# Risk and reliability of exploration methods used to define a heavy mineral sand deposit in Kwa-Zulu Natal, South Africa

By

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**Table of content**

## Summary


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The objective of the treatise is to review the sample methodology and the exploration methods at a heavy mineral sands deposit. The level of confidence and the risk associated with the resource calculations will be established based on the sample methodology.

Two drilling methods used at Hillendale are compared statistically and visually. It is clear from the comparison that the Wallis Aircore (WAC) method is significantly better than the Reverse Circulation (RCN) method. This is evident also when comparing results of the two methods with the

recovery from the mined out areas. The WAC drilling method reduces the risk of downhole contamination due to the change in the drilling method allowing air to be forced back in an inner tube after the sample is collected compared to the air blowout of the RCN method. The WAC method reduces the variability introduced in the sample collection as compared to the RCN method. The average calculated value (for total heavy minerals (THM) and Ilmenite) of the global population for the two methods is similar. The reduced variability in the sample population of the WAC method results in a lower population being required for the confidence interval about the mean at a 95% confidence level. The lower number of required samples results in a lowering of project cost.

Blockmodels created from the two drilling methods are compared statistically (mode, median, standard deviation). The global mean of the input data compares well with the global mean of the estimated blockmodel. In reconciling the resource blockmodels with actual production data, the variability as introduced by the RCN drilling method is clear. The WAC drilling information produces a blockmodel with an acceptable level of variance (deviation of the geological model from the actual values obtained during mining) as defined by Hillendale mine management of less than 10%. This is determined by reconciling the estimated geological blockmodel for a specific mined out area against the actual tonnages and plant recovery values achieved in the same area. Ultimately, because the drill spacing is standard in the mining operation under study, the required confidence in the mean might not be achieved by either of the two drilling methods in certain portions of the mine, but the results from the WAC method will be closer to the reality than the RCN method with the same number of drillholes.

Three main risks are identified in the sample methodology; they have a high probability to occur or have a high cost impact. The risk inherent in sampling and analysis is the most important of the risks identified in this study. The risk can be effectively reduced by implementing a quality assurance and quality control programme (QAQC). The other high risks are introduced by the drilling method and drillhole spacing. The risk can be reduced by continuous improvement and keeping up to date with new developments in the industry such as improved drilling techniques and by improved knowledge of the ore-body. The knowledge will help in understanding the risk - It may become clear in the text how this can reduce the risk.

In conclusion, the improvement and implementation of systems such as improved drilling technique and quality assurance and quality control programmes enables one to establish an acceptable confidence level in the resource calculation as well as reducing the inherent risk to an acceptable level for future decisions.

## List of abbreviations

| | | |
|---|---|---|
| CPC | - | Central processing centre |
| DTM | - | Digital terrain models |
| EOH | - | End of hole |
| HMC | - | Heavy mineral concentrate |
| KZN | - | Kwa-Zulu Natal |
| LIMS | - | Laboratory Information Management System |
| MSP | - | Mineral separation plant |
| My | - | Million Years |
| PWP | - | Primary wet plant |
| QAQC | - | Quality Assurance and Quality Control |
| RCN | - | Reverse Circulation |
| ROM | - | Run of mine |
| SABLE | - | Standardised Approach to Drillhole Logging for Exploration |

| | | |
|---|---|---|
| SAMREC Code | - | The South African code for the reporting of exploration results, Mineral Resources and Mineral Reserves. |
| SMU | - | Smallest mining unit |
| SQL | - | Standard Query Language |
| TBE | - | tetrabromoethane |
| THM | - | total heavy minerals |
| VHM | - | valuable heavy minerals |
| WAC | - | Wallis Aircore |
| XRF | - | X-ray fluorescence |

## List of figures

## List of tables

# 1 The problem and its setting

## 1.1 Introduction

The heavy mineral industry has, through the years, used numerous exploration and estimation methods considered to be accurate and precise for the deposit. Accurate and reliable geological information is critical as it forms the basis of resource calculation and of the geological model. The geological model forms the basis of production planning, marketing forecasts, operating expenses (OPEX) and capital expenditure (CAPEX) budgets, and the business plan. It is of utmost importance that the geological information is accurate and has a high level of confidence before extraction of the mineral deposit commences.

As described by de Jager (2005), traditionally risk evaluation in the mining industry has been on health and safety in relation to occupational hygiene and hazard identification and mitigation. Financial risk is evaluated through the establishment of a financial model. The financial model looks at the economics of the mineral deposit and relates this to a net present value (NPV) considering some economic risk factors within the financial model. Risk quantification for resources in terms of ore body definition is aided by the introduction and implementation of the SAMREC and Joint Ore Reserve

Committee (JORC) codes (de Jager, 2005). Very little research has been found on the application of a risk management strategy relating to factors contributing to exploration and the classification of a mineral resource.

The thesis will look at the various steps followed during the exploration of a heavy mineral sands mine with the aim of defining the risks of the consequences these have on the mineral resource estimate.

## 1.2 The Problem

In the modern era, there are numerous ways of collecting information about a possible mineral deposit. This document will focus on collecting information for a possible heavy mineral deposit. The problem, however, is which sampling method or method of data interpretation (statistical analysis) to apply at the beginning of an exploration programme to ensure that a resource calculation and geological model with a high confidence level in the global average total heavy minerals (THM) is produced. It is also of critical importance that the sampling methodology does not jeopardise the financial viability of the proposed project, but equally that it does not only focus on short term cost saving so that sampling of the deposit has to be repeated due to incomplete or insufficient sampling.

It is important to understand the effect of the sampling methodology on the reliability of the mineral sands exploration results. In addition, the risks involved, and how they relate to the project viability must be fully clarified.

### 1.2.1 Sub problems

#### 1.2.1.1 Sub problem 1

Can the sampling methodology improve the confidence in the values produced by a mineral resource model without escalating project cost to the point where project viability is affected?

#### 1.2.1.2 Sub problem 2

Does the estimation technique used to determine the mineral resource model affect the overall confidence of the project?

#### 1.2.1.3 Sub problem 3

Will the addition of a quality assurance, quality control (QAQC) programme increase the overall confidence levels in an estimated mineral resource model to ensure the best local grade estimate from the total information, therefore decreasing the project risk?

## 1.3 Hypothesis

The first hypothesis is that the resource estimation risk in heavy mineral sand deposits can be minimized by improving sampling methodology. If the sampling process is not correct, the sampling operation cannot be accurate regardless of how good the sampling methodology is (Pitard, 1993). The costs of the sampling methodology used should be balanced against the expected costs inherent in the risk.

The second hypothesis is that the resource estimation method used for the heavy mineral sand deposit is dependant to the original input data. The resource estimation alone cannot improve the overall confidence level in the mineral resource. If the input data is not accurate, the overall confidence of the values produced by a mineral resource model cannot be high, irrespective of what the statistics might indicate.

The third hypothesis is that the risk associated with estimation of mineral distribution in heavy mineral sand deposits can be minimized and controlled by improving or implementing quality parameters and controls at the various stages the project.

## 1.4 Limits of Research

The study is limited to a specific mining operation on the north coast of Kwa-Zulu Natal and the information available at that operation, including drilling methods used and geological models built at the time of exploration. This includes the Reverse Circulation (RCN) drilling method that used Inverse Distance squared estimation at Hillendale and the Wallis Aircore (WAC) drilling method that used the Kriging estimation method. No additional estimation will be done.

The study focuses on the major components constituting the HMC as determined by the sampling and analyses process and will not focus on the chemical, mineralogical analyses and downstream beneficiation.

Downhole drillhole sample values are composited to represent a single sample. The single sample will be used to determine the theoretical number of samples.

The reconciliation portion of the thesis will be limited to areas with overlapping drilling methods within a corresponding mining timeframe.

The risk assessment is done according to the process set out by Smith and Merritt (2002) in Proactive Risk Management: Controlling Uncertainty in Product Development.

The summary of probabilities for the total project loss is not included in the thesis and only the individual risks identified as part of the exploration sample methodology are discussed.

Due to confidentiality the drilling costs will not be presented in the document and will be available on request.

## 1.5 The importance of the study

Prospecting and exploration is a high-risk business and the profit margin for companies doing exploration must be high enough to cover all risks and thus ensure exploitation. Adequate beneficiation, product, and market information is required to ensure success. Companies strive for the maximum benefit at minimum cost and therefore the "cost of gathering information has to be weighed up against the potential cost of uncertainty". (Snowden, 2003).

History has shown that the largest contributing factor to mine failure is the inadequate definition and understanding of the geological resources for a mining project (McKenzie, 2009). The investment risk in relation to the geological resources is illustrated in Figure 1.

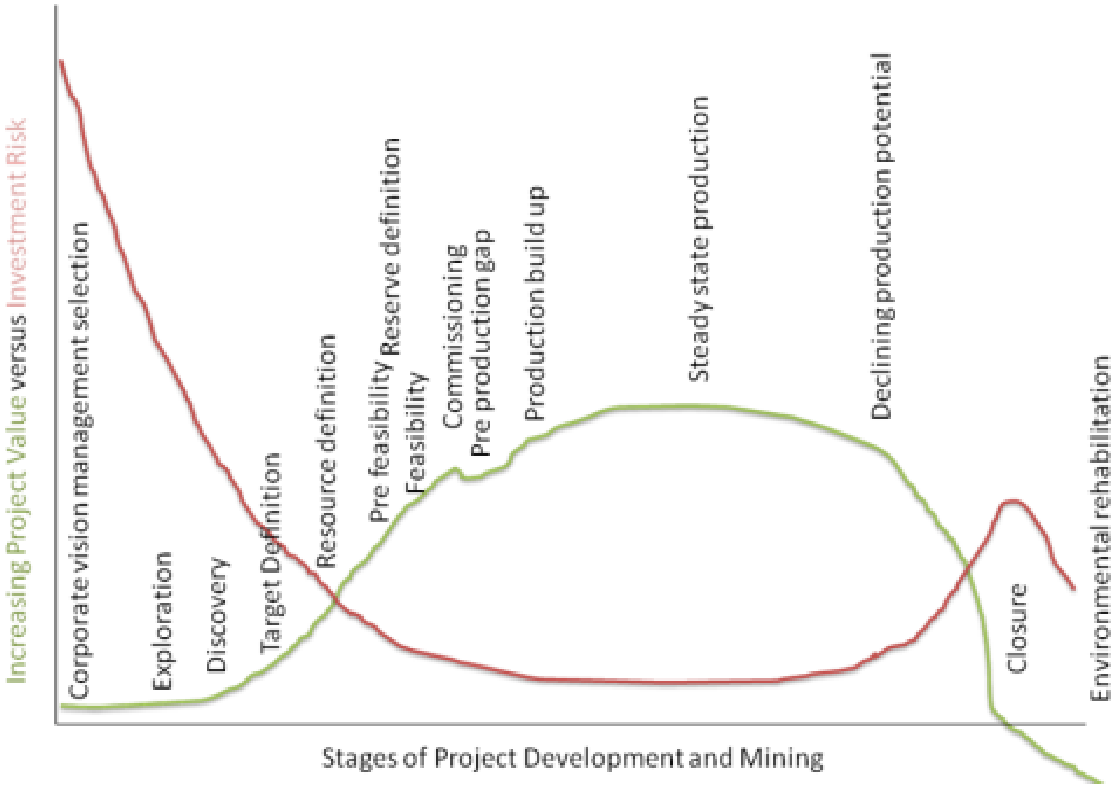


**Figure 1. Investment risk at the various stages of project development (McKenzie, 2009)**

When developing the geologic resource model, three main components need to be considered in order to effectively limit the risk that the resource model will have on downstream processes.

The first is the collection of samples from the deposit for which geologic information is obtained. The second is that the sample data must be sufficient to allow for the development of a reasonable geologic understanding and interpretation of the deposit which can be incorporated into a resource model. The third is the use of a reasonable grade estimation methodology in the resource model, in conjunction with the relevant geologic controls (Stevens, 2001). Continuous technological improvement in the mining industry includes improvement of drilling techniques. The implementation of improved processes can improve operational effectiveness (Bender, 2005). Technological improvements can therefore lower project risks that errors can occur in the set-up of a resource model and increase the confidence in the estimated resource.

## 1.6 Methodology

### 1.6.1 Sub problem 1

Downhole logs of the drillholes situated in relatively close proximity of one another will be plotted against one another to visualize the difference in downhole sample distribution of the two drilling methods. Drillholes situated within a distance of 50 metres of one another where the two drilling methods overlap will be considered. The distance is guided by the 50 x 50 drilling grid for a measured resource.

Descriptive statistical analyses to determine the distribution of the two datasets will be done. This includes the median, spread, symmetry, and peakedness of the population as well as the mean, mode, and kurtosis. The results will be reviewed using the required confidence interval of the mean at a 95% confidence level (central) for various drillhole spacing. Different drillhole spacing has been implemented during the various stages of exploration from target generation with an initial spacing of 400m x 200m through to production drilling of 50m x 50m. Selected drillhole spacing as listed in Table 1 is used to determine the confidence around the mean by using the central limit theorem.

**Table 1. Drillhole spacing as used at Hillendale Mine**

| Project stage | Drillhole spacing |
|---|---|
| Exploration Phase | 200 x 200 |
| Infill Drilling Phase (after positive exploration phase) | 100 x 100 |
| Production Drilling | 50 x 50 |

Comparative cost analysis for the required number of samples to achieve a 95% confidence level in the calculated mean of the population will be done for both the RCN and WAC drilling techniques.

### 1.6.2 Sub problem 2

The RCN blockmodel and the WAC blockmodel used at the project area with the respective estimation techniques applied at the project area will be statistically compared. Estimation methods used at Hillendale have progressed from inverse distance cubed ($ID^3$), as initially prescribed for the companies' Australian operations, to inverse distance squared ($ID^2$) and more recently ordinary kriging.

Estimation is the interpolation of neighbouring samples to determine the values at an un-sampled location. Inverse distance uses the relationship between the values of the variable to estimate the value at a specific location between the two sample points. The distance function is a function of the relationship between values. The larger the distance between samples the more unrelated their grades become. As the distance increases, the relationship between the samples becomes more tenuous (Clarke, 1979). Kriging uses a variogram to find the optimum set of weights used to estimate the grade at unsampled locations. The variogram is a graph that describes the spatial relationship between pairs of samples in a chosen direction (Clarke, 1979). The weights of the samples are derived from the distance between the samples and the block to be estimated as well as between the samples themselves.

### 1.6.3 Sub problem 3

The influence of mitigation steps, such as the introduction of a quality assurance programme, on the project will be determined. The various stages of the sampling methodology and the associated risk will be identified, as will the probability of that risk to occur. Costs will be determined for the WAC base case of Hillendale mine for a specific sample methodology thereafter the costs relating to the mitigation of the risk, or subsequent risk profile will be plotted. The risk profile will visually assist with determining the risks requiring mitigation if above the accepted risk threshold value.

## 1.7 Definition of terms

Carpco® analyses: first pass high intensity dry magnetic separation of a heavy mineral sample into distinct groups based on their inherent properties. The separator places all materials in contact with the magnetic field into zones of steepest gradient and utilizes magnetic force and gravity to capture weakly magnetic materials. The running roll provides a centrifugal force for separating the magnetic and nonmagnetic materials (University of Vermont, 2006).

Sampling methodology: The process of drilling, sampling, and analysis as defined by the company exploration procedures.

HS Mags (magn): The first fraction removal of Carpco® analysis. It is the high susceptibility magnetic fraction, which consists mainly of magnetite.

0.8Amp (mags): The second fraction removal of Carpco® analysis. The material consists mainly of ilmenite (98%).

Magnetic Others (mago): The third fraction removal of Carpco® analyses and is ‘waste’ material such as garnet, epidote and tourmaline.

Non – magnetic (nmag): The final fraction of Carpco® analyses. It consists mainly of zircon, rutile and leucoxene.

Quality Assurance is defined as: “All of those planned or systematic actions necessary to provide adequate confidence in the data collection and estimation process”. (CIM, 2003).

Quality Control: "the systems and mechanisms put in place to provide the Quality Assurance. The four steps of quality control include; setting standards; appraising conformance; acting when necessary and planning for improvements". (CIM, 2003).

# 2 Geology and exploration

## 2.1 Regional and local geology

The KwaZulu-Natal coastline developed during the second phase of Gondwanaland break-up (150 - 130 Million years [My] ago) as sediments were deposited seaward of the Early Cretaceous shoreline on the Mozambique coastal plain, which extends from northern Mozambique to south of Durban. The Mozambique coastal plain reaches a width of approximately 8 km in the vicinity of Hillendale but broadens considerably to almost 80 km in southern Mozambique (Botha, 1997). It narrows quite suddenly to less than 3 km immediately south of Mtunzini and continues as a narrow coastal strip towards the south.

Marine sedimentation occurred along the coastal zone during the major marine transgression of the Cretaceous period and continued into the Early Tertiary period, but all previously deposited material higher than the present-day ±100 m contour was eroded during the slow regression, which followed during Tertiary times (McCarthy, 1988). On the Mozambique coastal plain, the unconformity below the Tertiary shoreline strata is tilted and it truncates the underlying continental slope sediments of the Cretaceous period.

During the Miocene epoch of the Tertiary period (26 – 7 My ago), a more rapid drop in sea level left stranded beach sediments inland of the shore. As the coastal plain developed dune sediments covered the beach deposits. Concomitant with this regression was the lowering of river base levels, which promoted the incision of deep gorges along the coastal river valleys and increased sediment influx into the sea. The drop in sea level occurred in a number of pulses and resulted in the formation of several stranded wave-cut platforms, beach deposits and associated back-dune aeolianites during each period of still stand (McCarthy, 1988). Transgression, regression and progradation during each of these pulses occurred repeatedly at similar relative elevations above sea level, resulting in the formation of a number of stacked, heavy minerals bearing, lenses within these coastal sediments.

At the beginning of the Pleistocene epoch, about 2 My ago, changes in sea level were also rapid and coincided with periods of glaciation and deglaciation. These changes in sea level allowed for continued sediment reworking in the coastal zone and the overall regression, which occurred from Early Cretaceous through to Late Quaternary times, led to the widening of the coastal plain upon which later beach and other sediments accumulated.

Four formations were deposited sporadically and at different locations along the coast during the Pleistocene epoch, viz. the Muzi, Port Durnford, Bluff and Berea Formations.

- The Muzi Formation (Pliocene to Pleistocene) consists of mottled, brown, clayey sand and is generally covered by aeolian sands derived from the Bluff Formation.
- The Port Durnford Formation (Late Middle Pleistocene) is comprised of mudstone/shale, sandstone, lignite, and sand deposits associated with a barrier lagoon complex.
- The Bluff Formation (Middle to Late Pleistocene) consists of coastal dune cordons and offshore deposits of calcarenite.
- The Berea Formation (Early Late Pleistocene) comprises inland dune cordons (ancient dunes) mainly composed of decalcified red sand.

The Hillendale dune deposit is comprised almost entirely of older (Pliocene parent) Berea-type red sands. This is suggested by the relative position of the dune to the present-day coast and its elevation above the current sea level. Berea-type red sands were formed by the intense weathering of parent aeolianites originally deposited during the Late Tertiary-Early Quaternary marine regression as suggested by Belderson (1961).

Silt values of the Hillendale Berea-type red sands fluctuate between 15% and 45% with an average of 23.57%. The thickness of these Berea-type sands varies from 3m to 42m with an average thickness between 18m and 21m (Sibiya et al., 2005).

There are sporadic occurrences of a medium- to coarse-grained, yellowish to dark orange, low silt (3-8%) sands in the central western and north western parts of the Hillendale dune. Individual grains in these sands are generally sub-rounded to angular in shape. The sand is less cohesive than the Berea-type sands due to the lower silt content. No specific stratigraphic correlation between these sands and the Berea-type red sands has been made, but these sands can possibly represent younger sediments associated with local post-Pliocene river flooding and/or Pleistocene dune sand migration (Sibiya et al, 2005).

A grey-brown, fine-grained, semi-cemented sand/sandstone unit occurs intermittently between 9 and 30m below surface in the central parts of the dune.

A kaolinitic clay unit, varying in colour from yellow-brown and brown in the south to greenish in the north, underlies the entire Hillendale dune deposit. This possibly represents part of the weathered remains of a lagoonal complex which developed landward of the coastal dune system. The Hillendale heavy mineral deposit formed during early Late Pleistocene epoch (2-0.1 My ago) (Sibiya et al., 2005).

Heavy minerals, derived from inland rocks and sediments, concentrated because of progressive enrichment in the swash zones of several beaches, which developed along the large coastal beach / dune system (Whitmore et al., 2003).

Ilmenite, zircon, rutile and leucoxene form the valuable heavy minerals (VHM) of this deposit as defined by the company's internal document business strategy (Exxaro internal report, 2010).

The locality of Hillendale mine in relation to other Exxaro heavy minerals deposits on the north coast of Kwa-Zulu are illustrated in Figure 2. The other heavy mineral sand deposits are indicated in green.


**Figure 2. Locality map of Hillendale mine and other Exxaro heavy mineral deposits (image created by author)**

## 2.2 Exploitation

### 2.2.1 Mining

Hillendale mine is an opencast mine operation using hydraulic monitor guns for mining. There are four permanent hydraulic guns functional at any given time, with two additional monitor guns on standby to ensure uniform feed if any hydraulic gun movements need to be made or for maintenance issues. During mining the area is cleared of vegetation (mainly sugarcane). The topsoil is removed and stockpiled for rehabilitation.

The maximum face height for safe operations is 10m. Mining block sizes are measured at 10m x 10m x 10m. The mining method allows for flexibility since the operations are highly dependable on the amount of silt. There is both a minimum constraint of silt of 13% for mining purposes as well as a total maximum constraint of silt for the month of mining to deposit onto the residue dam. Mining can take place on different levels as well as in different directions. The actual mining varies considerably from the scheduled mining to accommodate the variability in mining method and percentage silt. The flexibility of the mining method is achieved by the two sets of hydraulic monitor guns operating at any given time Figure 3). The arrows in Figure 3 indicate the different mining directions.

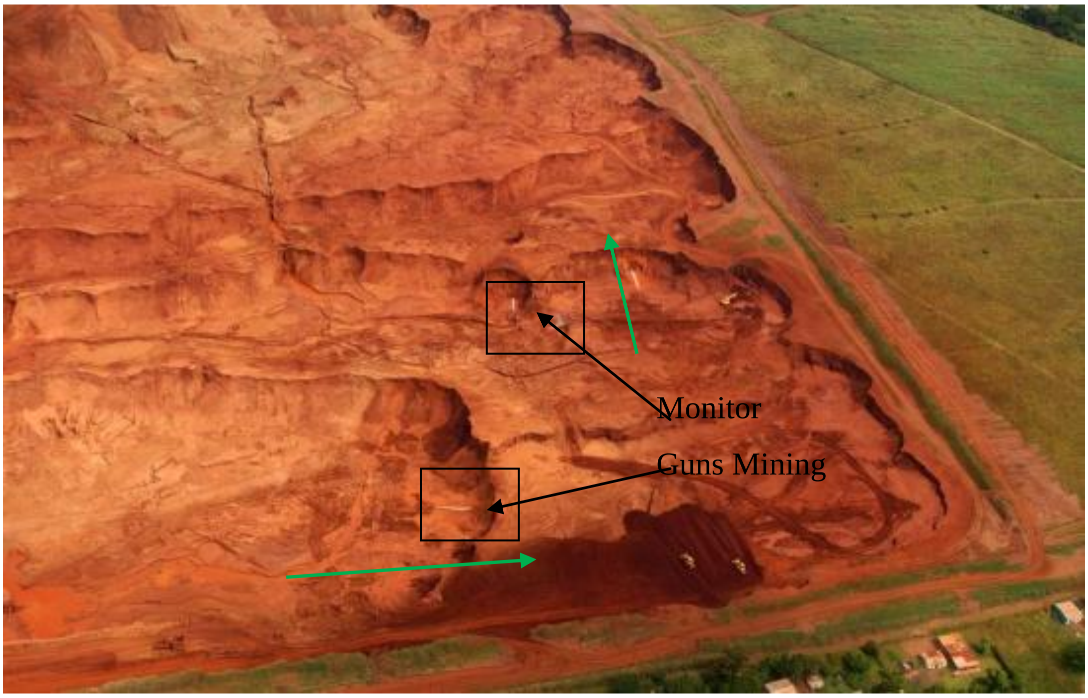


**Figure 3. Mining at Hillendale mine with hydraulic monitor guns**

The monitor guns propel water at a pressure of 40 bar onto a mining face, undermining the face and causing it to collapse (Figure 4). The face material is broken up and forms slurry. The slurry needs a minimum of 13% silt to keep the heavy minerals in suspension. It gravitates in channels to the pump stations and is transported to the primary wet plant through surge bins at the caisson area. The surge bins guarantee a constant supply to the primary wet plant (PWP) as well as controlling the density that is kept at 35% - 45% solids.

**Figure 4. Hydraulic monitor gun at Hillendale mine**

The mining process is optimum for Hillendale since it caters for the characteristic ‘high silt’, as well as allowing for flexibility in the mining process when areas of low grade / high grade material are intersected.

The accurate estimation of silt within the mining area is of crucial importance since the silt forms part of the mining operation. Inaccurate and insufficient information will inhibit the mining operation, increasing the risk and cost.

Mining is currently constrained to an elevation higher than10m above mean sea level (AMSL) due to the water table level.

Hillendale mine is designed to produce 1200 tonnes of slurry per hour to the rougher spiral feed of the PWP.

### 2.2.2 Beneficiation

The run of mine (ROM) to final product is done in phases. The heavy mineral concentrate (HMC) is produced at the PWP. The smelter feed, zircon and rutile is produced at the mineral separation plant (MSP) and the low manganese pig iron and slag are produced at the furnaces.

#### 2.2.2.1 Primary Wet Plant

Figure 5 is an illustration of the PWP beneficiation as described in the text below.

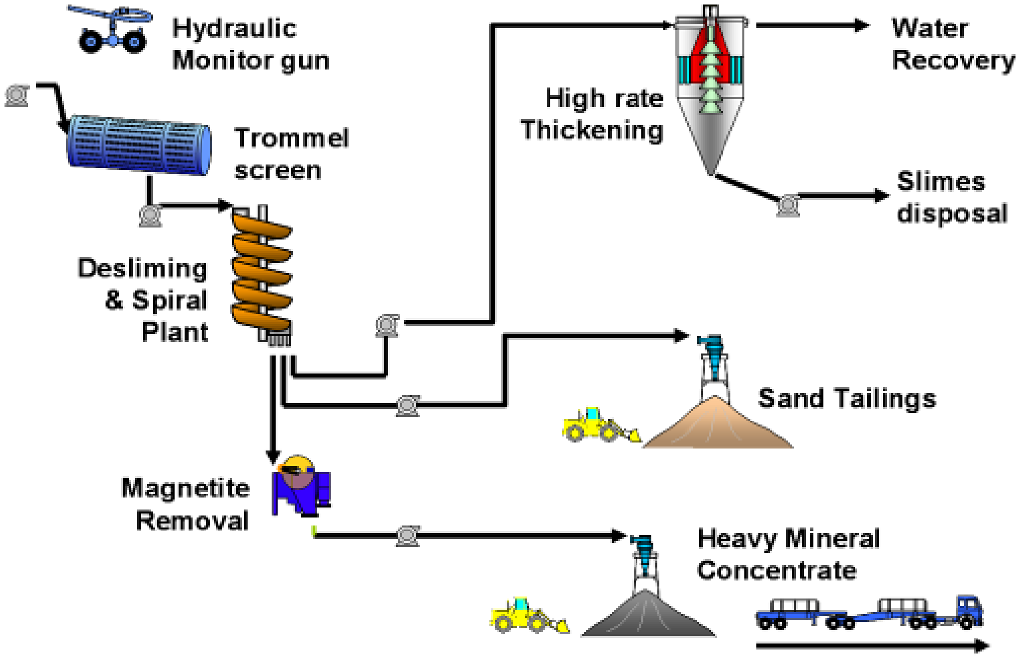


**Figure 5. PWP beneficiation process (illustration from Exxaro KZN Sands)**

The slurry from the mine is separated into three different streams. The first stream is the heavy mineral concentrate that is stockpiled for further processing. The second stream is the silt (slimes) which was separated from the ROM. The slimes are predominantly pumped to the slimes dam. The third stream is the sand (inclusive of the magnetite). The sand that is produced in the primary wet plant is pumped back to the mining void as backfill material. The sand is stacked with de-watering cyclones at an angle of 15°.

The heavy minerals are separated from the sand by means of gravity separation with spirals. Lastly, the magnetite is removed from the heavy minerals with low intensity magnetic separators.

The PWP plant is sensitive to mineralogical changes, especially for minerals within the magnetic-other (mago) group. The mago group is the third fraction of Carpco® analysis and is defined as 'waste' material such as garnet, epidote and tourmaline. It is essential that adequate geological information is gathered and appropriate planning takes place to ensure the correct spiral settings are achieved in the PWP to ensure optimum plant recoveries.

## 3 Sampling methodology

A grid spacing of approximately 50m x 50m (based on infill drilling) is used to establish a proven reserve for the production plan at Hillendale mine (Figure 6). The sampling plan is based on the accessibility of land area and therefore the 50m x 50m is not an exact grid size.

Primary exploration is done on an approximate grid of 200m x 400m. Hillendale mine is completely drilled with primary exploration holes using the RCN drilling method as illustrated in Figure 7. Infill drilling takes place to refine the information obtained of the mineral resource from 200m x 400m, to 200m x 200m to 100m x 100m with the drilling grid being completed for mine planning and production at 50m x 50m.

Infill drilling of the north eastern area of Hillendale was completed with WAC drilling (Figure 8) after the mineral resource was completely drilled by RCN due to replacement of the drilling technique. Due to the phase out of the RCN drilling method for the WAC drilling method, the two drilling methods predominate in specific areas as illustrated in Figure 6.

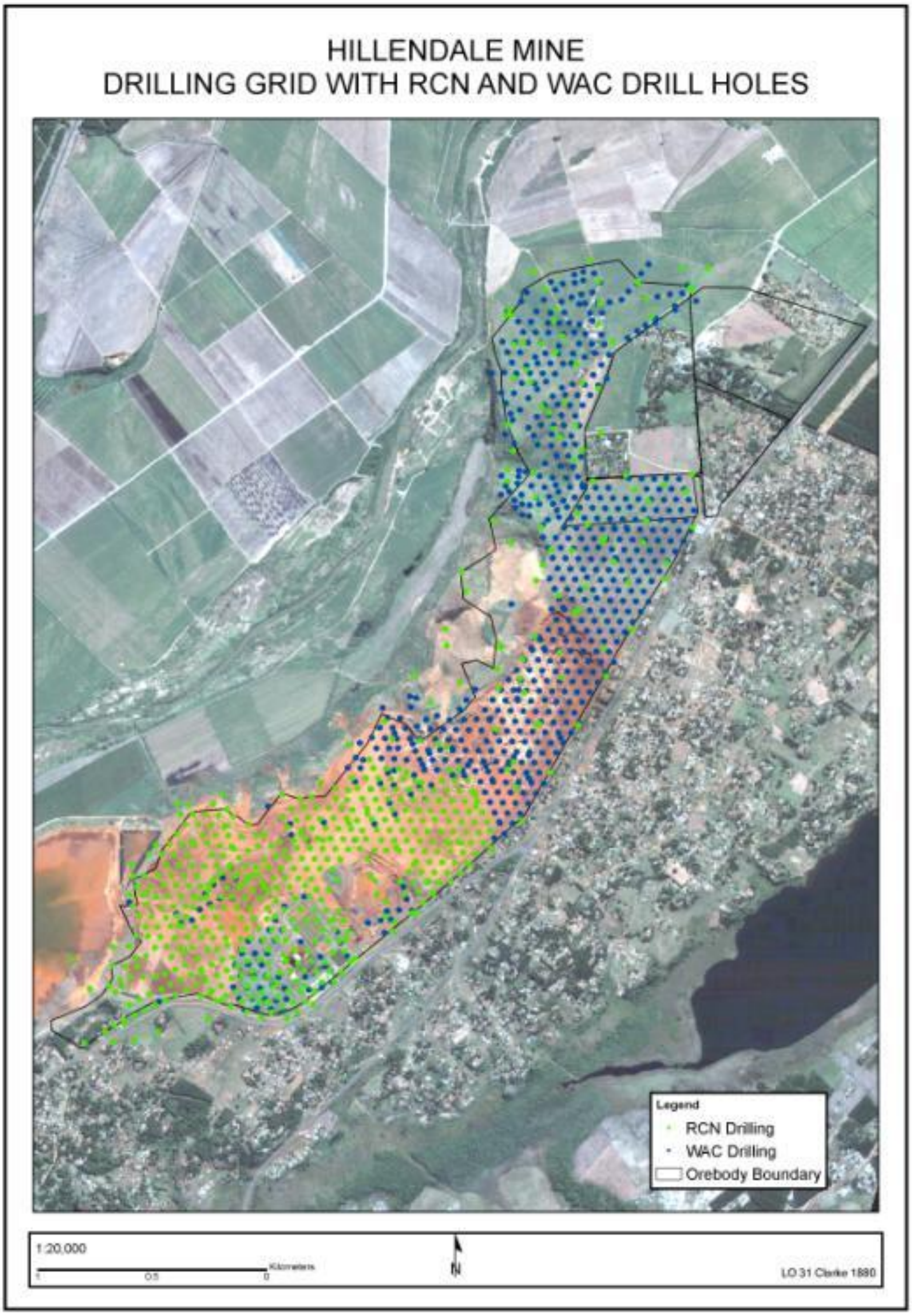


**Figure 6. Hillendale mine drilling grid – WAC and RCN drilling methods**

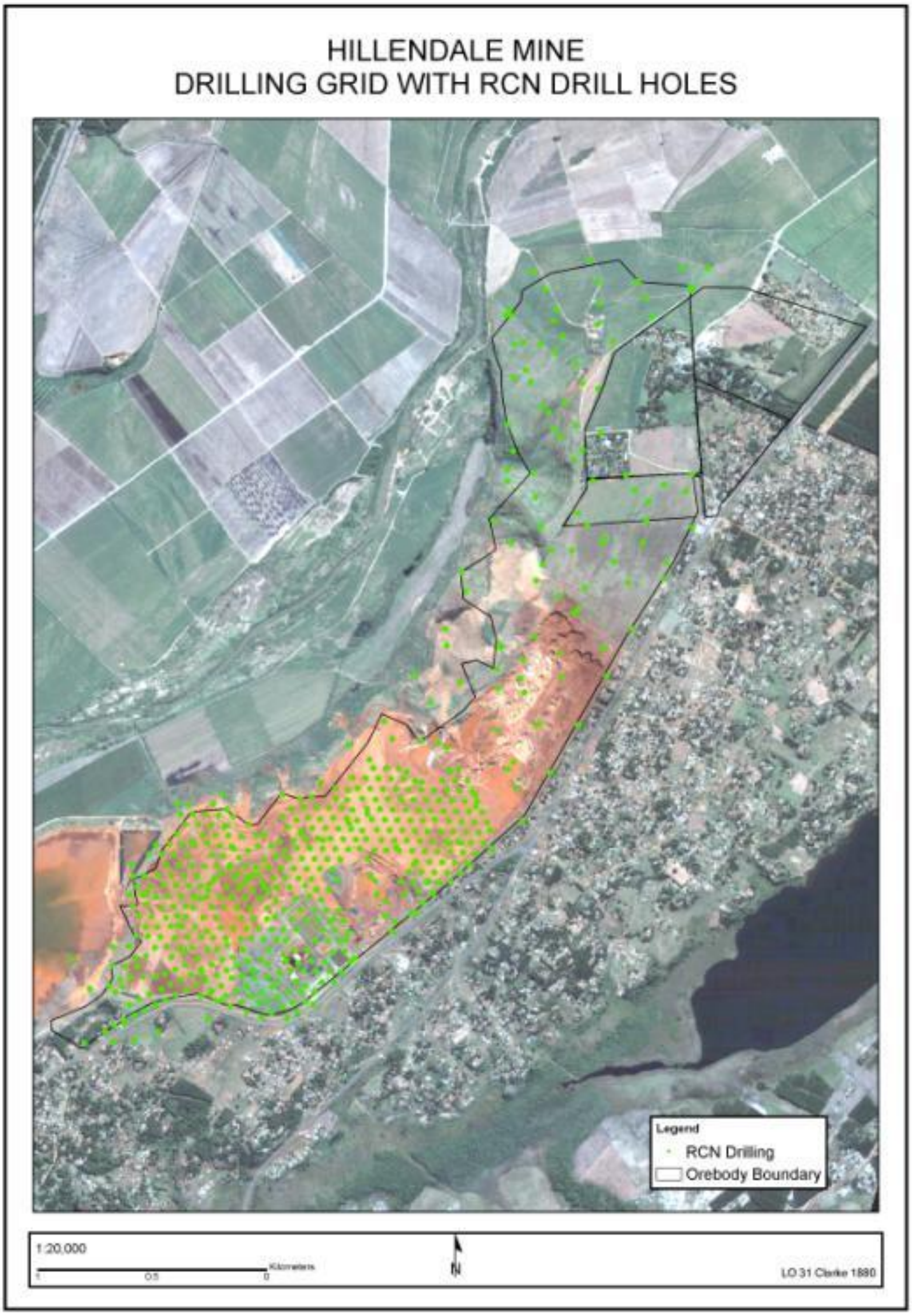


**Figure 7. Hillendale mine drilling grid - RCN drilling method**

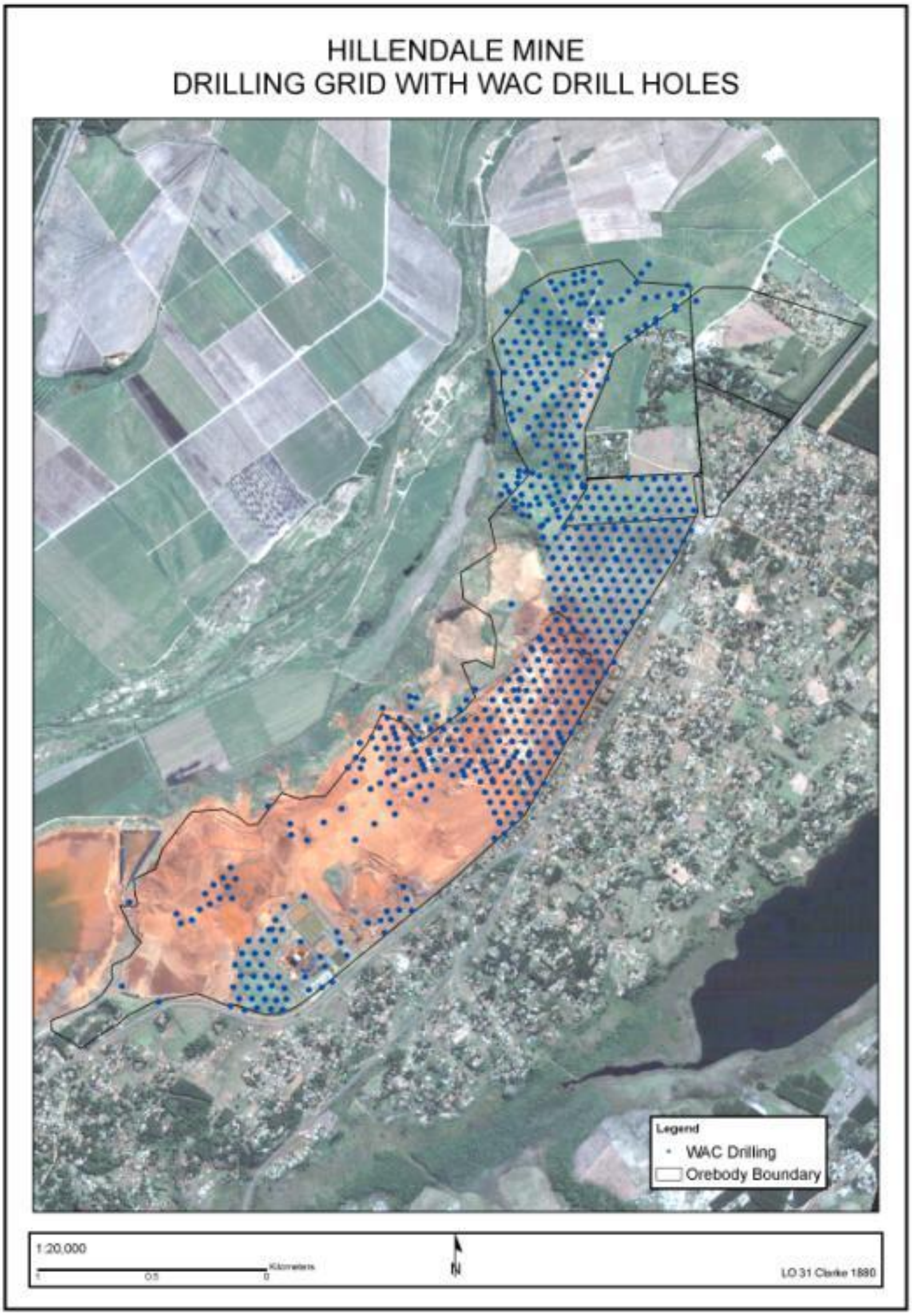


**Figure 8. Hillendale mine drilling grid - WAC drilling method**

The deposit is explored by drilling the identified mineral resource and analysing it by magnetic separation.  The magnetic separation produces four characteristic magnetic fractions.  This is done by using a Carpco® lift machine (model MLH(13)111-5).  The Carpco® lift machine separates materials in contact with the magnetic field into zones of steepest gradient and utilizes magnetic force and gravity to capture weakly magnetic materials. The running roll provides a centrifugal force for separating the magnetic and nonmagnetic materials (University of Vermont, 2006).

