m-4.0m in urban areas where plans with scales between 1:500 and 1:4,000 were often used, and in the range of 25m-100m in rural areas where plans of scales 1:25,000 – 1:100,000 were commonly used for digitising.

eg. http://www.gmat.unsw.edu.au/currentstudents/ug/projects/Watkins/introduction.htm



An example of this is the road in the photos above. This example took less than 1 minute to find by browsing the cadastral information overlain an orthorectified image, and is no doubt typical of Byron Shire.

This photography was ortho-rectified so that it was located reasonably accurately to the real world. Topographic information such as roads, streams and contours were captured from the photography. When the cadastral information is overlain, however, errors of 20m are apparent between where the cadastre is located from the equivalent features on the ground are really located.

Again, this is not something to blame anyone for, it is simply the state of information that we have to work with now.

The rectification of the cadastral database to accurately reflect the real world is an on-going process but is difficult and time-consuming, and involves such huge legal ramifications that it is done carefully. However, errors exist, particularly in rural areas, and even worse in rural areas with undulating or steep topography.

The result is that even if you were able to perfectly map the vegetation communities may still end up on a neighbour's property because the cadastre is not accurately mapped in the real world.

To be accurate and useful, zonings that are not based on whole cadastral parcels need to be defined as mets and bounds (surveyed degrees and distances) from a surveyed designated property landmark. Thus a survey team needs to visit each property that has a split zoning, and the actual zoning split defined in bearings and distances from a local reference point.

I have done produced the GIS mapping for 3 shire zoning schemes in the past, and none of these contained split zonings that were defined as a line on a map without accompanying mets and bounds descriptions.