

## **APPENDIX C**

Overview of Methodology for  
Remote Sensing/GIS Analysis

# Overview of Methodology for Remote Sensing/GIS Analysis of Lakes Lewisville and Grapevine Shoreline Management Project

**Bruce Hunter**  
**Director, Center of Spatial Analysis and Mapping**  
**University of North Texas**  
**Denton, TX**  
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The goals of the Remote Sensing/GIS component of the project were to identify general vegetative land cover classes within the Corps of Engineers' (COE) lake property boundary and to calculate buffer zones within that property. Land cover classification was conducted with satellite imagery and digital aerial orthophotos using remote sensing computer software. Buffer calculation was conducted using GIS technology. An overview of the process follows.

## Satellite Image Processing

IKONOS (Space Imaging Corporation) satellite imagery was chosen for the vegetative land cover analysis. IKONOS multispectral imagery has a spatial resolution of 4 meter x 4 meter and a spectral resolution of 4 bands (blue, green, red, and near infra-red). A total of nine digital files were obtained for the two-lake, Lewisville and Grapevine, study area. Due to flight paths, atmospheric conditions and collection schedules, there was no single satellite image available for one date that covered the entire study area. As a result, nine separate files acquired on seven dates were used (Figure1). All imagery was obtained georectified to UTM WGS84 coordinate system with metric units.

