



## TOPOGRAFIA GENERAL Y APLICADA:

- Minería
- Obra civil
- Edificación
- Movimientos de Tierra
- Proyectos e Informes.



## MEDICION DE APILES DE ESTERILES DE MINA EN CARBALLO- CANGAS DEL NARCEA - ASTURIAS

JULIO DE 2019

# ÍNDICE

|   |           |
|---|-----------|
| <b>1. LOCALIZACION CARBALLO – CANGAS DEL NARCEA - ASTURIAS.....</b> | <b>2</b>  |
| 1.1 CARACTERÍSTICAS DEL LEVANTAMIENTO: .....                        | 2         |
| 1.2 PROCESAMIENTO DE LAS OBSERVACIONES: .....                       | 2         |
| 1.3 COMPROBACIONES Y PARTICULARIDADES:.....                         | 4         |
| <b>2. FOTOGRAFIAS:.....</b>   | <b>4</b>  |
| <b>3. LISTADO DE COORDENADAS.....</b>                               | <b>6</b>  |
| <b>4. RESULTADOS DE CUBICACION OBTENIDOS:.....</b>                  | <b>10</b> |
| <b>5. CARTOGRAFIA GENERADA .....</b>                                | <b>12</b> |

# 1. LOCALIZACION CARBALLO – CANGAS DEL NARCEA - ASTURIAS

## 1.1 Características del levantamiento:

*Equipos utilizados:* Para realizar el levantamiento de los apiles de esteriles de mina, se han utilizado los siguientes equipos:

- *GPS rover:* Leica 900 con conexión a redes VRS.
- *Estación total:* Leica 1200 TCRP.

*Sistema de Coordenadas Utilizado:* Las coordenadas son UTM, sobre el sistema de referencia geodesico ETRS 89, y alturas ortometricas. Concretamente, estamos en esta zona, en el HUSO 29.

*Metodología empleada:* El primer paso, ha sido, utilizar el equipo GPS conectado a la red GNSS del Principado de Asturias, utilizando como base de referencia de Cangas del Narcea para obtenemos precisiones de +-2cm tanto en planimetría como en altimetría.

Se han observado los puntos de todas las líneas de rotura que se consideraban necesarias para realizar una representación fiel de la realidad existente, y aquellas que por su ubicación fuese imposible situarse sobre las mismas ( cabezas de talud, rellenos de ladera, etc ), se ha procedido a materializar bases auxiliares, temporales, sobre las que nos hemos apoyado para georreferenciar la estación total utilizando el método de intersección inversa, que nos permite controlar los errores de estacionamiento para posteriormente radiar los puntos de interés utilizando la medición sin prisma del equipo. Se han descartado estaciones cuyo error de estacionamiento fuese superior a 2 cm, tanto en planimetría como en altimetría.

## 1.2 Procesamiento de las observaciones:

*Equipos utilizados:* Para el volcado de las observaciones se ha utilizado el programa Leica Geofice, mediante el cual, obtenemos un listado de coordenadas en un fichero TXT, que posteriormente, se carga en el MDT v5 que funciona como complemento al programa de dibujo asistido AUTCAD 2008.

Importados los ficheros de texto con las observaciones al programa de dibujo asistido, nos aparece la nube de puntos observados, con sus respectivos códigos, que nos permite unir los mismos, generando las líneas de rotura necesarias para proceder a realizar la triangulación de los mismos y dando lugar al modelo digital del terreno, que representa la superficie 3d observada.

*Método de cálculo:* En función del objetivo del trabajo, que consiste en obtener una cubicación de los diferentes acopios, se barajan diferentes metodologías de cálculo; mediante perfiles transversales o comparación de mallas.

Método de malla: Calcula los volúmenes de desmonte y terraplén a partir de dos ficheros de malla. Ambos ficheros deben estar generados con el mismo tamaño de celda. Cuanto menor es este valor, más preciso resulta el cálculo, pero los ficheros de mallas son mayores, y su proceso es más lento.

Para cada celda, se halla la cota media a partir de sus cuatro vértices, y si la diferencia de cotas es superior a la tolerancia, se calcula el volumen de la celda y se acumula al volumen de desmonte o terraplén, según el signo. El proceso de cálculo consiste en hallar el volumen de los paralelepípedos formados por cada celda, con la siguiente fórmula:

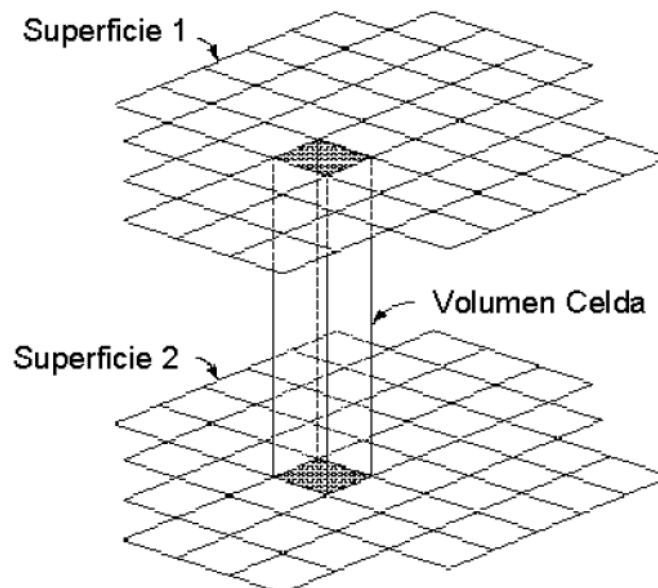
donde:

$V_i$  = Volumen de la celda  $i$

$D$  = Dimensión de la celda

$Z_1$  = Cota media de la celda en la superficie 1

$Z_2$  = Cota media de la celda en la superficie 2



Método de perfiles transversales: Calcula los volúmenes por la diferencia de superficie entre existente entre las secciones generadas por un plano perpendicular a un eje y el terreno natural inicial y el estado final.