Selective, composite mineralogical and chemical analyses are done on the primary magnetic fractions on a larger grid size.  In general, composite mineralogy and chemical analysis will be done on a 200m x 200m grid if the Carpco® is done a 50m x 50m grid.  The composite is done to achieve a minimum sample size for especially the smaller fractions such as non-magnetic fraction.  The larger grid size is largely due to cost constraints.

## 3.1 Exploration Drilling

Two drilling methods are used at Hillendale for exploration and resource estimation.  The RCN and WAC drilling methods are discussed below.  All drillhole samples are 3 metre long.  With the latest drilling campaign the WAC drilling method changed the approach to stopping depth. The drillhole is only stopped if it intersects bedrock or if the last sample did not contain any heavy mineral concentrate as determined by panning, with another drill rod length added. The additional rod length is to ensure that the hole is not stopped in ore. With the RCN method and at the beginning of using the WAC method, drilling stopped if it was estimated that there was less than 1.5 % THM with panning. This is a very subjective approach and was therefore revised.

### 3.1.1 Reverse Circulation Drilling

RCN rotary drilling uses a dual tube drill pipe string, with the flushing medium going down the annulus, between the inner and outer tubes with the drill cuttings returning to the surface between the drill pipe and the wall of the hole as illustrated in Figure 9 (Ryan et al., 2004).

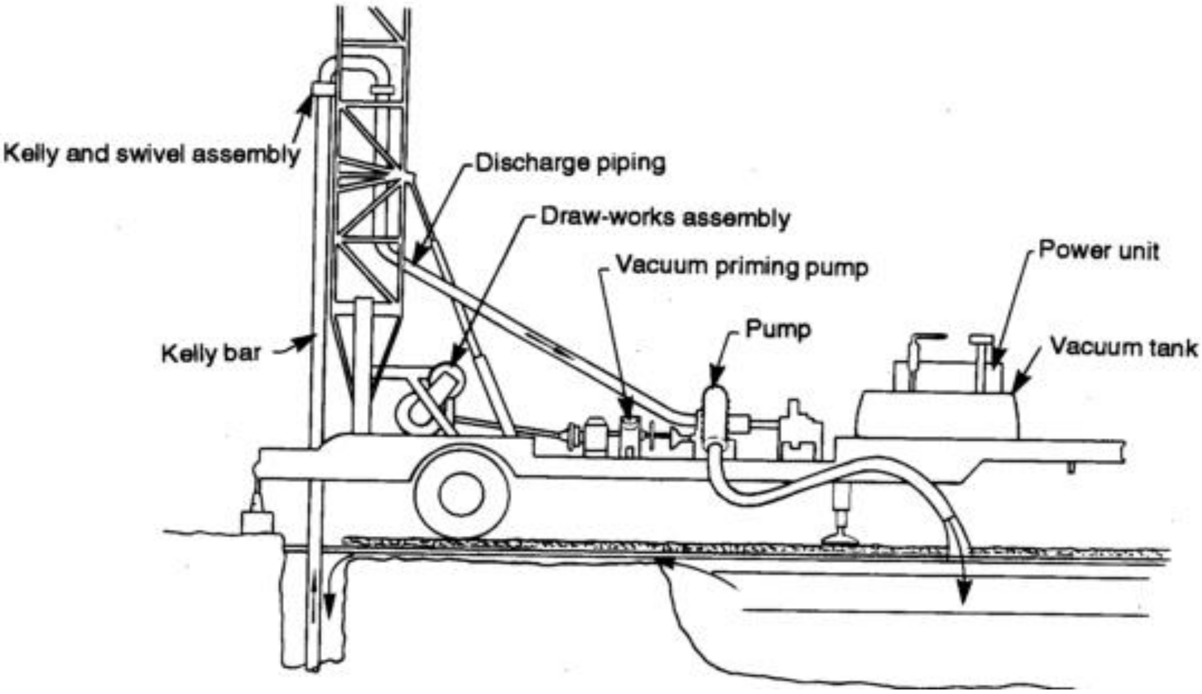


**Figure 9. Schematic representation of reverse circulation drilling**

**(http://www.globalsecurity.org/military/library/policy/army/fm/5-484/Ch5.htm)**

### 3.1.2 Aircore drilling

Aircore drilling (AC) uses an open centre bit that cuts a core using air as a flushing medium. The drilling principal for WAC and RCN methods is the same in that the presence of an inner tube allows air to be pumped down the outer tube to the drill bit and the sample to be retrieved through the inner tube. The Aircore method use much less air and incorporates a sucking action for the inner tube so that the sample is 'vacuumed' into the inner tube instead of 'blown' in, as is the case with the RCN method. The key to the system is the ‘turn around’ near the face of the bit and best performance is obtained if there is a slight vacuum at the face (Ryan et al., 2004).

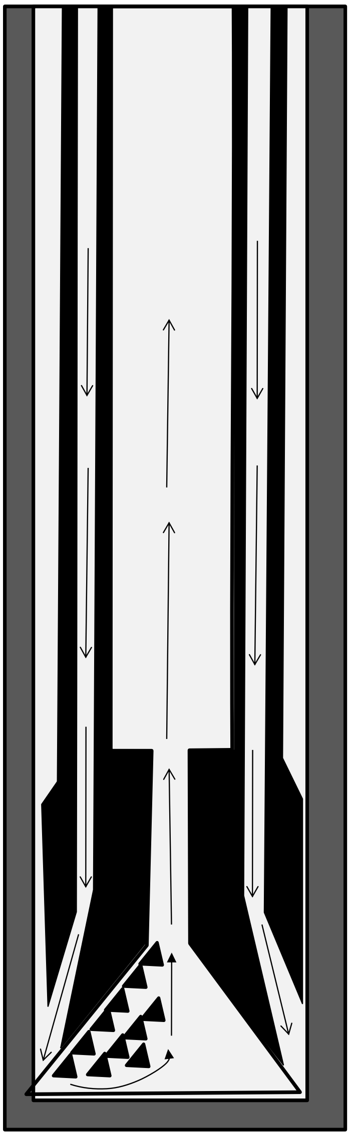

**Figure 10. Schematic representation of aircore drilling after (Ryan et al., 2004)**

The WAC method was introduced at Hillendale to potentially replace the RCN method as the WAC method has been successfully implemented at the company's Australian operation, Ti-West. The implementation of the drilling method was subsequently rolled out to all the companies' heavy mineral sand deposits (personal communication, Botha, 2006).

The main difference between the RCN and WAC drilling methods is that the air that blows back into the drilling tube the WAC method, while the RCN method the air is blown out.

## 3.2 Logging and Sampling

### 3.2.1 Geological Logging

All geological logging is done in the field as the drilling programme produces samples. Logging is done in accordance to the drilling reference chart (Figure 11) and all information is recorded on standardised logging sheets as follows:

- colour – according to a standard simplified colour chart (guided by Munsell® colour chart);

- grain size, roundness and sorting – according to standard geological charts;
- moisture content – subjective estimate of wet, damp, slightly damp or dry;
- sample mass is recorded as sample is received by using a field scale
- drilling hardness – subjective estimate of hardness of formation, especially applicable for RCN drilling; non-standard and not particularly appropriate for WAC drilling because almost all drilling occurs at the same rate, irrespective of formation hardness;
- panning of a standard-sized sub-sample (approximately the size of a teaspoon) is done for a visual, subjective estimate of the silt and THM contents;
- comments – especially for recording anything out of the ordinary that may be significant, e.g. concretions or indurated lumps of sand, excessive vegetation, water strikes, bedrock chips, etc.

Three of the six geological information collected are subjective. The standardised logging sheet maximises data collection consistency.

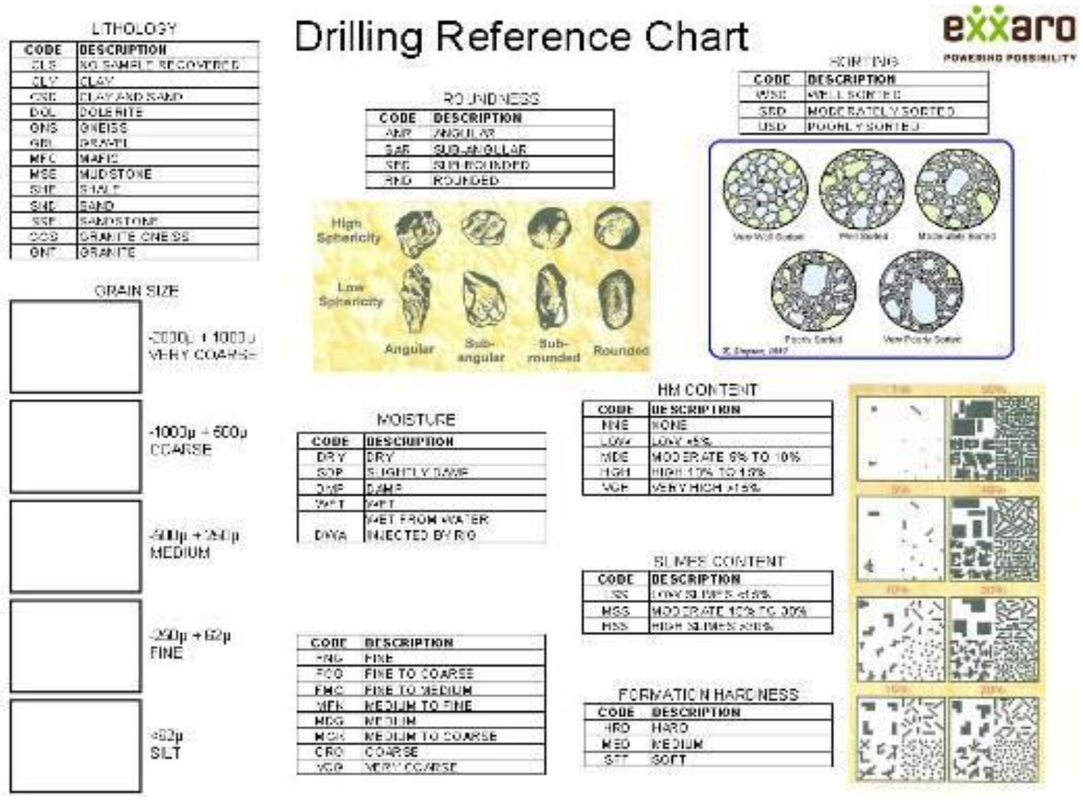


**Figure 11. Exxaro drilling reference chart (from MSA consultants, consulting for Exxaro, unpublished)**

Logging data is captured regularly during a drilling program, although, given the limited resources, data capture on a daily basis is impossible. Based on past performance, all logging data has been captured within a month after a drilling program has been completed.

Use of the standardised drilling reference chart for logging of all KZN Sands heavy mineral exploration projects, results in minimizing the subjectivity of interpretation by geologists.

### 3.2.2 Survey

Both the RCN and WAC drillholes are surveyed using survey instruments or a dual-frequency global positioning system (GPS). Although the accuracy of the two systems are not the same, all the drillholes are plotted against the original surface topography done by surveying department on a 2 metre interval using survey instruments.

Drillholes are rated against the distance from the original surface topography as part of resource risk for estimation. Elevations with an elevation variation of greater than 15 metres are rated 3 and an elevation variation less than 5 is rated 1. Surface elevation variations of between 5 and 15 metres are rated 2. Due to the rapid topographical change on the dune, an acceptable variation of 5 meters was deemed adequate.

Drillholes moved due to physical constraints such as steep slope, power lines or fencing is resurveyed at the drilled positions and the coordinates are updated in the database.

### 3.2.3 Sample Preparation

Samples consist of the returns from 3 metres of drilling. This is a standard drill rod length. The 3 metre interval was decided on to ensure a standard sample size is drilled with the original RCN drilling method. This procedure was followed through with the WAC drilling.

Drilling samples are collected in a 480mm x 700mm x 200µm new plastic sample bag and weighed. The weight of a 3 metre sample is between 12 and 20 kg for WAC samples. Sample weight for reverse circulation is a lot more variable, sometimes with no sample being recovered from some 3 metre intervals due to the air blowout method of the RCN drilling (Sibiya et al., 2005).

With completion of logging and field panning the sample bag is sealed and marked. Since only a small portion of the drillhole material is used to estimate the silt and heavy mineral percentages. The sample used for estimating the slime and heavy mineral content is not returned to the original sample bag to avoid contamination. Plastic labels are inserted in the bag that is also labelled on top. An aluminium tag is placed inside the sample bag. The aluminium tag is added in the sample tray when drying the sample for tracking purposes. All data logged are captured into the SABLE®

database.  It is the field geologist's responsibility to ensure the data is captured accurately and validated.  Analytical data are imported into the SABLE® database once all analyses are completed and validated by the laboratory.

During the RCN drilling campaign and the WAC drilling campaign the dry samples were split in the field with a riffle splitter, while wet samples were transported to the mine for further preparation.

All samples currently drilled are transported back to the sample preparation facility at Hillendale mine.  Wet samples are dried by either oven or gas burners.  The dried sample consolidates and is subsequently crushed before being split into four bags.  Splitting takes place with a riffle splitter similar to the field splitting.  The sample split for laboratory submission consists of two bags of approximately 1.5 to 2kg of sample each.  The remainder of the sample is combined for a 'zone work' sample (geometallurgical test work). One sample is submitted to the laboratory for analysis, while the sample other is kept as a backup.  The samples are assigned a sample number consisting of a prefix 'EXP' followed by the date drilled, time and a sequential sample number, i.e. EXP061201_0900_1.  This is followed for the day and restarts the next day.

The aim of the geometallurgical test work is to simulate the production process from the PWP through to the MSP.  It was identified with the beneficiation of the Hillendale deposit that some mining units behave differently when processed.  The ore body has been divided into specific zones based on similar characteristics that may behave in a similar way in the beneficiation process.  Processing of these zones is simulated through a pilot plant and the results studied to highlight potential problems that might occur during beneficiation and further downstream processes.

Zones are delineated using the 0.8Amp (mags) fraction as the primary criteria.  The 0.8Amp consist mainly of ilmenite on which the mining business case is based and is therefore used as the primary criteria for defining zones.

The 0.8Amp fraction is relationally compared with the downhole magnetic-other mineral fraction.  The magnetic-other mineral fraction has proved to be a major problem in all downstream processes.  It has been identified during current mining operations that a ratio of 1:4 mags:mago is a problem for the processing plant.  The selected downhole areas are compared with the geological logging to assist with the selection of particular zone, specifically focussing on the estimated silt.

Drillholes falling into a specific zone are compared vertically and similar samples are composited into a bulk sample for test work.

The metallurgical test work provides information on size of materials and products, expected recoveries for the various processes and expected qualities of products.

### 3.2.4 Analysis

#### 3.2.4.1 Carpco® analyses

Both RCN and WAC samples are analysed by the same process. Hillendale samples are analysed at the in-house laboratory at the CPC. The laboratory is not accredited for Carpco® fraction analyses (magnetic separation fraction analyses) as used with the exploration samples, but accredited for final product X-ray fluorescence (XRF). There were no accredited laboratories for Carpco ® fractions at the time of exploration.

Although there is no laboratory accreditation for the Carpco® analyses used for exploration samples, the analytical results are deemed to be acceptable and representative of the ore body as presented in section 5.5, Reconciliation.

Once received by the CPC laboratory, the sample number is logged into 'Laboratory Information Management System' (LIMS) where after the sample is dried for approximately 12 hours. After the sample is cooled, it is crushed and reduced to a sample mass of approximately 500g by a rotary splitter.

The second step consists of recovering the <-1mm material by screening. Material coarser than 1mm is classified as oversize. The remaining material is screened using a 45µm screen. The +45µm –1mm fraction is analysed for its total THM by dense medium separation using tetrabromoethane (TBE).

The tetrabromoethane has a specific gravity of ±2.96, which is checked daily as a control measure. Samples with THM content greater than 1.5% as determined by dense medium separation process are magnetically separated by using a Carpco® lifting machine. The fraction values for samples that have a THM content of less than 1.5% are recorded as 0% by the laboratory since they cannot be analysed further.

The Carpco® lifting machine divides the THM into four electrostatically different fractions. The Carpco® lifting machine is a high-intensity induced-roll magnetic separator that is top fed (Figure 12). It is designed to separate paramagnetic materials from non-magnetic materials (University of Vermont, 2006).


**Figure 12. Carpco® - high-intensity induced-roll magnetic separator.**

The first fraction removed is the high susceptibility magnetic fraction (HS Mags), which is mainly magnetite. The material is passed twice through the Carpco® machine with the settings to 0.05 ampere and a magnetic field strength of approximately 257 – 300 gauss. The second fraction removed is defined as mags (magnetically susceptible) and contains mainly of ilmenite (98%). The machine is set to 0.8 Ampere and 3000 – 5200 Gauss. The 0.8Amp fraction is passed five times through the Carpco® machine to ensure depletion. Magnetic 'others' consisting of 'waste' material such as garnets, epidote and tourmalines are removed with an ampere setting between 0.8amp and 2.4amp (10000 and 14000 gauss). The material is passed five times through the Carpco® machine to ensure depletion. The final fraction (with an ampere setting of greater than 2.4 ampere) is defined as the non-magnetic fraction and contains mainly of zircon and rutile (Figure 13).

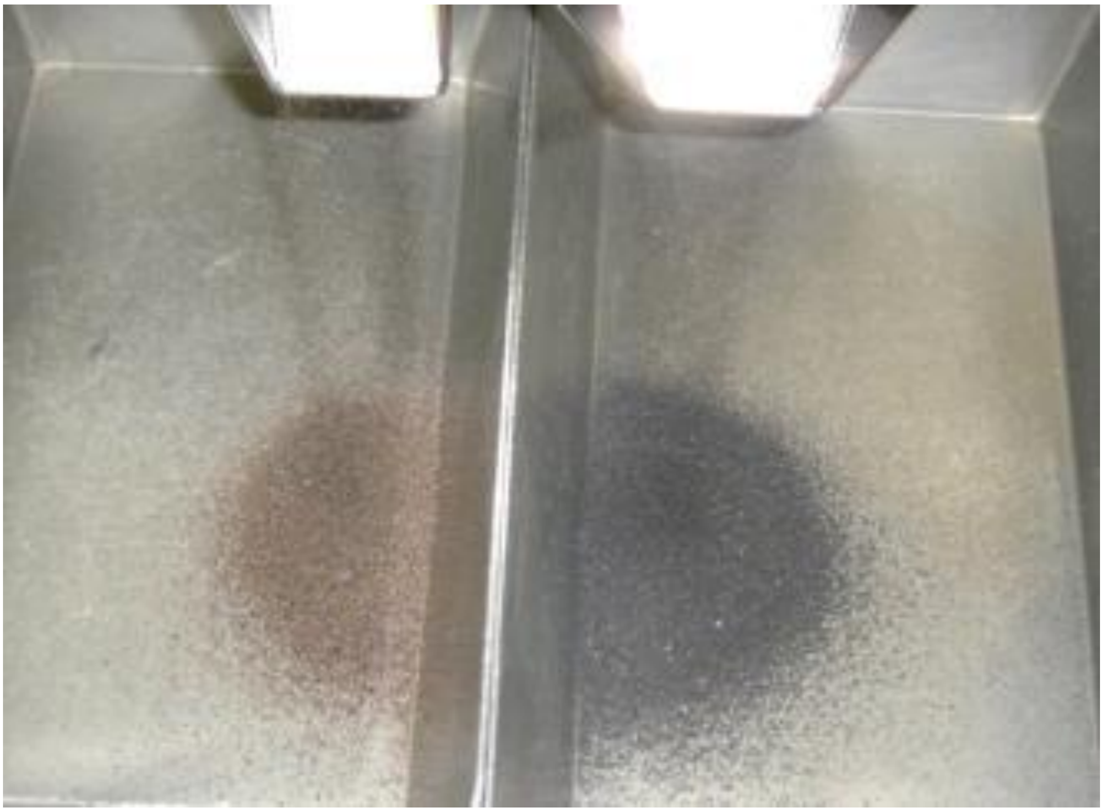

**Figure 13. Separated fractions produced by the Carpco® high-intensity induced-roll magnetic separator.**

A summary of the magnetic fraction specifications as defined by KZN sands is listed in Table 2.

**Table 2. Magnetic separation fractions (Carpco® Fractions)**

| Fraction | | Description |
|---|---|---|
| HS mags | - | Mainly magnetite. Split at 0.05A. |
| 0.8A mags | - | Used for estimation of in-situ ilmenite content (>0.05A<0.8A). |
| Magnetic others | - | Kyanite, amphiboles, epidote, garnets, tourmaline (>0.8A<24A). |
| Non-magnetic | - | Contains zircon, rutile and leucoxene (>2.4A). |

After completing the Carpco ® split, the various fractions are back calculated to give the percentages of each fraction as a proportion of the total THM.

#### 3.2.4.2 Mineralogical and Chemical Composite samples

XRF and mineralogy composites are combined based on Carpco ® analyses results and geological boundaries, similar to the metallurgical test work composite. Due to the analytical costs, composite samples are selected on a larger grid size than the drilling grid used for generating the Carpco ® fractions. The composites are prepared per drillhole on a larger, approximate

200m x 200m drilling grid from the Carpco® drillhole analyses grid of 50m x 50m. The 0.8Amp, and non-magnetic fractions are composited over intervals of at least 9 metres, depending on facies changes as observed during geological logging and assay results (magnetic other mineral fraction % in THM, magnetic other:0.8 Amp fraction ratio). The composited samples are first send for grain counting (mineralogical analyses) where after XRF analysis is conducted on the samples.

# 4 Comparative Drillhole values per drilling method

RCN and Wallis WAC drilling data in the project area is reviewed statistically by means of descriptive statistical analyses (mean, mode, standard deviation) as part of the sample methodology for the exploration campaign to determine the sample distributions required of the two drilling methods.

Twinned drillholes of both the RCN and WAC drilling methods, situated relatively closely to one another (within a block model dimension (i.e. 50 meters)) are selected for comparison. Looking at the selected twin holes elevation (Table 3), are all within 3 meters horizontally from one another. Considering the survey rating as described previously, the elevation difference is acceptable.

**Table 3. Absolute elevation difference of comparative twinned holes.**

| RCN | RCN Z | WAC | WAC Z | ABS Z DIFF |
|---|---|---|---|---|
| **HE0052** | 72.78 | HE0385 | 69.49 | 3.29 |
| **HE0414** | 84.00 | HE0418 | 82.05 | 1.95 |
| **HE0060** | 58.16 | HE0462 | 60.18 | 2.02 |
| **HE0047** | 87.29 | HE0467 | 85.57 | 1.72 |
| **HE0059** | 53.91 | HE0406 | 51.64 | 2.27 |
| **HE0538** | 69.12 | HE0658 | 66.67 | 2.45 |
| **HE0004** | 66.82 | HE0483 | 65.62 | 1.20 |
| **HE0551** | 61.12 | HE0659 | 63.53 | 2.41 |
| **Average** | | | | **2.16** |

Comparative downhole values of both silt % and THM % are plotted against one another to visualize the downhole sample distribution for each 3 metre length sample. Each sample interval is linked to visually illustrate the downhole variation of the actual sample value relative to the subsequent sample with a straight line. The twinned holes are illustrated in Figure 14. The end-of-hole (EOH) variation between the WAC and the RCN is due to the subjective method of determining the EOH with panning where there is an estimated THM of less than 3%. The EOH determination has subsequently been updated in later drilling campaigns to continue one drillrod length after no heavy minerals have been seen after panning.

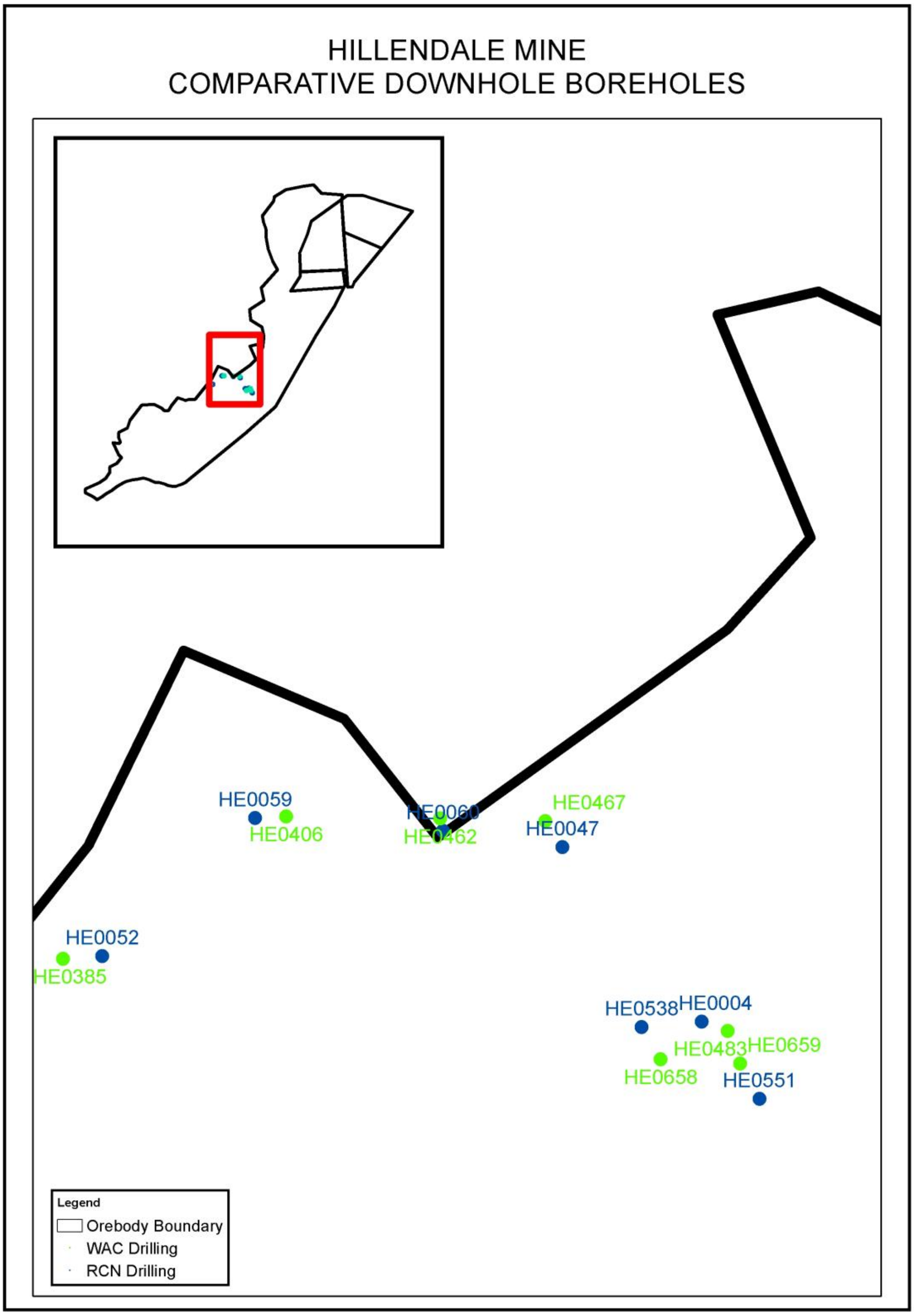


**Figure 14. Hillendale mine comparative downhole RCN and WAC drillholes**

Figure 15 to Figure 21 is the graphically representation of the twinned drillhole downhole variation of the silt% and THM%.

The individual sample values are listed in Addendum A.