**Figure 1: IKONOS Satellite Images - Dates of Acquisition**

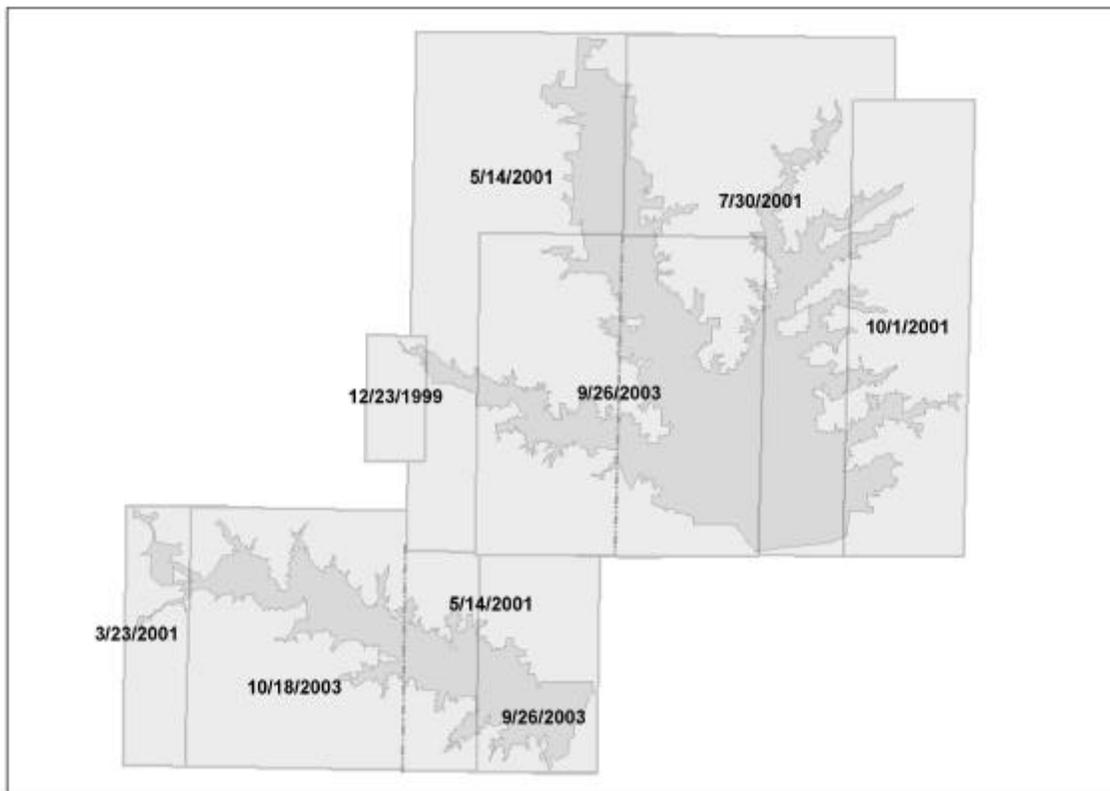


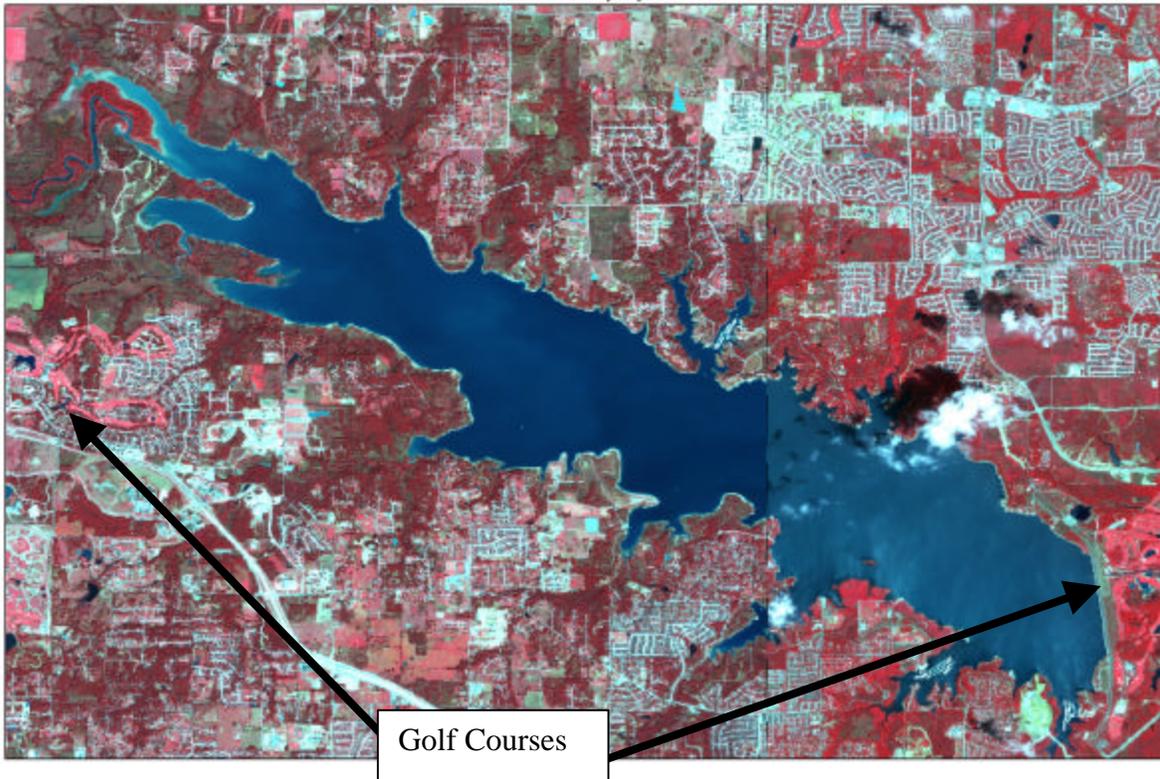
Image processing was conducted using Leica Geosystems, Inc., ERDAS Imagine remote sensing software. Since the IKONOS images were acquired on different dates, the nine images were processed separately and then compiled for each lake. The following is step-by-step overview of the classification process:

- Unsupervised Classification (USC): The USC method uses reflectance values recorded in four multispectral bands. The computer statistically groups pixels into one of a predetermined number of classes, however, there is no *a priori* knowledge of the classification types. A USC was performed on each of the nine images with output consisting of fifty land cover classes.
- The USC output was examined and compared to 2003, 1ft. resolution Orthophoto imagery (digital aerial photography) obtained from COE GIS archives. Pixels identified as Water or Bare classes were marked for use in the next step, all others were ignored.
- A Mask process was conducted on the original IKONOS images using the Water and Bare classes. Water and Bare areas within the original images were masked out to facilitate the classification process for remaining land cover types. This process is known as “Cluster Busting” and is commonly used technique for initial stages of the classification process (Jensen, 1996).
- The “masked” original image was then reprocessed using an unsupervised classifier (USC) and fifteen classes.
- The 15-class output file was then compared visually to the 2003 Orthophoto aeriels and the 15 classes were recoded and assigned to one of 4 classes – Woody, Herbaceous, Maintained, Bare.