Método de Área Media

En este caso el volumen se calculará según la siguiente fórmula:

$$V = ((A_1 + A_2) / 2) H$$

donde:

$V$  = Volumen entre el pk actual y el anterior.

$H$  = Intervalo entre el pk anterior y el actual.

$A_1$  = Superficie del pk anterior.

$A_2$  = Superficie del pk actual.

Con la finalidad de poder obtener los volúmenes, es preciso generar el terreno natural antes del vertido de estériles que se ha obtenido generando un modelo digital, apoyándonos en la cartografía 1/5000 del Principado de Asturias, estimando así los buzamientos o dirección, así como la pendiente de las laderas sobre las que se apoyan los apiles.

Se adjunta plano en el que se puede apreciar las curvas de nivel consideradas como terreno natural y la modificación que se ha realizado a la cartografía 1/5000 utilizada como referencia y en la que ya figuran los apiles.

### 1.3 Comprobaciones y particularidades:

Una vez volcados los datos se comprueba que no existen diferencias significativas en altimetría y planimetría, descartando posibles errores en las observaciones. Así mismo, los equipos GPS, están configurados para que si la desviación típica en planimetría y altimetría o calidad de las observaciones es superior a 3 cm, no se grabe la observación.

En cuanto la definición del terreno natural, se han observado puntos de las laderas, con el fin de comprobar la fiabilidad de la cartografía utilizada como base y se ha considerado apta ya que no hay diferencias superiores al metro de desnivel

## 2. FOTOGRAFIAS:



*Fotografía que muestra los dos niveles de la escombrera*



*Fotografía de la escombrera nivel superior*

*E*



*Fotografía de la escombrera*

### 3. LISTADO DE COORDENADAS

| Nº | COORDENADA X | COORDENADA Y | ALTITUD | COD |
|----|--------------|--------------|---------|-----|
| 1  | 705225,18    | 4776882,428  | 683,462 |     |
| 2  | 705204,802   | 4776894,762  | 682,481 |     |
| 3  | 705206,82    | 4776897,282  | 682,565 | LR1 |
| 4  | 705203,13    | 4776893,789  | 682,163 | LR1 |
| 5  | 705200,679   | 4776890,725  | 682,221 | LR1 |
| 6  | 705196,577   | 4776888,271  | 682,008 | LR1 |
| 7  | 705195,864   | 4776885,33   | 682,051 | LR1 |
| 8  | 705195,289   | 4776882,266  | 681,857 | LR1 |
| 9  | 705195,412   | 4776881,024  | 681,856 | LR1 |
| 10 | 705193,379   | 4776880,408  | 681,199 | LR1 |
| 11 | 705192,384   | 4776878,654  | 681,016 | LR1 |
| 12 | 705194,19    | 4776880,599  | 681,404 | R   |
| 13 | 705194,624   | 4776879,189  | 681,514 | R   |
| 14 | 705195,893   | 4776878,868  | 681,937 | R   |
| 15 | 705195,837   | 4776880,801  | 682,061 | R   |
| 16 | 705196,881   | 4776883,132  | 682,155 | R   |
| 17 | 705200,596   | 4776886,162  | 682,407 | R   |
| 18 | 705204,976   | 4776888,277  | 682,724 | R   |
| 19 | 705210,93    | 4776893,8    | 682,968 | R   |
| 20 | 705212,706   | 4776896,241  | 683,001 | R   |
| 21 | 705219,068   | 4776896,095  | 682,968 | R   |
| 22 | 705224,802   | 4776891,542  | 683,216 | R   |
| 23 | 705228,518   | 4776887,506  | 683,337 | R   |
| 24 | 705228,564   | 4776885,893  | 683,343 | R   |
| 25 | 705225,924   | 4776879,334  | 683,515 | R   |
| 26 | 705223,086   | 4776871,666  | 683,599 | R   |
| 27 | 705217,722   | 4776867,699  | 683,719 | R   |
| 28 | 705213,428   | 4776869,736  | 683,366 | R   |
| 29 | 705213,289   | 4776873,411  | 683,15  | R   |
| 30 | 705213,578   | 4776879,26   | 682,972 | R   |
| 31 | 705213,934   | 4776885,902  | 683,023 | R   |
| 32 | 705214,653   | 4776890,306  | 683,129 | R   |
| 33 | 705208,489   | 4776885,248  | 682,967 | R   |
| 34 | 705205,216   | 4776877,821  | 682,701 | R   |
| 35 | 705203,419   | 4776874,816  | 682,602 | R   |
| 36 | 705205,896   | 4776868,358  | 682,917 | R   |
| 37 | 705201,105   | 4776864,558  | 682,705 | R   |
| 38 | 705196,3     | 4776862,22   | 682,328 | R   |
| 39 | 705190,553   | 4776869,396  | 681,611 | LR1 |
| 40 | 705191,765   | 4776867,077  | 681,596 | LR1 |
| 41 | 705193,191   | 4776864,316  | 682,794 | LR1 |
| 42 | 705193,493   | 4776862,164  | 682,352 | LR1 |
| 43 | 705194,612   | 4776858,242  | 682,394 | LR1 |
| 44 | 705195,44    | 4776858,491  | 682,339 | LR1 |
| 45 | 705195,855   | 4776860,242  | 682,311 | LR1 |
| 46 | 705197,933   | 4776859,996  | 682,531 | LR1 |
| 47 | 705199,625   | 4776858,545  | 682,808 | LR1 |
| 48 | 705203,728   | 4776858,436  | 683,223 | LR1 |
| 49 | 705205,725   | 4776858,08   | 683,314 | LR1 |
| 50 | 705215,961   | 4776855,943  | 683,909 | LR1 |
| 51 | 705220,823   | 4776857,832  | 683,917 | LR1 |