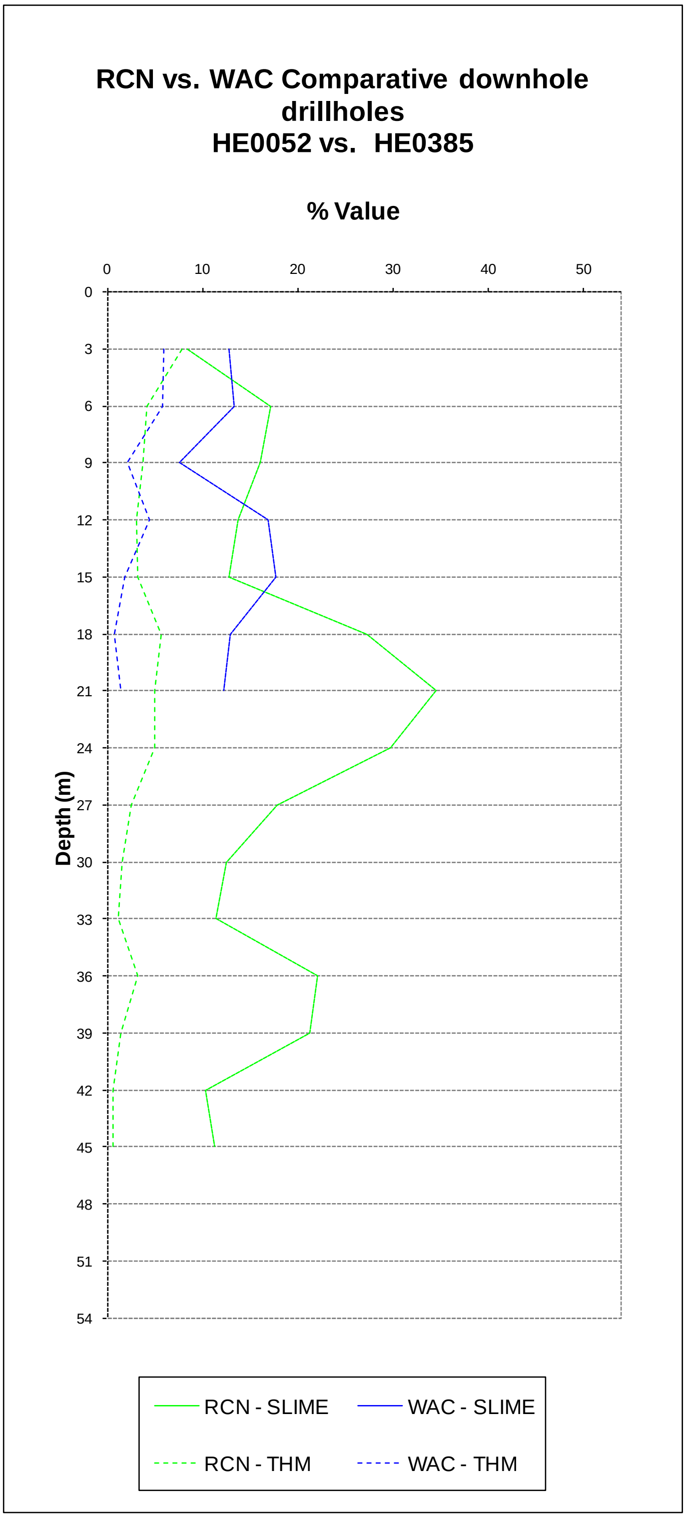


**Figure 15. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0052 and WAC - HE0385**

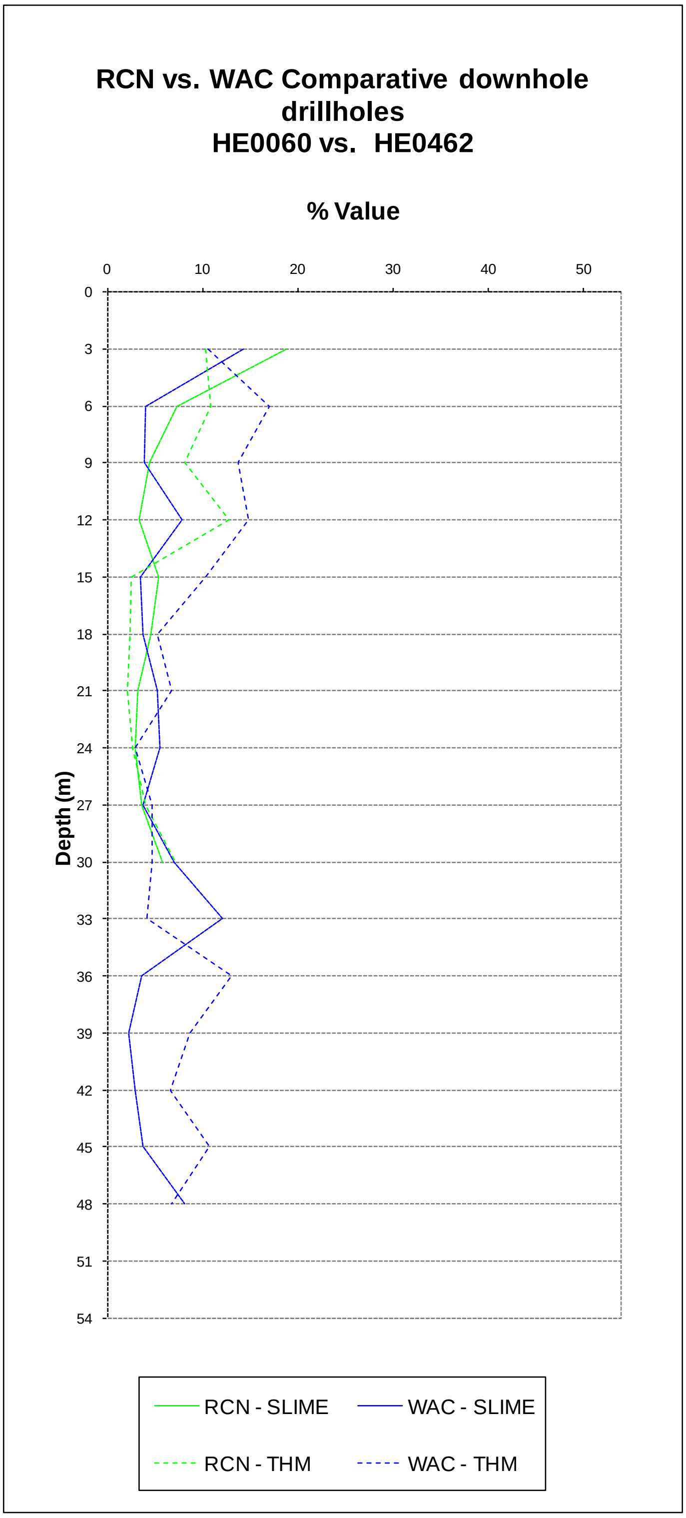


**Figure 16. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0060 and WAC - HE0462**

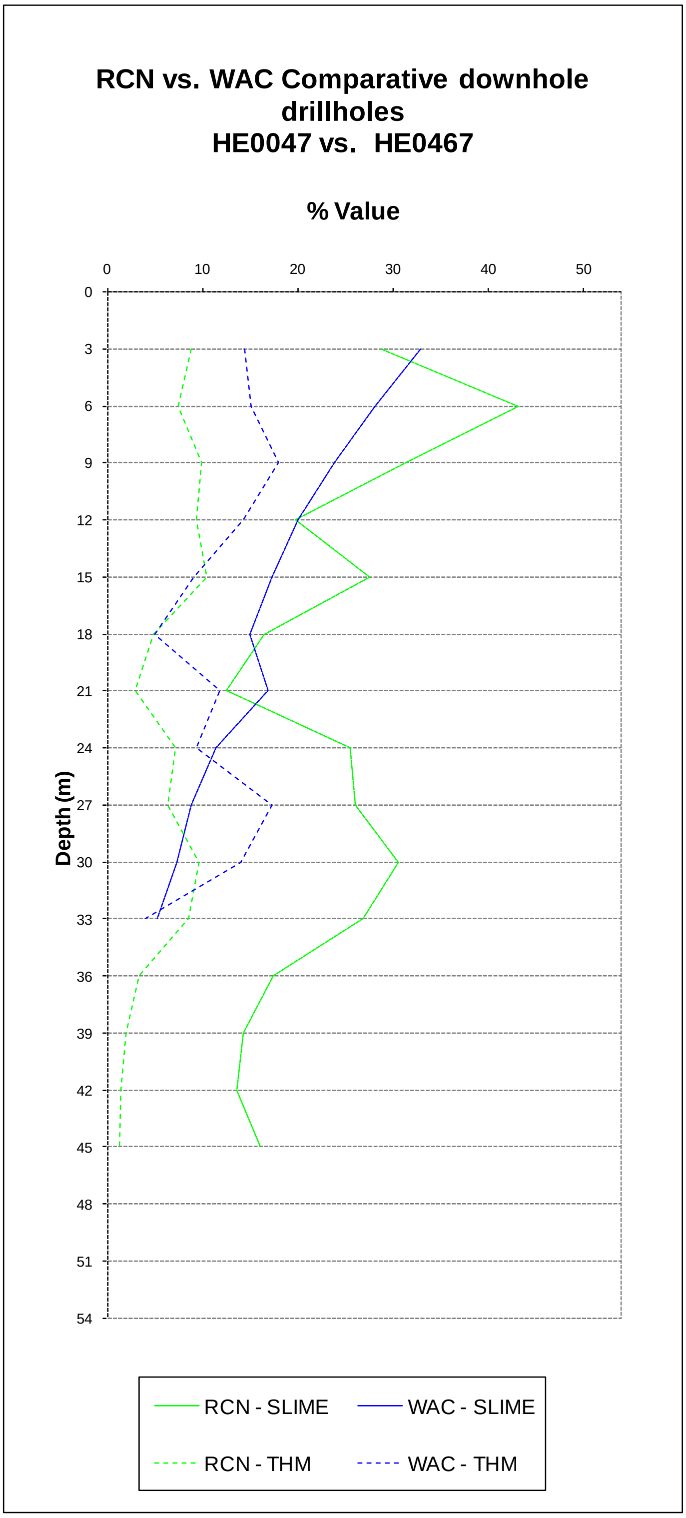


**Figure 17. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0047 and WAC - HE0467**

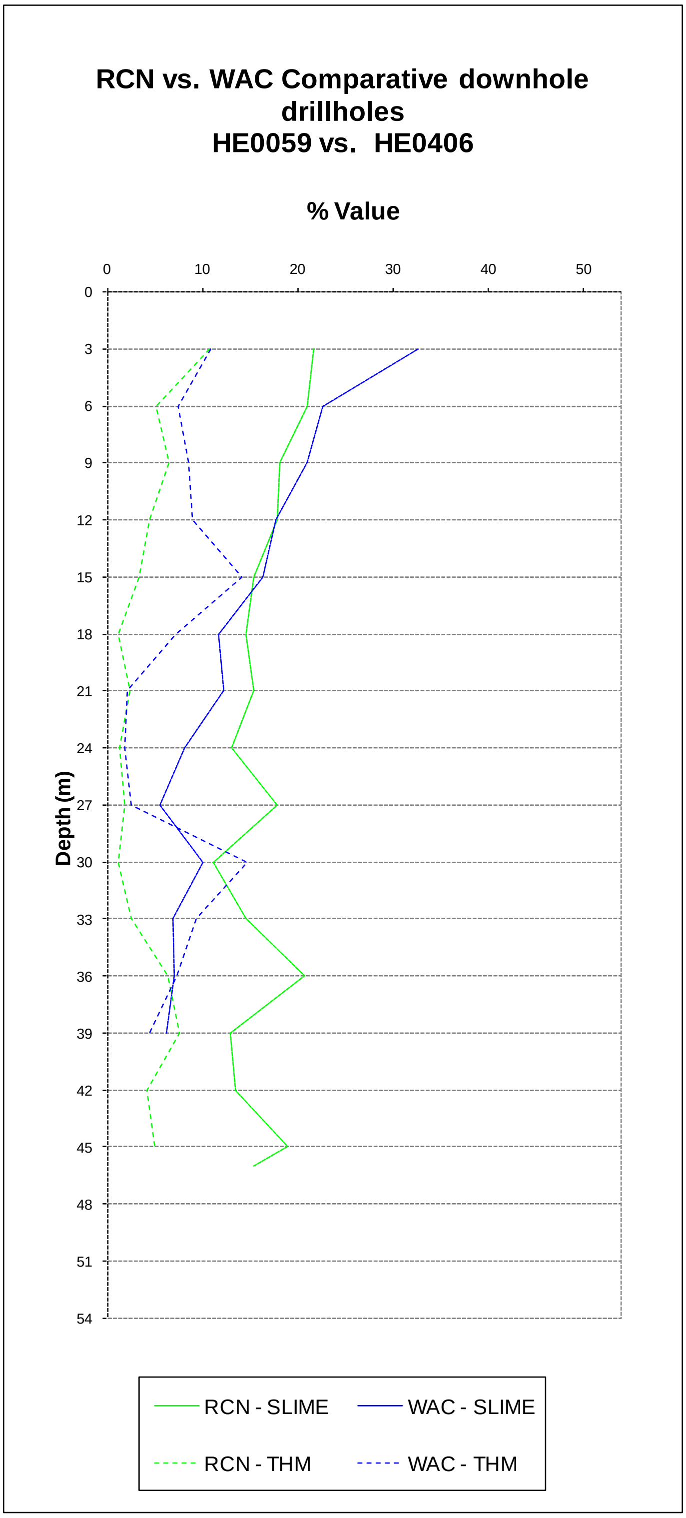


**Figure 18. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0059 and WAC - HE0406**

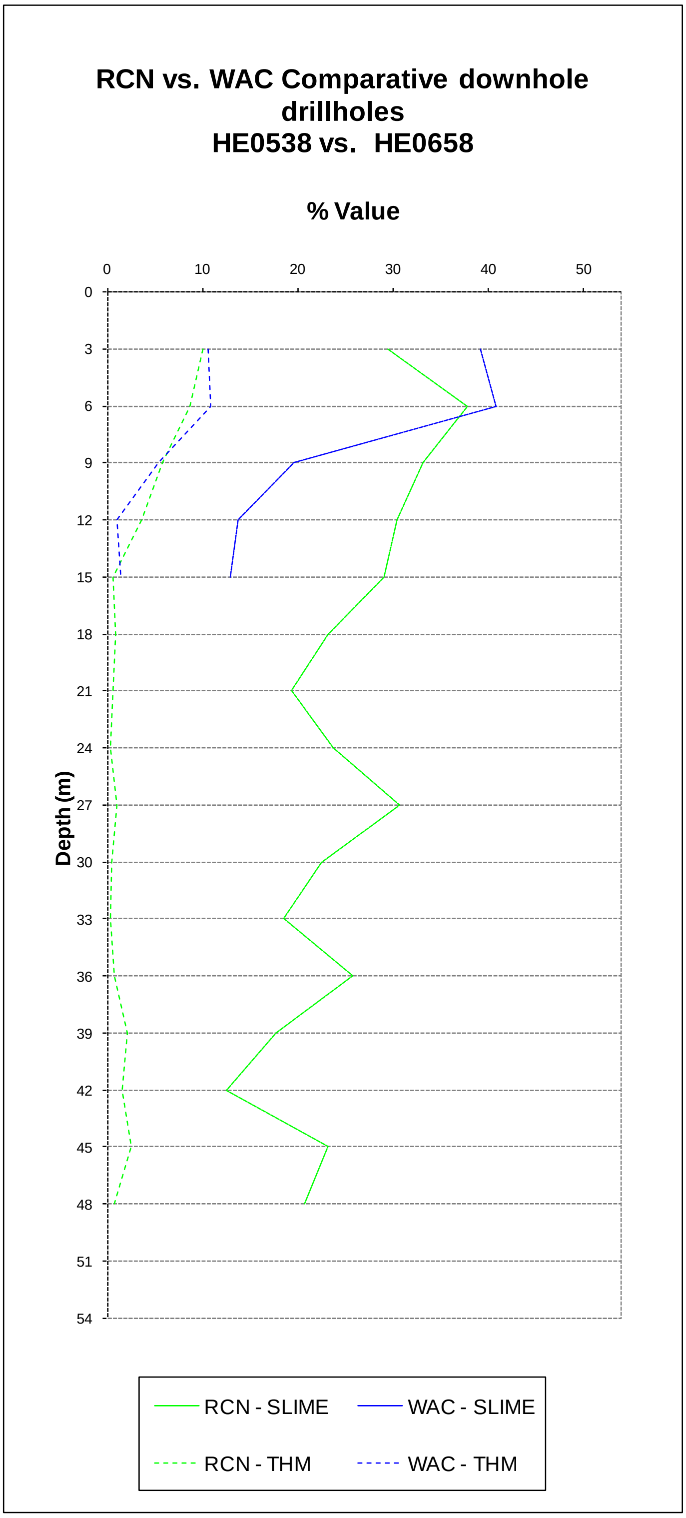


**Figure 19. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0538 and WAC - HE0658**

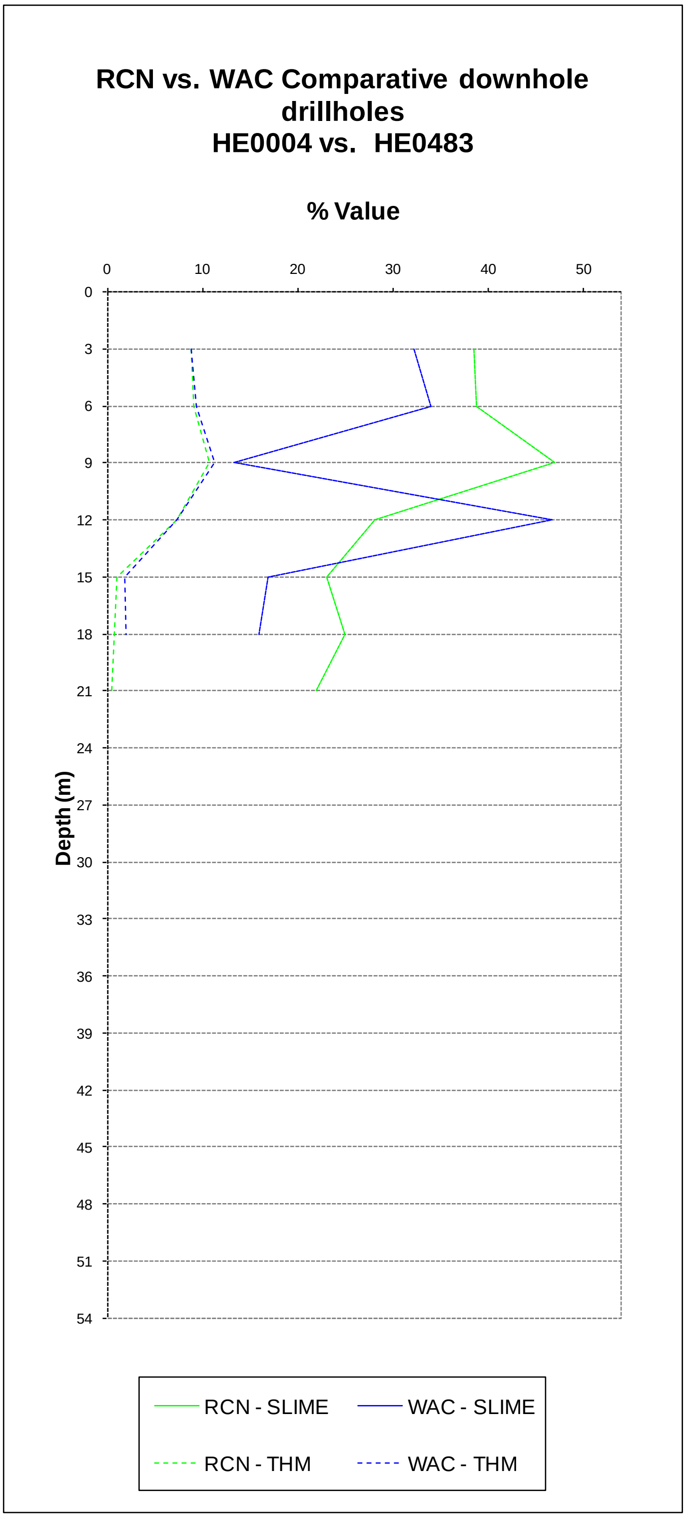


**Figure 20. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0004 and WAC - HE0483**

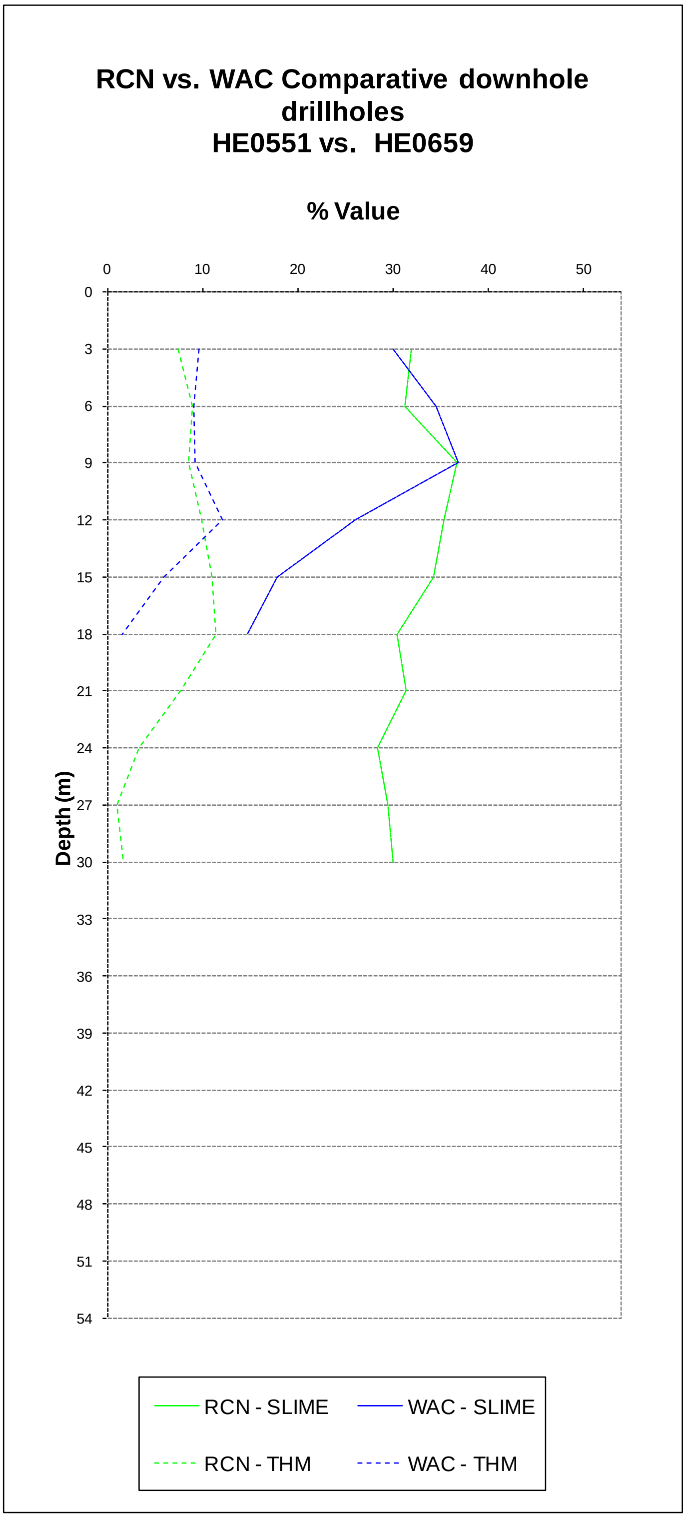


**Figure 21. Comparative downhole drillhole analyses of silt% and THM% for RCN - HE0551 and WAC - HE0659**

Comparing the analytical values of the silt% and the THM% of the downhole data for the two drilling methods at each corresponding depth interval of three metres, the analysed values of the samples vary considerably between the downhole sample plots for silt% and THM% of closely situated drillhole pairs. This is shown in Table 4 and Table 5, which gives the percentage difference (PD) for THM% and silt% of the comparative drillholes of the RCN and WAC drilling methods on each 3 metre interval. The percentage difference is calculated by:

$$\mathrm{PD} = \left(\frac{\mathrm{WAC} - \mathrm{RCN}}{\mathrm{WAC}}\right) \text{ x } 100$$

The variance of the two drilling methods is in general more than 10%. This indicates that there is no real comparison between the individual down hole samples for the two drilling methods.

**Table 4. Percentage difference for the THM% for comparative downhole drillholes**

| PERCENTAGE DIFFERENCE OF THE THM % FOR COMPARATIVE DOWN HOLE DRILL HOLES FOR RCN AND WAC DRILLHOLES AT HILLENDALE MINE | | | | | | | |
|---|---|---|---|---|---|---|---|
| | HE0052 vs. HE0385 | HE0060 vs. HE0462 | HE0047 vs. HE0467 | HE0059 vs. HE0406 | HE0538 vs. HE0658 | HE0004 vs. HE0483 | HE0551 vs. HE0659 |
| DEPTH | THM | THM | THM | THM | THM | THM | THM |
| 3 | -32% | 3% | 38% | 1% | 5% | 0% | 24% |
| 6 | 28% | 36% | 51% | 31% | 20% | 2% | 2% |
| 9 | -73% | 41% | 45% | 25% | -9% | 6% | 7% |
| 12 | 31% | 14% | 35% | 50% | -244% | 0% | 18% |
| 15 | -67% | 76% | -15% | 76% | 58% | 42% | -87% |
| 18 | -748% | 56% | 3% | 84% | | 66% | -659% |
| 21 | -266% | 70% | 75% | -19% | | | |
| 24 | | 12% | 24% | 32% | | | |
| 27 | | 13% | 64% | 24% | | | |
| 30 | | -51% | 32% | 92% | | | |
| 33 | | 100% | -112% | 73% | | | |
| 36 | | 100% | | 13% | | | |
| 39 | | 100% | | -71% | | | |
| 42 | | 100% | | | | | |
| 45 | | 100% | | | | | |
| 48 | | 100% | | | | | |
| 51 | | | | | | | |
| 54 | | 100% | | | | | |

**Table 5. Percentage difference for the silt% for comparative downhole drillholes**

| PERCENTAGE DIFFERENCE OF THE SILT% FOR COMPARATIVE DOWN HOLE DRILL HOLES FOR RCN AND WAC DRILLHOLES AT HILLENDALE MINE | | | | | | | |
|---|---|---|---|---|---|---|---|
| | HE0052 vs. HE0385 | HE0060 vs. HE0462 | HE0047 vs. HE0467 | HE0059 vs. HE0406 | HE0538 vs. HE0658 | HE0004 vs. HE0483 | HE0551 vs. HE0659 |
| DEPTH | silt | silt | silt | silt | silt | silt | silt |
| 3 | 34% | -32% | 13% | 33% | 25% | -20% | -6% |
| 6 | -30% | -83% | -54% | 7% | 7% | -14% | 10% |
| 9 | -111% | -14% | -31% | 14% | -69% | -253% | 0% |
| 12 | 18% | 58% | 1% | -1% | -121% | 40% | -36% |
| 15 | 28% | -57% | -60% | 6% | -125% | -36% | -91% |
| 18 | -111% | -22% | -10% | -24% | | -57% | -107% |
| 21 | -182% | 38% | 26% | -26% | | | |
| 24 | | 47% | -124% | -62% | | | |
| 27 | | 2% | -194% | -226% | | | |
| 30 | | 16% | -318% | -11% | | | |
| 33 | | 100% | -404% | -111% | | | |
| 36 | | 100% | | -196% | | | |
| 39 | | 100% | | -107% | | | |
| 42 | | 100% | | | | | |
| 45 | | 100% | | | | | |
| 48 | | 100% | | | | | |
| 51 | | | | | | | |
| 54 | | 100% | | | | | |

The comparisons of the downhole data gives an indication of the variability introduced between the two drilling methods downhole. Although inconsistent, it can be seen that in general the variation increases down the hole, rather than on surface with comparing the two drilling method results.

## 4.1 Summary statistics for drilling methods

Comparative descriptive statistics of the composite drillhole data for the two drilling methods and is listed in Table 6 and Table 7.

**Table 6. Summary statistics of composite drillholes - Reverse Circulation**

| SUMMARY STATISTICS FOR HILLENDALE MINE COMPOSITE - REVERSE CIRCULATION | | | | | | |
|---|---|---|---|---|---|---|
| | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
| **N** | 539 | 539 | 539 | 539 | 539 | 539 |
| **Min** | 4.10 | 0.76 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Max** | 47.30 | 26.95 | 3.61 | 13.04 | 13.90 | 2.47 |
| **Average** | 24.92 | 6.24 | 0.73 | 3.62 | 1.22 | 0.89 |
| **Range** | 43.20 | 26.19 | 3.61 | 13.04 | 13.90 | 2.47 |
| **Mode** | 27.70 | 3.00 | 0.60 | 2.48 | 0.46 | 0.70 |
| **Median** | 25.74 | 4.97 | 0.54 | 3.23 | 0.61 | 0.81 |
| **Variance** | 50.94 | 18.12 | 0.38 | 4.23 | 3.29 | 0.22 |
| **Std. Dev** | 7.14 | 4.26 | 0.61 | 2.06 | 1.81 | 0.47 |
| **Skewness** | -0.37 | 1.81 | 1.83 | 1.22 | 3.43 | 0.83 |
| **Kurtosis** | 3.31 | 6.61 | 6.47 | 5.06 | 16.20 | 3.52 |
| **CoV** | 0.29 | 0.68 | 0.84 | 0.57 | 1.48 | 0.52 |

Note: THM sample containing less than 1.5% THM is not magnetic separated due to laboratory procedure.

**Table 7. Summary statistics of composite drillholes - Wallis Aircore**

| SUMMARY STATISTICS FOR HILLENDALE MINE COMPOSITE - WALLIS AIRCORE | | | | | | |
|---|---|---|---|---|---|---|
| | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
| **N** | 752 | 752 | 752 | 752 | 752 | 752 |
| **Min** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Max** | 61.52 | 23.62 | 2.48 | 8.81 | 12.06 | 2.62 |
| **Average** | 23.79 | 5.39 | 0.54 | 3.20 | 0.92 | 0.83 |
| **Range** | 61.52 | 23.62 | 2.48 | 8.81 | 12.06 | 2.62 |
| **Mode** | 24.60 | 2.74 | 0.68 | 2.82 | 0.22 | 0.75 |
| **Median** | 22.46 | 4.83 | 0.48 | 2.95 | 0.39 | 0.77 |
| **Variance** | 87.28 | 8.47 | 0.12 | 2.39 | 1.73 | 0.15 |
| **Std. Dev** | 9.34 | 2.91 | 0.34 | 1.55 | 1.31 | 0.39 |
| **Skewness** | 1.05 | 1.57 | 1.13 | 0.80 | 3.43 | 1.00 |
| **Kurtosis** | 4.66 | 7.16 | 5.08 | 3.45 | 19.61 | 4.70 |
| **CoV** | 0.39 | 0.54 | 0.62 | 0.48 | 1.43 | 0.46 |

Note: THM sample containing less than 1.5% THM is not magnetic separated due to laboratory procedure

It can be seen that the data distribution of the sample populations for the two drilling methods are similar in terms of average values. The average is used as a guideline since the central limit theorem will be used to determine a theoretical number of drillholes required for resource classification.

The RCN drilling method induces more variability than the WAC method for the THM% and Carpco® fractions as seen with the variance and standard deviation. The opposite is true when considering the silt%, since the variability of the THM% is lower when using the WAC drilling method.

From the data statistics the RCN is slightly negatively skewed for silt. The THM and the Carpco® fraction are positively skewed. The WAC data is positively skewed.

The coefficient of variation is all below one for both drilling methods, except for ‘’mago’. There is a large degree of variation for ’mago’. The remaining analyses all have a relatively low to low degree of variance.

## 4.2 Mineral resource classification approaches in the mining industry

In the SAMREC code mineral resources are classified in three categories depending on the increasing level of geoscientific knowledge and confidence (SAMREC, 2009), this and is illustrated in Figure 22.

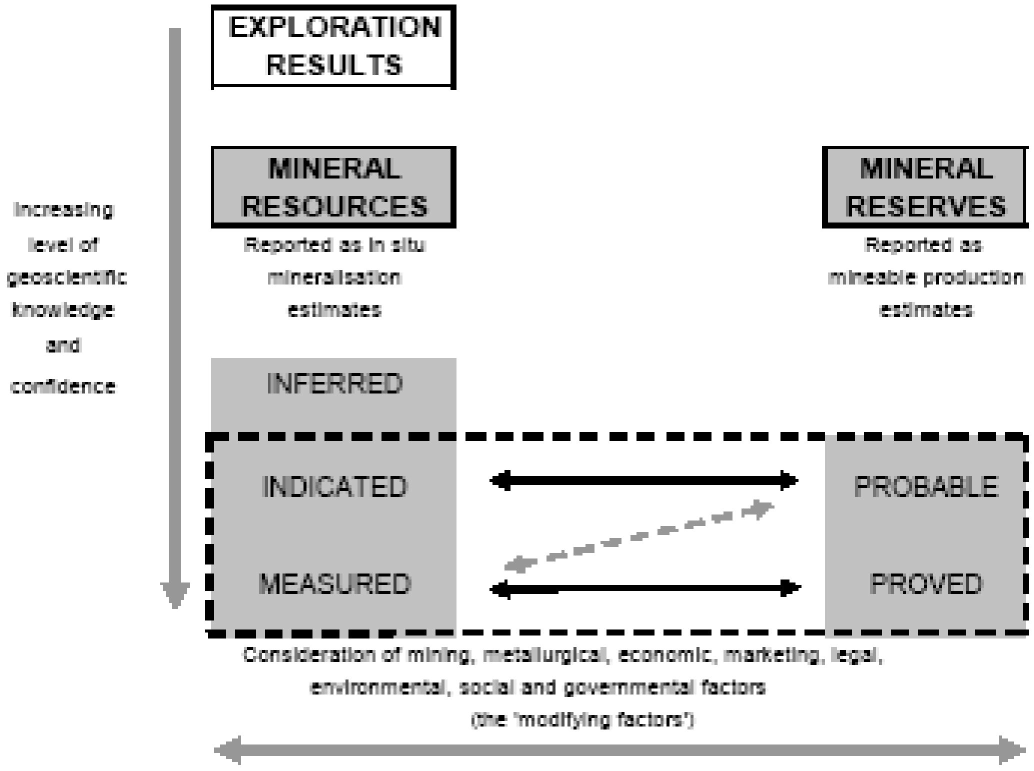


**Figure 22. SAMREC Classification (SAMREC, 2009)**

Mineral resources are classified focussing on three different aspects namely geological continuity, data quality and technical feasibility (Dominy et al., 2002). There are a number of classification methods for defining the resource for different commodities. One approach, as applied in some of the Witwatersrand gold deposits and presented by Camisani (2009), is based on the confidence in the mean of the small mining unit (SMU) with Kriging. A confidence in the kriged estimate is determined to define the resource into Measured, Indicated and Inferred using:

$$T^{*} - 1.645\sigma_k < T < T^{*} + 1.645\sigma_k$$

At a 90% confidence level the SMU resource is classified as Measured, Indicated or Inferred depending on which of the following relations is true:

Measured - $1.645\sigma_k < 0.2T^{*}$

Indicated - $1.645\sigma_k < 0.4T^{*}$

Inferred - $1.645\sigma_k > 0.4T^{*}$

Similarly Dominy et al., (2002) suggests potential precision levels at a determined confidence level (suggested at 80% or 90%) for classifying mineral resources and ore reserves using the following criteria (based on gold) as listed in Table 8:

**Table 8. Potential precision levels at 80 or 90% confidence as described by Dominy et al (2002)**

| Mineral Resource Precision | | |
|---|---|---|
| **Category** | **Developed** | **Undeveloped** |
| Measured | ±5-10% | ± 10-15% |
| Indicated | ±15-25% | ± 25-35% |
| Inferred | ±35-100% | |

The above mentioned table indicates that a drilled out proved ore mining block could lie within potentially 10 – 15% potential precision level while the same block fully developed mining block lies within a 5 - 10% potential precision level.

Using the approach as described by Camisani (2009) mine management can decide to continue with mining at any stage of prospecting with a defined percentage of mineral resources classified as measured (say 10%), indicated (say 20%) and inferred (70%). The resources is converted to reserves as defined by SAMREC code with the measured resources converting to proved reserves. The percentage reserves converted from resources should be adequate for mining business case.

Figure 23 is an illustration as presented by Feldman (2007) for resource categorisation as used at Thabazimibi mine. The resource is classified into a measured, indicated and Inferred category based on the variogram where measured resource equates to information being within 2/3 of the range of the variogram, indicated resources when the information is up to the range of the variogram and inferred where information is extended outside the range of the variogram. This approach is based on a process as described by

Snowden, V. (2003). In 'Practical interpretation of mineral resource and ore reserve classification guidelines'.

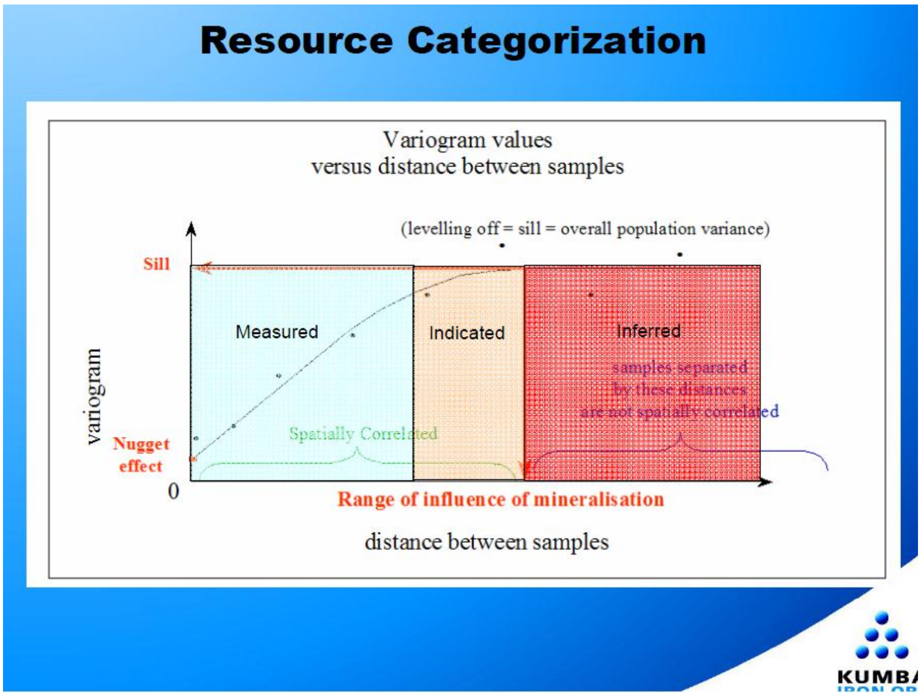


**Figure 23. Resource categorization as used at Thabazimbi mine (Feldman, 2007)**

## 4.3 Drillhole spacing

Exploration is done in various stages. With positive results, more exploration is done until there is enough confidence in the continuity of mineralisation for the establishment of a mine. During the first stages of exploration there is not necessarily enough resources or data to complete an in depth geostatistical analysis of the potential ore body. Using the central limit theorem is an alternative approach compared to using the above descriptions such as the SMU or the semi-variogram using geostatistics, already in advanced stages of exploration. The central limit theorem can use the first stage analytical results of the exploration data to calculate a theoretical number of drillholes required to convert the resources to a measured category. At Hillendale, each SAMREC category is traditionally assigned a statistical level of confidence as indicated in Table 9. The decision on the statistical level of confidence was subjective and deemed adequate for the deposit.

**Table 9. Confidence intervals used at the mine for the three SAMREC classification Categories**

| SAMREC Category | Confidence in the mean measured as deviation from the mean at the 95% Confidence level (Central) |
|---|---|
| Inferred | 10% - 32% |
| Indicated | 5% - 10% |
| Measured | $\leq$ 5% |

The minimum number of drillholes required (n) for a specific SAMREC category is determined as a percent deviation from the mean at a certain confidence level (95% Central) (see above Table 9).

The following formula from the Central Limit Theorem (CLT) is used:

$$\mu \pm 1.96\left(\frac{\sigma}{\sqrt{n}}\right)$$

where:

μ = mean

1.96 = 95% confidence level (Central)

σ = standard deviation

n = no. of samples (i.e. the number of drillholes), which is the variable in this case, and where:

A measured resource would be defined by: **1.96 [σ/sqrt(n)]** being equal or less than 0.05μ (equivalent in the mining jargon to "95% confidence").

An indicated resource would be defined by **1.96 [σ/sqrt(n)]** being equal or less than 0.10μ (equivalent in the mining jargon to "90% confidence").

Taking into consideration the planned production area over which a SAMREC category is defined, e.g. measured for first 5 years of production, the drillhole spacing is determined in order to obtain the level of confidence required.

The central limit theorem states that the mean of a sufficiently large number of independent random variables with a finite mean and variance will be approximately normally distributed (Rice, 1995). Using the central limit theorem taking the mean and variance of the completed drilling campaign into consideration, the optimal sample size (n) can be determined for an assigned confidence.

From the central limit theorem it is derived that although the sample distribution will never be normal, it will, with a large enough sample size, tend to normal.

Descriptive statistics for the composite sample analyses of the drillholes on various grid intervals for the two main exploration methods are listed in Table 10 and Table 11. The required number of samples for measured resources is determined based on the statistical analyses of the data.

Table 10. Approximate sample size of WAC drilling at Hillendale for measured resources

| HILLENDALE WAC DRILLING INFORMATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0.8 Amp Fraction | | | | | | | | |
| Grid | Count | Min | Max | Average | Variance | Std Dev | Maximum drillholes per drilling grid | Theoretical number of drillholes to reach confidence |
| 50 grid | 435 | 0.00 | 8.81 | 3.55 | 2.09 | 1.44 | 1 031 | 707 |
| 100 grid | 105 | 1.02 | 7.23 | 3.58 | 1.79 | 1.34 | 258 | 594 |
| 200 grid | 38 | 1.03 | 7.23 | 3.17 | 2.55 | 1.60 | 64 | 1083 |
| THM % | | | | | | | | |
| Grid | Count | Min | Max | Average | Variance | Std Dev | Maximum drillholes per drilling grid | Theoretical number of drillholes to reach confidence |
| 50 grid | 435 | 0.00 | 23.62 | 5.62 | 6.28 | 2.51 | 1 031 | 848 |
| 100 grid | 105 | 2.07 | 12.40 | 5.79 | 4.12 | 2.03 | 258 | 524 |
| 200 grid | 38 | 1.93 | 12.40 | 5.28 | 5.23 | 2.29 | 64 | 799 |

Table 11. Approximate sample size of RCN drilling at Hillendale based for measured resources

| HILLENDALE RCN DRILLING INFORMATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0.8 Amp Fraction | | | | | | | | |
| Grid | Count | Min | Max | Average | Variance | Std Dev | Maximum drillholes per drilling grid | Theoretical number of drillholes to reach confidence |
| 50 grid | 282 | 0.70 | 13.04 | 3.99 | 4.35 | 2.08 | 1 031 | 1164 |
| 100 grid | 84 | 0.62 | 10.71 | 3.65 | 4.53 | 2.13 | 258 | 1449 |
| 200 grid | 32 | 0.62 | 8.37 | 3.52 | 2.70 | 1.64 | 64 | 930 |
| THM % | | | | | | | | |
| Grid | Count | Min | Max | Average | Variance | Std Dev | Maximum drillholes per drilling grid | Theoretical number of drillholes to reach confidence |
| 50 grid | 282 | 0.98 | 26.95 | 6.33 | 18.87 | 4.34 | 1 031 | 2013 |
| 100 grid | 84 | 0.98 | 21.31 | 5.94 | 18.12 | 4.26 | 258 | 2193 |
| 200 grid | 32 | 1.74 | 18.64 | 5.99 | 12.03 | 3.47 | 64 | 1430 |

The theoretical required number of samples are based on the THM and the 0.8Amp. The analyses are still the first phase Carpco® analyses where the 0.8Amp represents the mostly ilmenite fraction. The determination of the theoretical number of drillholes uses the THM and 0.8Amp fractions since they are the basis for the business case. The original aim for most heavy mineral sand mining operations was as ilmenite producers.

The amount of theoretical drillholes required to achieve a measured resource is estimated by using the actual drilling information. The borehole information of Hillendale mine is used to select the determined grid sizes of approximately 50m x 50m, 100m x 100m and 200m x 200m (illustrated in Figure 24 and Figure 25). This is done for each drilling method. The drillholes are composited by length with no selected cut-off values. The drillholes are composited using SUPRAC ® downhole compositing function weighting the analytical sample by length. The composite value of the drillholes are used instead of the individual sample value. Each drillhole represents a sample. The specific methodology is followed to determine the grid size required to achieve a specific resource classification confidence.

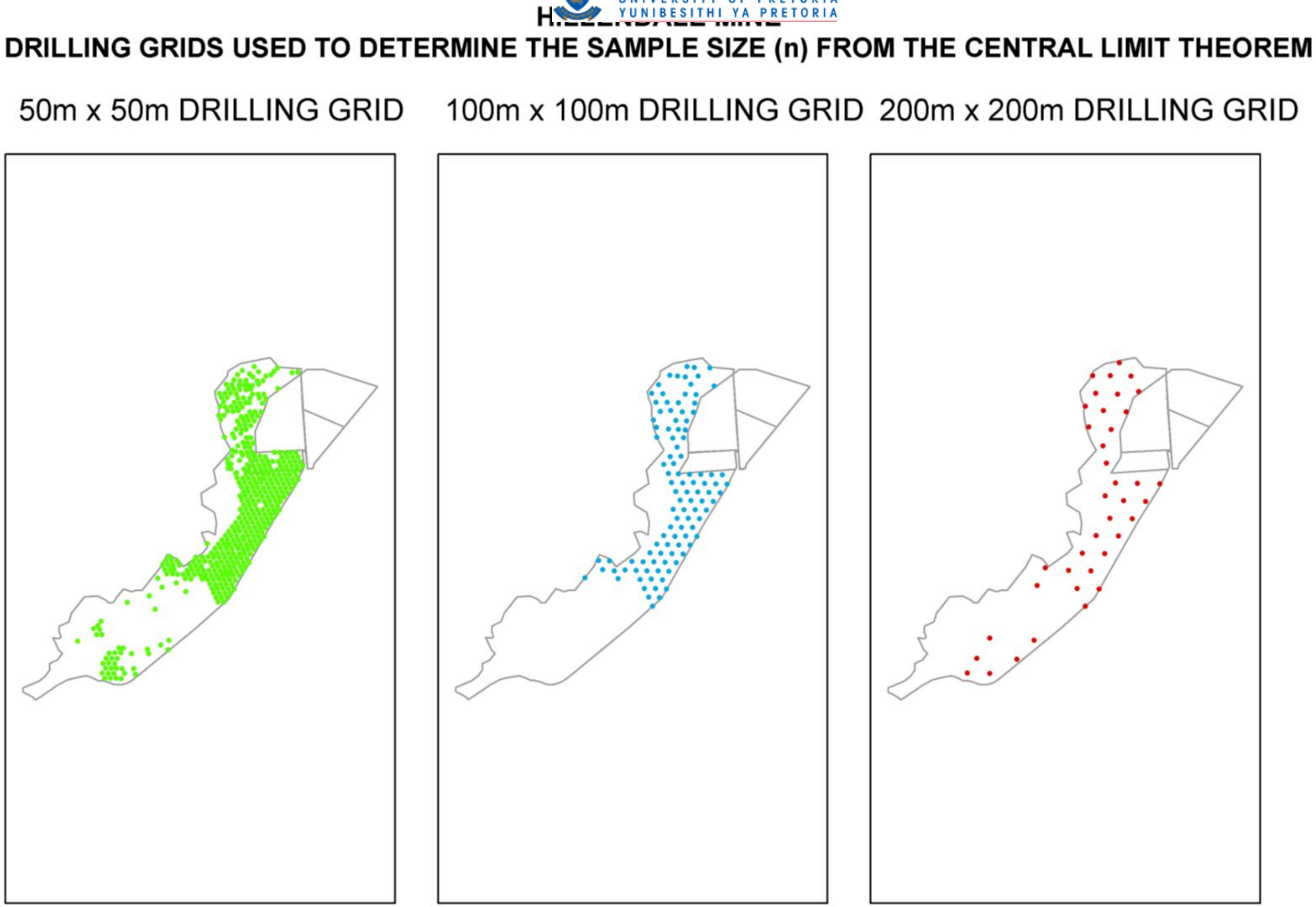


**Figure 24. WAC drillholes selected for determining the descriptive statistics for the central limit theorem**

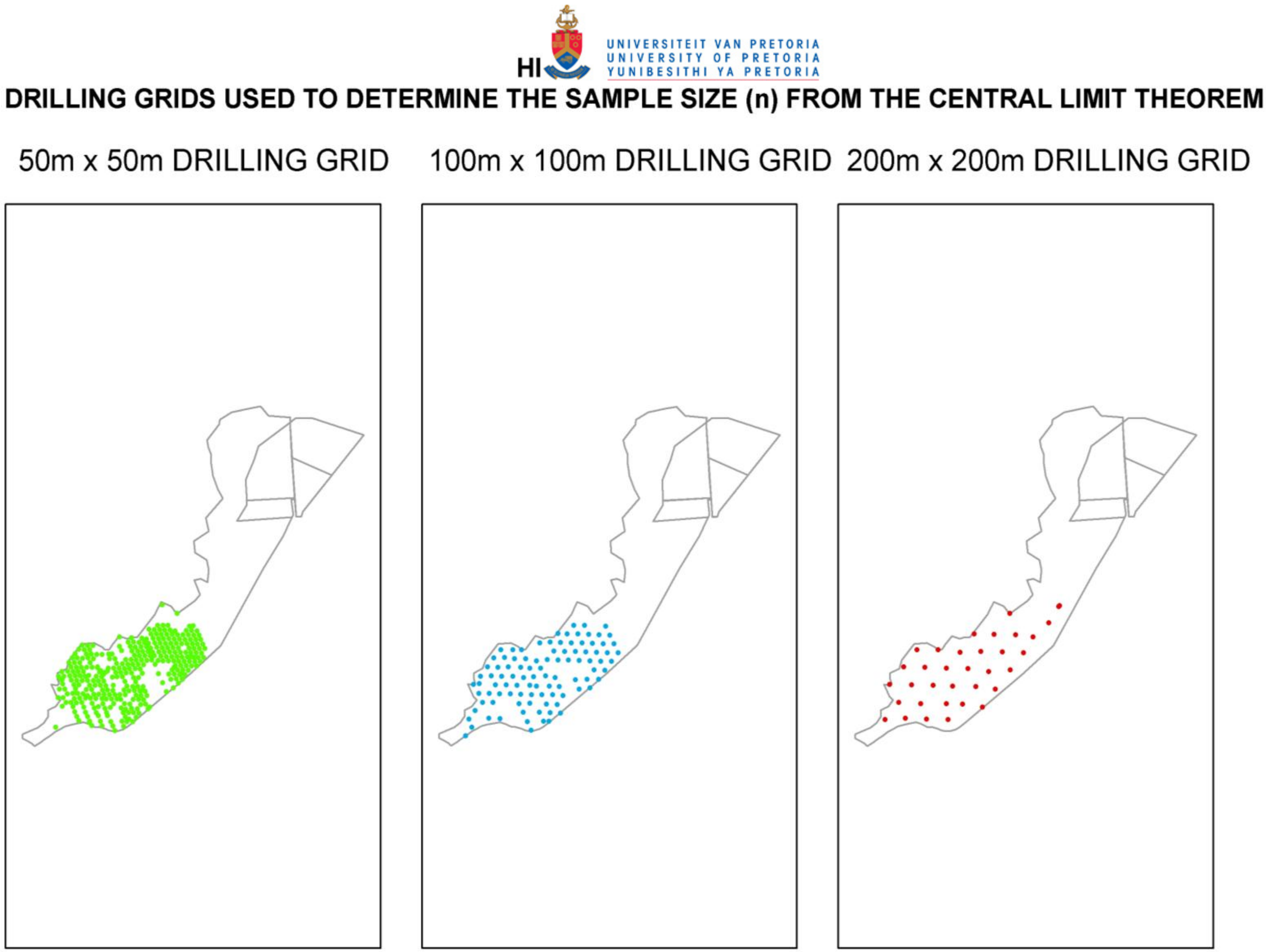


**Figure 25. RCN drillholes selected for determining the descriptive statistics for the central limit theorem**

The average depth of boreholes at Hillendale, using the 50m x50m grid is 56 meters relating to approximately 19 samples per calculated drillhole. The number of samples required is however dependant on the topography of the dune and the underlying mineralisation.