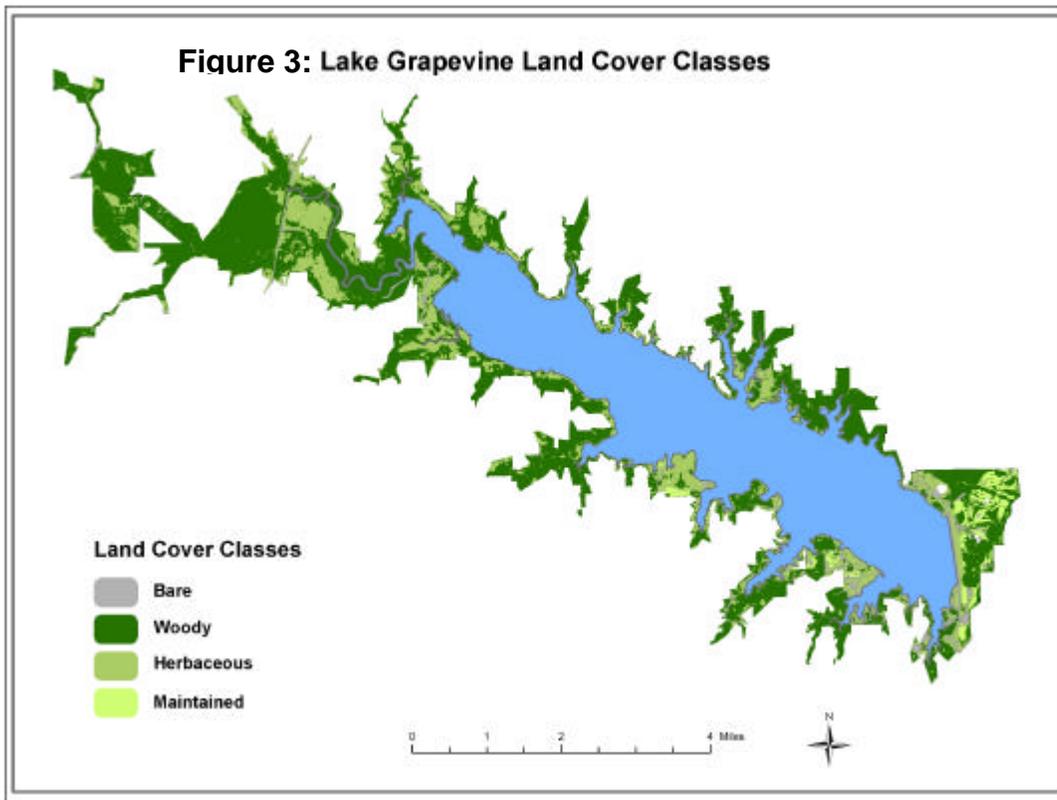
**Note!** The choice of the 4-class classification system above was based upon the fact that IKONOS 4 m resolution imagery is very useful for identifying small features on the ground (each pixel is 4 m x 4 m) but the 4 band spectral resolution does not allow for separation into specific vegetative types such as oak, willow, blue stem, etc. The imagery does permit good separation into woody (leaves, branches and boles – trees and shrubs) and non-woody (herbaceous) classes. The Bare class comprised areas of bare ground such as asphalt roads, rooftops and other impervious surfaces. The Maintained class consisted of areas of “bright” vegetation easily identified in the imagery. For example, golf courses, baseball fields and manicured lawns typically presented a different visual signature in the imagery (Figure 2).

- At this point in the classification process there existed digital files containing USC classifications in 4 classes for each of the nine satellite images.
- The final classification step was conducted using a Supervised Classifier (SUP). The SUP differs from the USC in that the computer operator uses prior knowledge of land cover types to identify ground areas within the satellite imagery prior to classification. Using Orthophotos for referral, “signatures” for Woody, Herbaceous, Maintained and Bare were obtained by circling areas within the satellite imagery that met the class types. Approximately 20 signatures were gathered (usually 5 per class) for each of the nine images. A Supervised Classification was performed on each on the nine images; the output produced was a file exhibiting the 4 class types as specified by the signatures. The output files were recoded into a final class files, using the 4 classes, for use in the next step.
- The SUP files was overlaid on top of the USC files and everything recoded to 4 classes – Bare, Woody, Herbaceous, Maintained. This overlay process had the effect of combining supervised classes with unsupervised, with the supervised dominating the process.
- The individual class files for each of the nine images were mosaiced together to produce one classification file for Grapevine and one for Lewisville (Figure 3).