| Nº  | COORDENADA X | COORDENADA Y | ALTITUD | COD |
|-----|--------------|--------------|---------|-----|
| 52  | 705223,171   | 4776857,35   | 683,904 | LR1 |
| 53  | 705223,411   | 4776864,386  | 683,923 | LR1 |
| 54  | 705224,106   | 4776865,824  | 683,751 | LR1 |
| 55  | 705225,489   | 4776860,065  | 682,543 | LR1 |
| 56  | 705225,991   | 4776855,991  | 681,998 | LR1 |
| 57  | 705227,907   | 4776856,269  | 681,933 | LR1 |
| 58  | 705229,627   | 4776859,345  | 682,828 | LR1 |
| 59  | 705230,353   | 4776865,45   | 683,514 | LR1 |
| 60  | 705231,262   | 4776866,482  | 683,933 | LR1 |
| 61  | 705231,951   | 4776864,979  | 684,044 | LR1 |
| 62  | 705231,713   | 4776861,155  | 684,123 | LR1 |
| 63  | 705231,236   | 4776858,007  | 684,059 | LR1 |
| 64  | 705232,606   | 4776857,557  | 684,016 | LR1 |
| 65  | 705234,412   | 4776856,653  | 683,989 | LR1 |
| 66  | 705236,803   | 4776853,758  | 683,976 | LR1 |
| 67  | 705249,2     | 4776859,664  | 684,958 | LR1 |
| 68  | 705250,011   | 4776860,445  | 684,933 | LR1 |
| 69  | 705248,712   | 4776863,463  | 684,96  | LR1 |
| 70  | 705247,652   | 4776864,846  | 684,928 | LR1 |
| 71  | 705246,398   | 4776867,527  | 684,507 | LR1 |
| 72  | 705242,917   | 4776871,066  | 684,463 | LR1 |
| 73  | 705239,182   | 4776874,548  | 684,101 | LR1 |
| 74  | 705231,445   | 4776882,685  | 683,28  | LR1 |
| 75  | 705239,517   | 4776851,312  | 684,328 | LR1 |
| 76  | 705240,261   | 4776850,349  | 684,135 | LR1 |
| 77  | 705241,574   | 4776848,556  | 684,468 | LR1 |
| 78  | 705242,699   | 4776851,779  | 684,153 | LR1 |
| 79  | 705231,115   | 4776884,01   | 683,236 | LR2 |
| 80  | 705234,548   | 4776887,068  | 683,031 | LR3 |
| 81  | 705241,737   | 4776881,338  | 682,693 | LR3 |
| 82  | 705239,528   | 4776876,914  | 682,613 | LR2 |
| 83  | 705246,89    | 4776871,247  | 682,542 | LR2 |
| 84  | 705246,891   | 4776871,242  | 682,538 | LR2 |
| 85  | 705250,158   | 4776867,278  | 682,174 | LR2 |
| 86  | 705254,966   | 4776869,722  | 682,254 | LR3 |
| 87  | 705252,796   | 4776865,051  | 682,194 | LR2 |
| 88  | 705254,363   | 4776858,348  | 682,126 | LR2 |
| 89  | 705262,121   | 4776856,192  | 681,785 | LR2 |
| 90  | 705267,043   | 4776858,031  | 681,774 | LR3 |
| 91  | 705265,563   | 4776851,992  | 681,544 | LR2 |
| 92  | 705267,67    | 4776846,868  | 681,371 | LR2 |
| 93  | 705274,981   | 4776849,74   | 681,431 | LR3 |
| 94  | 705267,154   | 4776843,534  | 680,938 | LR2 |
| 95  | 705264,965   | 4776839,792  | 680,134 | LR2 |
| 96  | 705263,999   | 4776841,342  | 679,844 | LR2 |
| 97  | 705264,703   | 4776847,458  | 679,492 | LR2 |
| 98  | 705261,499   | 4776850,433  | 679,567 | LR2 |
| 99  | 705258,224   | 4776852,331  | 679,38  | LR2 |
| 100 | 705254,567   | 4776852,412  | 679,383 | LR2 |
| 101 | 705252,751   | 4776855,013  | 680,162 | R   |
| 102 | 705249,984   | 4776853,441  | 680,909 | R   |
| 103 | 705248,928   | 4776851,616  | 680,833 | R   |
| 104 | 705248,455   | 4776848,485  | 680,491 | R   |