Statistical analysis is done on the selected downhole composite drillholes falling within the chosen grid sizes to determine the minimum, maximum, average, range, and standard deviation. The theoretical number of drillholes required is calculated as follows, for measured resources:

$$n = \left(\frac{1.96\,\sigma}{0.05\mu}\right)^2$$

Where:

| | | |
|---|---|---|
| μ | = | mean |
| 1.96 | = | 95% confidence level for a normal distribution |
| σ | = | standard deviation |
| n | = | number of drillholes. |

The available surface area is a constraint when determining the maximum drillholes required on Hillendale mine. The adjustments necessitated by the area constraint signify that at times the mine area is too small for the number of drillholes required to obtain the required confidence for the chosen

SAMREC category. Consequently a slight adjustment in the drillhole spacing with regard to the rigid 200m x 200m grid, 100m x100m grid and 50m x 50m may be required from time to time.

Table 10 indicates the theoretical number of drillholes required for Hillendale mine based on a 95% confidence using the WAC drilling method. The theoretical number of drillholes required was determined for both the THM% and the 0.8 Amp fraction. The THM% carries the complete package of heavy mineral sand fractions and the 0.8 Amp fraction was used for the original business case to decide if a mining operation will be viable for the deposit.

Following the sequence of exploration and therefore looking at the 0.8 Amp analyses for the 200m x 200m grid, the RCN drilling method requires less theoretic samples than the WAC to achieve the required confidence level with 930 samples required by RCN and 1083 for WAC. A maximum number of 64 drillholes based on the area extend of the mining operations for a 200m x 200m grid can be drilled. Neither of the drilling methods achieves the required confidence level to classify a measured resource due to the surface constraint of the mining property.

With continuous infill drilling to achieve a 100m x 100m grid size, the RCN drilling method requires 1149 theoretical samples compared to the 594 theoretical samples required by WAC. A maximum number of 258 drillholes based on the areal extent of the mining operations for a 100m x 100m grid can be drilled. The required confidence level for a measured category is not achieved.

For the final stages of drilling to achieve a drilling grid suitable for production planning currently set at 50m x 50m, the RCN drilling method requires a theoretical sample size of 1164 while the WAC requires a sample size of 707. The surface area allows for a maximum number of samples of 1031.

The RCN is close to achieving the required level of confidence with the theoretical number or samples while the WAC can probably achieve the required level of confidence with a wider spacing than the 50m x 50m grid.

### 4.3.1 Drillhole spacing confidence

The confidence level from 10% to 99% is calculated using the actual drillhole information as illustrated below in Table 12 and Table 13. The achieved level of confidence for the data is established when the theoretical number of drillhole samples are the closest to the number of drillholes required to achieve the required level of confidence. This is subject to the constraint of the areal extent of the block being drilled, which can only contain a certain number of drillholes per grid.

**Table 12. Table indicating the theoretical number of drillholes for WAC drilling to reach the required confidence level**

HILLENDALE WAC DRILLING INFORMATION

| Theoretical number of drillholes to reach the required confidence | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Central Confidence level | | 2.580 | 1.960 | 1.645 | 1.280 | 1.030 | 0.840 | 0.674 | 0.525 | 0.385 | 0.253 | 0.126 |
| WAC / 0.8 Amp | Maximum drillholes per drilling grid | 99% | 95% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| 50 grid | 1031 | 1224 | 707 | 498 | 301 | 195 | 130 | 84 | 51 | 27 | 12 | 3 |
| 100 grid | 258 | 1030 | 594 | 419 | 254 | 164 | 109 | 70 | 43 | 23 | 10 | 2 |
| 200 grid | 64 | 1876 | 1083 | 763 | 462 | 299 | 199 | 128 | 78 | 42 | 18 | 4 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| WAC / THM | Maximum drillholes per drilling grid | 99% | 95% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| 50 grid | 1031 | 1470 | 848 | 598 | 362 | 234 | 156 | 100 | 61 | 33 | 14 | 3 |
| 100 grid | 258 | 908 | 524 | 369 | 224 | 145 | 96 | 62 | 38 | 20 | 9 | 2 |
| 200 grid | 64 | 1385 | 799 | 563 | 341 | 221 | 147 | 95 | 57 | 31 | 13 | 3 |

Note: The green shading indicates the where the level of confidence is achieved for specific drilling grid.

**Table 13. Table indicating the theoretical number of drillholes for RCN drilling to reach the required confidence level**

HILLENDALE RCN DRILLING INFORMATION

| Theoretical number of drillholes to reach the required confidence | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Central Confidence level | | 2.580 | 1.960 | 1.645 | 1.280 | 1.030 | 0.840 | 0.674 | 0.525 | 0.385 | 0.253 | 0.126 |
| RCN / 0.8 Amp | Maximum drillholes per drilling grid | 99% | 95% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| 50 grid | 1031 | 2016 | 1164 | 820 | 496 | 321 | 214 | 138 | 83 | 45 | 19 | 5 |
| 100 grid | 258 | 2510 | 1449 | 1020 | 618 | 400 | 266 | 171 | 104 | 56 | 24 | 6 |
| 200 grid | 64 | 1612 | 930 | 655 | 397 | 257 | 171 | 110 | 67 | 36 | 16 | 4 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| RCN / THM | Maximum drillholes per drilling grid | 99% | 95% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| 50 grid | 1031 | 3488 | 2013 | 1418 | 859 | 556 | 370 | 238 | 144 | 78 | 34 | 8 |
| 100 grid | 258 | 3801 | 2193 | 1545 | 936 | 606 | 403 | 259 | 157 | 85 | 37 | 9 |
| 200 grid | 64 | 2479 | 1430 | 1008 | 610 | 395 | 263 | 169 | 103 | 55 | 24 | 6 |

The data is graphically presented in Figure 26.

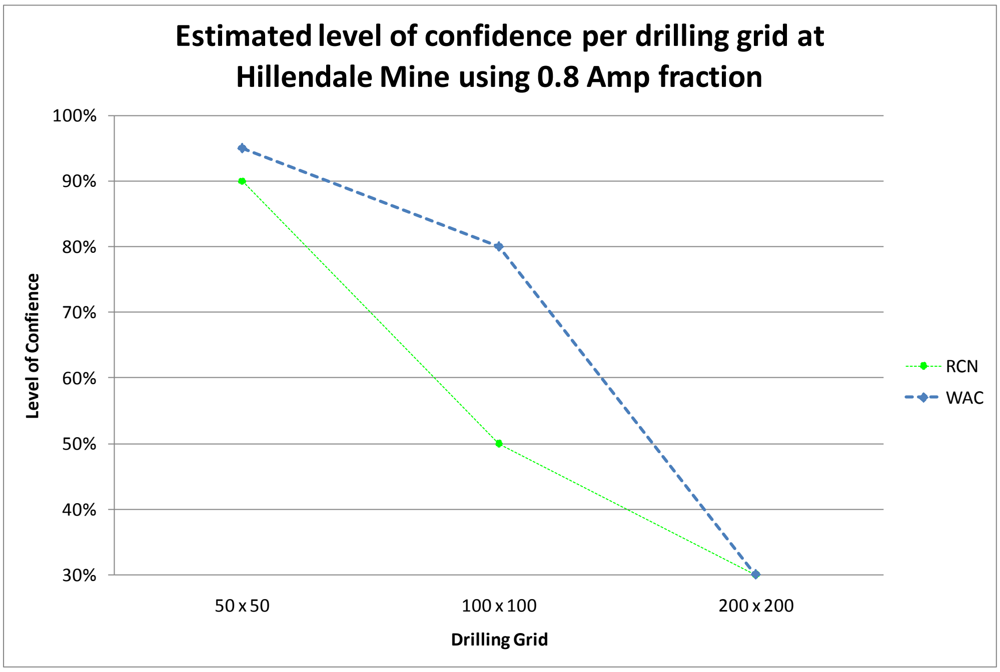


**Figure 26. Drilling grid size versus level of confidence**

For RCN a 30% level of confidence is achieved using the 200m x 200m grid spacing. WAC also achieves a 30% confidence level on the 200m x 200m grid spacing.

For the 100m x 100m grid spacing, RCN achieves a 50% confidence level while WAC achieves an 80% confidence level.

The 50m x 50m drillholes spacing as used for production achieves a 90% confidence for RCN and 95% confidence for WAC.

Using the theoretical approach, Hillendale mine can be classified into an indicated resource category by using a 100m x 100m grid with the WAC drilling technique, while the resource will be classified as Inferred with using the RCN drilling technique with the same drilling grid.

### 4.4 Drilling costs versus geological Knowledge

The drilling costs (actual costs as per confidential information made available to the author) of the minimum required number of drillholes to achieve the required level of confidence is calculated for both the RCN and WAC drilling techniques.  Figure 27 illustrates the cost order estimate of both the RCN and WAC drilling methods.  The cost for the theoretical number of drillholes for RCN increases markedly compared to the WAC costs.

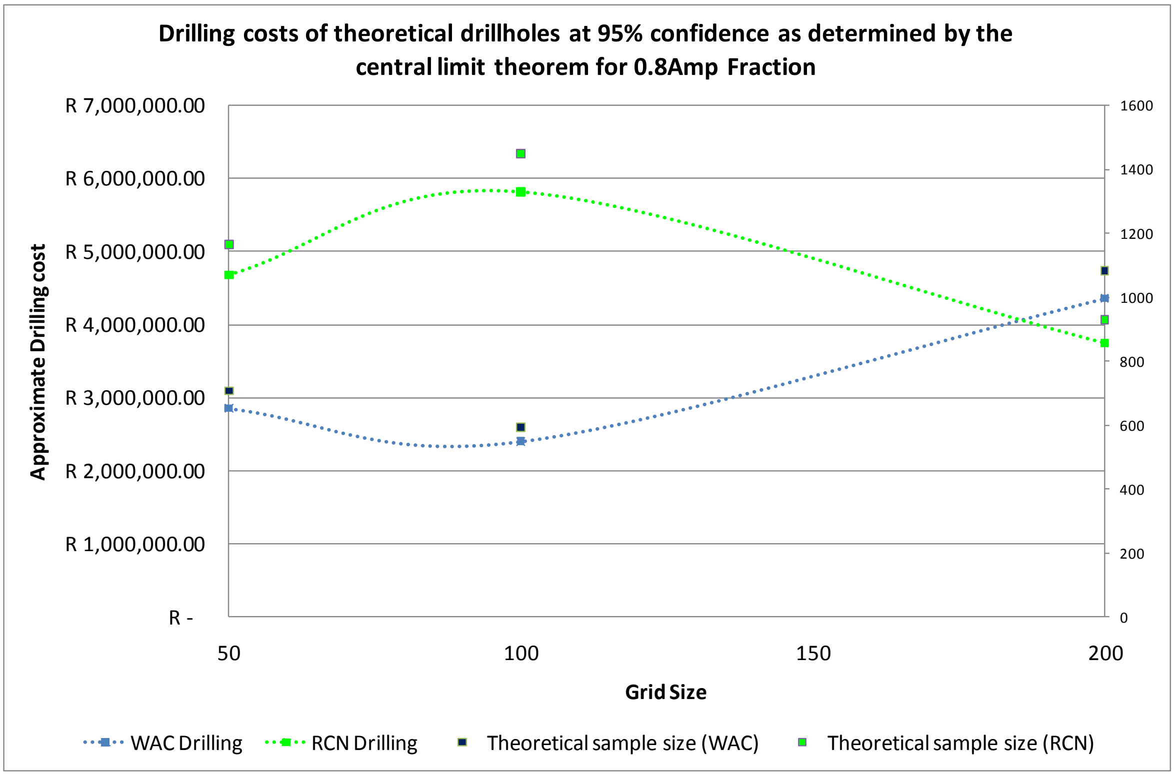


**Figure 27. Drilling costs on drillhole spacing grids for two drilling techniques**

Figure 27 graphically indicates the cost variation with using the WAC compared to the RCN drilling methods. Based on the number of holes required, initial costs for using RCN is lower with using the 200m x 200m drilling grid due to the higher ‘overhead’ costs related to the drilling. The actual rate per metre is very similar for both the RCN and the WAC. For a smaller grid size the cost for the RCN increases more compared to the WAC since there is a smaller number of drillholes required to for WAC to achieve the required confidence.

## 4.5 Conclusion on the drilling methods

During the life of Hillendale project, two drilling methods are used. Due to technological improvements in drilling methods management was enabled to convert to the WAC method, thus increasing the overall confidence in the data acquired and decreasing the costs.

RCN methods yield inconsistent sample sizes because sample recovery is dependent on the competency of the unit being drilled – the softer the sand formation, the lower the sample recovery because more air is required for drilling (Sibiya et al., 2005). Air is lost to the surrounding unconsolidated sand more readily than in harder formations. This loss of air into the surrounding ground leaves insufficient air available for the sample to be effectively blown into the inner tube for recovery. Another disadvantage of RCN drilling is that the method typically requires the addition of water if drilling high-silt units. The addition of water is not considered good sampling practice due to the increased potential of obtaining contaminated samples from wet equipment. Additionally, estimating the in situ moisture content of the unit is not possible. The WAC method does not require the addition of water.

With both the drilling methods contamination can play a part in reducing sample quality and information. Contamination can be caused by wall material falling down and being picked up as the drilling progresses as well as material being abraded from the walls of the hole as it returns to the surface. The material from which the bit or other in-hole components are manufactured may also cause contamination of the samples.

Twin hole comparisons between the downhole drillholes from the two drilling methods comparing the individual sample silt% and THM% do not correspond very well on a detailed level. Summary statistics indicate that the average of the analytical drillhole information for the project area correlates.

Using the population properties of the datasets as determined by the descriptive statistics with the central limit theorem, the number of samples required to produce the necessary confidence on the mean at a 95% confidence level is determined. Both the RCN and WAC drilling methods produce a cumulative sample. The WAC indicates a lower variance than the RCN drilling method for the same cumulative sample and therefore the drillhole spacing to define a 95% confidence level is wider. Due to the drillhole spacing it is more economical to use the WAC method than the RCN drilling method.

# 5 Estimation technique

Two interpolation methods are used through the life of mine (LOM) of Hillendale to determine the available mineral resources. The inverse distance to the power 3 ($ID^3$) interpolation method was initially used but the factor was updated to inverse distance to the power 2 ($ID^2$). Inverse distance is used with the RCN drilling data. Recent resource estimation uses kriging as interpolation method with WAC drilling data. WAC is the only method currently used at the mine.

Initially the $ID^3$ was introduced due to the affiliation with the Australian company Ti-West where the specific estimation method was used. This method was found inappropriate at Hillendale since it localises the estimation around the sample value. For the $ID^2$ method was subsequently introduced and used for the RCN drilling. This was mostly due accessibility and user constraints at the time of mining. With the WAC drilling method, improved technology (both hardware and software) kriging was implemented at Hillendale mine.

The process of estimation for all the methods is similar and is described below.

## 5.1 Database

The geological database is setup to capture the relevant primary information obtained from the drilling campaign. Hillendale uses SABLE® data warehouse as the geological database. The databases use a flexible database structure to ensure and enhance data validations and checks while assuring confidence in the data (Figure **28**). Ore body modelling assumes that mineralisation occurs within discrete units and these assumptions are further used in the evaluation of a mineral resource (Van Aswegen, 2005). SABLE® uses the principle of standardised logging and capturing to ensure consistency in data while reducing the complexity in the problem domain through defining discrete parts. The database is structured on a SQL Server database with one person as the super user. Functionality is built into the database to ensure the data is validated while captured. Additional controls include lookup tables for fields with standardised information as well as mandatory fields for compulsory but variable information.

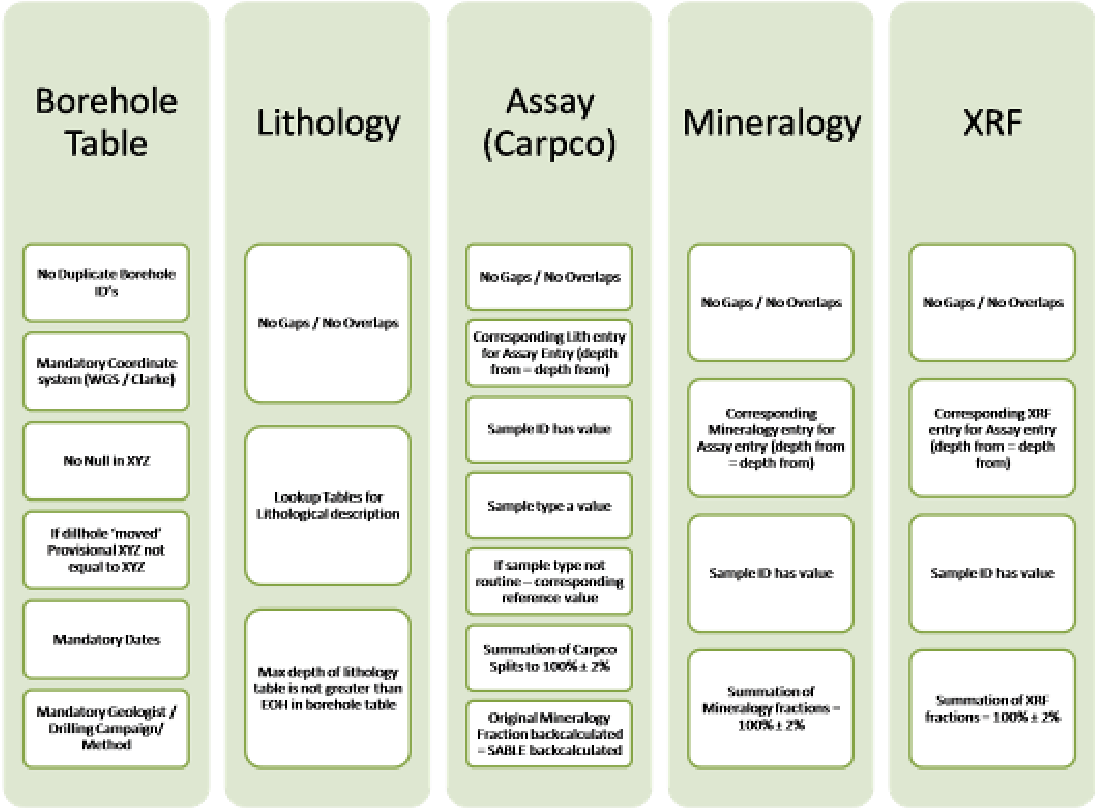


**Figure 28. Simplified database structure with database checks (image created by author)**

### 5.1.1 Geological data validation – database

All geological information is stored within the SABLE ® Dataworks database on a SQL platform.

### 5.1.2 Database Inventory

A comprehensive assay database inventory for the resource evaluation is created. The inventory sheet is comprised of two evaluation columns with an assigned rating to determine 'Resource Risk' as listed in Table 14. The 'Resource Risk' establishes whether a drillhole is representative for use in the resource estimation. The inventory was implemented because of the different drilling methods and stopping distance methodologies applied historically. Table 14 in conjunction with other information such as the survey method the database inventory is used to determine the resource representativeness listed in Table 15.

Differences in Table 14 are largely brought by missing values compared to intentional stopping short of the drillholes, as well as the ore grade (floor, low grade or ore).

For evaluation purposes 'low grade' ore is defined as below 3% ilmenite. Floor is defined as any ilmenite value below 1.5% and ore is defined as an ilmenite value above 1.5%.

**Table 14. Resource Risk Inventory Table**

| Flag Rating | Analysis Accuracy | Drillhole Intersection |
|---|---|---|
| 1 | Accurate - All samples included | Standard Ore Intersection': Ore / Low Grade / Floor |
| 2 | Lower grade samples missing | Ore / Low Grade / Floor Intersection |
| 3 | Ore and Lower grade samples missing | Ore / Floor / Ore Intersection |
| 4 | Ore Samples missing at end of drillhole | Drillhole intersection stopped in Ore |
| 5 | Ore Samples missing at beginning of drillhole | Ore / Low Grade / Ore - Drillhole Intersection stopped in ore |
| 6 | Accurate samples – drillhole stopped short | Drillhole Intersection stopped in Ore > 3% Ilmenite (drillhole stopped short) |
| 7 | Accurate samples | Low Grade Drillhole |
| 8 | Accurate samples | Ore / Low Grade / Floor / Low Grade |
| 9 | No Analysis Data | |

Table 15 lists the representativeness of a drillhole based on the evaluations above where the resource risk increases from 1 to 5.

Analyses data represented in Table 14 as accurate with all samples included and normal facies (ore, low grade, floor) is related to Table 15 as the most representative and assigned ‘1’. Drillholes stopped short or with missing ore in Table 14 has a lower representativeness and is therefore assigned ‘2’ in Table 15. Least representative samples are listed in Table 15 as ‘5’ and is defined in Table 14 as no analyses data available (although drilled) or samples stopped in ore.

Drillhole data with a flag of 5 is not exported and not used for information. The other flags from 1 – 4 are exported and used, but assist with the resource classification. A flag number of ‘1’ has the highest confidence while a flag number of ‘4’ has the lowest confidence.

**Table 15. Resource Representative table**

| Representativeness | | |
|---|---|---|
| Flag | Representativeness | Description |
| 1 | Yes | All analyses available |
| 2 | Yes - drillhole stopped short | All analyses available but drillhole stopped short in Low Grade Ore - Not used for floor determination |
| 3 | Yes - Low Grade Analysis | Low Grade Ore analysis missing |

| Representativeness | | |
|---|---|---|
| Flag | Representativeness | Description |
| | Missing | |
| 4 | Yes - Low Grade and Ore analysis Missing but representative | Low Grade Ore and Ore analysis missing. Sufficient data throughout drillhole to interpolate information |
| 5 | Not representative | No data or limited amount of data available |

## 5.2 Estimation methods

### 5.2.1 Kriging (Wallis Aircore Data)

#### 5.2.1.1 Domaining / anisotropy and search parameters

No domaining is done at Hillendale mine and the complete orebody is composited and estimated as a whole. A single pass search strategy is used for the resource estimation. The major axis, as described in SURPAC ®, is defined at 45° with a maximum horizontal search radius of 750m on the major axis. A maximum of 25 samples is to be used and a minimum of 5 samples. A maximum of 9 metre search radius is defined for the vertical axis. The major axis of 45° is determined by the predominant direction of the ore deposit as situated on the north coast.

The horizontal search radius was chosen to ensure that the complete orebody drilled with the selected drilling method would be estimated.

#### 5.2.1.2 3D model creation

A single geological block model is created for Hillendale mineral resources using WAC drilling information. The block model is created with all WAC drilling drillhole information. The Wallis Aircore Block model is created using SURPAC ® geological software. Data is exported from SABLE ® Dataworks and re-imported into SURPAC ® database, giving each sample individual coordinate points. A 10m x 10m x 5m geological block model is created using the ore boundary string to define the block model. Subcell splitting of 5m x 5m x 2.5m is defined for smaller block cells. The block model is not rotated.

All drillhole intersections are composited into 3 metre intervals using the ‘Composite, Downhole’ function in SURPAC ®. No grade constraints are used at this time, since this function gives a total composite value for the drillhole intersection, smoothing the drillhole values. Digital terrain models (DTM) from the original surface topography and from the floor contours are used to define the ore section of the geological block model. The floor contours are based on a 1.5% 0.8 Amp (98% ilmenite) cut off from both drillhole intersections and floor updates during production. Due to the 3 metre sampling interval for the majority of the resource, there is an inherent inaccuracy with the floor definition with production.

### 5.2.2 Inverse distance (Reverse Circulation)

The inverse distance estimation is described in the 2005 Ticor South Africa, Heavy Mineral Operations, Reserve and Resource Statement (Sibiya et al., 2005). A 3D solid model is constructed by combining the 1m-interval aerial survey digital terrain model (DTM) with the topographically defined dune structure and the 1.5% THM cut-off limit. Potential 'ore' polygons are created on sections throughout the deposit, where sections are drawn every 50m if grid lines were 50m apart or 100m if they were100m apart. Each polygon is created on-screen by snap digitising the area encompassed by the surface (1m-interval aerial survey contours), the edges of the dune (defined by the topography) and the 1.5% THM cut-off limit (from drillhole on the section). Joining the 1.5% THM potential 'ore' polygons from each section within a deposit thus creates the 3D solid for that deposit.

A drillhole occurring at the edge of a dune, in which the cumulative THM content of all samples within the drillhole is <1.5% THM, is excluded from the

3D solid volume. Similarly, drillhole within the dune structure that have thick (up to 9m) bands of waste material between ore zones are included in the 1.5% resource outline only if the cumulative THM% of the drillhole remains >1.5.

It is significant that the cut-off grade for estimating the potential mineral resource volume is 1.5% THM, but the cut-off used to report the final, ore-grade mineral resources within this volume is 3% THM. The volume difference between the two cut off grades that defines the 1.5%THM ore volume and the 3% THM cut-off grade (3% ≥ THM grade >1.5%) is classified as low-grade ore.

The search radii defined by the geostatistical investigations are used to fill the blocks in the grade model. Blocks (10m x 10m x 5m) are first filled using $ID^3$ and then checked by being filled using kriging. There are only minor differences between the results and conducting two runs serves as a good check that mineral resource grade estimations are as accurate as possible.

In a similar way that confidence levels are assigned to drillhole co-ordinates according to how accurately they have been surveyed, confidence levels are assigned to blocks within the grade model according to which estimation run filled each block. If a block was filled using the specific search radii on the first run, then the estimation for that block is assigned the highest level of confidence (3); if it was only filled on the last run (nearest neighbour method), the estimation is assigned the lowest confidence level (1). The different search parameters are considered when classifying the mineral resource.

## 5.3 Relative density determinations

A sand replacement study was done on various colour zones in the mining area during 2003. The densities varied from 1.68 g/cm$^3$ to 1.72 g/cm$^3$. Thereafter an average density of 1.70 g/cm$^3$ is applied to the resource estimations and block models. The relative density value is used for both inverse distance and Kriging blockmodels.

## 5.4 Comparative blockmodels

The estimated resource blockmodels are statistically compared to establish the central tendancy of the data spread. The RCN drilling blockmodels are divided into three separate areas due to computer hardware constraints at the time the blockmodels where built. The three areas are illustrated in Figure 29. The whole ore body of Hillendale mine area is used to estimate the WAC blockmodel and represented in a single resource blockmodel using kriging.

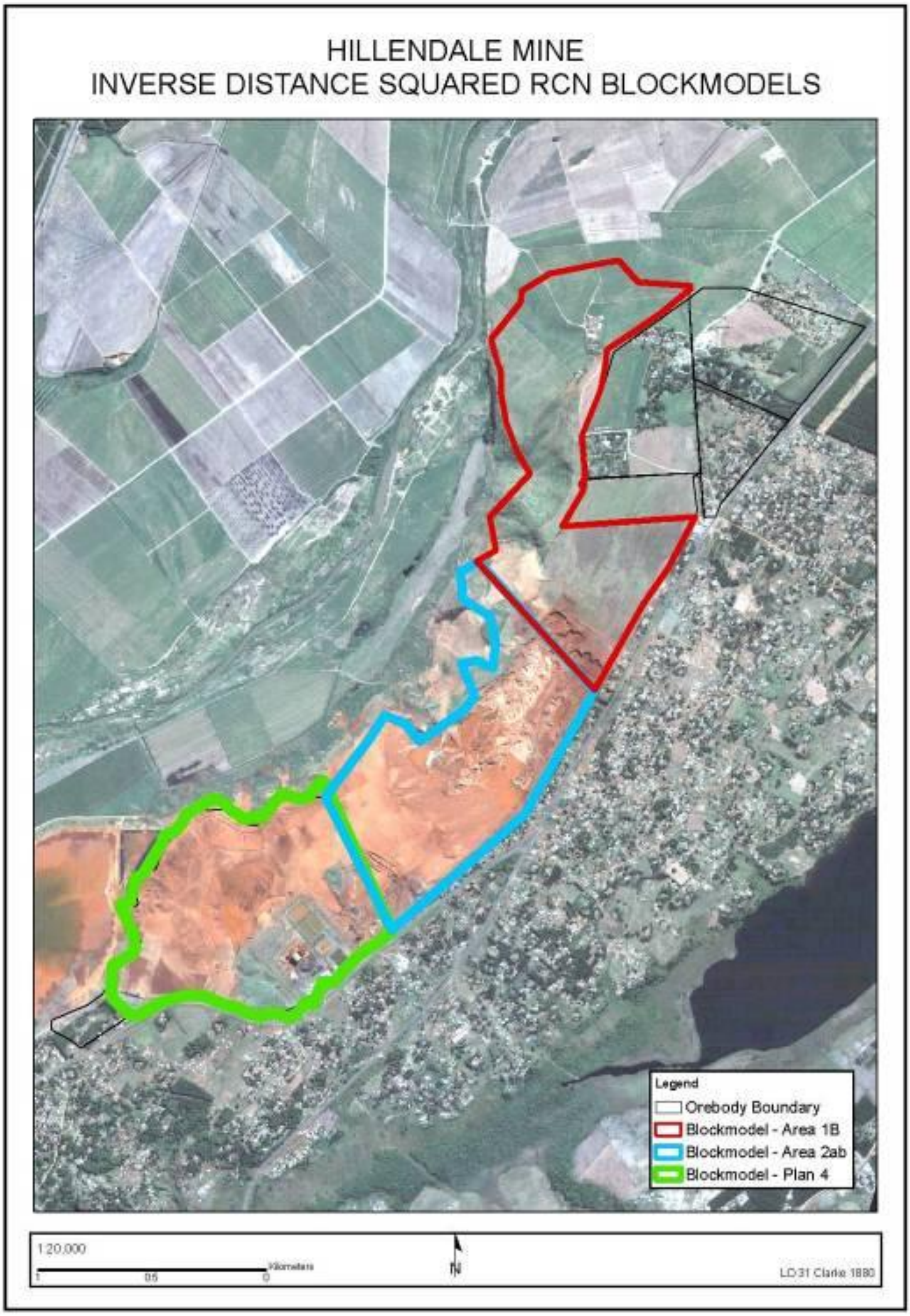


**Figure 29. RCN drilling, inverse distance squared blockmodel**

The statistical data of the blockmodels are listed in Table 16 to Table 19.

**Table 16. Summary statistics for Hillendale mine WAC – Kriging blockmodel**

| SUMMARY STATISTICS FOR HILLENDALE MINE - WALLIS AIRCORE DRILLING | | | | | | |
|---|---|---|---|---|---|---|
| | SILT % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
| **Min** | 6.10 | 0.45 | 0.00 | 0.02 | 0.03 | 0.02 |
| **Max** | 73.68 | 23.40 | 2.58 | 11.94 | 10.05 | 3.10 |
| **Average** | 26.33 | 6.06 | 0.63 | 3.51 | 0.93 | 0.92 |
| **Range** | 67.58 | 22.95 | 2.58 | 11.92 | 10.02 | 3.08 |
| **Mode** | 19.35 | 4.55 | 0.48 | 3.06 | 0.22 | 0.76 |
| **Median** | 27.21 | 5.68 | 0.58 | 3.43 | 0.44 | 0.92 |
| **Variance** | 123.20 | 10.06 | 0.15 | 3.03 | 1.59 | 0.19 |
| **Std. Dev** | 11.10 | 3.17 | 0.38 | 1.74 | 1.26 | 0.43 |
| **Skewness** | 0.52 | 0.99 | 0.95 | 0.61 | 2.66 | 0.59 |
| **Kurtosis** | 2.59 | 4.12 | 3.85 | 3.22 | 11.03 | 3.36 |
| **CoV** | 0.42 | 0.52 | 0.60 | 0.50 | 1.35 | 0.47 |

**Table 17. Summary statistics for Hillendale mine - area 1 B blockmodel**

| SUMMARY STATISTICS FOR HILLENDALE MINE - REVERSE CIRCULATION - ID area 1B | | | | | | |
|---|---|---|---|---|---|---|
| | SILT % | THM % | ILM % | MAGN % | MAGO % | NMAG % |
| **Min** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Max** | 44.93 | 39.73 | 13.47 | 2.89 | 22.11 | 5.72 |
| **Average** | 23.16 | 7.73 | 4.60 | 0.67 | 1.30 | 1.16 |
| **Range** | 44.93 | 39.73 | 13.47 | 2.89 | 22.11 | 5.72 |
| **Mode** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Median** | 25.23 | 7.05 | 4.52 | 0.57 | 0.48 | 1.12 |
| **Variance** | 81.12 | 13.67 | 3.84 | 0.15 | 4.79 | 0.21 |
| **Std. Dev** | 9.01 | 3.70 | 1.96 | 0.39 | 2.19 | 0.46 |
| **Skewness** | -0.62 | 1.85 | 0.36 | 1.20 | 3.53 | 0.90 |
| **Kurtosis** | 2.56 | 9.86 | 3.24 | 4.94 | 17.57 | 6.48 |
| **CoV** | 0.39 | 0.48 | 0.43 | 0.59 | 1.68 | 0.40 |

**Table 18. Summary statistics for Hillendale mine - area 2 blockmodel**

| SUMMARY STATISTICS FOR HILLENDALE MINE - REVERSE CIRCULATION - ID area 1B | | | | | | |
|---|---|---|---|---|---|---|
| | SILT % | THM % | ILM % | MAGN % | MAGO % | NMAG % |
| **Min** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Max** | 44.93 | 39.73 | 13.47 | 2.89 | 22.11 | 5.72 |
| **Average** | 23.16 | 7.73 | 4.60 | 0.67 | 1.30 | 1.16 |
| **Range** | 44.93 | 39.73 | 13.47 | 2.89 | 22.11 | 5.72 |
| **Mode** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Median** | 25.23 | 7.05 | 4.52 | 0.57 | 0.48 | 1.12 |
| **Variance** | 81.12 | 13.67 | 3.84 | 0.15 | 4.79 | 0.21 |
| **Std. Dev** | 9.01 | 3.70 | 1.96 | 0.39 | 2.19 | 0.46 |
| **Skewness** | -0.62 | 1.85 | 0.36 | 1.20 | 3.53 | 0.90 |
| **Kurtosis** | 2.56 | 9.86 | 3.24 | 4.94 | 17.57 | 6.48 |
| **CoV** | 0.39 | 0.48 | 0.43 | 0.59 | 1.68 | 0.40 |

**Table 19. Summary statistics for Hillendale mine - area 4 blockmodel**

| SUMMARY STATISTICS FOR HILLENDALE MINE - REVERSE CIRCULATION - ID area 4 | | | | | | |
|---|---|---|---|---|---|---|
| | SILT % | THM % | ILM % | MAGN % | MAGO % | NMAG % |
| **Min** | 1.82 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Max** | 47.67 | 46.31 | 22.30 | 7.69 | 23.56 | 4.78 |
| **Average** | 23.25 | 10.07 | 5.64 | 1.34 | 1.78 | 1.32 |
| **Range** | 45.85 | 46.31 | 22.30 | 7.69 | 23.56 | 4.78 |
| **Mode** | 28.44 | 1.85 | 1.24 | 0.22 | 0.29 | 0.39 |
| **Median** | 23.42 | 8.27 | 4.87 | 1.02 | 0.86 | 1.17 |
| **Variance** | 55.73 | 37.23 | 10.15 | 1.00 | 6.92 | 0.47 |
| **Std. Dev** | 7.47 | 6.10 | 3.19 | 1.00 | 2.63 | 0.68 |
| **Skewness** | -0.15 | 1.03 | 0.88 | 1.14 | 3.53 | 0.84 |
| **Kurtosis** | 2.79 | 3.91 | 3.48 | 4.04 | 17.03 | 3.46 |
| **CoV** | 0.32 | 0.61 | 0.57 | 0.75 | 1.48 | 0.52 |

Histograms of the various blockmodels for both RCN area 1B, 2 and 4 as well as the WAC blockmodel of the THM % are represented from Figure 30 to Figure 33. Histograms of the other components and mineral fractions of the analyses are listed in the Addendum B.

The individual composite drillhole information for WAC is listed in Addendum C and for RCN is listed in Addendum D.