**Figure 2: IKONOS Satellite Image Example - Lake Grapevine  
Bands 4, 3, 2**



**Figure 3: Lake Grapevine Land Cover Classes**

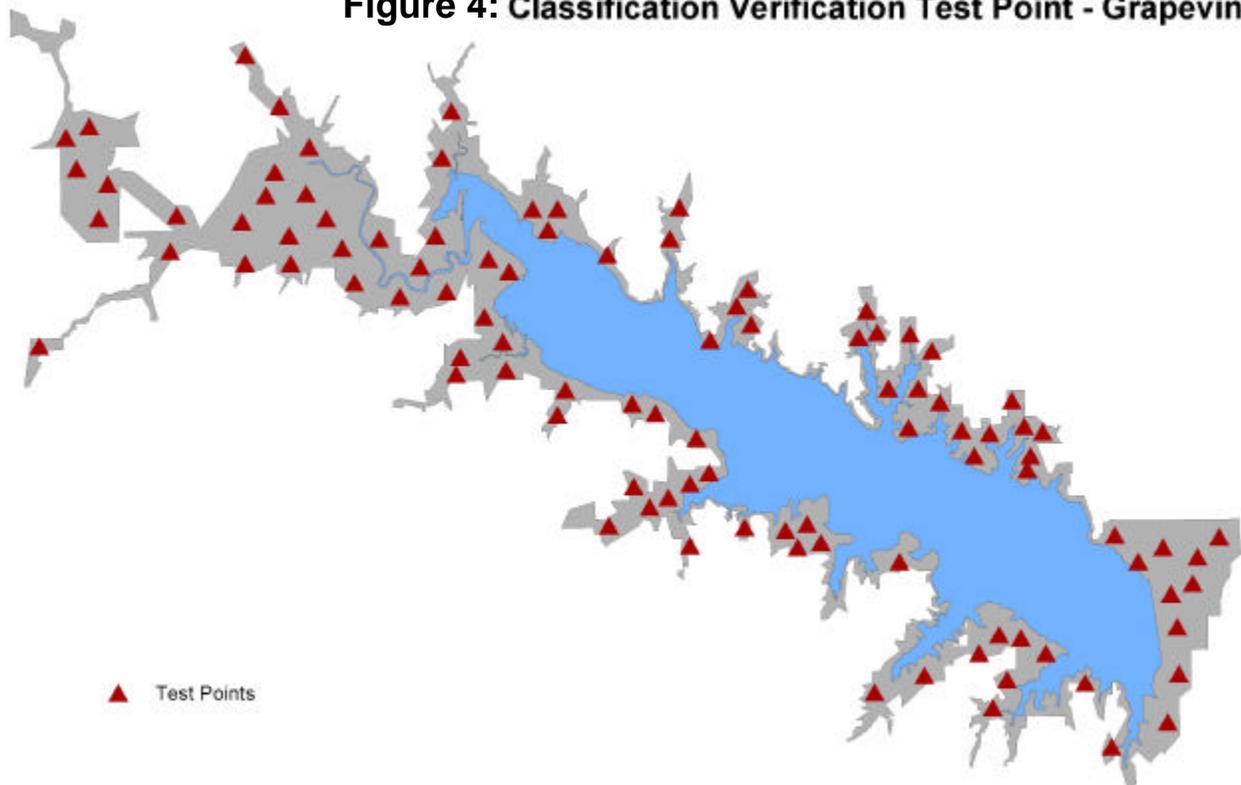


## Classification Verification

- A laboratory process was used to conduct a check of the classification process. A series of points were randomly placed within the COE boundary but outside the Conservation Pool boundary, 100 points for Gr and 150 for Le (Figure 4). This was done without prior knowledge of the underlying classifications.
- The points were overlaid on top of the Orthophotos in GIS (Figure 5) and for each point (numbered 1 – 250) a class was visually determined and recorded for that point by examining the air photo.
- The 250 points were overlaid on top of the satellite 4-classification output and each point was digitally assigned a class depending upon the underlying value.
- Each of the 250 points were checked against each other to determine if the value in the digital satellite classification was the same or different from that determined from visual inspection of aerial photography.