| Nº  | COORDENADA X | COORDENADA Y | ALTITUD | COD |
|-----|--------------|--------------|---------|-----|
| 105 | 705249,748   | 4776848,804  | 680,445 | R   |
| 106 | 705250,224   | 4776850,908  | 680,596 | R   |
| 107 | 705252,847   | 4776847,181  | 679,264 | LR2 |
| 108 | 705251,713   | 4776845,849  | 679,243 | LR2 |
| 109 | 705249,157   | 4776845,358  | 679,193 | LR2 |
| 110 | 705245,646   | 4776840,513  | 679,135 | LR2 |
| 111 | 705241,949   | 4776839,605  | 679,106 | LR2 |
| 112 | 705234,676   | 4776843,416  | 678,625 | LR2 |
| 113 | 705231,182   | 4776847,405  | 678,439 | LR2 |
| 114 | 705229,925   | 4776846,712  | 678,45  | LR2 |
| 115 | 705229,773   | 4776846,502  | 678,468 | LR2 |
| 116 | 705225,613   | 4776846,994  | 678,639 | LR2 |
| 117 | 705223,647   | 4776849,385  | 678,599 | LR2 |
| 118 | 705221,564   | 4776849,885  | 678,478 | LR2 |
| 119 | 705217,896   | 4776850,025  | 678,545 | LR2 |
| 120 | 705215,359   | 4776848,752  | 678,507 | LR2 |
| 121 | 705211,097   | 4776847,878  | 678,467 | LR2 |
| 122 | 705208,294   | 4776848,616  | 678,471 | LR2 |
| 123 | 705205,209   | 4776849,999  | 678,357 | LR2 |
| 124 | 705203,984   | 4776851,21   | 678,413 | LR2 |
| 125 | 705203,981   | 4776851,299  | 678,366 | LR2 |
| 126 | 705200,61    | 4776853,018  | 678,457 | LR2 |
| 127 | 705199,009   | 4776851,538  | 678,402 | LR2 |
| 128 | 705194,849   | 4776851,438  | 678,303 | LR2 |
| 129 | 705193,847   | 4776849,983  | 678,359 | LR2 |
| 130 | 705190,049   | 4776852,184  | 678,143 | LR2 |
| 131 | 705188,473   | 4776854,478  | 678,213 | LR2 |
| 132 | 705187,814   | 4776856,822  | 678,039 | LR2 |
| 133 | 705187,505   | 4776859,798  | 677,976 | LR2 |
| 134 | 705186,048   | 4776861,478  | 677,987 | LR2 |
| 135 | 705185,06    | 4776861,786  | 677,984 | LR2 |
| 136 | 705184,641   | 4776859,461  | 677,857 | LR2 |
| 137 | 705183,244   | 4776853,06   | 678,076 | LR2 |
| 138 | 705178,44    | 4776842,829  | 677,656 | LR2 |
| 139 | 705179,878   | 4776838,682  | 678,063 | LR2 |
| 140 | 705184,389   | 4776838,448  | 678,128 | LR2 |
| 141 | 705189,404   | 4776839,465  | 678,266 | LR2 |
| 142 | 705192,597   | 4776839,909  | 678,571 | LR2 |
| 143 | 705196,758   | 4776840,343  | 678,64  | LR2 |
| 144 | 705201,556   | 4776840,063  | 678,644 | LR2 |
| 145 | 705207,758   | 4776836,827  | 678,803 | LR2 |
| 146 | 705214,56    | 4776834,006  | 678,958 | LR2 |
| 147 | 705218,971   | 4776830,942  | 678,999 | LR2 |
| 148 | 705222,154   | 4776827,203  | 678,975 | LR2 |
| 149 | 705190,016   | 4776883,192  | 679,322 | R   |
| 150 | 705190,047   | 4776886,348  | 678,977 | R   |
| 151 | 705182,413   | 4776889,258  | 673,422 | R   |
| 152 | 705182,45    | 4776894,112  | 672,464 | R   |
| 153 | 705179,656   | 4776899,637  | 668,646 | R   |
| 154 | 705184,353   | 4776901,883  | 670,067 | R   |
| 155 | 705188,95    | 4776899,879  | 673,225 | R   |
| 156 | 705190,902   | 4776900,149  | 673,788 | R   |
| 157 | 705173,77    | 4776909,998  | 661,028 | R   |
| 158 | 705153,246   | 4776913,047  | 648,007 | R   |

| Nº  | COORDENADA X | COORDENADA Y | ALTITUD | COD |
|-----|--------------|--------------|---------|-----|
| 159 | 705177,819   | 4776896,246  | 669,057 | R   |
| 160 | 705161,382   | 4776893,686  | 658,721 | R   |
| 161 | 705160,057   | 4776892,298  | 658,114 | R   |
| 162 | 705164,448   | 4776888,327  | 661,923 | R   |
| 163 | 705174,484   | 4776883,757  | 669,536 | R   |
| 165 | 705100,875   | 4776873,45   | 623,716 | L1  |
| 166 | 705109,753   | 4776873,649  | 628,818 | R   |
| 167 | 705117,465   | 4776872,174  | 633,418 | R   |
| 168 | 705111,993   | 4776870,604  | 631,258 | R   |
| 169 | 705111,265   | 4776867,501  | 632,072 | L1  |
| 170 | 705107,965   | 4776866,007  | 632,138 | L1  |
| 172 | 705143,48    | 4776815,302  | 674,718 | L1  |
| 173 | 705153,833   | 4776817,757  | 679,193 | R   |
| 175 | 705158,753   | 4776826,082  | 676,903 | R   |
| 176 | 705160,357   | 4776831,015  | 674,775 | R   |
| 177 | 705117,59    | 4776870,263  | 634,328 | R   |
| 178 | 705111,218   | 4776875,138  | 628,891 | R   |
| 179 | 705100,859   | 4776878,646  | 621,849 | R   |
| 180 | 705186,874   | 4776908,75   | 667,652 | L1  |
| 181 | 705194,987   | 4776901,156  | 675,156 | L1  |
| 182 | 705205,048   | 4776898,019  | 681,95  | L1  |
| 183 | 705203,393   | 4776898,478  | 680,826 | L1  |
| 184 | 705197,03    | 4776900,287  | 676,742 | L1  |
| 185 | 705222,614   | 4776824,355  | 679,462 | LR2 |
| 186 | 705225,138   | 4776823,489  | 679,436 | LR2 |
| 187 | 705240,848   | 4776815,592  | 679,664 | LR2 |
| 188 | 705253,35    | 4776810,052  | 682,024 | L2  |
| 189 | 705258,837   | 4776799,853  | 691,732 | L2  |
| 190 | 705253,228   | 4776791,504  | 694,329 | LR4 |
| 191 | 705250,007   | 4776793,942  | 692,005 | LR4 |
| 192 | 705247,293   | 4776798,273  | 689,253 | LR4 |
| 193 | 705245,577   | 4776802,228  | 686,674 | LR4 |
| 194 | 705244,551   | 4776805,593  | 684,373 | LR4 |
| 195 | 705260,749   | 4776773,842  | 703,739 | R   |
| 196 | 705257,118   | 4776777,232  | 702,639 | R   |
| 197 | 705253,579   | 4776779,461  | 701,972 | R   |
| 198 | 705251,303   | 4776779,99   | 701,529 | R   |
| 199 | 705247,562   | 4776779,402  | 701,618 | R   |
| 200 | 705244,291   | 4776778,624  | 701,589 | R   |
| 201 | 705235,319   | 4776783,868  | 699,764 | R   |
| 202 | 705228,071   | 4776788,605  | 698,773 | R   |
| 203 | 705219,113   | 4776796,447  | 697,253 | R   |
| 204 | 705212,33    | 4776796,498  | 699,351 | R   |
| 205 | 705206,955   | 4776803,438  | 698,106 | R   |
| 206 | 705201,185   | 4776808,631  | 697,449 | R   |
| 207 | 705196,21    | 4776810,345  | 697,594 | R   |
| 208 | 705188,392   | 4776807,375  | 698,879 | R   |
| 209 | 705181,762   | 4776803,184  | 700,348 | R   |
| 210 | 705179,655   | 4776807,113  | 697,111 | R   |
| 211 | 705188,696   | 4776815,541  | 693,707 | R   |
| 212 | 705193,281   | 4776817,754  | 692,631 | R   |
| 213 | 705199,199   | 4776819,017  | 691,26  | R   |
| 214 | 705202,767   | 4776817,964  | 691,17  | R   |
| 215 | 705207,503   | 4776815,296  | 691,248 | R   |