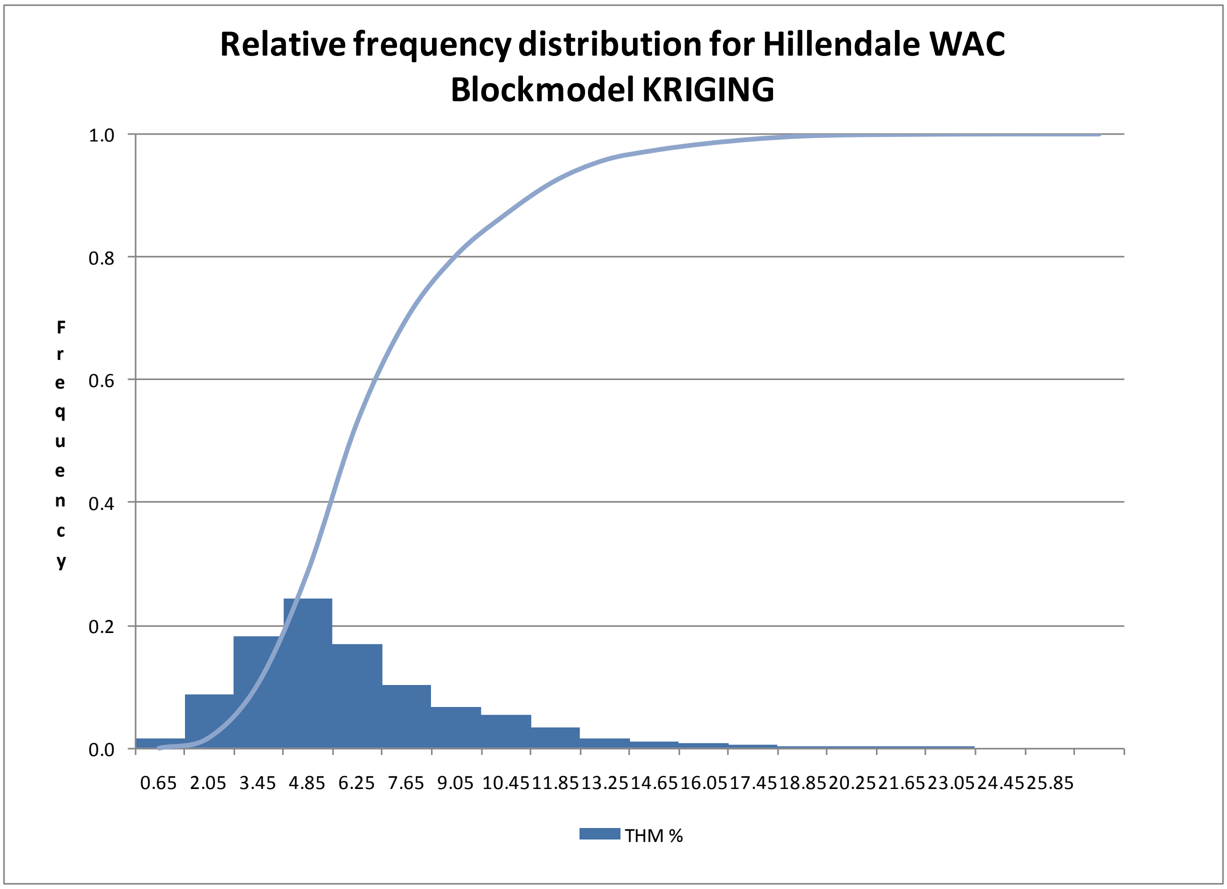


**Figure 30. Histogram of THM% for WAC, Kriging**

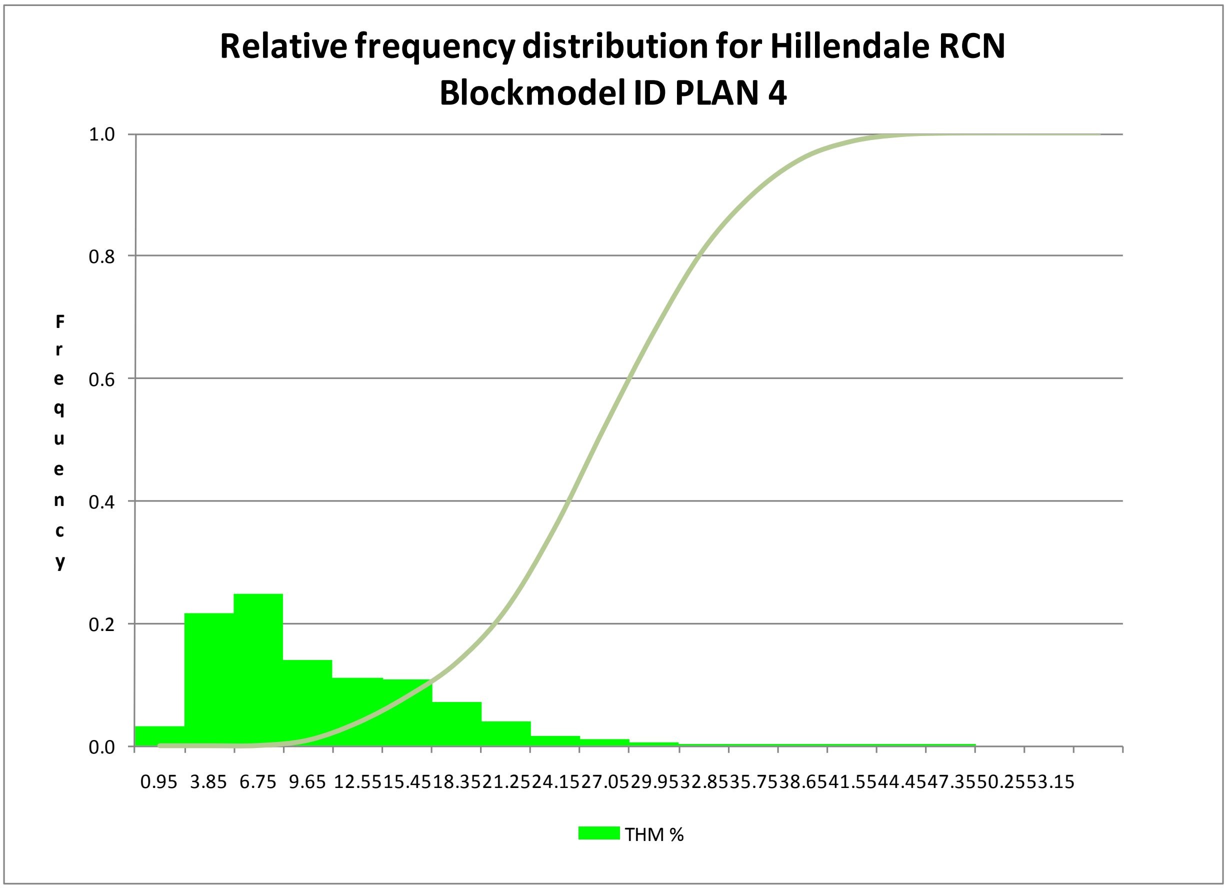


**Figure 31. Histogram of THM% for RCN, ID2 (plan 4)**

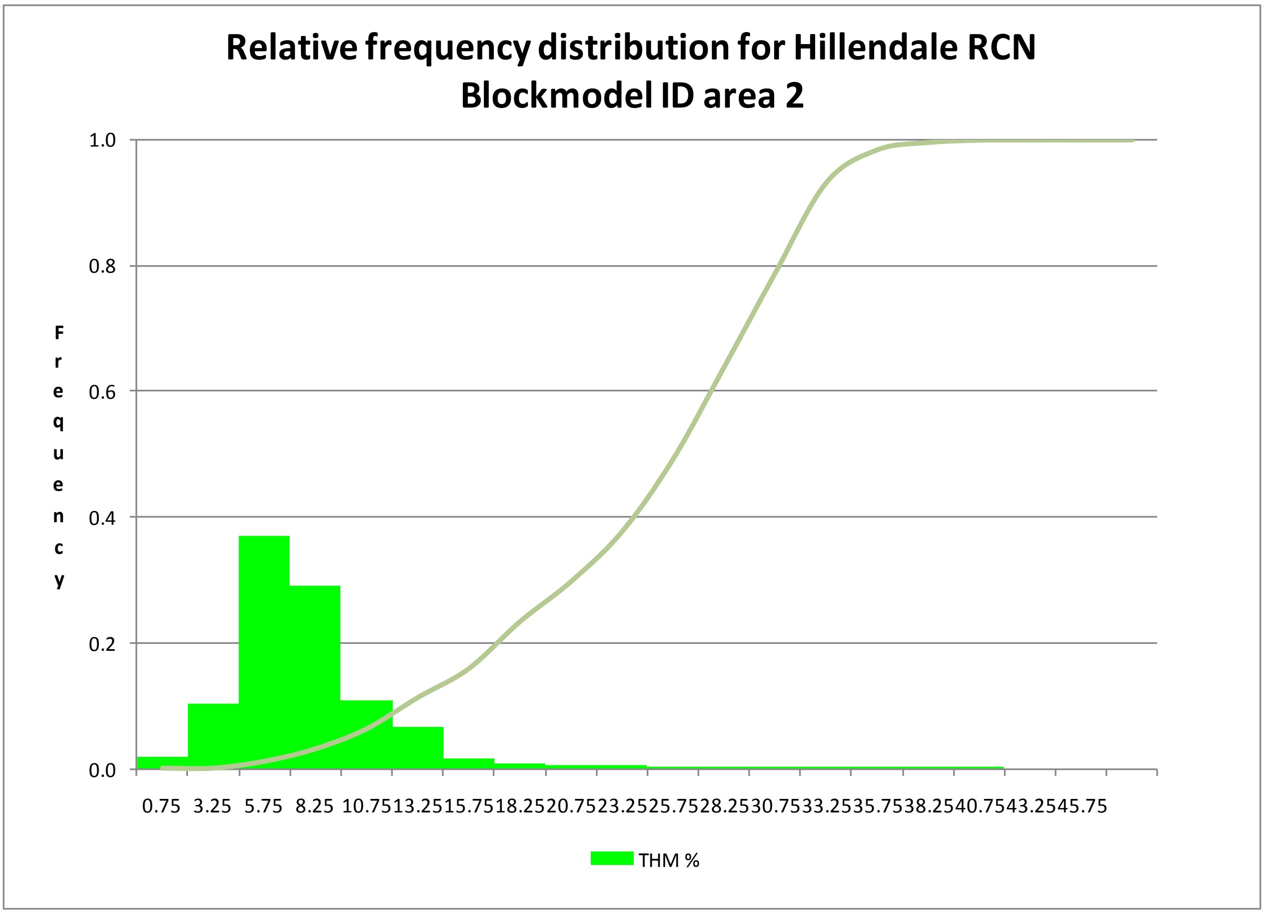


**Figure 32. Histogram of THM% for RCN, ID² (plan 2)**

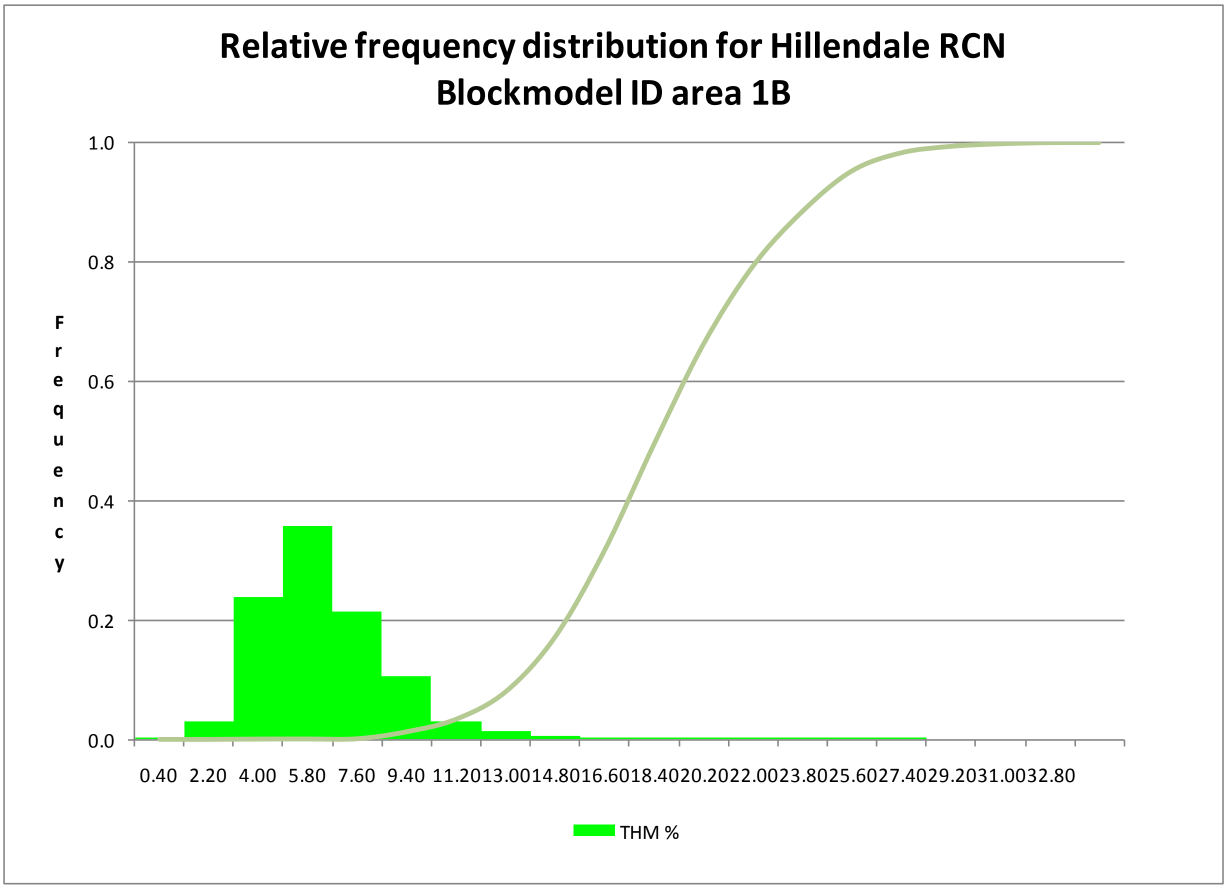


**Figure 33. Histogram of THM% for RCN, $ID^2$ (area 1B)**

Reviewing the histograms, it is seen that all are slightly positively to positively skewed. The silt% histogram for the kriged WAC drilling data and the inverse distance squared 'area 2' RCN data indicates a bimodal structure. The bimodal distribution indicates that there are two populations and that domaining is required in the 'area 2'.

All the histograms are in Addendum A

## 5.5 Reconciliation

Mine reconciliation is used to determine the quality and the performance of the geological resource model against the production results of the operation. The resource grade is compared to the production grade (Schofield, 1998). Reconciliation is a historical process that aims to improve the performance of the operation and therefore increasing confidence.

Figure 34 shows the reconciliation figures of the geological blockmodel for the RCN drilling method compared to the actual production tonnages from the PWP at Hillendale mine for the period March 2005 to November 2005.

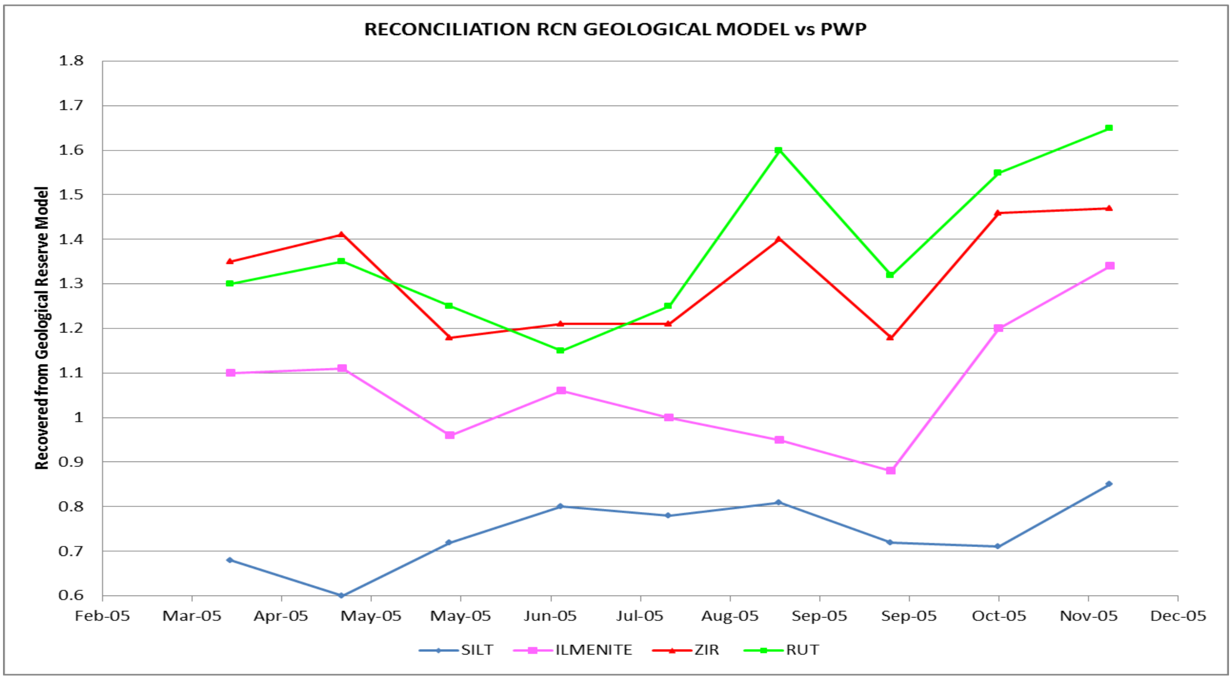


**Figure 34. Reconciliation of RCN Geological model and primary wet plant output (PWP), with 1.00 being 100% reconciliation.**

Figure 35 shows the reconciliation figures for the WAC drilling method for the corresponding period.

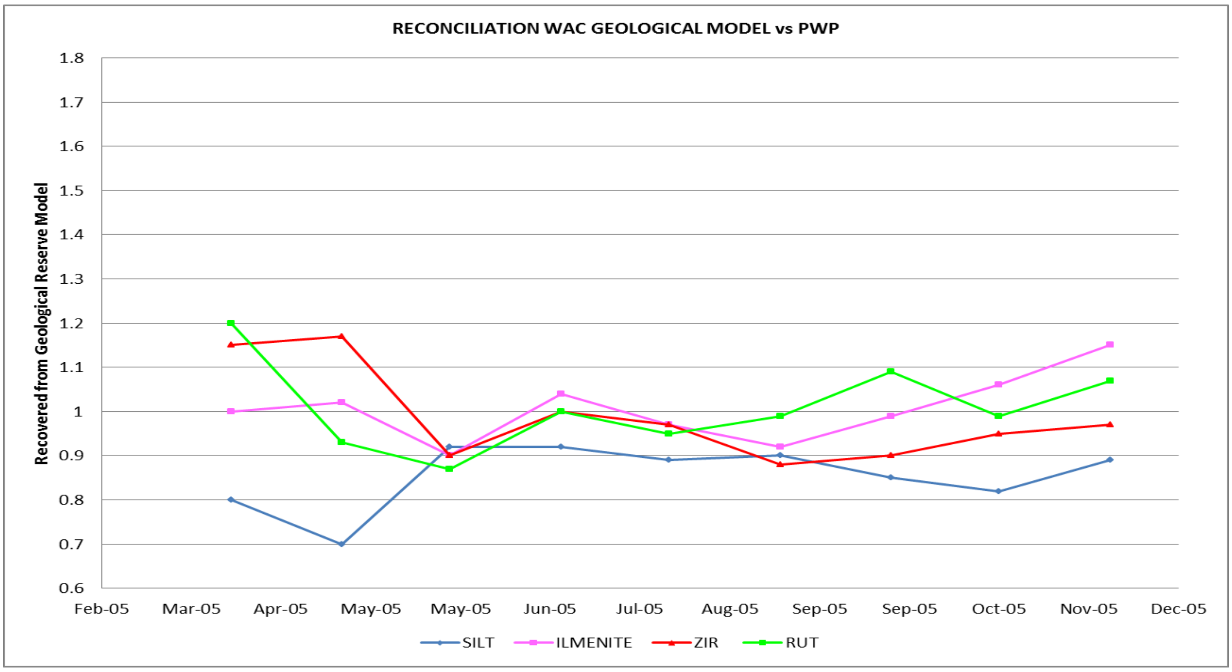


**Figure 35. Reconciliation of WAC Geological model and primary wet plant output**

The reconciliation is done by constraining the geological blockmodel with the specific DTM files for the months mine production. The tonnages, silt%, THM% and Carpco® fractions as determined by the estimation process for the geological model are extracted for the specific month. The extracted values are compared against the actual tonnages as processed by the plant and actual plant silt%, THM% and Carpco® fractions.

Comparing the reconciliation information of the two drilling methods at Hillendale mine during similar periods as indicated in Figure 34 and Figure 35, the RCN blockmodel resource grades reconciliation deviates more from the actual plant grades compared to the WAC blockmodel reconciliation.

The WAC resource estimation is mostly within 10% for the main products of Hillendale mine of the actual recovered grade from the plant. The RCN resource estimation for the main products varies with up to 40% from the actual recovered grade. The mine however accepts a maximum discrepancy of 10%.

Comparing the process of deriving a resource block model for Hillendale mine within the thesis, the two differences are the drilling method and the estimation technique. The sampling methodology for both drilling methods are the same. RCN uses $ID^2$ as estimation technique while WAC uses kriging. These processes as done on the mine was adequate for the time as WAC was only developed later and human/technology resources constrained the use of other estimation methods. Looking at the improvement the reconciliation data of the estimated values compared to the actual plant performance, viewing that the largest change in the process is the drilling method, one can deduct that the WAC drilling method is the largest contributor to the improvement of the resource estimation. This also explains while the WAC method is currently the only method used at the mine.

## 5.6 Conclusion on estimation techniques

Inverse distance squared and Kriging interpolation methods are used for the estimation of the geological resource model at Hillendale mine. The estimation process in terms of data selection, compositing, search and estimation parameters are similar. Two different datasets are used. Inverse distance uses the RCN drilling method dataset and the kriging uses the WAC drilling method dataset. The global data distribution for both datasets are however similar. The RCN drilling introduces more variability to the population.

Looking at the statistical data distribution of the block models there is a similar data spread to all block models with both datasets. This also correlates to the original drillhole information.

Reconciliation of the geological resource model with the mining production data clearly indicates that the RCN produces a geological model with elevated variability. This is based on the original input data that already has a high level of variability introduced by the sampling methodology.

The confidence and accuracy of the overall geological resource model is therefore dependant on the original data.  The variability introduced from the drilling method is incorporated in the estimation of the geological blockmodel. Improving the resource estimate by changing interpolation methods, will not increase the overall confidence in the calculated values of the ore-body.

# 6 Resource model risk

Risk is defined as: “the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood.” (MDG 1010, 1997).

Risk associated with the resource estimation is controlled by the activities that are prerequisites for estimating resources with a high confidence level. If the risks that can lead to an unreliable resource model are not managed properly, it will have a huge effect on the rest of the project.

This section identifies and reviews resource risks associated with the sampling methodology, taking into consideration that a single risk can cause multiple effects (Duncan, 1996). The identified risk is cumulated to illustrate the effect of the risk on the overall project with time.

The following risks are identified with the exploration phase and sample methodology as accepted by researchers such as Annels and Dominy (2003) and Morley, Snowden, and Day (1999) and adapted for KZN Sands exploration and Hillendale mine:

- Drilling Method
- Drillhole spacing
- Logging
- Sample preparation and analyses
- Database
- Estimation technique

A probabilistic analyses of the risk is used to determine the likelihood for the specific risk to occur and the possible financial impact on the exploration project by following the process of proactive risk management as set out by Smith and Merritt (2002) and indicated in Figure 36.

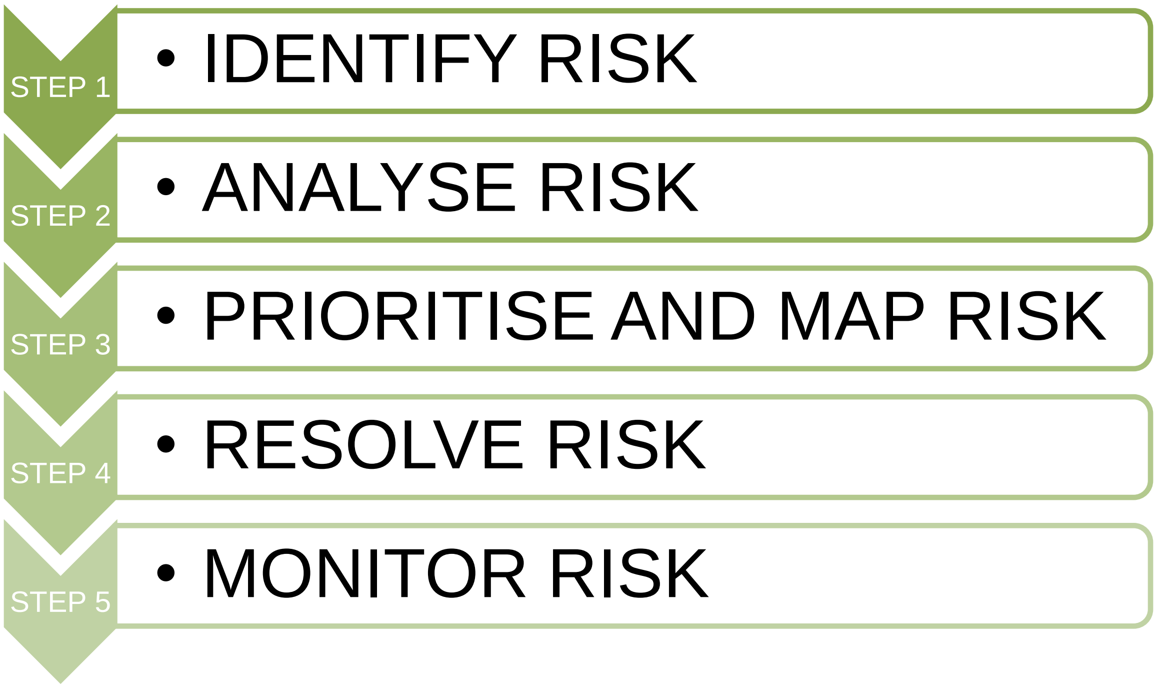


**Figure 36. Five step risk management process from Smith and Merritt (2002)**

The probability for each of the risks identified to occur was determined through an internal KZN Sand workshop for the Port Durnford exploration project in 2007 / 2008 (Addendum E). A determination of historic exploration practices at KZN properties, considering historic information at Hillendale, was used to establish the probability of the event to occur based on the best available knowledge from the workshop team. The values are applied and adapted for Hillendale since it is the adjacent property that formed from the same dune environment.

Although Hillendale is an operating mine the risk is viewed as a total project risk from initial exploration to production.

## 6.1 Sources of Risk

The risks identified have both internal and external sources, ranging from technology (drilling method) to human factor (sample preparation).

## 6.2 Cost of Risk

Estimated cost for the identified risks are determined based on the cost of the required number of samples (the cost is determined on actual figures as per confidential information made available to the author). The cost is determined for a minimum 50 m x 50 m grid and is based on the theoretical number of drillholes required for the WAC. For RCN the number of holes needed to reach the required confidence level is often too high to fit the available area with a 50m x 50m grid and in those circumstances the number of drillholes that would entirely cover the surface area at the same drill spacing is chosen. The RCN is selected based on the limit to areal extent and the WAC is selected based on the achieved confidence level. The calculated costs are presented in Table 20. Since the thesis is about risk and reliability in exploration, the operational revenue is not used to calculate the total loss.

Table 20. Costs for exploration of Hillendale based on the minimum required number of samples

| Description | WAC Cost for the theoretical number of samples required | | RCN Cost for the theoretical number of samples required | |
|---|---|---|---|---|
| Drilling Method | R | 2,855,000.00 | R | 5,842,920.00 |
| Sample Location (Survey) | R | 6,240.00 | R | 6,240.00 |
| Sample Preparation including QAQC | R | 4,595,500.00 | R | 7,566,000.00 |
| Geological Model | R | 560,000.00 | R | 560,000.00 |
| Logging | R | 285,500.00 | R | 584,292.00 |
| | **R** | **8,302,240.00** | **R** | **14,559,452.00** |

Comparing the cost of a theoretical exploration project using WAC and RCN drilling there is a significant increase in cost when using the RCN. In addition to RCN drilling method being more costly, it is also limited by the area constraint of Hillendale mine and does not reach the required confidence level. The WAC does achieve the required confidence level for all cases.

The probability and the expected loss for the identified risks for the sample methodology are listed in Table 21 and are determined using the proactive risk management approach as set out by Smith and Merritt (2002). Each identified event has a probability of 0 to 1 to occur with 0 indicating no risk and 1 a total certainty of the risk.

All risks are listed as independent of one another as determined by the workshop. For the first two risks identified as drilling method and drillhole spacing. Snowden (2003) describes the drilling method to contribute to the data quality and risk associated with achieving the required data quality while the drillhole spacing relates to sufficient continuity of geological confidence in relation to the risk threshold the company is willing to take at the specific project stage and is therefore seen as independent. The sample preparation and analyses is independent of both the drilling method and drillhole spacing, although it uses the sample that is derived from the drilling method, the preparation method, for the purpose of the risk evaluation, is not influenced by the way the sample is generated. The risk is only focused on the specific action of the event i.e. drilling method, sample preparation etc.

**Table 21. Sampling Methodology risks identified with probability and expected loss**

| Nr | Risk | Assumed Probability risk factors as determined by workshop (adapted for Hillendale Mine) | Total Loss if risk occurs | Expected loss (EMV) with risk taking |
|---|---|---|---|---|
| 1 | Drilling Method | 0.5 | R 2,828,000.00 | R 1,414,000.00 |
| 2 | Drillhole Spacing | 0.4 | R 2,828,000.00 | R 1,131,200.00 |
| 3 | Logging | 0.1 | R 14,140.00 | R 1,414.00 |
| 4 | Sample preparation & Analysis | 0.6 | R 4,595,500.00 | R 2,757,300.00 |
| 5 | Database | 0.4 | R 268,660.00 | R 107,464.00 |
| 6 | Estimation | 0.2 | R 560,000.00 | R 112,000.00 |

The event sequence is the relative process of exploration as done at Hillendale, starting with selecting a drilling method, determining the drillhole spacing and subsequent drilling, logging of the sample, where after the sample preparation and analyses takes place. Lastly the database and database management takes place followed by the estimation.

The risk type is the risk as previously listed and identified by the workshop held for Port Durnford and adapted for Hillendale. The assumed probability is the probability of the risk event to occur. The total loss is the loss that occurs if the risk realises and the expected loss is the 'average' loss associated with the risk and is the anticipated accepted loss associated with the event. The expected loss can also be seen as the expected monetary value (EMV) (Smith and Merritt, 2002). The expected loss used in the criteria to determine the risk mitigation strategy since this is the actual damage that can be expected from each individual risk identified in the project (Smith and Merritt, 2002). The total loss is used to establish the resource risk chart (Figure 37) since the risk, if not considered after expected loss is mitigated, might have catastrophic consequences.

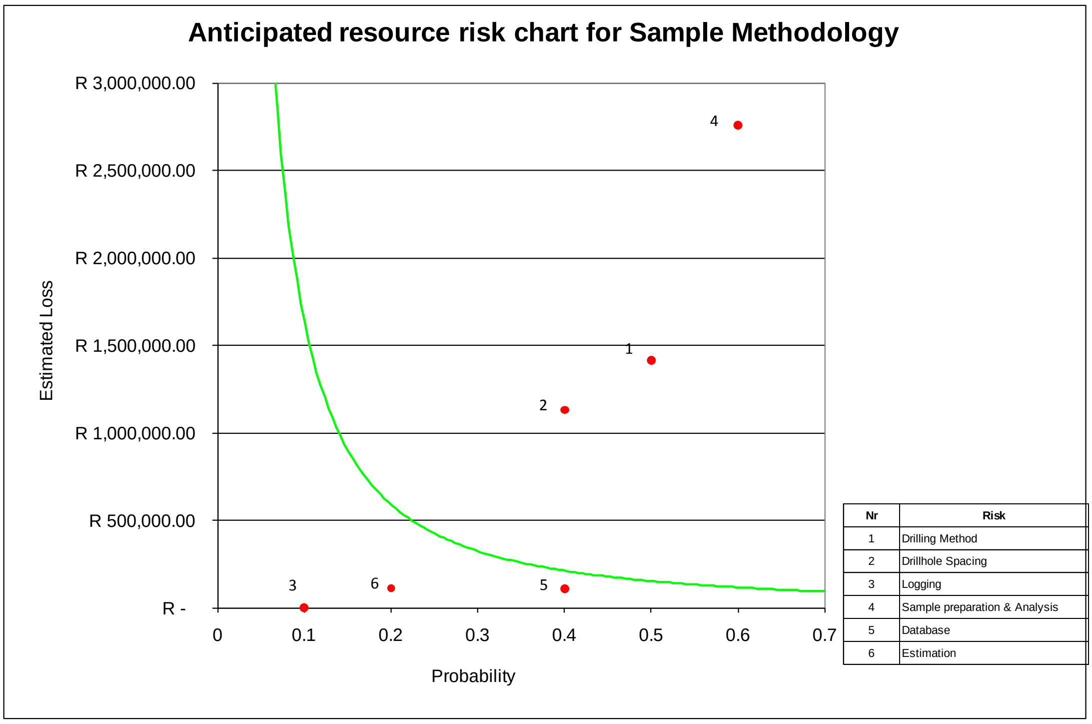


**Figure 37. Indicative resource risk chart for expected sample methodology risks**

The resource risk chart displays the total risk against the likelihood of the risk to occur as established in Table 21.

The graph presented in Figure 37 indicates the risks identified (risks plot, red points) in relation to the company's accepted risk threshold, which is indicated with the green line. The risk threshold is a constant level of expected loss separating the risk which requires active management against the risks that can be managed later (Smith and Merritt, 2002) and is the level of risk the company is willing to take as determined by costs versus time and knowledge.

The risk identified with the highest probability of occurring is inadequate sample preparation and analyses (point 4 in Figure 37), the next anticipated highest risk is an inadequate drilling method (point 1 in Figure 37), and thereafter insufficient drillhole spacing (point 2 in Figure 37).

The theoretical amount of drillholes is determined by the central limit theorem for the specific drilling method under consideration. Additional variability introduced by the selected drilling method will in addition influence the inherent data variability.

### 6.3 Treatment of Risk

As described by the Australian/New Zealand Standards ® Risk Management, Appendix G, risk can be treated by the following means:

1. Risk avoidance
2. Risk reduction
3. Risk acceptance
4. Transfer of risk

5. Contingency planning

6. Knowledge and research

The three main risks identified from the probability plots to have a significant influence on the resource confidence as well as falling outside the acceptable risk threshold are re-evaluated to determine the probability of the risk to occur once treated. The risks identified for the exploration phase and sample methodology are treated by risk reduction followed by knowledge and research to decrease the probability of the risk to occur. For the specific task and the type of risk, risk reduction is the best suited mitigation strategy. The risk treatment strategies and implications on the assessed probability are listed in Table 22.

**Table 22. Risk treatment and risk treatment strategy**

| Risk Type | Treatment Method | Process of Treatment | Assumed Probability that one would like to achieve | Total loss if risk occurs | Expected loss if risk occurs |
|---|---|---|---|---|---|
| Sample preparation & analysis | Risk reduction | By implementing and managing a QA/QC system to produce accurate ad reputable results | 0.15 | R 4,595,500.00 | R 689,325.00 |
| Drilling Method | Risk reduction / Knowledge and Research | By studying & understanding the geology to motivate correct drilling techniques. Understand the effect & recovery of various methods on the sampling | 0.2 | R 2,828,000.00 | R 565,600.00 |
| Drillhole spacing | Risk reduction / Knowledge and Research | Continuously evaluate drillhole spacing required to accomplish confidence required | 0.1 | R 2,828,000.00 | R 282,800.00 |

By treating the three anticipated anomalous risks, the probability of them occurring is expected to decrease as well as the cost associated with the expected loss. It is generally accepted in mining and strongly advocated by the undersigned that the probability of the risk associated with sample preparation and analyses would decreases with the implementation of a QAQC programme.

The Company would like to mitigate the risk to below or close to the established risk threshold. In order to achieve the required risk reduction, the risk associated with sampling preparation and sample analyses needs to be reduced from 0.6 to 0.15 as illustrated in Figure 38 point 4. Currently the only method economically acceptable for this is the introduction and monitoring of an adequate QAQC programme. The undersigned has no prove that the introduction of such programme would achieve the results hoped for by the mine, though obviously a QAQC would contribute to reduce the risk. No published literature on risk reduction and improvement with the introduction of QAQC has been found.

Similarly, the probability of the risk occurring by selecting the incorrect drilling method is lowered by improving the understanding of the geology of the ore body and the effect of better sample recovery using a more appropriate drilling method (Figure 38 point 1). The company would like to lower the risk probability associated to incorrect drilling method from 0.5 to 0.2.

For the third risk identified - inadequate drillhole density in certain areas -, the company would like to lower this risk from 0.4 to 0.1 (Figure 38 point 2). A contribution to reducing such risk would be to monitor the effect of changes of the drillhole spacing and, subject to mine management being flexible, optimise the spacing for each area to be mined to obtain a better reconciliation with the plant output within the boundaries of the confidence required by the mine.

Whether these approaches are sufficient to lower the risks (No 1, 2 and 4) to the acceptable threshold or whether additional routes have to be investigated and implemented cannot be established now and only time will tell. It is however envisaged that the corrective actions suggested in the paragraphs above would lower these anomalous risks and in any event to a more comfortable level than would otherwise be the case had the status quo been maintained.