The initial overall accuracy process determined that 84% of the 250 points were of the same class in both the satellite classification and the visual interpretation of the air photo.

**Figure 4: Classification Verification Test Point - Grapevine**



**Figure 5: Classification Verification Test Points - Grapevine**

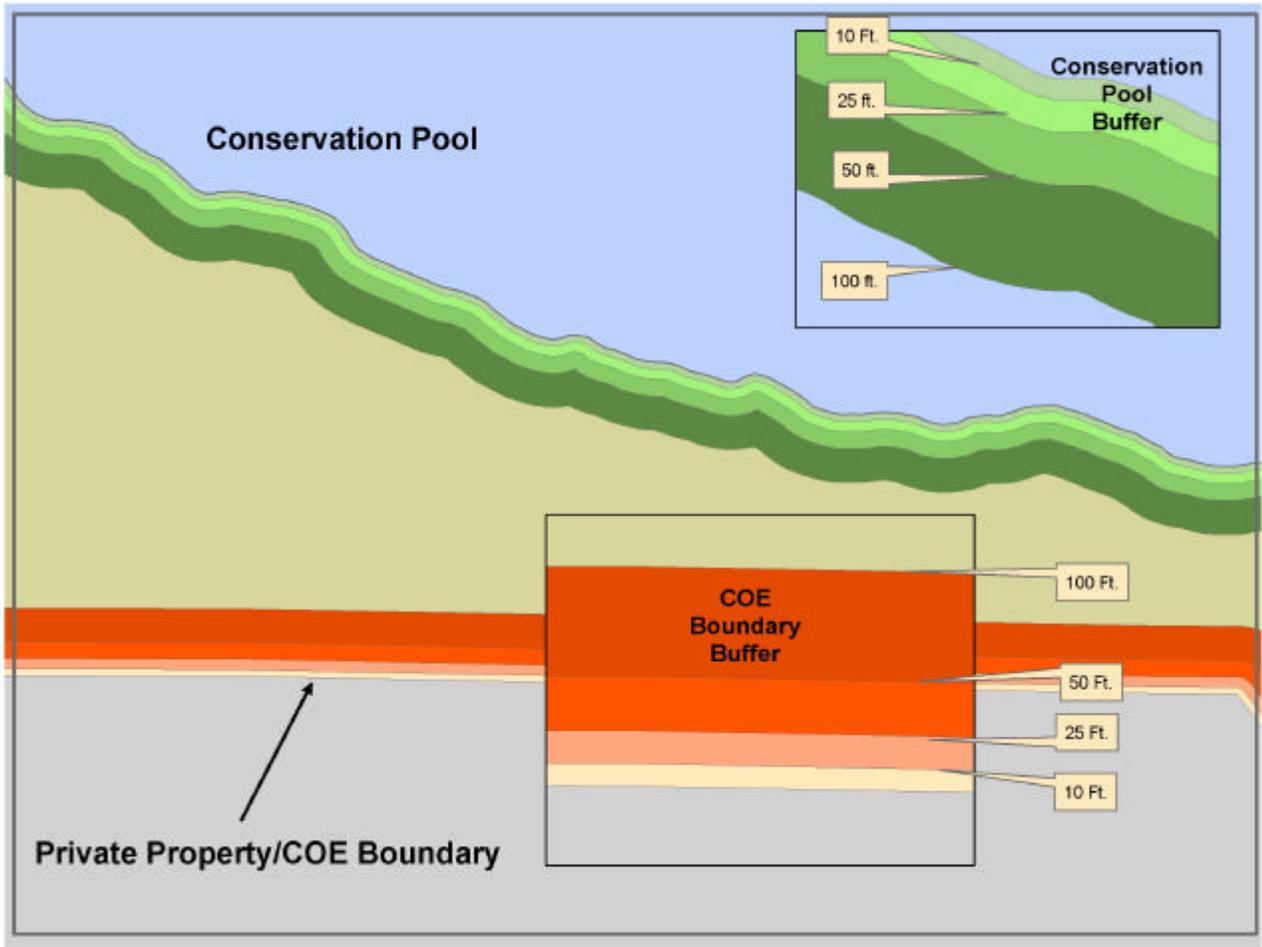


### **Buffer Determination**

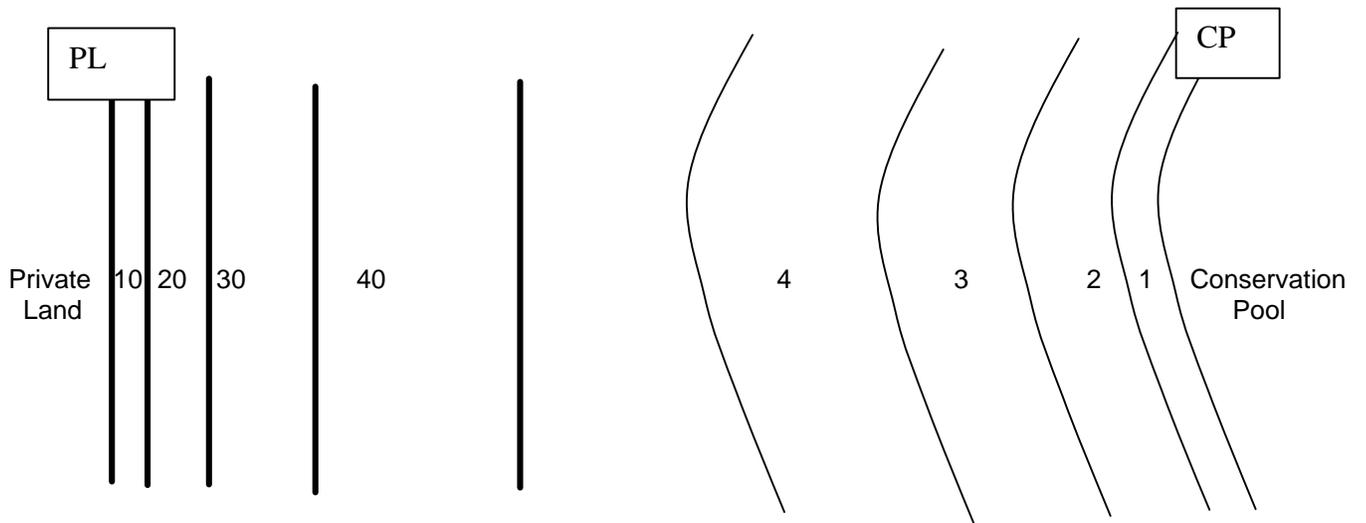
The next steps consisted of determining buffers (designated as Mow and Conservation buffers) from the Conservation Pool and the COE property boundaries.

- GIS digital shapefiles were obtained from the COE for the property (Fee) boundary and conservation pool of the two lakes. The conservation pool boundaries were determined from 2ft. contour data obtained from the North Central Texas Council of Governments (NCTCOG) GIS department and were a product of LIDAR scanning of the elevation of the surface of the earth in the north Texas area.
- The contour value of 522 ft. is the Conservation Pool (CP) for Lake Lewisville and 535 ft. is the pool for Grapevine. These elevations were taken as the Conservation Pool boundary for the two lakes.
- The Fee or Property Line (PL) is a line determined through GPS location of surveyed monuments bordering the COE land and defining the property boundaries. Neither of these GIS boundaries (PL or CP) are products of certified surveyors and are to be considered as mapping quality only for purposes of this project, not survey quality for legal definition.
- Using ESRI, Inc. GIS software, a series of buffers were generated using the inside of the PL and the outside of the CP as base lines. The buffers were created at 10', 25', 50' and 100' intervals from the base lines (Figure 6).