| Nº  | COORDENADA X | COORDENADA Y | ALTITUD | COD |
|-----|--------------|--------------|---------|-----|
| 216 | 705211,887   | 4776811,054  | 691,613 | R   |
| 217 | 705216,033   | 4776807,008  | 692,03  | R   |
| 218 | 705219,648   | 4776802,294  | 693,237 | R   |
| 219 | 705228,345   | 4776801,271  | 691,386 | R   |
| 220 | 705236,379   | 4776797,133  | 690,62  | R   |
| 221 | 705241,867   | 4776797,858  | 689,182 | R   |
| 222 | 705247,775   | 4776796,802  | 690,106 | R   |
| 223 | 705227,641   | 4776783,04   | 701,864 | R   |
| 224 | 705244,381   | 4776808,184  | 682,706 | R   |
| 225 | 705230,417   | 4776814,352  | 682,579 | R   |
| 226 | 705231,043   | 4776810,874  | 684,731 | R   |
| 227 | 705222,244   | 4776813,625  | 685,19  | R   |
| 228 | 705217,416   | 4776815,9    | 686,036 | R   |
| 229 | 705211,461   | 4776822,121  | 685,223 | R   |
| 230 | 705202,994   | 4776827,762  | 684,567 | R   |
| 231 | 705196,689   | 4776829,087  | 684,542 | R   |
| 232 | 705191,451   | 4776829,42   | 684,267 | R   |
| 233 | 705183,778   | 4776828,94   | 683,956 | R   |
| 234 | 705177,933   | 4776825,387  | 684,927 | R   |
| 235 | 705170,347   | 4776828,408  | 680,486 | R   |
| 236 | 705176,984   | 4776831,976  | 680,777 | R   |
| 237 | 705178,116   | 4776832,242  | 680,51  | R   |
| 238 | 705226,292   | 4776820,496  | 680,627 | LR5 |
| 239 | 705213,509   | 4776828,65   | 681,497 | LR5 |
| 240 | 705212,591   | 4776829,524  | 681,609 | LR5 |
| 241 | 705213,336   | 4776831,646  | 680,623 | LR5 |
| 242 | 705205,892   | 4776834,385  | 680,902 | LR5 |
| 243 | 705199,171   | 4776836,748  | 680,665 | LR5 |
| 244 | 705182,293   | 4776836,21   | 679,708 | LR5 |
| 245 | 705178,436   | 4776833,393  | 679,699 | LR6 |
| 246 | 705196,511   | 4776834,84   | 681,034 | LR6 |
| 247 | 705205,094   | 4776832,225  | 681,063 | LR6 |
| 248 | 705212,809   | 4776827,565  | 681,474 | LR6 |
| 249 | 705221,327   | 4776821,555  | 681,193 | LR6 |
| 250 | 705227,24    | 4776818,004  | 680,937 | LR6 |
| 251 | 705207,875   | 4776841,861  | 678,72  | R   |
| 252 | 705213,131   | 4776838,387  | 678,742 | R   |
| 253 | 705216,806   | 4776844,723  | 678,495 | R   |
| 254 | 705220,892   | 4776834,994  | 678,736 | R   |
| 255 | 705222,909   | 4776840,268  | 678,618 | R   |
| 256 | 705229,998   | 4776841,501  | 678,476 | R   |
| 257 | 705238,062   | 4776824,131  | 679,138 | R   |
| 258 | 705242,482   | 4776832,961  | 679,161 | R   |
| 259 | 705262,395   | 4776818,882  | 680,492 | R   |
| 260 | 705260,724   | 4776825,573  | 680,176 | R   |
| 261 | 705275,156   | 4776819,565  | 680,89  | R   |
| 262 | 705274,096   | 4776825,51   | 680,785 | R   |
| 263 | 705304,849   | 4776823,148  | 685,605 | TN  |
| 264 | 705305,574   | 4776815,643  | 685,845 | TN  |
| 265 | 705305,732   | 4776809,084  | 687,077 | TN  |
| 266 | 705296,17    | 4776801,805  | 685,216 | TN  |
| 267 | 705282,093   | 4776800,749  | 686,983 | TN  |
| 268 | 705257,321   | 4776810,443  | 683,87  | TN  |
| 269 | 705243,463   | 4776893,792  | 683,754 | TN  |