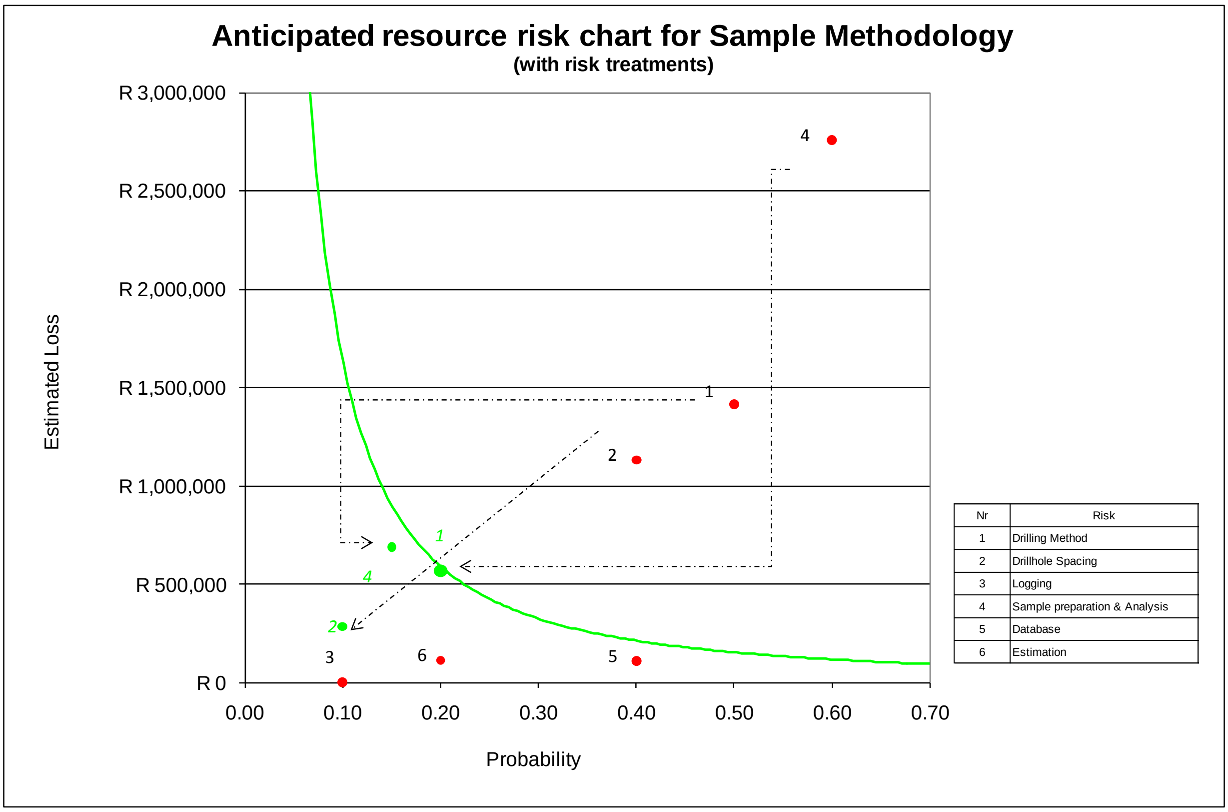


**Figure 38. Indicative resource risk chart showing order-of-magnitude improvement that the mine management would like to achieve to be within their risk threshold**

## 6.3.1 Exploration drilling Quality assurance and quality control

The quality assurance and quality control are similar for both the RCN and WAC drilling methods under review. These include field procedures, laboratory control, duplicate samples and control samples.

Measures are taken to ensure sample quality and control by ensuring that basic procedures are adhered to in the field. These include:

- Flushing the rods and cyclone of the drilling equipment after each 3 m section drilled to prevent contamination of samples;
- Not riffling wet samples;
- Ensuring that sampling equipment is clean before splitting;
- Checking the sample numbers after every completed drillhole;
- Verifying the final depth of the drillhole with the drilling contractor;
- Comparing lab sample numbers with drillhole numbers to ensure correct analysis results are paired with the correct drillhole.

### 6.3.2 Laboratory Control

The laboratory has its own quality assurance and quality control measures as defined by the Service Level Agreement (SLA) between exploration and the laboratory.

- The laboratory does twice daily checks at the start of shift change on the 45µm screens ensuring that they are kept in a good condition and performing as expected.

- The specific gravity of the TBE is checked once daily at the beginning of shift change, with an allowable variance of the specific gravity between 2.90 and 2.98

- The magnetic separation equipment is checked for amperage, pole gaps and gauss readings at the start, halfway through and at the end of each batch of 60 samples as listed in Table 23

**Table 23. Magnetic separation equipment check parameters**

| AMPS | ROLL SPEED (RPM) | POLE GAP | GAUSS READING KGauss | NO. OF PASSES | CARPCO® EFFICIENCY |
|---|---|---|---|---|---|
| 0.05 | 237 | 4mm | 0.421 | 2 | 99% |
| 0.8 | 237 | 4mm | 4.06 | 5 | 98-100% |
| 2.40 | 287 | 4mm | 13.03 | 5 | |

A control sample is used to monitor the Carpco® instruments performance. Magnetic separation for the drilling programme is done only on the Primary Wet plant (PWP) Carpco® (Orange Carpco) machine to ensure uniformity. Each sample has a predefined amount of passes within a specific magnetic separation as listed in Table 23.

Laboratory checks are done every working shift and structured feedback is a formal meeting once a week. Any deviances are reported immediately by the laboratory shift head and corrected before continuing with the sample preparation and analyses.

### 6.3.3 Control Samples

Control samples are inserted at every 20$^{th}$ sample within the sequential exploration sample numbering system, starting at sample number ten. Control samples are created from ore material acquired from the current Hillendale Mining operations. The material is homogenised with a rotary splitter at the CPC laboratory after and approximately twenty samples are submitted to the CPC laboratory to determine the statistical average and deviation of the material. The process of creating control samples is illustrated in Figure 39. It should be noted that the control samples are not certified by an accredited laboratory and therefore not referred to as Standard Reference material.

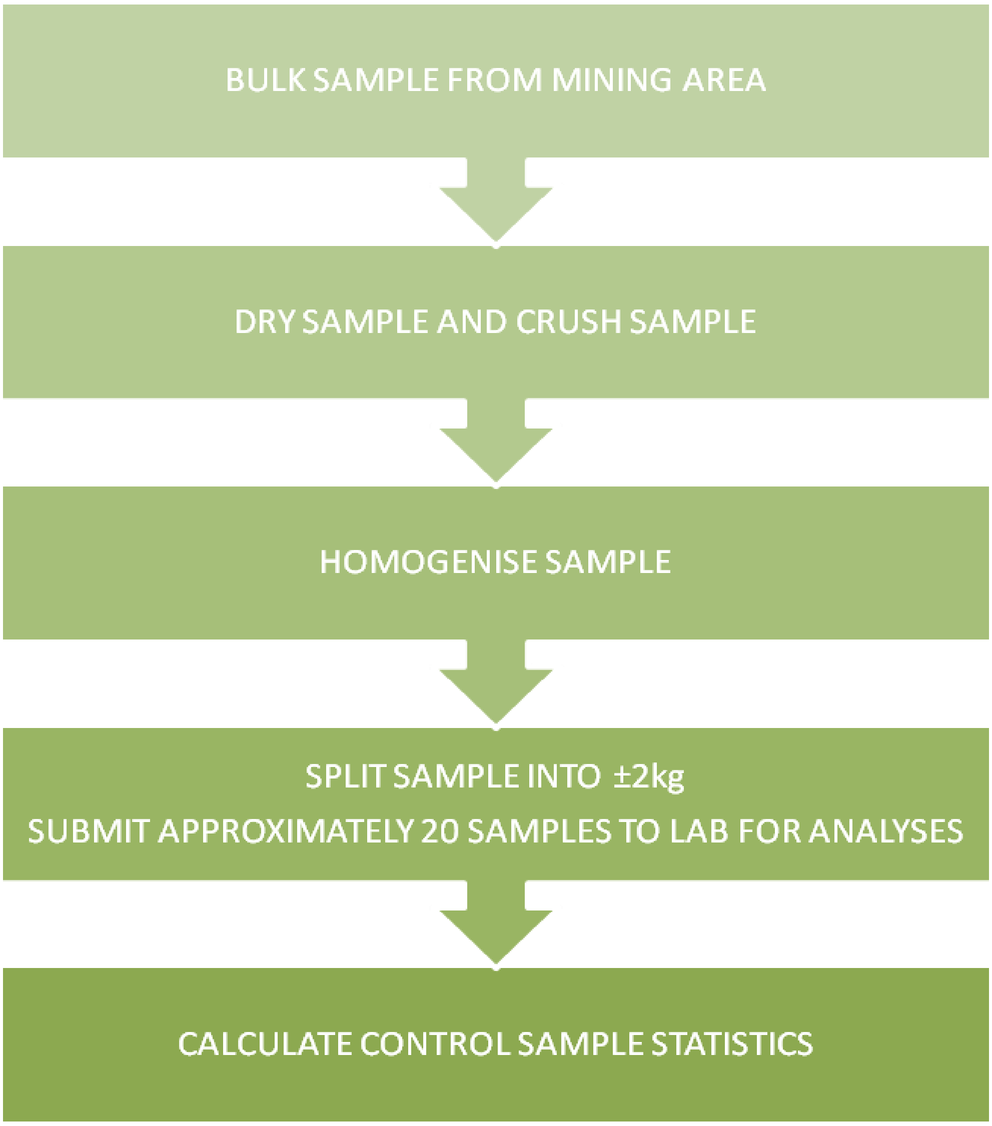


**Figure 39. Method for creating reference material (image by author)**

Various control samples are created with a variety of silt and THM values. The range in values indicates the efficiency of the process with high / low silt and high / low THM values. The control samples are rotated in the submission sequence.

The control samples are evaluated daily by using quality control charts. Control limits are set at ± 1 standard deviation and ± 2 standard deviations from the mean as determined by the original statistics.

### 6.3.4 Repeat Samples

Repeat samples are inserted after every 19$^{th}$ sample. This is a direct repeat of the previous sample. In future, this will be revised so that the duplicate sample will be within another batch of analysis to assess the repeatability of the analysis throughout the exploration programme.

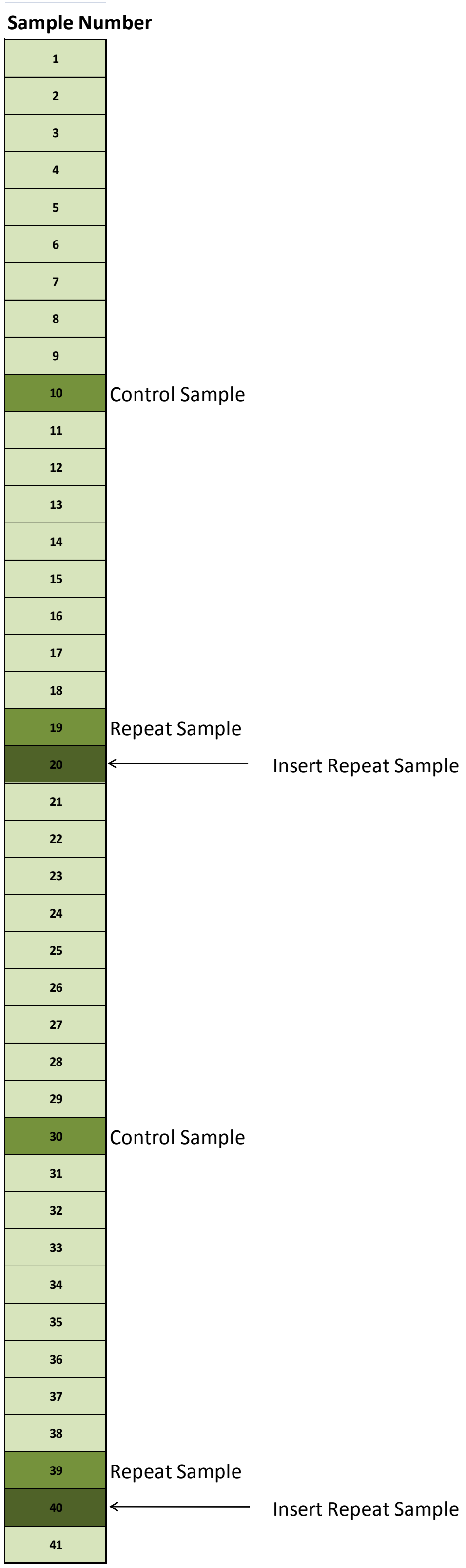


**Figure 40. Illustration of Placement of Control and Repeat Samples in drillholes (image by author)**

Repeat samples exceeding the predetermined allowable percentage deviation of control intervals (10%) will require a batch to be repeated. The repeat samples are evaluated by using repeat graphs.

### 6.3.5 Drilling Method Risk

Keeping up to date with technological improvements and industry specific discoveries with understanding the geology of the ore body can reduce the risk associated with determining the true value of the resource. The WAC drilling method proved through the reconciliation with the plant output to be effective at Hillendale and is now used throughout the mining area. It is important to keep up with technology to ensure that the drilling method used in still the best for the resource. Currently new development introduced sonic drilling, although with high cost it is not viable to have a complete resource model based on sonic drilling. This should be continuously reviewed to implement when viable.

### 6.3.6 Drillhole Spacing Risk

A geological ore body is generally not homogeneous. It is important to continuously update and review the required information to achieve an acceptable level of confidence as defined by the competent person for a specific purpose such as exploration or mining production. Additional drilling can often better define the geological complexity of an ore body that would have been missed otherwise. The information on local variability is ultimately essential for the smooth running of the plant.

## 6.4 Conclusion on risk

A number of risks are identified in the sample methodology of Hillendale. The risks are affected by both internal and external factors. A probabilistic review of the risks identifies the combination sampling- analyses (Risk No 4) as the risk with the highest probability of occurring.

Two other risks with a high probability to occur are the drilling method (Risk No 1) and drillhole spacing (Risk No 2). Both these risks can be mitigated against by continuous improvement of the understanding and knowledge of the industry and the ore body.

Whether the approaches suggested in the chapters above are sufficient to lower the risks (No 1, 2 and particularly 4) to the acceptable threshold or whether additional routes have to be investigated and implemented cannot be established now and only time will tell. It is however envisaged that the corrective actions suggested here would lower these anomalous risks and in any event to a more comfortable level than would otherwise be the case had the status quo been maintained.

The three other risks namely logging, database management and estimation are not reduced through mitigation due to the relative low probability of occurring compared to drilling method, drilling spacing and sample methodology, since their occurrence is limited through the data validation process. The risks can be controlled by the effective training and monitoring of personnel since these risks are largely controlled by human factor.

# 7 Overall conclusions

The purpose of the thesis is to review the risk associated with the exploration techniques used at Hillendale mine. The process was aided through the following three hypotheses:

- Improving the sampling methodology, the resource estimation risk can be minimised:
- The quality of the input data has a greater influence on the statistical confidence of the mean of the mineral resource than the estimation method will have.
- The implementation of quality assurance and quality control systems can minimize or control the risk through the various stages of the deposit.

For the first hypothesis:

Improving the sampling methodology, the resource estimation risk can be minimised.

Hillendale project has used two drilling methods namely reverse circulation and Wallis Aircore. The sample methodology for both methods is similar through the various drilling phases with minor differences such as the criteria for the final depth of the drillhole (EOH).

Comparing similar sample depth between the two drilling techniques of downhole sample information in closely situated drillholes, there is no clear correlation between the similar depth sample intervals.

Descriptive statistical analyses of the area drilled by both drilling methods correspond in general, although the RCN drilling method samples have a larger variance. This is expected due to the drilling method of air blow out.

The population properties of the datasets are used with the central limit theorem to determine the number of samples required for a 95% confidence on the mean. This 95% confidence relates to a measured resource classification. Due to the variability introduced by the RCN drilling method, the ore body cannot be drilled to a measured resource classification due to the area constraint and the number of drillholes required. The WAC method can be used to explore the ore body to a 95% confidence and achieve a measured resource classification.

The second hypothesis:

The quality of the input data has a greater influence on the statistical confidence of the mean of the mineral resource than the estimation method will have.

Inverse distance squared and Kriging interpolation techniques are now routinely used at Hillendale. The inverse distance squared is used with RCN drilling technique and the Kriging with the WAC information. The general statistics for both the drilling technique sample data are similar which translates to the estimated mean of the global geological blockmodel being similar. Comparing the model to the production, the RCN method shows the higher level of variability of the two drilling methods. The estimated blockmodel grades of the RCN, once taken individually, differ by more than 10% when compared to the actual production grades. This exceeds the company's criteria that are set to a maximum discrepancy of 10%.

The geological blockmodel confidence relates to the drilling method confidence and the variability introduced with the drilling method is conveyed to the geological blockmodel.

The variability introduced by the drilling method cannot be reduced by changing estimation techniques.

The third hypothesis:

The implementation of quality assurance and quality control (QAQC) systems can lower or control the risk through the various stages of prospecting and sampling of the deposit.

Exploration has inherent risks associated with any method chosen for the exploration process and sample methodology. Reviewing the various risks and identifying the risks with the highest probability of occurring, a decision on improving the reliability of the methods used can be made. Each risk is viewed as an independent event.

At Hillendale mine, sampling and analysis are identified as the risk with the highest probability to occur as determine by a workshop held for Port Durnford. Risk mitigation for the sample analysis is achievable in most instances through quality assurance and quality control.

The second and third highest risks to occur are identified as the drilling method and drillhole spacing. These risks are mitigated through the knowledge of the lithological and depositional characteristics of deposit that will enable to understand the influence and relevance of the drilling method on sample recovery.  The continuous improvement on the deposit knowledge using the newly available information will allow more accurate decisions for the deposit exploitation.

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# 9 Addendum A

Downhole comparative boreholes

| BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG | BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HE0052 | 3 | 8.43 | 7.82 | 1.02 | 4.66 | 1.02 | 1.05 | HE0385 | 3 | 12.8 | 5.94 | 0.6 | 4.14 | 0.26 | 0.93 |
| HE0052 | 6 | 17.21 | 4.18 | 0.46 | 2.53 | 0.56 | 0.53 | HE0385 | 6 | 13.28 | 5.84 | 0.43 | 4.23 | 0.2 | 0.96 |
| HE0052 | 9 | 16.1 | 3.68 | 0.4 | 2.27 | 0.47 | 0.51 | HE0385 | 9 | 7.63 | 2.13 | 0.22 | 1.43 | 0.12 | 0.35 |
| HE0052 | 12 | 13.77 | 3.05 | 0.21 | 1.88 | 0.42 | 0.5 | HE0385 | 12 | 16.86 | 4.41 | 0.33 | 3.06 | 0.19 | 0.81 |
| HE0052 | 15 | 12.72 | 3.16 | 0.27 | 2.52 | 0.14 | 0.24 | HE0385 | 15 | 17.73 | 1.89 | 0.13 | 1.04 | 0.15 | 0.56 |
| HE0052 | 18 | 27.28 | 5.68 | 0.41 | 3.64 | 0.66 | 0.91 | HE0385 | 18 | 12.9 | 0.67 | | | | |
| HE0052 | 21 | 34.51 | 5.01 | 0.38 | 3.18 | 0.73 | 0.9 | HE0385 | 21 | 12.25 | 1.37 | | | | |
| HE0052 | 24 | 29.69 | 4.98 | 0.35 | 3.28 | 0.89 | 0.73 | HE0385 | 24 | | | | | | |
| HE0052 | 27 | 17.89 | 2.57 | 0.15 | 1.5 | 0.48 | 0.37 | HE0385 | 27 | | | | | | |
| HE0052 | 30 | 12.48 | 1.5 | 0 | 0 | 0 | 0 | HE0385 | 30 | | | | | | |
| HE0052 | 33 | 11.37 | 1.21 | 0 | 0 | 0 | 0 | HE0385 | 33 | | | | | | |
| HE0052 | 36 | 22.08 | 3.15 | 0.23 | 1.75 | 0.66 | 0.43 | HE0385 | 36 | | | | | | |
| HE0052 | 39 | 21.21 | 1.44 | 0 | 0 | 0 | 0 | HE0385 | 39 | | | | | | |
| HE0052 | 42 | 10.37 | 0.65 | 0 | 0 | 0 | 0 | HE0385 | 42 | | | | | | |
| HE0052 | 45 | 11.27 | 0.55 | 0 | 0 | 0 | 0 | HE0385 | 45 | | | | | | |
| HE0060 | 3 | 18.86 | 10.25 | 0.83 | 4.77 | 3.81 | 0.79 | HE0462 | 3 | 14.25 | 10.62 | 0.78 | 4.2 | 4.77 | 0.85 |

| BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG | BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HE0060 | 6 | 7.3 | 10.93 | 0.53 | 2.46 | 7.51 | 0.43 | HE0462 | 6 | 3.99 | 17.08 | 0.77 | 5.95 | 9.4 | 0.96 |
| HE0060 | 9 | 4.49 | 8.15 | 0.24 | 1.24 | 6.19 | 0.38 | HE0462 | 9 | 3.94 | 13.76 | 0.42 | 3.68 | 9.1 | 0.55 |
| HE0060 | 12 | 3.31 | 12.74 | 0.21 | 1.76 | 10.49 | 0.28 | HE0462 | 12 | 7.82 | 14.78 | 0.28 | 3.18 | 10.87 | 0.45 |
| HE0060 | 15 | 5.42 | 2.47 | 0.07 | 0.24 | 1.98 | 0.1 | HE0462 | 15 | 3.46 | 10.27 | 0.18 | 2.1 | 7.45 | 0.54 |
| HE0060 | 18 | 4.58 | 2.32 | 0 | 0 | 0 | 0 | HE0462 | 18 | 3.75 | 5.27 | 0.12 | 1 | 3.79 | 0.33 |
| HE0060 | 21 | 3.24 | 2.07 | 0 | 0 | 0 | 0 | HE0462 | 21 | 5.24 | 6.79 | 0.17 | 1.86 | 4.3 | 0.45 |
| HE0060 | 24 | 2.93 | 2.62 | 0.03 | 0.34 | 2.05 | 0.07 | HE0462 | 24 | 5.51 | 2.99 | 0.09 | 0.65 | 1.79 | 0.43 |
| HE0060 | 27 | 3.6 | 4.08 | 0.1 | 0.45 | 3.43 | 0.1 | HE0462 | 27 | 3.68 | 4.7 | 0.15 | 1.49 | 2.54 | 0.48 |
| HE0060 | 30 | 5.85 | 7.19 | 0.21 | 1 | 5.5 | 0.41 | HE0462 | 30 | 6.99 | 4.75 | 0.23 | 1.84 | 2.16 | 0.47 |
| | | | | | | | | HE0462 | 33 | 12.12 | 4.11 | 0.28 | 1.39 | 1.91 | 0.47 |
| | | | | | | | | HE0462 | 36 | 3.56 | 13.05 | 1.26 | 4.68 | 6.1 | 1 |
| | | | | | | | | HE0462 | 39 | 2.19 | 8.61 | 0.52 | 2.43 | 4.93 | 0.74 |
| | | | | | | | | HE0462 | 42 | 2.96 | 6.6 | 0.28 | 1.77 | 3.79 | 0.76 |
| | | | | | | | | HE0462 | 45 | 3.74 | 10.7 | 0.66 | 4.16 | 5 | 0.89 |
| | | | | | | | | HE0462 | 48 | 8.15 | 6.69 | 0.29 | 1.86 | 3.93 | 0.61 |
| | | | | | | | | HE0462 | 51 | | | | | | |
| | | | | | | | | HE0462 | 54 | 21.88 | 1.63 | 0.13 | 0.79 | 0.44 | 0.27 |
| HE0047 | 3 | 28.77 | 8.84 | 0.53 | 5.83 | 1.21 | 1.21 | HE0467 | 3 | 32.89 | 14.36 | 0.93 | 10.18 | 0.95 | 2.19 |
| HE0047 | 6 | 43.2 | 7.46 | 0.62 | 4.98 | 0.83 | 1.08 | HE0467 | 6 | 28.05 | 15.12 | 2.07 | 10.33 | 0.61 | 2.1 |
| HE0047 | 9 | 31.38 | 9.9 | 1.48 | 5.79 | 1.19 | 1.36 | HE0467 | 9 | 23.89 | 18.01 | 3.26 | 11.13 | 1.19 | 2.39 |
| HE0047 | 12 | 19.8 | 9.33 | 1.8 | 4.45 | 1.87 | 1.18 | HE0467 | 12 | 20.01 | 14.28 | 2.46 | 8.98 | 0.86 | 1.96 |
| HE0047 | 15 | 27.6 | 10.51 | 1.69 | 5.71 | 1.73 | 1.3 | HE0467 | 15 | 17.26 | 9.13 | 1.8 | 5.33 | 0.77 | 1.23 |
| HE0047 | 18 | 16.42 | 4.85 | 1 | 2.29 | 0.94 | 0.59 | HE0467 | 18 | 14.95 | 4.98 | 0.96 | 2.48 | 0.85 | 0.67 |

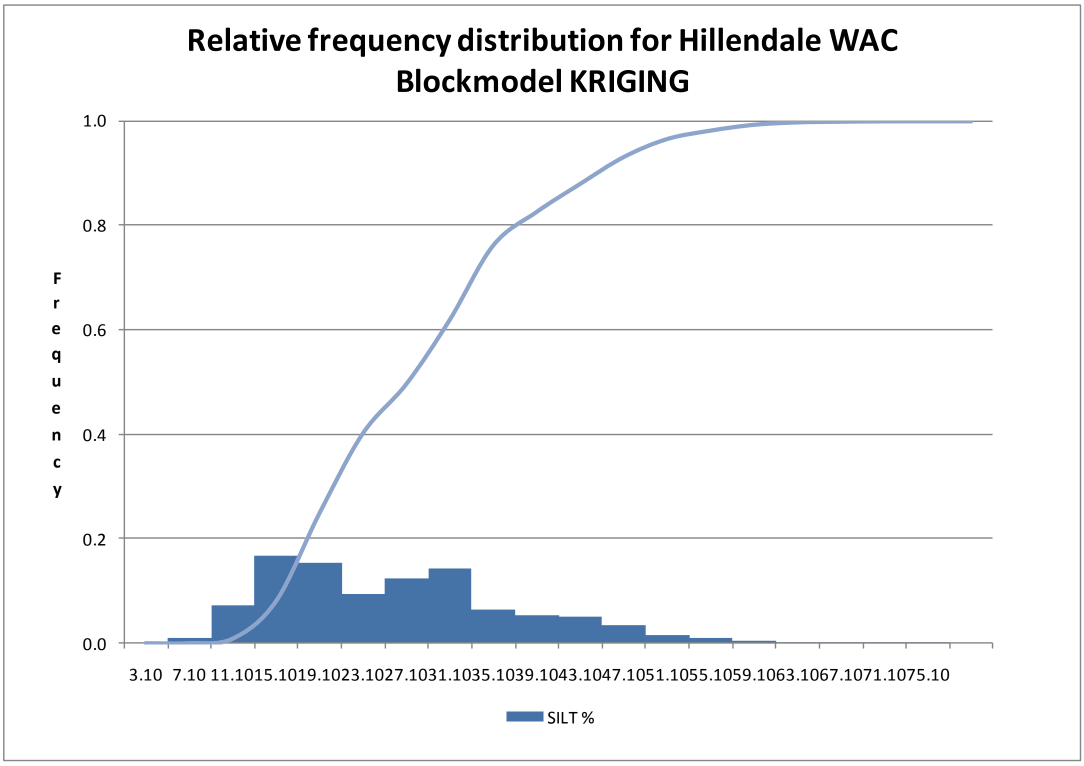
| BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG | BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HE0047 | 21 | 12.49 | 2.91 | 0.48 | 1.69 | 0.44 | 0.29 | HE0467 | 21 | 16.85 | 11.83 | 2.08 | 7.07 | 1.15 | 1.51 |
| HE0047 | 24 | 25.57 | 7.12 | 0.97 | 3.3 | 2 | 0.83 | HE0467 | 24 | 11.41 | 9.38 | 1.82 | 4.94 | 1.54 | 1.07 |
| HE0047 | 27 | 26 | 6.3 | 1.24 | 3.26 | 1.16 | 0.6 | HE0467 | 27 | 8.84 | 17.36 | 2.84 | 8.22 | 4.79 | 1.48 |
| HE0047 | 30 | 30.59 | 9.59 | 1.44 | 3.28 | 3.96 | 0.76 | HE0467 | 30 | 7.32 | 14.03 | 1.64 | 4.21 | 6.77 | 1.38 |
| HE0047 | 33 | 26.81 | 8.54 | 0.95 | 2.98 | 3.87 | 0.77 | HE0467 | 33 | 5.32 | 4.03 | 0.23 | 1.05 | 2.31 | 0.44 |
| HE0047 | 36 | 17.46 | 3.33 | 0.4 | 1.41 | 1.16 | 0.36 | | | | | | | | |
| HE0047 | 39 | 14.3 | 1.9 | 0 | 0 | 0 | 0 | | | | | | | | |
| HE0047 | 42 | 13.57 | 1.46 | 0 | 0 | 0 | 0 | | | | | | | | |
| HE0047 | 45 | 16.04 | 1.27 | 0 | 0 | 0 | 0 | | | | | | | | |
| HE0059 | 3 | 21.68 | 10.76 | 0.37 | 7.35 | 0.97 | 1.56 | HE0406 | 3 | 32.57 | 10.89 | 0.69 | 7.58 | 0.92 | 1.68 |
| HE0059 | 6 | 20.98 | 5.15 | 0.46 | 3.01 | 1.14 | 0.46 | HE0406 | 6 | 22.61 | 7.47 | 0.72 | 4.23 | 1.46 | 1.03 |
| HE0059 | 9 | 18.06 | 6.46 | 0.48 | 3.73 | 1.26 | 0.96 | HE0406 | 9 | 20.95 | 8.58 | 0.9 | 4.31 | 2.21 | 1.12 |
| HE0059 | 12 | 17.9 | 4.47 | 0.33 | 1.92 | 1.66 | 0.52 | HE0406 | 12 | 17.76 | 8.99 | 0.88 | 4.53 | 2.49 | 1.09 |
| HE0059 | 15 | 15.34 | 3.33 | 0.24 | 1.56 | 1.05 | 0.37 | HE0406 | 15 | 16.28 | 14.17 | 1.57 | 7.47 | 3.38 | 1.71 |
| HE0059 | 18 | 14.54 | 1.16 | 0 | 0 | 0 | 0 | HE0406 | 18 | 11.69 | 7.19 | 0.61 | 3.54 | 2.01 | 1.03 |
| HE0059 | 21 | 15.34 | 2.44 | 0 | 0 | 0 | 0 | HE0406 | 21 | 12.22 | 2.05 | 0.19 | 0.74 | 0.77 | 0.34 |
| HE0059 | 24 | 13.07 | 1.28 | 0 | 0 | 0 | 0 | HE0406 | 24 | 8.09 | 1.89 | 0.13 | 0.45 | 1.01 | 0.31 |
| HE0059 | 27 | 17.81 | 1.87 | 0 | 0 | 0 | 0 | HE0406 | 27 | 5.46 | 2.47 | 0.13 | 0.48 | 1.56 | 0.29 |
| HE0059 | 30 | 11.09 | 1.11 | 0 | 0 | 0 | 0 | HE0406 | 30 | 9.99 | 14.73 | 2.16 | 5.62 | 5.42 | 1.48 |
| HE0059 | 33 | 14.61 | 2.49 | 0.25 | 0.55 | 1.54 | 0.18 | HE0406 | 33 | 6.94 | 9.38 | 1.21 | 3.1 | 4.17 | 0.87 |
| HE0059 | 36 | 20.72 | 6.39 | 1.14 | 1.79 | 2.87 | 0.53 | HE0406 | 36 | 7.01 | 7.36 | 0.65 | 2.44 | 3.47 | 0.79 |
| HE0059 | 39 | 12.88 | 7.6 | 1.41 | 2.48 | 3.02 | 0.63 | HE0406 | 39 | 6.22 | 4.45 | 0.27 | 1.19 | 2.47 | 0.53 |
| HE0059 | 42 | 13.53 | 4.21 | 0.4 | 1.05 | 2.54 | 0.22 | | | | | | | | |

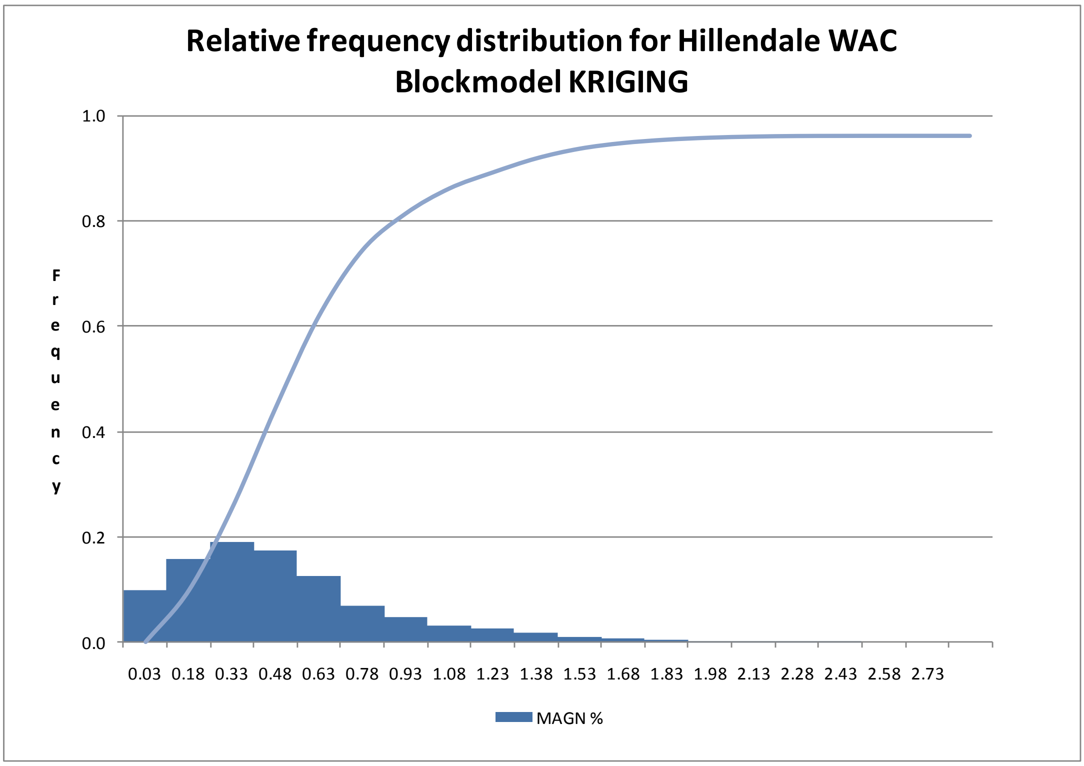
| BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG | BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HE0059 | 45 | 19 | 5.04 | 0.22 | 1.05 | 3.33 | 0.44 | | | | | | | | |
| HE0059 | 46 | 15.34 | 5.68 | 0.47 | 1.4 | 3.3 | 0.47 | | | | | | | | |
| HE0538 | 3 | 29.46 | 10.05 | 0.71 | 6.99 | 0.58 | 1.77 | HE0658 | 3 | 39.15 | 10.63 | 0.76 | 7.82 | 0.36 | 1.67 |
| HE0538 | 6 | 37.85 | 8.66 | 0.81 | 5.8 | 0.48 | 1.53 | HE0658 | 6 | 40.88 | 10.87 | 0.86 | 7.9 | 0.4 | 1.69 |
| HE0538 | 9 | 33.14 | 5.82 | 0.7 | 3.67 | 0.32 | 1.1 | HE0658 | 9 | 19.59 | 5.36 | 0.55 | 3.62 | 0.32 | 0.87 |
| HE0538 | 12 | 30.46 | 3.65 | 0.59 | 2.1 | 0.28 | 0.69 | HE0658 | 12 | 13.77 | 1.06 | | | | |
| HE0538 | 15 | 29.05 | 0.58 | | | | | HE0658 | 15 | 12.91 | 1.39 | 0.13 | 0.82 | 0.18 | 0.25 |
| HE0538 | 18 | 23.15 | 0.89 | | | | | | | | | | | | |
| HE0538 | 21 | 19.35 | 0.6 | | | | | | | | | | | | |
| HE0538 | 24 | 23.71 | 0.37 | | | | | | | | | | | | |
| HE0538 | 27 | 30.64 | 1.05 | 0.14 | 0.54 | 0.11 | 0.26 | | | | | | | | |
| HE0538 | 30 | 22.53 | 0.46 | | | | | | | | | | | | |
| HE0538 | 33 | 18.51 | 0.28 | | | | | | | | | | | | |
| HE0538 | 36 | 25.73 | 0.71 | | | | | | | | | | | | |
| HE0538 | 39 | 17.74 | 2.12 | 0.08 | 0.41 | 1.23 | 0.4 | | | | | | | | |
| HE0538 | 42 | 12.54 | 1.51 | 0.05 | 0.2 | 0.94 | 0.32 | | | | | | | | |
| HE0538 | 45 | 23.21 | 2.58 | 0.12 | 0.78 | 1.05 | 0.62 | | | | | | | | |
| HE0538 | 48 | 20.66 | 0.75 | | | | | | | | | | | | |
| HE0004 | 3 | 38.52 | 8.86 | 0.56 | 6.22 | 0.59 | 1.44 | HE0483 | 3 | 32.18 | 8.86 | 0.57 | 6.58 | 0.28 | 1.43 |
| HE0004 | 6 | 38.79 | 9.06 | 0.78 | 6.13 | 0.77 | 1.36 | HE0483 | 6 | 33.96 | 9.29 | 0.74 | 6.72 | 0.28 | 1.54 |
| HE0004 | 9 | 47 | 10.67 | 1.05 | 7.26 | 0.78 | 1.56 | HE0483 | 9 | 13.31 | 11.3 | 1.79 | 7.5 | 0.41 | 1.58 |
| HE0004 | 12 | 28.14 | 7.25 | 0.85 | 4.52 | 0.9 | 0.95 | HE0483 | 12 | 46.71 | 7.26 | 0.65 | 5.2 | 0.23 | 1.15 |
| HE0004 | 15 | 23.03 | 1.06 | 0 | 0 | 0 | 0 | HE0483 | 15 | 16.94 | 1.84 | 0.22 | 1.15 | 0.16 | 0.31 |

| BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG | BHID | To | Slime | THM | MAGN | MAGS | MAGO | NMAG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HE0004 | 18 | 24.9 | 0.67 | 0 | 0 | 0 | 0 | HE0483 | 18 | 15.87 | 1.97 | 0.19 | 1.26 | 0.17 | 0.34 |
| HE0004 | 21 | 21.91 | 0.52 | 0.04 | 0.2 | 0.2 | 0.1 | | | | | | | | |
| HE0551 | 3 | 31.93 | 7.38 | 0.44 | 5.16 | 0.48 | 1.29 | HE0659 | 3 | 30.04 | 9.68 | 1.42 | 6.31 | 0.51 | 1.43 |
| HE0551 | 6 | 31.29 | 9 | 0.64 | 6.34 | 0.45 | 1.55 | HE0659 | 6 | 34.59 | 9.14 | 0.75 | 6.67 | 0.26 | 1.43 |
| HE0551 | 9 | 36.73 | 8.59 | 0.59 | 5.81 | 0.68 | 1.49 | HE0659 | 9 | 36.9 | 9.19 | 0.76 | 6.56 | 0.36 | 1.49 |
| HE0551 | 12 | 35.43 | 9.89 | 0.99 | 6.69 | 0.53 | 1.66 | HE0659 | 12 | 26.03 | 12.04 | 1.42 | 8.21 | 0.44 | 1.95 |
| HE0551 | 15 | 34.21 | 11.01 | 1.27 | 7.13 | 0.65 | 1.93 | HE0659 | 15 | 17.91 | 5.89 | 0.8 | 3.69 | 0.44 | 0.94 |
| HE0551 | 18 | 30.41 | 11.38 | 1.61 | 7.02 | 0.83 | 1.88 | HE0659 | 18 | 14.66 | 1.5 | 0.15 | 0.91 | 0.16 | 0.27 |
| HE0551 | 21 | 31.43 | 7.71 | 1.22 | 4.61 | 0.57 | 1.27 | | | | | | | | |
| HE0551 | 24 | 28.42 | 3.33 | 0.48 | 1.88 | 0.3 | 0.63 | | | | | | | | |
| HE0551 | 27 | 29.53 | 1.06 | | | | | | | | | | | | |
| HE0551 | 30 | 30.08 | 1.73 | 0.2 | 1 | 0.19 | 0.32 | | | | | | | | |