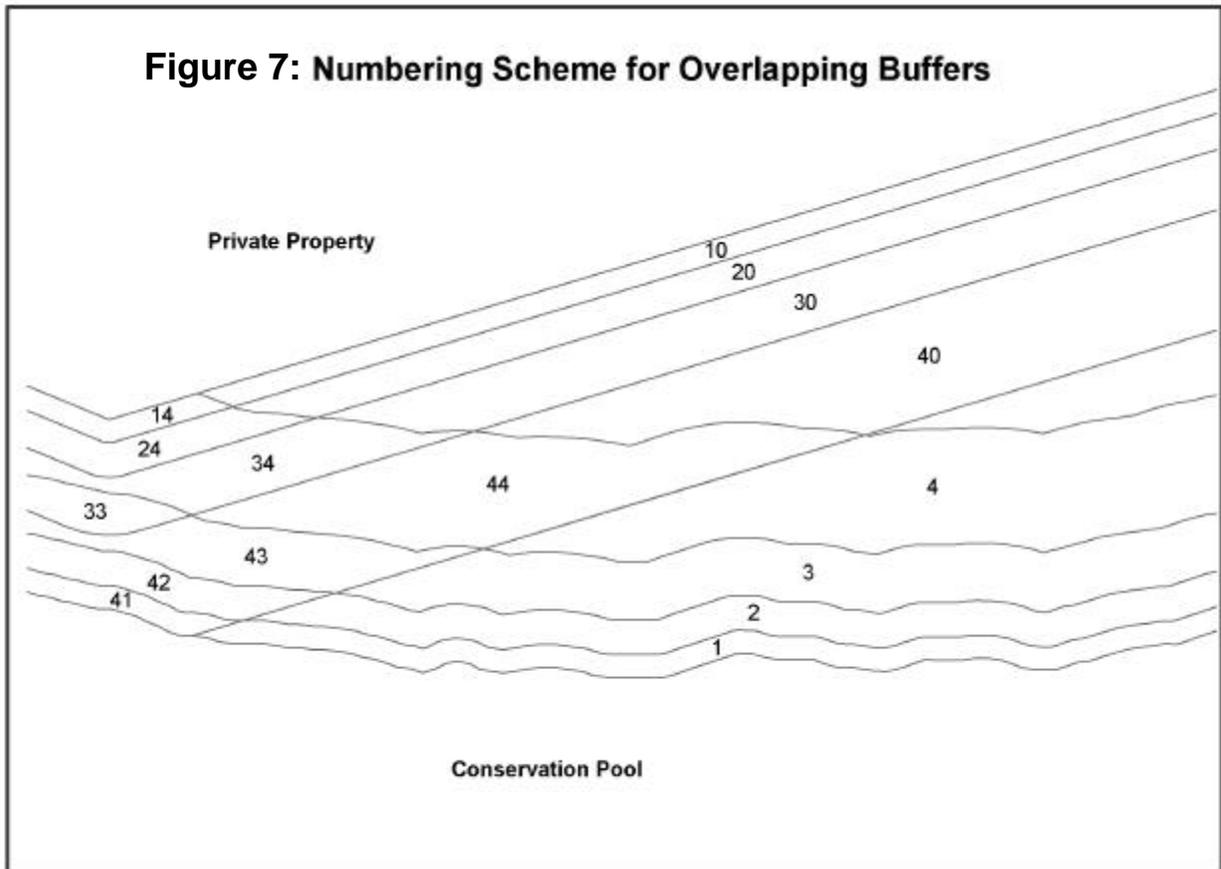
**Figure 6: Detail of Conservation Pool and Property Boundary Buffers**



- Note: Where the CP buffers extended beyond the PL, they were clipped off. In other words, in many cases the PL was a shorter distance than the 50' or 100' buffer from the CP and so we clipped by the PL.
- The CP buffers were numbered, starting with the 10' buffer, 1 – 4. The PL buffers were numbered, again starting with the 10' buffer, 10 – 40.



- The 4 CP buffers were overlaid on top of the 4 PL buffers to create a new file – a matrix of all the buffers. Where the buffers overlap, the buffer ID is determined by the combination of the original IDs. For example, an ID of 44 signifies that buffer 40 (the 100' PL buffer) overlaps with buffer 4 (the 100' CP buffer) (Figure 7).
- In addition to the buffer construction, the Conservation Pool digital polygon file was subtracted on the Fee Boundary polygon file and the total acreage for the area was calculated. This figure is the GIS calculated acreage for COE property that lies between the Fee Boundary and the lake Conservation Pool.



### Buffer and Vegetation Calculations

- The final analysis of files consists of the buffer file overlaid on top of the satellite classification file. The combination of the two files produces a quantitative value for the number of acres of each of the 4 classification types within each buffer.
- For the overlay, the vegetation classes were recoded to 200 (Bare), 300 (Woody), 400 (Herbaceous) and 500 (Maintained). An additional class, 100, was added to include all areas within the COE boundary that could not be classified. This class represents "Other."
- The overlay of the buffers with the vegetation layers produced an output with class values ranging from 1 to 544 (Figure 8). An explanation of the class overlay and the values accompany the results for the EA.