| Nº  | COORDENADA X | COORDENADA Y | ALTITUD | COD    |
|-----|--------------|--------------|---------|--------|
| 270 | 705241,26    | 4776899,093  | 683,827 | CAMINO |
| 271 | 705247,627   | 4776892,533  | 684,744 | CAMINO |
| 272 | 705261,217   | 4776879,356  | 686,2   | CAMINO |
| 273 | 705273,113   | 4776867,368  | 687,346 | CAMINO |
| 274 | 705288,86    | 4776852,673  | 689,718 | CAMINO |
| 275 | 705305,455   | 4776835,977  | 691,765 | CAMINO |
| 276 | 705314,454   | 4776819,907  | 694,092 | CAMINO |
| 277 | 705317,075   | 4776811,444  | 695,39  | CAMINO |
| 278 | 705311,921   | 4776795,964  | 696,411 | CAMINO |
| 279 | 705305,731   | 4776792,13   | 697,132 | CAMINO |
| 280 | 705292,748   | 4776789,637  | 699,062 | CAMINO |
| 281 | 705273,913   | 4776784,271  | 700,402 | CAMINO |
| 282 | 705273,293   | 4776770,146  | 701,776 | CAMINO |
| 283 | 705274,087   | 4776766,043  | 701,548 | CAMINO |
| 284 | 705271,495   | 4776764,58   | 699,047 | PIE    |
| 285 | 705264,069   | 4776777,523  | 700,702 | R      |
| 286 | 705252,955   | 4776796,357  | 692,938 | R      |
| 287 | 705251,452   | 4776804,727  | 685,717 | R      |
| 288 | 705262,301   | 4776778,038  | 700,682 | R      |
| 289 | 705261,207   | 4776780,653  | 699,197 | R      |
| 290 | 705256,531   | 4776778,817  | 701,829 | R      |
| 291 | 705260,333   | 4776772,399  | 704,806 | R      |
| 292 | 705258,597   | 4776774,482  | 703,877 | R      |
| 296 | 705253,851   | 4776765,719  | 709,894 | LR10   |
| 297 | 705253,238   | 4776767,191  | 710,038 | TN     |
| 298 | 705253,236   | 4776767,193  | 710,04  | LR10   |
| 299 | 705249,692   | 4776767,985  | 710,066 | LR10   |
| 300 | 705245,267   | 4776766,188  | 709,718 | LR10   |
| 301 | 705243,604   | 4776764,884  | 709,685 | LR10   |
| 302 | 705240,34    | 4776767,652  | 709,165 | LR10   |
| 303 | 705238,025   | 4776768,719  | 709,503 | LR10   |
| 304 | 705232,068   | 4776770,86   | 709,517 | LR10   |
| 305 | 705182,877   | 4776778,297  | 709,45  | LR10   |
| 306 | 705186,28    | 4776784,618  | 708,43  | LR10   |
| 307 | 705185,806   | 4776787,367  | 708,406 | LR10   |
| 308 | 705182,844   | 4776790,388  | 706,936 | LR10   |
| 309 | 705183,811   | 4776793,942  | 706,493 | LR10   |
| 310 | 705187,613   | 4776795,032  | 706,448 | LR10   |
| 311 | 705195,847   | 4776793,4    | 707,275 | LR10   |
| 312 | 705198,228   | 4776789,22   | 707,986 | LR10   |
| 313 | 705202,666   | 4776785,343  | 708,709 | LR10   |
| 314 | 705206,058   | 4776782,147  | 708,995 | LR10   |
| 315 | 705211,31    | 4776780,614  | 709,093 | LR10   |
| 316 | 705195,779   | 4776788,469  | 708,105 | R      |
| 317 | 705192,594   | 4776788,104  | 708,612 | R      |
| 318 | 705189,344   | 4776789,983  | 708,033 | R      |
| 319 | 705186,471   | 4776792,924  | 707,008 | R      |
| 320 | 705179,128   | 4776793,995  | 704,14  | R      |
| 321 | 705179,301   | 4776795,922  | 703,637 | R      |
| 322 | 705180,346   | 4776798,353  | 702,659 | R      |
| 323 | 705181,926   | 4776801,796  | 701,189 | R      |
| 324 | 705183,358   | 4776803,578  | 700,451 | R      |
| 325 | 705180,467   | 4776802,855  | 700,011 | R      |
| 326 | 705177,216   | 4776800,977  | 699,908 | R      |