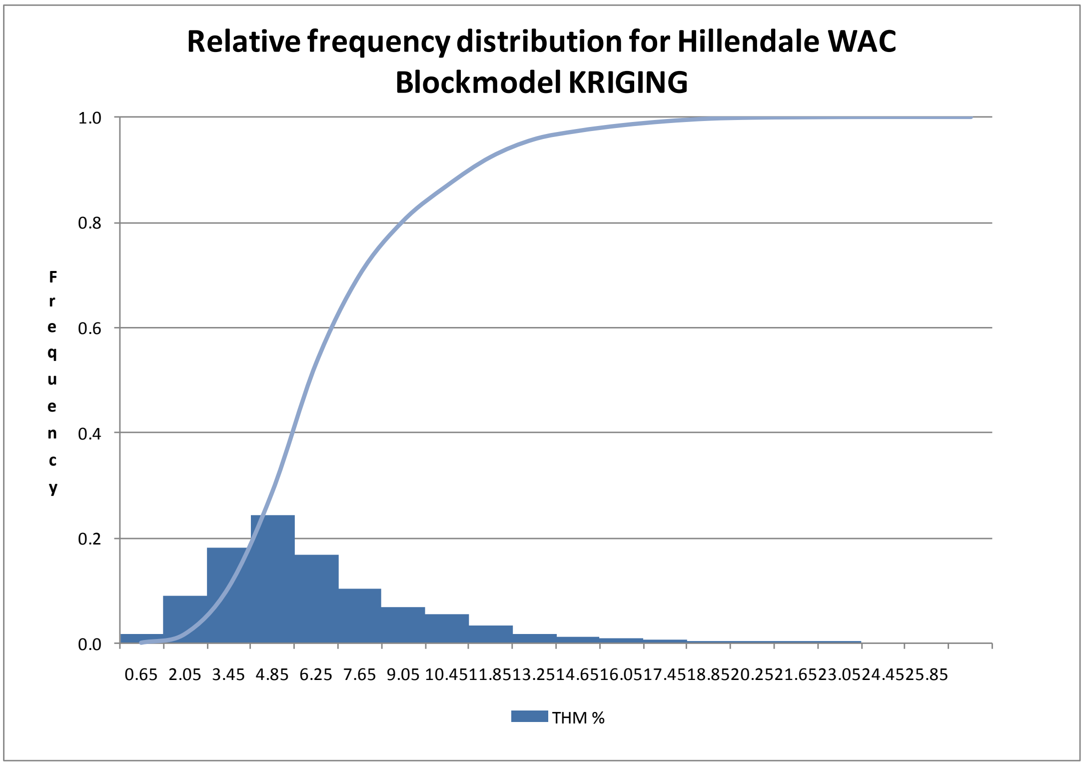
# 10 Addendum B

WAC Blockmodel Histograms

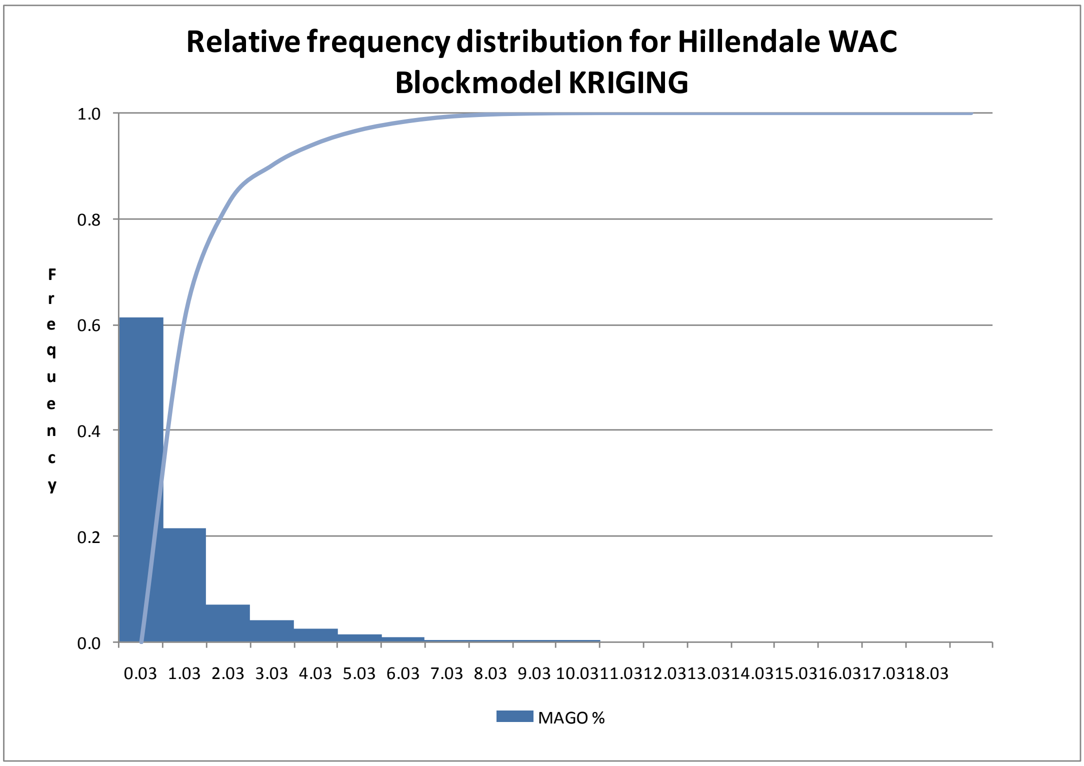


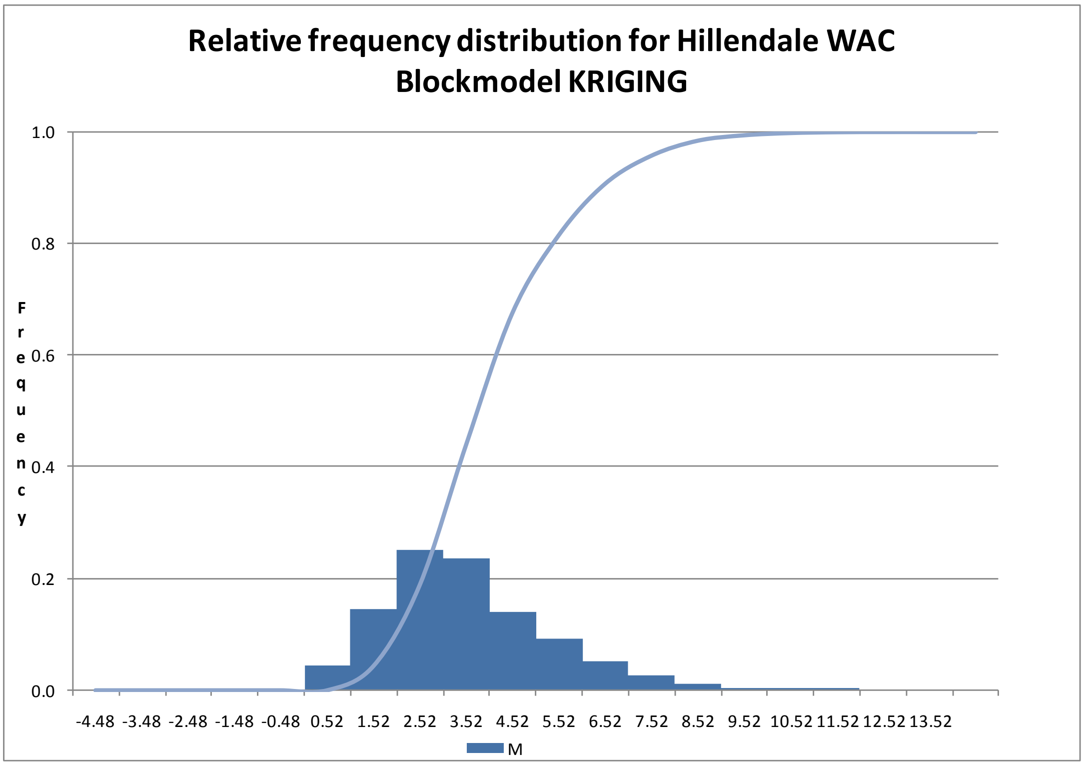


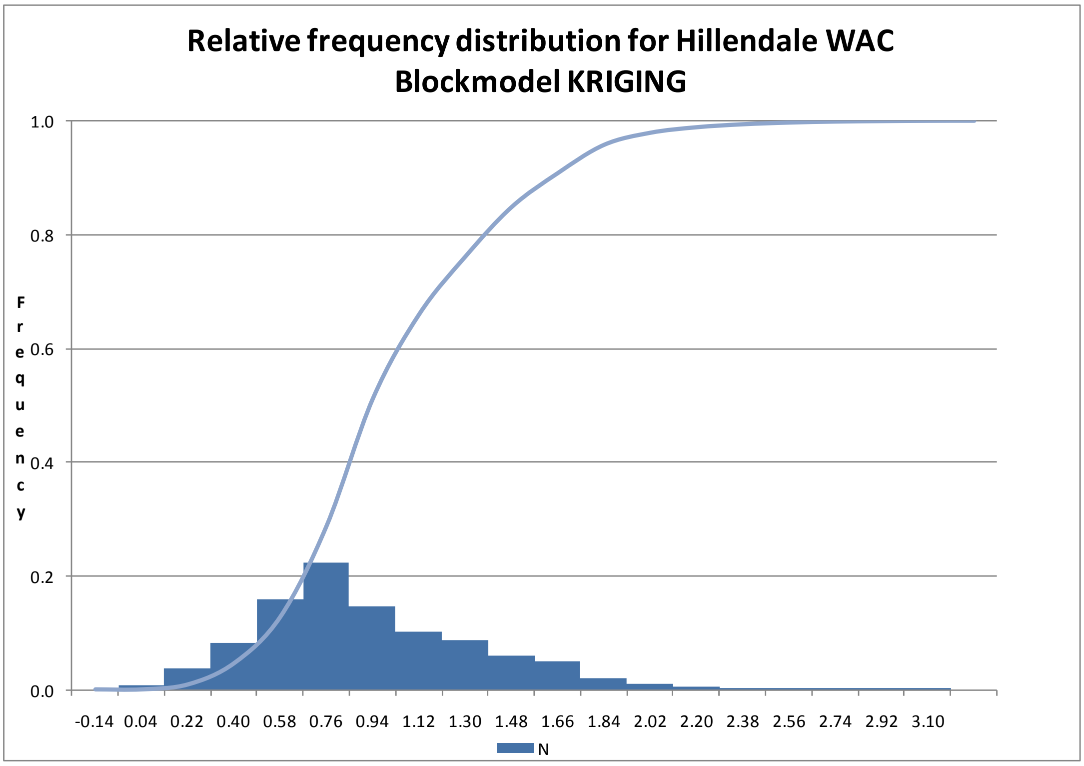
Relative frequency distribution for Hillendale WAC Blockmodel KRIGING
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
0.03 0.18 0.33 0.48 0.63 0.78 0.93 1.08 1.23 1.38 1.53 1.68 1.83 1.98 2.13 2.28 2.43 2.58 2.73
MAGN %

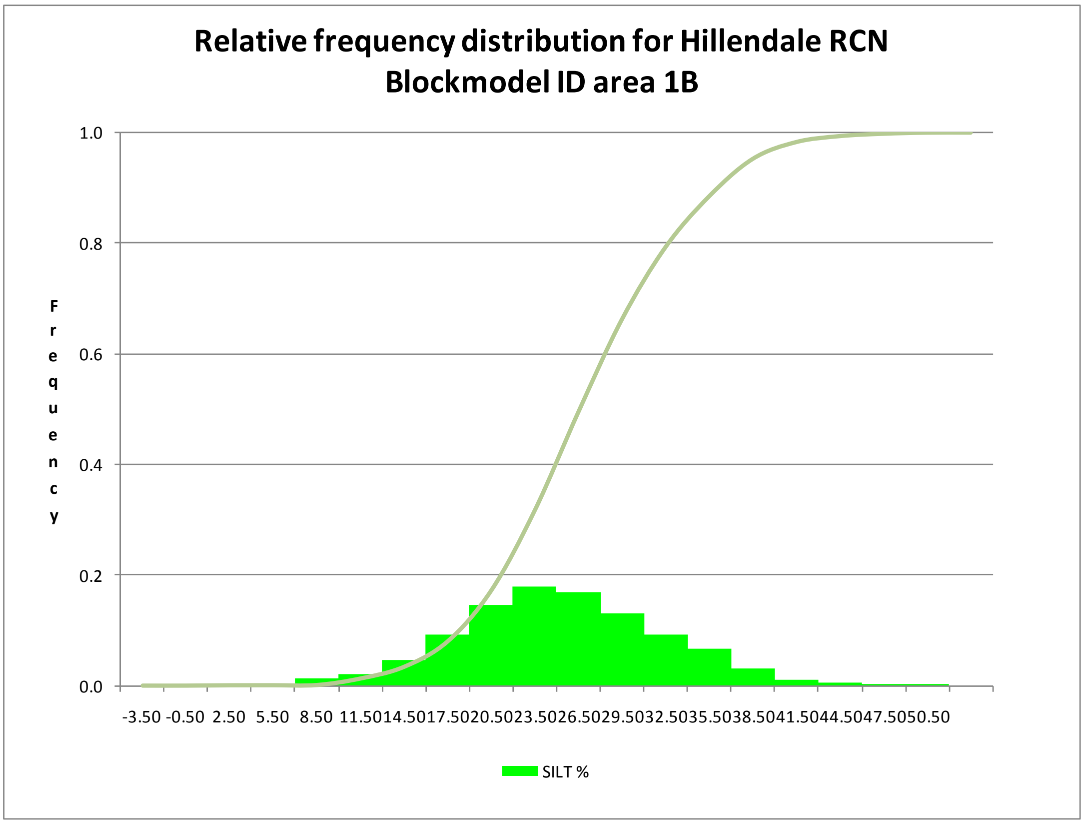
Relative frequency distribution for Hillendale WAC Blockmodel KRIGING
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
0.65 2.05 3.45 4.85 6.25 7.65 9.05 10.45 11.85 13.25 14.65 16.05 17.45 18.85 20.25 21.65 23.05 24.45 25.85
THM %

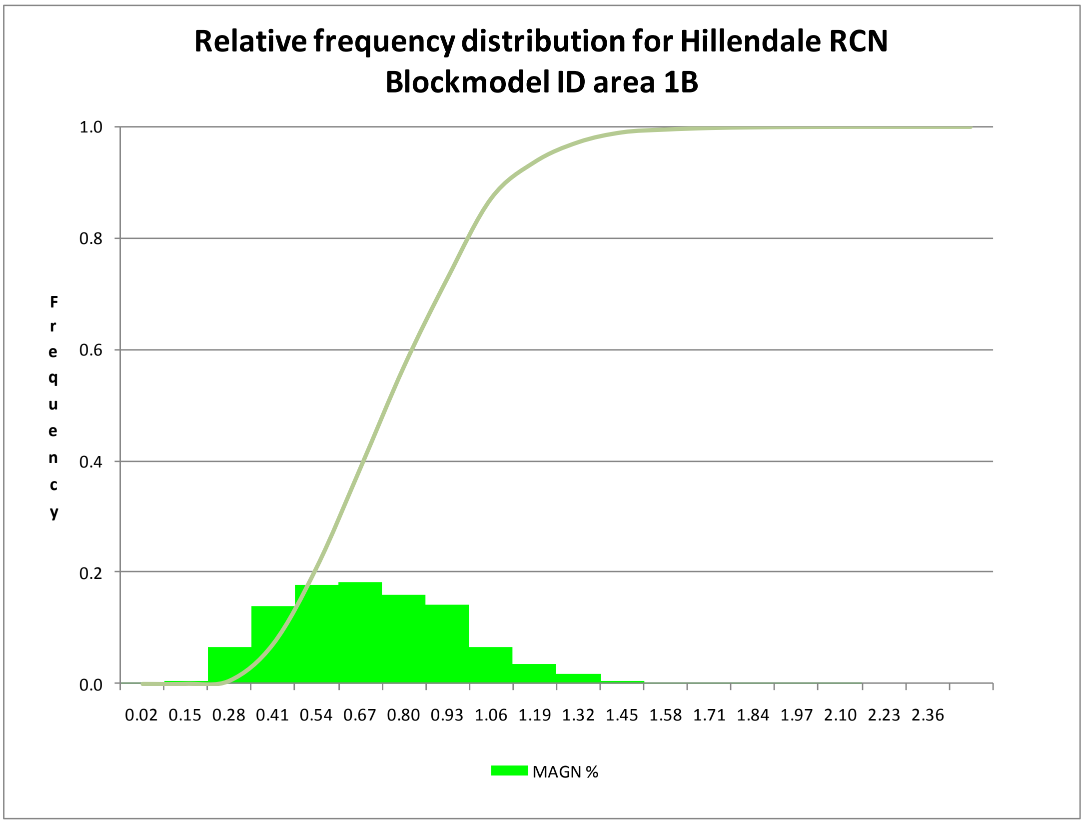

Relative frequency distribution for Hillendale WAC Blockmodel KRIGING
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
0.03 1.03 2.03 3.03 4.03 5.03 6.03 7.03 8.03 9.03 10.03 11.03 12.03 13.03 14.03 15.03 16.03 17.03 18.03
MAGO %

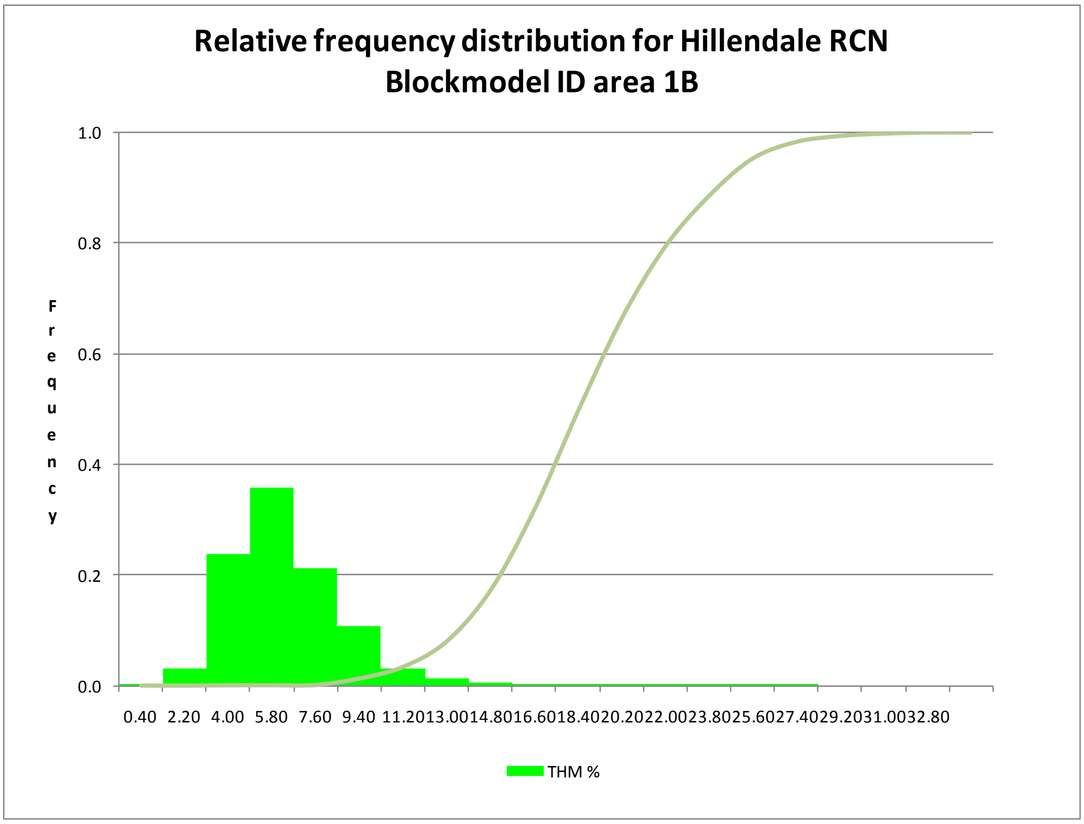

Relative frequency distribution for Hillendale WAC Blockmodel KRIGING
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
-4.48 -3.48 -2.48 -1.48 -0.48 0.52 1.52 2.52 3.52 4.52 5.52 6.52 7.52 8.52 9.52 10.52 11.52 12.52 13.52
M

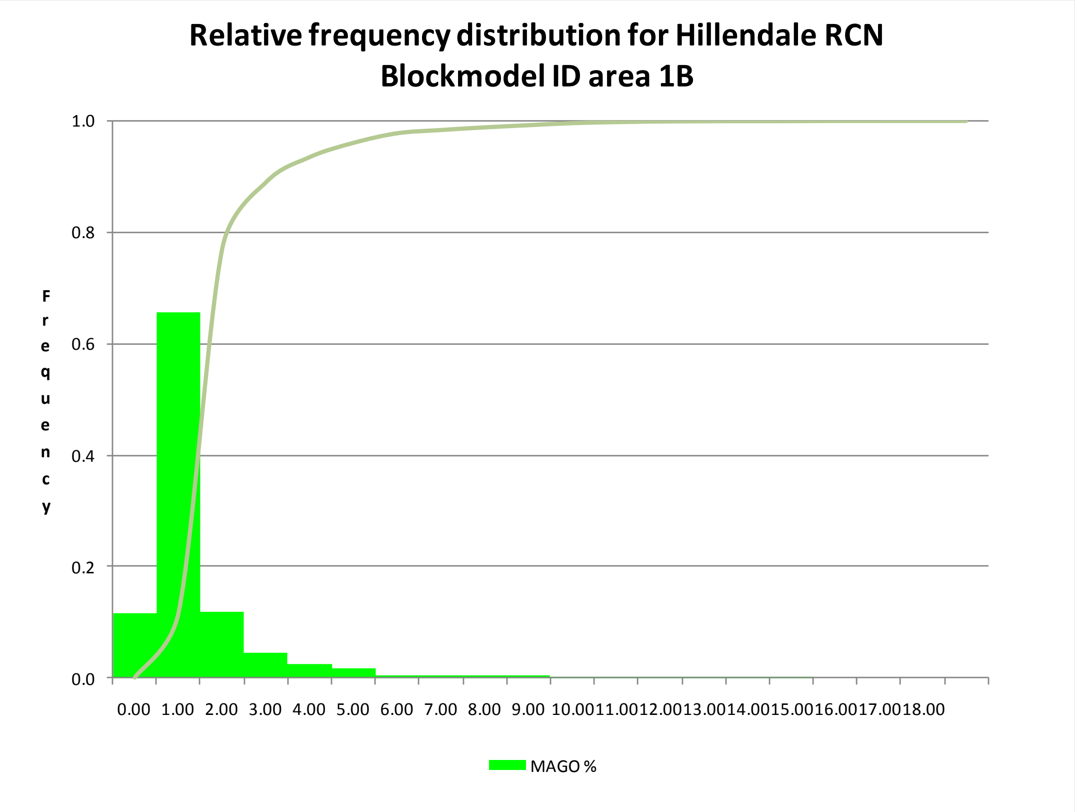

Relative frequency distribution for Hillendale WAC Blockmodel KRIGING
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
-0.14
0.04
0.22
0.40
0.58
0.76
0.94
1.12
1.30
1.48
1.66
1.84
2.02
2.20
2.38
2.56
2.74
2.92
3.10
N

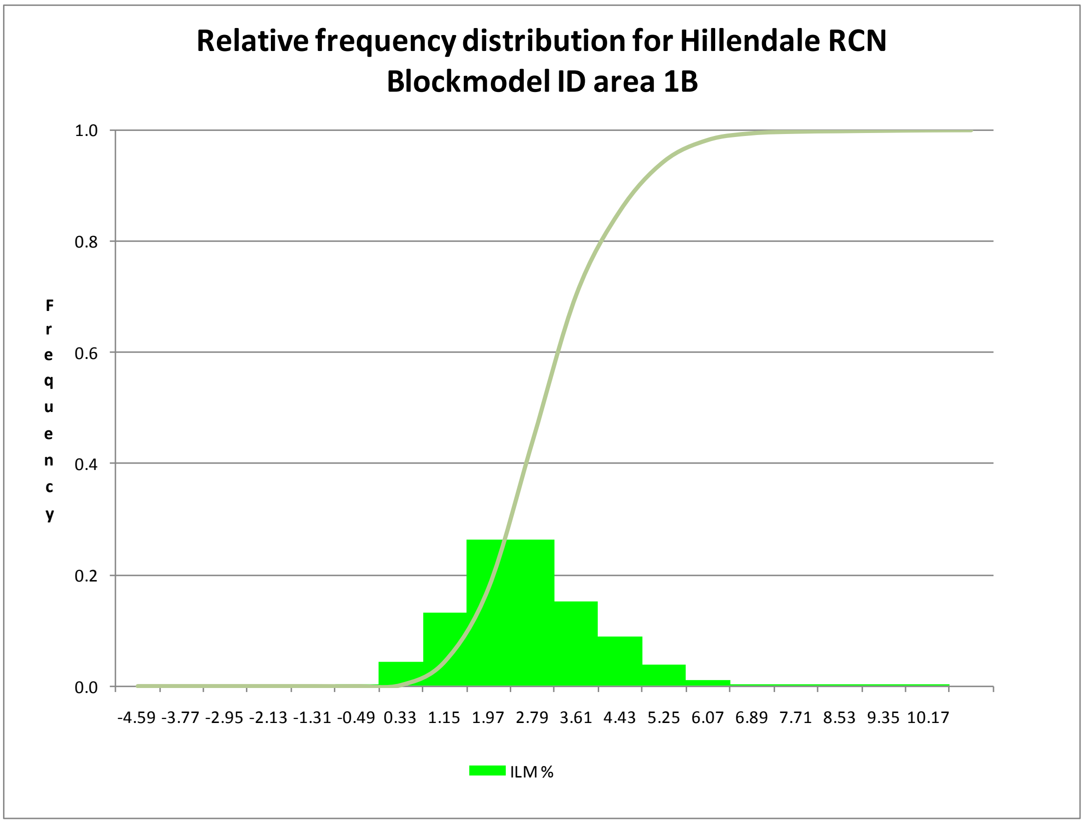
RCN Blockmodel Histograms – Area 1B

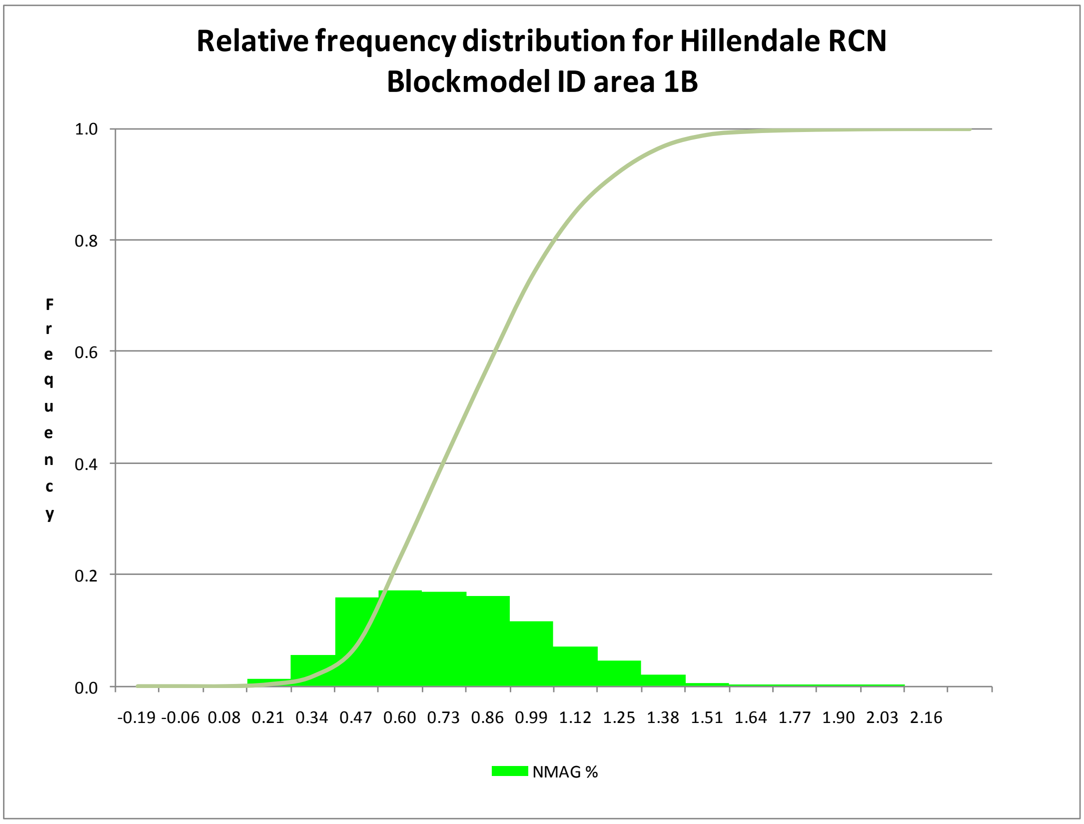



Relative frequency distribution for Hillendale RCN Blockmodel ID area 1B
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
0.02 0.15 0.28 0.41 0.54 0.67 0.80 0.93 1.06 1.19 1.32 1.45 1.58 1.71 1.84 1.97 2.10 2.23 2.36
MAGN %

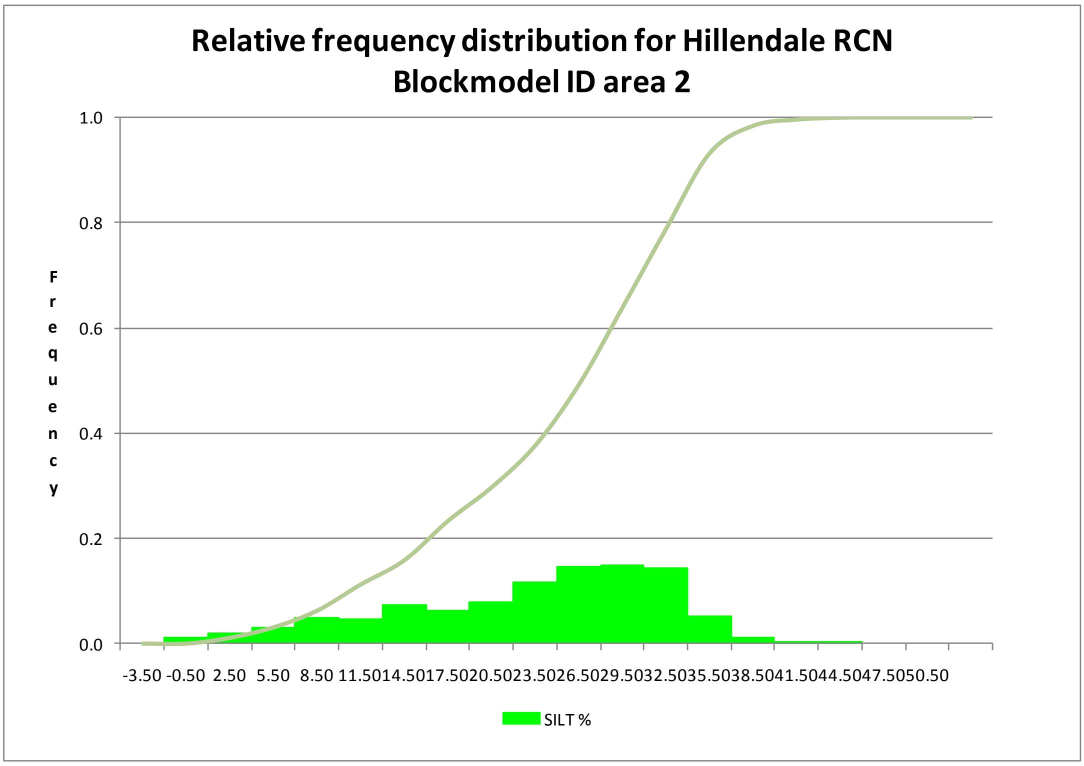

Relative frequency distribution for Hillendale RCN Blockmodel ID area 1B
1.0
0.8
0.6
0.4
0.2
0.0
Frequency
0.40 2.20 4.00 5.80 7.60 9.40 11.2013.0014.8016.6018.4020.2022.0023.8025.6027.4029.2031.0032.80
THM %

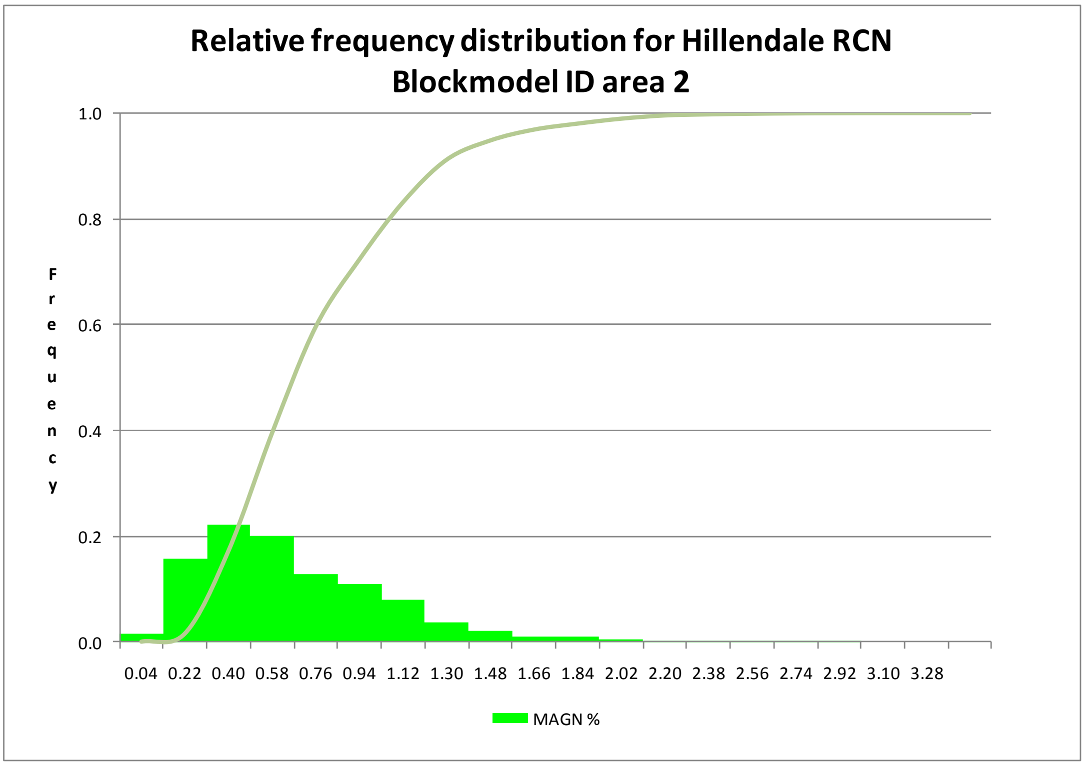

Relative frequency distribution for Hillendale RCN Blockmodel ID area 1B
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.0011.0012.0013.0014.0015.0016.0017.0018.00
MAGO %


Relative frequency distribution for Hillendale RCN Blockmodel ID area 1B
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
-4.59 -3.77 -2.95 -2.13 -1.31 -0.49 0.33 1.15 1.97 2.79 3.61 4.43 5.25 6.07 6.89 7.71 8.53 9.35 10.17
ILM %

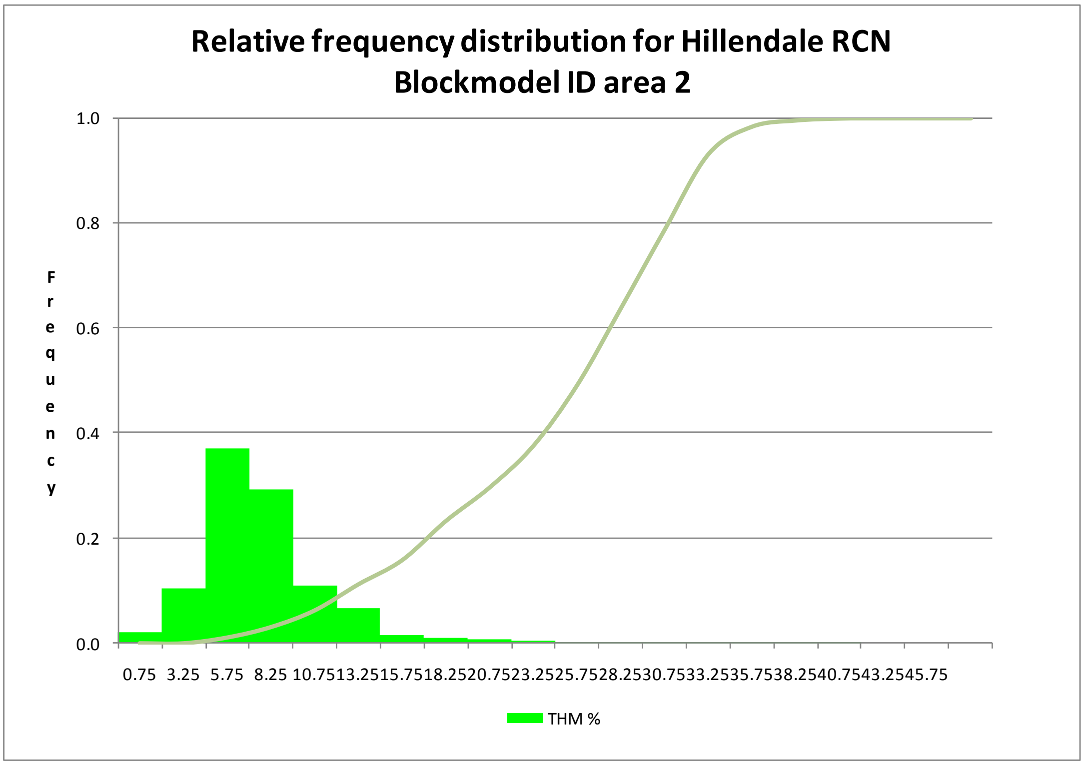

Relative frequency distribution for Hillendale RCN Blockmodel ID area 1B
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
-0.19 -0.06 0.08 0.21 0.34 0.47 0.60 0.73 0.86 0.99 1.12 1.25 1.38 1.51 1.64 1.77 1.90 2.03 2.16
NMAG %