| Nº  | COORDENADA X | COORDENADA Y | ALTITUD | COD    |
|-----|--------------|--------------|---------|--------|
| 327 | 705173,206   | 4776797,693  | 699,403 | R      |
| 328 | 705169,927   | 4776793,555  | 698,626 | R      |
| 329 | 705169,366   | 4776786,917  | 699,714 | L1     |
| 330 | 705167,156   | 4776794,047  | 696,891 | R      |
| 331 | 705166,782   | 4776798,56   | 695,321 | R      |
| 332 | 705166,755   | 4776802,196  | 693,907 | R      |
| 333 | 705167,348   | 4776805,94   | 692,391 | R      |
| 334 | 705165,515   | 4776808,111  | 690,207 | R      |
| 335 | 705166,703   | 4776810,559  | 689,647 | R      |
| 336 | 705160,977   | 4776806,574  | 688,524 | R      |
| 337 | 705156,489   | 4776803,004  | 687,454 | R      |
| 338 | 705151,538   | 4776801,515  | 684,884 | L2     |
| 339 | 705161,061   | 4776813,415  | 685,191 | R      |
| 340 | 705163,954   | 4776817,276  | 684,364 | R      |
| 341 | 705166,742   | 4776819,948  | 683,911 | R      |
| 342 | 705170,108   | 4776824,613  | 682,412 | R      |
| 343 | 705172,802   | 4776828,017  | 681,475 | R      |
| 344 | 705176,497   | 4776833,184  | 679,824 | R      |
| 345 | 705177,516   | 4776835,24   | 679,033 | R      |
| 346 | 705177,009   | 4776835,343  | 678,807 | LR11   |
| 347 | 705174,598   | 4776838,035  | 676,597 | LR11   |
| 348 | 705173,014   | 4776839,304  | 675,247 | LR11   |
| 349 | 705169,575   | 4776841,735  | 672,491 | LR11   |
| 350 | 705166,453   | 4776844,387  | 669,844 | LR11   |
| 351 | 705166,456   | 4776844,394  | 669,862 | LR11   |
| 352 | 705163,406   | 4776847,336  | 666,842 | LR11   |
| 353 | 705160,582   | 4776849,915  | 664,255 | LR11   |
| 354 | 705156,542   | 4776855,41   | 659,699 | LR11   |
| 355 | 705154,776   | 4776859,001  | 656,997 | LR11   |
| 356 | 705149,843   | 4776862,071  | 653,565 | LR11   |
| 357 | 705141,009   | 4776866,636  | 646,955 | LR11   |
| 358 | 705137,912   | 4776866,907  | 645,464 | R      |
| 359 | 705135,38    | 4776862,546  | 646,548 | R      |
| 360 | 705133,116   | 4776857,925  | 647,535 | R      |
| 361 | 705131,182   | 4776855,154  | 647,841 | R      |
| 362 | 705128,337   | 4776875,02   | 637,262 | LR11   |
| 363 | 705121,776   | 4776880,028  | 633,174 | LR11   |
| 365 | 705117,236   | 4776876,935  | 631,226 | R      |
| 366 | 705113,839   | 4776872,789  | 631,284 | R      |
| 367 | 705153,861   | 4776859,768  | 656,488 | LR12   |
| 368 | 705159,712   | 4776859,596  | 660,151 | LR12   |
| 369 | 705164,42    | 4776859,375  | 663,403 | LR12   |
| 370 | 705167,456   | 4776859,521  | 665,774 | LR12   |
| 371 | 705174,166   | 4776860,553  | 670,44  | LR12   |
| 372 | 705174,931   | 4776861,741  | 671,008 | LR12   |
| 373 | 705179,992   | 4776862,745  | 674,481 | LR12   |
| 374 | 705185,054   | 4776861,579  | 677,998 | LR12   |
| 375 | 705275,87    | 4776836,788  | 681,05  | R      |
| 376 | 705275,41    | 4776844,026  | 681,373 | R      |
| 377 | 705262,489   | 4776859,304  | 681,984 | R      |
| 378 | 705306,602   | 4776792,206  | 696,97  | CAMINO |
| 379 | 705308,969   | 4776793,298  | 696,649 | CAMINO |

|     |            |             |         |        |
|-----|------------|-------------|---------|--------|
| 380 | 705294,209 | 4776789,603 | 698,684 | CAMINO |
| 381 | 705277,916 | 4776787,14  | 700,481 | CAMINO |
| 382 | 705274,25  | 4776748,956 | 704,153 | CAMINO |
| 383 | 705271,948 | 4776741,843 | 705,33  | CAMINO |
| 384 | 705265,837 | 4776737,531 | 706,367 | CAMINO |
| 385 | 705257,681 | 4776735,12  | 707,46  | CAMINO |
| 386 | 705236,89  | 4776731,357 | 709,494 | CAMINO |
| 387 | 705222,393 | 4776735,791 | 710,236 | CAMINO |
| 388 | 705207,25  | 4776743,645 | 711,393 | CAMINO |
| 389 | 705199,423 | 4776749,583 | 712,214 | CAMINO |
| 390 | 705214,507 | 4776744,128 | 710,516 | LR13   |
| 391 | 705209,654 | 4776748,4   | 710,141 | LR13   |
| 392 | 705203,342 | 4776754,094 | 709,961 | LR13   |
| 393 | 705190,793 | 4776765,797 | 709,42  | LR13   |
| 394 | 705178,945 | 4776770,778 | 708,819 | LR14   |
| 395 | 705182,772 | 4776770,418 | 709,168 | LR14   |
| 396 | 705187,793 | 4776769,382 | 709,522 | LR14   |
| 397 | 705198,58  | 4776765,389 | 709,946 | LR14   |
| 398 | 705204,058 | 4776763,665 | 709,778 | LR14   |
| 399 | 705209,673 | 4776759,427 | 709,809 | R      |
| 400 | 705210,329 | 4776757,34  | 709,872 | R      |
| 401 | 705216,358 | 4776754,138 | 710,074 | R      |
| 402 | 705222,412 | 4776751,76  | 710,062 | R      |
| 403 | 705228,821 | 4776748,132 | 710,18  | R      |
| 404 | 705237,735 | 4776752,322 | 710,114 | R      |
| 405 | 705230,265 | 4776756,814 | 709,889 | R      |
| 406 | 705221,519 | 4776761,06  | 710,049 | R      |
| 407 | 705213,475 | 4776765,056 | 709,76  | R      |
| 408 | 705268,639 | 4776782,32  | 695,25  |        |
| 409 | 705180,67  | 4776870,924 | 674,5   | R      |
| 410 | 705170,145 | 4776874,298 | 667,42  | R      |
| 411 | 705160,217 | 4776872,74  | 660,25  | R      |
| 412 | 705150,56  | 4776879,575 | 653,15  | R      |
| 413 | 705140,083 | 4776879,441 | 646,56  | R      |
| 414 | 705133,621 | 4776912,034 | 628,85  |        |
| 415 | 705238,762 | 4776890,854 | 680,52  |        |
| 416 | 705255,896 | 4776876,313 | 680,85  |        |
| 417 | 705271,087 | 4776861,013 | 680,95  |        |
| 418 | 705280,846 | 4776847,941 | 680,9   |        |
| 419 | 705292,777 | 4776830,534 | 680,92  |        |
| 420 | 705299,315 | 4776819,363 | 680,93  |        |
| 421 | 705298,485 | 4776809,306 | 680,65  |        |
| 422 | 705273,311 | 4776807,722 | 680,8   |        |
| 423 | 705259,807 | 4776813,025 | 680,62  |        |
| 424 | 705257,836 | 4776813,237 | 680,75  |        |
| 425 | 705142,091 | 4776890,815 | 648,1   |        |
| 426 | 705123,579 | 4776893,511 | 635,25  |        |
| 427 | 705154,953 | 4776916,188 | 647,52  |        |
| 428 | 705164,014 | 4776917,446 | 650     |        |
| 429 | 705093,19  | 4776890,359 | 612,05  |        |
| 430 | 705116,502 | 4776905,685 | 622,45  |        |

#### 4. RESULTADOS DE CUBICACION OBTENIDOS:

##### VOLUMEN TOTAL ESCOMBRERA

| <b>NIVEL INFERIOR</b> |                   | <b>NIVEL SUPERIOR</b> |                   |
|-----------------------|-------------------|-----------------------|-------------------|
| <b>P.K.</b>           | <b>Vol.Ter.</b>   | <b>PK</b>             | <b>Vol.Ter.</b>   |
| <b>10</b>             |                   | <b>0</b>              |                   |
|                       | 50,017            |                       | 34945,63          |
| <b>20</b>             | <b>50,017</b>     | <b>10</b>             | <b>34945,63</b>   |
|                       | 5528,321          |                       | 31951,531         |
| <b>30</b>             | <b>5578,338</b>   | <b>20</b>             | <b>66897,162</b>  |
|                       | 16501,725         |                       | 29644,527         |
| <b>40</b>             | <b>22080,062</b>  | <b>30</b>             | <b>96541,689</b>  |
|                       | 26135,719         |                       | 28719,302         |
| <b>50</b>             | <b>48215,782</b>  | <b>40</b>             | <b>125260,991</b> |
|                       | 33472,535         |                       | 27533,85          |
| <b>60</b>             | <b>81688,317</b>  | <b>50</b>             | <b>152794,841</b> |
|                       | 37173,243         |                       | 23405,05          |
| <b>70</b>             | <b>118861,56</b>  | <b>60</b>             | <b>176199,891</b> |
|                       | 10722,855         |                       | 12568,55          |
| <b>72,882</b>         | <b>129584,415</b> | <b>70</b>             | <b>188768,441</b> |
|                       |                   |                       | 3343,95           |
|                       |                   | <b>80</b>             | <b>192112,391</b> |
|                       |                   |                       | 130,51            |
|                       |                   | <b>82,882</b>         | <b>192242,901</b> |

|                      |                     |
|----------------------|---------------------|
| <b>VOLUMEN TOTAL</b> | <b>321827,32 M3</b> |
|----------------------|---------------------|

**CUBICACION PRIMERA FASE HASTA COTA 665**

| <b>NIVEL INFERIOR</b> |                 | <b>NIVEL SUPERIOR</b> |                  |
|-----------------------|-----------------|-----------------------|------------------|
| P.K.                  | Vol.Des         | PK                    | Vol.Des          |
| <b>10</b>             |                 | <b>0</b>              |                  |
|                       |                 |                       | 10286,30         |
| <b>20</b>             |                 | <b>10</b>             | <b>10286,30</b>  |
|                       | 4082,45         |                       | 13935,60         |
| <b>30</b>             | <b>4082,45</b>  | <b>20</b>             | <b>24221,90</b>  |
|                       | 8868,75         |                       | 20280,90         |
| <b>40</b>             | <b>12951,20</b> | <b>30</b>             | <b>44502,80</b>  |
|                       | 11924,65        |                       | 25291,60         |
| <b>50</b>             | <b>24875,85</b> | <b>40</b>             | <b>69794,40</b>  |
|                       | 13039,20        |                       | 27533,85         |
| <b>60</b>             | <b>37915,05</b> | <b>50</b>             | <b>97328,25</b>  |
|                       | 12066,90        |                       | 23405,05         |
| <b>70</b>             | <b>49981,95</b> | <b>60</b>             | <b>120733,30</b> |
|                       | 3050,83         |                       | 12568,55         |
| <b>72,882</b>         | <b>53032,78</b> | <b>70</b>             | <b>133301,85</b> |
|                       |                 |                       | 3343,95          |
|                       |                 | <b>80</b>             | <b>136645,80</b> |
|                       |                 |                       | 130,51           |
|                       |                 | <b>82,882</b>         | <b>136776,31</b> |

|                      |                     |
|----------------------|---------------------|
| <b>VOLUMEN TOTAL</b> | <b>189809,09 M3</b> |
|----------------------|---------------------|

Fdo: Ignacio Villamil Cabo  
Ingeniero Técnico en Topografía  
Colegiado numero 4731

## **5. CARTOGRAFIA GENERADA**