RCN Blockmodel Histograms – Area 2

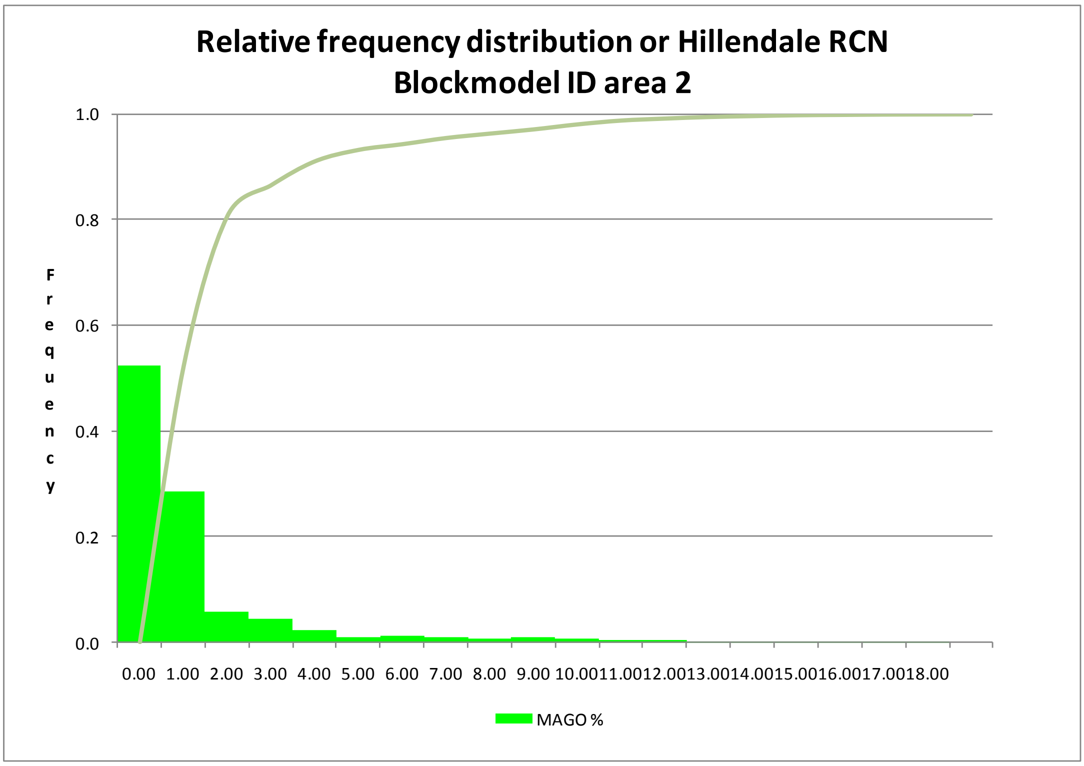


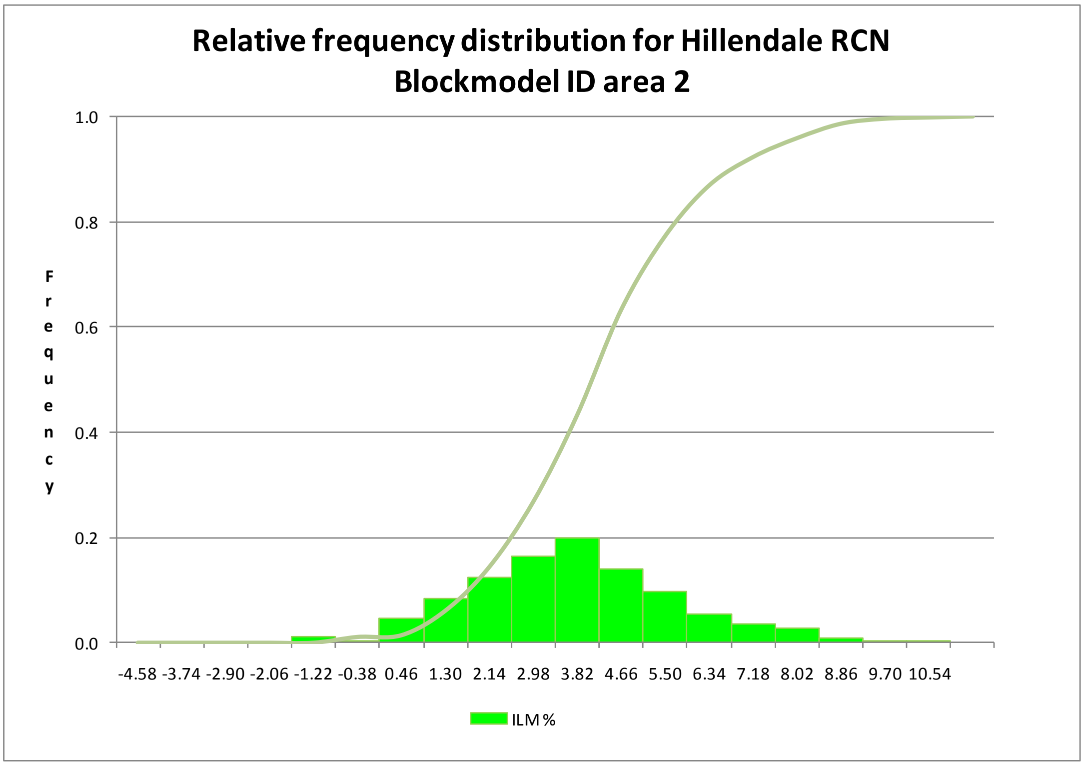


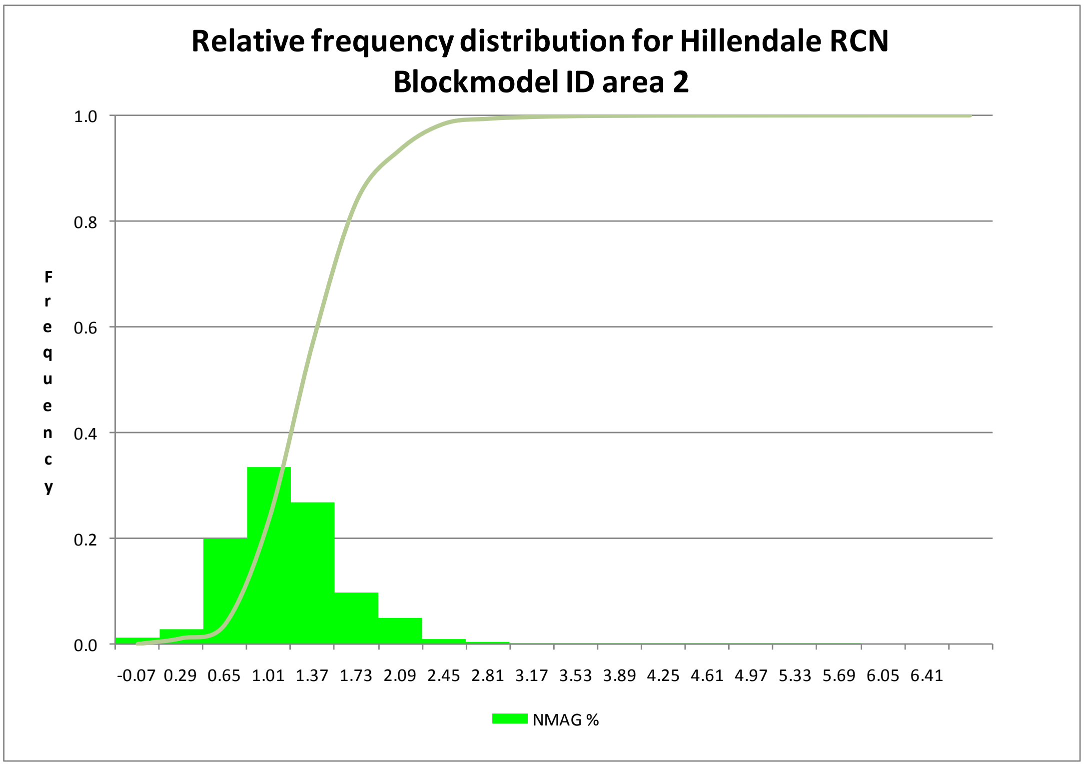
Relative frequency distribution for Hillendale RCN Blockmodel ID area 2
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.04 0.22 0.40 0.58 0.76 0.94 1.12 1.30 1.48 1.66 1.84 2.02 2.20 2.38 2.56 2.74 2.92 3.10 3.28
MAGN %

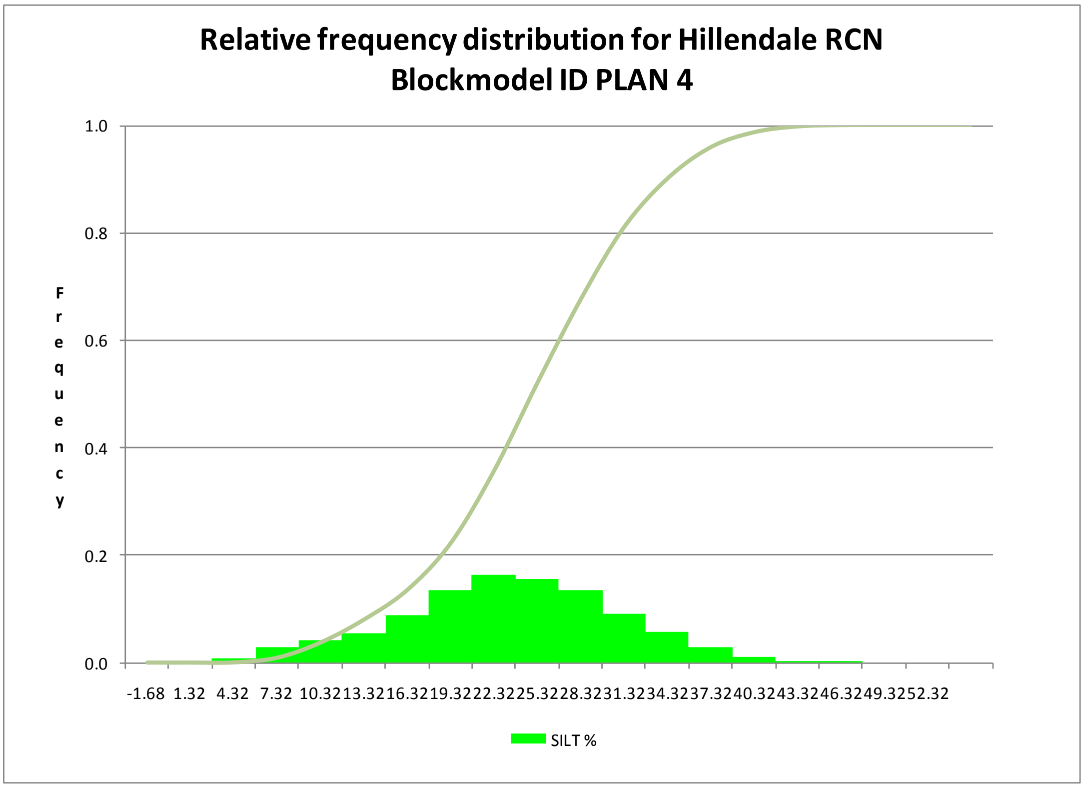
Relative frequency distribution for Hillendale RCN Blockmodel ID area 2
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.75 3.25 5.75 8.25 10.75 13.25 15.75 18.25 20.75 23.25 25.75 28.25 30.75 33.25 35.75 38.25 40.75 43.25 45.75
THM %

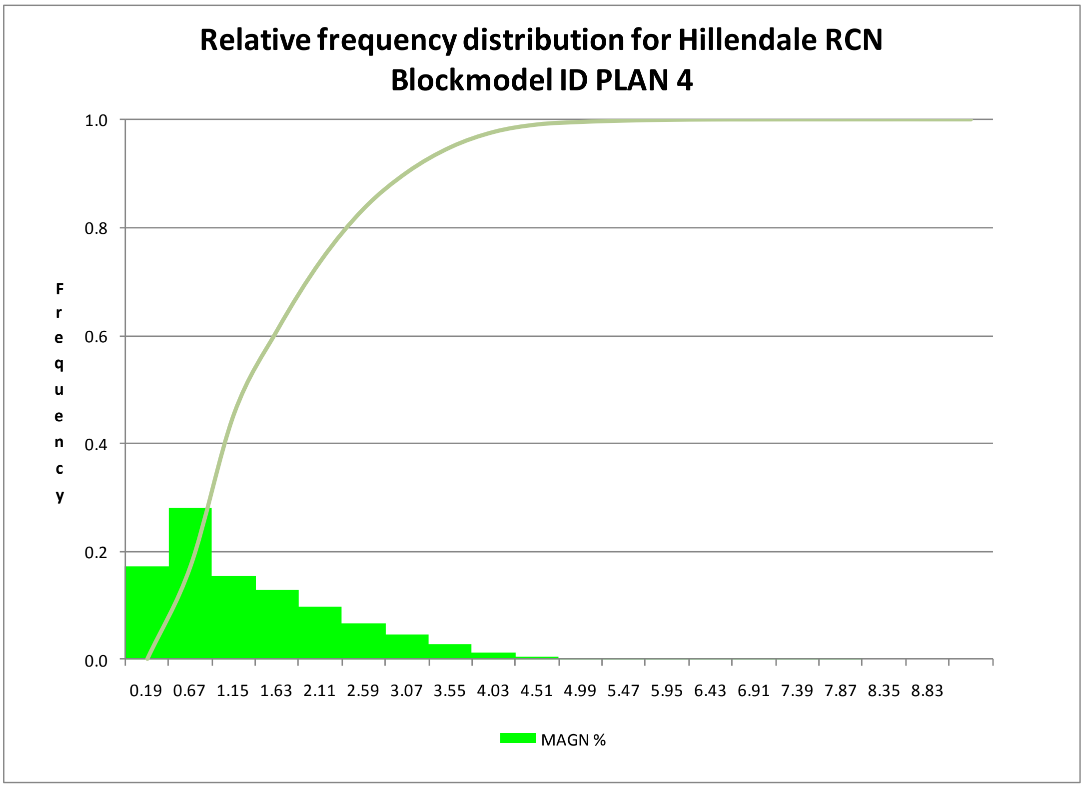

Relative frequency distribution or Hillendale RCN Blockmodel ID area 2
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00 14.00 15.00 16.00 17.00 18.00
MAGO %

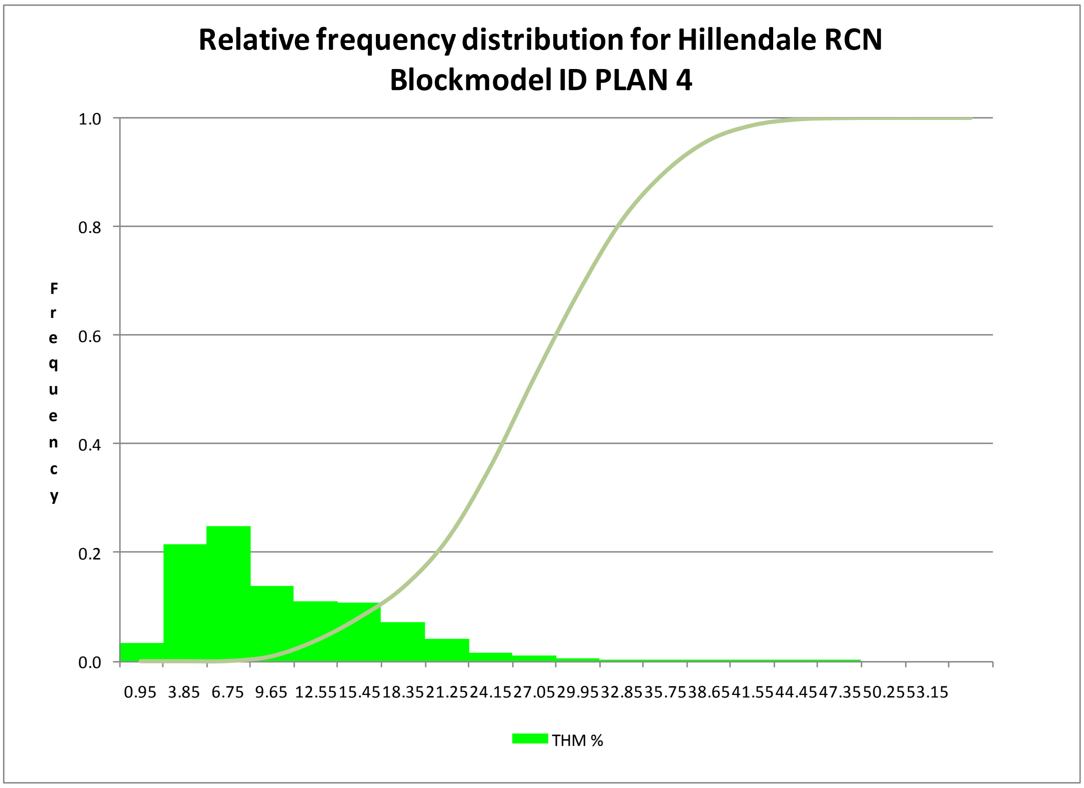

Relative frequency distribution for Hillendale RCN Blockmodel ID area 2
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
-4.58 -3.74 -2.90 -2.06 -1.22 -0.38 0.46 1.30 2.14 2.98 3.82 4.66 5.50 6.34 7.18 8.02 8.86 9.70 10.54
ILM %

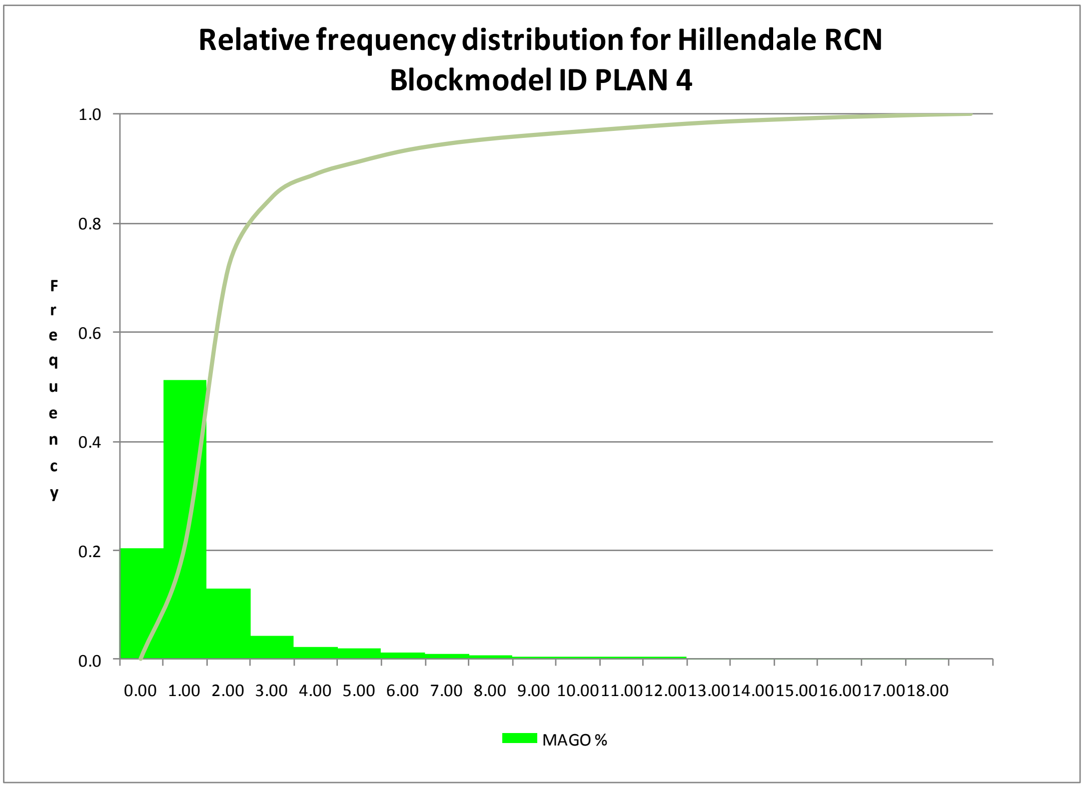

Relative frequency distribution for Hillendale RCN Blockmodel ID area 2
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
-0.07 0.29 0.65 1.01 1.37 1.73 2.09 2.45 2.81 3.17 3.53 3.89 4.25 4.61 4.97 5.33 5.69 6.05 6.41
NMAG %

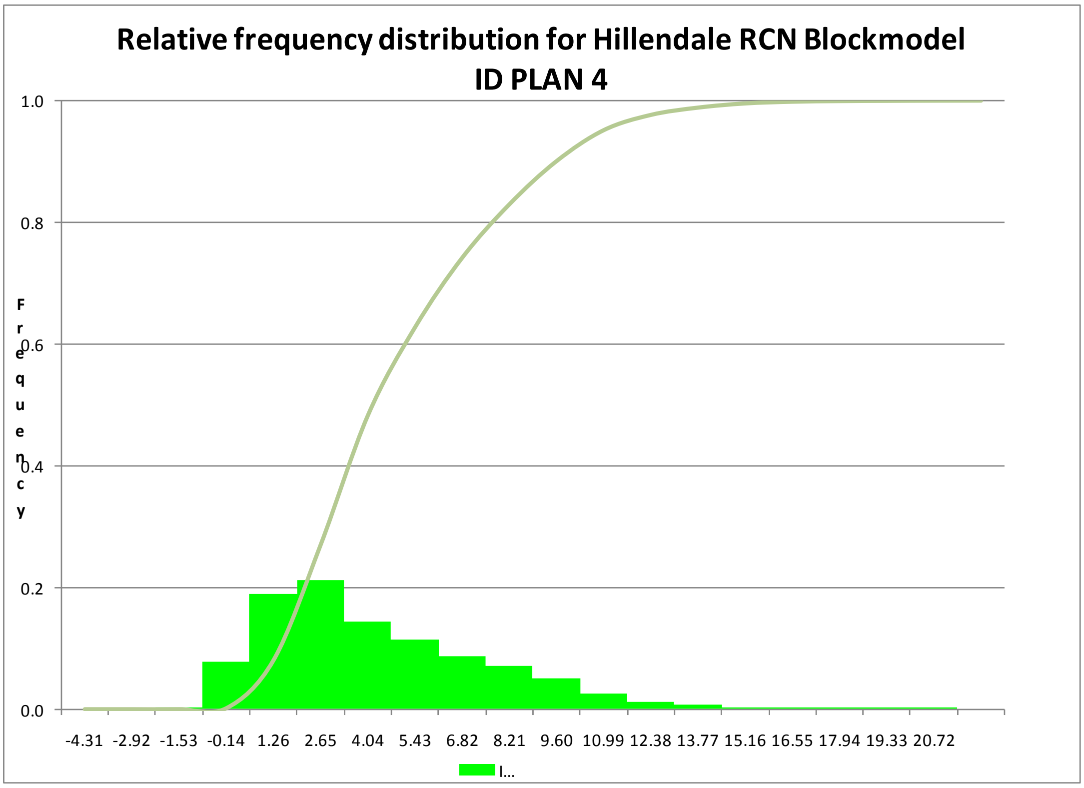
RCN Blockmodel Histograms – Plan 4

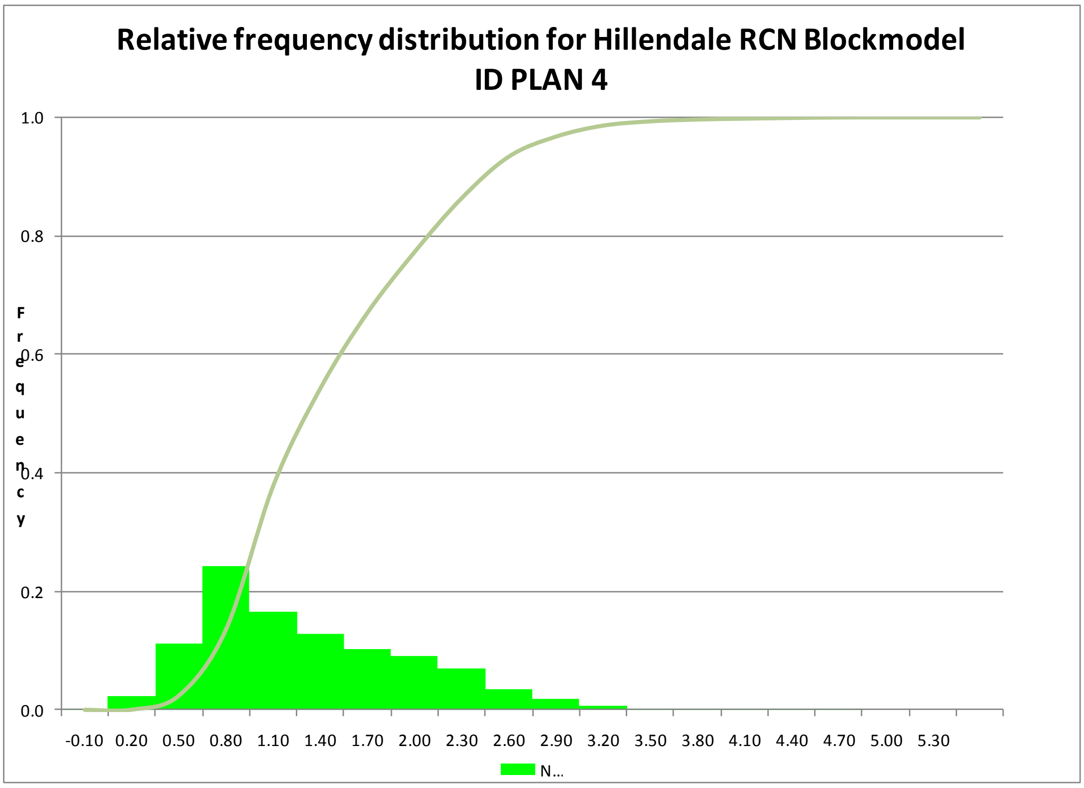



Relative frequency distribution for Hillendale RCN
Blockmodel ID PLAN 4
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.95 3.85 6.75 9.65 12.55 15.45 18.35 21.25 24.15 27.05 29.95 32.85 35.75 38.65 41.55 44.45 47.35 50.25 53.15
THM %


Relative frequency distribution for Hillendale RCN
Blockmodel ID PLAN 4
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00 14.00 15.00 16.00 17.00 18.00
MAGO %


Relative frequency distribution for Hillendale RCN Blockmodel ID PLAN 4
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
-4.31 -2.92 -1.53 -0.14 1.26 2.65 4.04 5.43 6.82 8.21 9.60 10.99 12.38 13.77 15.16 16.55 17.94 19.33 20.72
I...


Relative frequency distribution for Hillendale RCN Blockmodel ID PLAN 4
Frequency
1.0
0.8
0.6
0.4
0.2
0.0
-0.10 0.20 0.50 0.80 1.10 1.40 1.70 2.00 2.30 2.60 2.90 3.20 3.50 3.80 4.10 4.40 4.70 5.00 5.30
N...

# 11 Addendum C

Wallis Aircore drillhole information

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0562 | 3191493.290 | -91264.350 | 43.580 | 12.00 | 33.30 | 5.23 | 0.37 | 3.76 | 3.76 | 0.23 |
| HE0780A | 3190698.610 | -91665.970 | 48.890 | 24.00 | 23.47 | 6.08 | 0.78 | 4.64 | 4.64 | 0.35 |
| HE0369 | 3191251.390 | -90599.940 | 71.420 | 33.00 | 18.39 | 1.91 | 0.26 | 1.74 | 1.74 | 0.21 |
| HE0372 | 3191118.500 | -90648.340 | 54.120 | 27.00 | 11.92 | 2.29 | 0.47 | 2.11 | 2.11 | 0.55 |
| HE0376 | 3191165.020 | -90669.170 | 65.730 | 36.00 | 15.42 | 3.88 | 0.38 | 2.74 | 2.74 | 0.34 |
| HE0386 | 3191074.700 | -90683.130 | 47.090 | 24.00 | 11.30 | 2.46 | 0.27 | 1.25 | 1.25 | 0.59 |
| HE0387 | 3191120.450 | -90706.000 | 53.650 | 39.00 | 13.65 | 4.87 | 0.60 | 2.65 | 2.65 | 1.09 |
| HE0402 | 3191165.280 | -90725.330 | 63.430 | 24.00 | 11.16 | 4.98 | 0.23 | 2.02 | 2.02 | 2.08 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0403 | 3191210.630 | -90746.430 | 74.060 | 15.00 | 11.97 | 4.87 | 0.47 | 2.85 | 2.85 | 0.78 |
| HE0404 | 3191030.740 | -90717.670 | 37.970 | 36.00 | 12.67 | 3.00 | 0.35 | 2.05 | 2.05 | 0.45 |
| HE0405 | 3191076.210 | -90738.990 | 44.050 | 27.00 | 13.03 | 7.65 | 0.65 | 3.44 | 3.44 | 2.60 |
| HE0406 | 3191122.900 | -90757.880 | 51.640 | 39.00 | 13.68 | 7.66 | 0.78 | 3.51 | 3.51 | 2.41 |
| HE0417 | 3191165.180 | -90763.860 | 63.040 | 21.00 | 11.44 | 7.45 | 0.41 | 3.03 | 3.03 | 2.83 |
| HE0420 | 3191077.680 | -90794.910 | 41.130 | 15.00 | 8.92 | 7.07 | 0.46 | 2.86 | 2.86 | 2.97 |
| HE0431 | 3191123.060 | -90815.930 | 49.890 | 24.00 | 9.77 | 8.95 | 0.77 | 4.58 | 4.58 | 2.49 |
| HE0434 | 3191213.720 | -90858.180 | 79.630 | 27.00 | 14.20 | 10.15 | 0.82 | 6.17 | 6.17 | 1.58 |
| HE0442 | 3191258.990 | -90879.250 | 81.500 | 69.00 | 5.64 | 8.61 | 0.54 | 3.51 | 3.51 | 4.01 |
| HE0463 | 3191173.060 | -90894.970 | 76.520 | 21.00 | 13.61 | 17.07 | 1.31 | 7.19 | 7.19 | 5.97 |
| HE0464 | 3191215.200 | -90914.080 | 82.330 | 36.00 | 7.27 | 17.77 | 1.60 | 7.50 | 7.50 | 6.81 |
| HE0465 | 3191260.490 | -90935.090 | 77.020 | 21.00 | 11.53 | 17.15 | 1.86 | 8.33 | 8.33 | 5.01 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0467 | 3191126.140 | -90927.730 | 85.570 | 33.00 | 16.98 | 12.05 | 1.83 | 6.72 | 6.72 | 1.98 |
| HE0468 | 3191171.480 | -90948.660 | 81.470 | 30.00 | 18.41 | 8.28 | 1.31 | 5.50 | 5.50 | 0.92 |
| HE0477 | 3191216.700 | -90969.990 | 74.510 | 15.00 | 18.09 | 12.01 | 1.94 | 6.44 | 6.44 | 2.18 |
| HE0479 | 3191082.260 | -90962.510 | 80.920 | 27.00 | 10.78 | 12.19 | 1.10 | 6.92 | 6.92 | 2.47 |
| HE0480 | 3191127.590 | -90983.590 | 80.910 | 15.00 | 18.22 | 6.34 | 0.74 | 5.42 | 5.42 | 0.41 |
| HE0481 | 3191172.910 | -91004.740 | 74.740 | 15.00 | 22.29 | 2.98 | 0.39 | 2.22 | 2.22 | 0.23 |
| HE0482 | 3191218.210 | -91025.850 | 70.200 | 12.00 | 24.75 | 3.80 | 0.43 | 4.80 | 4.80 | 0.21 |
| HE0483 | 3191263.600 | -91046.970 | 65.620 | 18.00 | 26.50 | 6.75 | 0.69 | 4.74 | 4.74 | 0.26 |
| HE0484 | 3191040.940 | -90988.460 | 85.330 | 27.00 | 8.91 | 3.10 | 0.96 | 1.29 | 1.29 | 0.50 |
| HE0485 | 3191083.840 | -91018.310 | 80.020 | 18.00 | 20.64 | 4.25 | 0.34 | 3.50 | 3.50 | 0.26 |
| HE0495 | 3191129.240 | -91039.420 | 74.320 | 12.00 | 27.35 | 3.84 | 0.39 | 3.48 | 3.48 | 0.22 |
| HE0496 | 3191174.530 | -91060.520 | 70.300 | 15.00 | 20.61 | 6.83 | 0.47 | 7.23 | 7.23 | 1.69 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0497 | 3191219.770 | -91081.710 | 66.520 | 15.00 | 27.15 | 5.03 | 0.51 | 4.41 | 4.41 | 0.22 |
| HE0498 | 3191265.050 | -91102.790 | 62.780 | 21.00 | 29.26 | 10.32 | 1.24 | 7.11 | 7.11 | 0.37 |
| HE0500 | 3191310.470 | -91123.900 | 58.220 | 33.00 | 24.84 | 6.27 | 0.71 | 5.28 | 5.28 | 0.25 |
| HE0501 | 3191355.760 | -91145.080 | 54.020 | 54.00 | 20.84 | 4.32 | 0.56 | 4.16 | 4.16 | 0.32 |
| HE0534 | 3191401.110 | -91166.150 | 50.530 | 27.00 | 23.61 | 5.59 | 0.52 | 3.88 | 3.88 | 0.29 |
| HE0535 | 3191446.400 | -91187.380 | 48.470 | 27.00 | 24.03 | 5.12 | 0.44 | 3.47 | 3.47 | 0.29 |
| HE0536 | 3191491.710 | -91208.450 | 46.170 | 30.00 | 23.66 | 4.47 | 0.45 | 3.39 | 3.39 | 0.22 |
| HE0547 | 3191040.040 | -91053.110 | 82.790 | 18.00 | 14.85 | 4.81 | 1.59 | 3.07 | 3.07 | 0.27 |
| HE0548 | 3191085.430 | -91074.130 | 75.090 | 9.00 | 30.46 | 5.36 | 0.38 | 3.93 | 3.93 | 0.17 |
| HE0550 | 3191175.960 | -91116.420 | 67.580 | 24.00 | 23.56 | 4.92 | 0.41 | 3.94 | 3.94 | 0.20 |
| HE0556 | 3191221.330 | -91137.660 | 62.670 | 21.00 | 24.35 | 4.32 | 0.35 | 4.05 | 4.05 | 0.23 |
| HE0557 | 3191266.720 | -91158.710 | 58.700 | 30.00 | 24.49 | 7.94 | 0.88 | 6.09 | 6.09 | 0.35 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0558 | 3191311.980 | -91179.830 | 55.110 | 30.00 | 26.43 | 7.21 | 0.71 | 5.02 | 5.02 | 0.29 |
| HE0559 | 3191357.240 | -91200.930 | 52.860 | 24.00 | 27.78 | 6.75 | 0.64 | 4.71 | 4.71 | 0.35 |
| HE0560 | 3191402.660 | -91222.060 | 49.090 | 30.00 | 26.97 | 4.78 | 0.42 | 3.34 | 3.34 | 0.20 |
| HE0561 | 3191447.870 | -91243.210 | 45.890 | 24.00 | 26.22 | 5.06 | 0.54 | 3.51 | 3.51 | 0.21 |
| HE0562A | 3191493.980 | -91265.570 | 43.490 | 42.00 | 20.87 | 3.90 | 0.39 | 2.52 | 2.52 | 0.27 |
| HE0565 | 3191038.050 | -91108.060 | 75.100 | 27.00 | 19.85 | 2.77 | 0.19 | 2.60 | 2.60 | 0.21 |
| HE0566 | 3191086.820 | -91130.070 | 71.180 | 15.00 | 25.06 | 4.16 | 0.25 | 3.64 | 3.64 | 0.19 |
| HE0567 | 3191132.210 | -91151.270 | 67.820 | 66.00 | 16.41 | 2.14 | 0.37 | 2.95 | 2.95 | 0.33 |
| HE0572 | 3191177.540 | -91172.330 | 64.720 | 18.00 | 24.45 | 4.14 | 0.24 | 3.50 | 3.50 | 0.20 |
| HE0573 | 3191222.960 | -91193.520 | 59.660 | 24.00 | 29.21 | 8.77 | 0.76 | 6.27 | 6.27 | 0.32 |
| HE0574 | 3191262.690 | -91215.940 | 57.210 | 39.00 | 25.16 | 5.90 | 0.67 | 4.64 | 4.64 | 0.27 |
| HE0575 | 3191313.570 | -91235.600 | 55.590 | 33.00 | 23.13 | 5.40 | 0.46 | 4.00 | 4.00 | 0.35 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0576 | 3191358.860 | -91256.820 | 51.800 | 33.00 | 26.77 | 5.16 | 0.42 | 3.91 | 3.91 | 0.30 |
| HE0577 | 3191404.080 | -91277.950 | 46.440 | 42.00 | 24.10 | 3.84 | 0.44 | 2.83 | 2.83 | 0.28 |
| HE0578 | 3191449.490 | -91299.150 | 43.190 | 30.00 | 24.29 | 4.49 | 0.54 | 3.37 | 3.37 | 0.19 |
| HE0579 | 3190907.210 | -91101.490 | 87.720 | 42.00 | 10.71 | 5.04 | 1.03 | 3.18 | 3.18 | 0.95 |
| HE0581 | 3190997.870 | -91143.700 | 76.470 | 18.00 | 13.16 | 3.75 | 0.24 | 2.37 | 2.37 | 0.61 |
| HE0582 | 3191043.190 | -91164.800 | 74.100 | 15.00 | 18.71 | 3.36 | 0.20 | 2.30 | 2.30 | 0.27 |
| HE0583 | 3191095.380 | -91189.620 | 66.860 | 15.00 | 22.50 | 2.78 | 0.16 | 2.36 | 2.36 | 0.21 |
| HE0584 | 3191133.750 | -91207.090 | 64.870 | 21.00 | 20.95 | 3.57 | 0.29 | 4.03 | 4.03 | 0.26 |
| HE0585 | 3191179.090 | -91228.120 | 61.610 | 27.00 | 26.70 | 6.43 | 0.48 | 5.20 | 5.20 | 0.25 |
| HE0586 | 3191224.410 | -91249.330 | 57.110 | 33.00 | 25.35 | 7.70 | 0.67 | 6.01 | 6.01 | 0.34 |
| HE0587 | 3191269.700 | -91270.560 | 53.190 | 33.00 | 25.55 | 6.07 | 0.52 | 4.27 | 4.27 | 0.28 |
| HE0588 | 3191315.020 | -91291.570 | 50.980 | 33.00 | 26.37 | 5.25 | 0.42 | 4.05 | 4.05 | 0.23 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0589 | 3191360.350 | -91312.700 | 45.330 | 30.00 | 24.29 | 4.77 | 0.47 | 3.69 | 3.69 | 0.22 |
| HE0590 | 3191405.680 | -91333.840 | 42.330 | 36.00 | 21.37 | 4.52 | 0.50 | 3.31 | 3.31 | 0.25 |
| HE0592 | 3190954.050 | -91178.500 | 77.210 | 18.00 | 7.73 | 4.70 | 0.17 | 1.66 | 1.66 | 2.42 |
| HE0593 | 3190999.370 | -91199.610 | 72.340 | 21.00 | 8.77 | 5.19 | 0.18 | 1.87 | 1.87 | 2.13 |
| HE0594 | 3191044.610 | -91220.670 | 68.390 | 9.00 | 19.60 | 4.74 | 0.32 | 4.70 | 4.70 | 0.34 |
| HE0595 | 3191089.930 | -91241.820 | 63.900 | 12.00 | 20.82 | 5.76 | 0.51 | 3.81 | 3.81 | 0.38 |
| HE0596 | 3191135.290 | -91263.000 | 60.210 | 12.00 | 20.48 | 10.23 | 1.36 | 8.38 | 8.38 | 1.18 |
| HE0597 | 3191180.590 | -91284.090 | 59.310 | 36.00 | 24.25 | 8.85 | 0.77 | 6.56 | 6.56 | 0.59 |
| HE0598 | 3191225.880 | -91305.220 | 55.820 | 60.00 | 22.25 | 4.83 | 0.47 | 4.19 | 4.19 | 0.37 |
| HE0599 | 3191271.210 | -91326.370 | 51.190 | 30.00 | 25.99 | 5.39 | 0.40 | 3.85 | 3.85 | 0.21 |
| HE0600 | 3191316.610 | -91347.460 | 45.630 | 27.00 | 27.83 | 5.61 | 0.52 | 3.87 | 3.87 | 0.29 |
| HE0601 | 3191361.910 | -91368.540 | 41.800 | 30.00 | 26.28 | 4.31 | 0.49 | 3.61 | 3.61 | 0.27 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0603 | 3190910.240 | -91213.260 | 77.240 | 18.00 | 7.38 | 8.73 | 0.33 | 3.07 | 3.07 | 4.45 |
| HE0604 | 3190955.610 | -91234.280 | 71.920 | 18.00 | 11.14 | 5.99 | 0.31 | 2.56 | 2.56 | 2.39 |
| HE0605 | 3191000.940 | -91255.480 | 66.990 | 18.00 | 17.35 | 4.36 | 0.43 | 3.07 | 3.07 | 0.85 |
| HE0606 | 3191046.150 | -91276.690 | 62.860 | 18.00 | 20.74 | 5.96 | 0.66 | 4.83 | 4.83 | 0.43 |
| HE0607 | 3191091.520 | -91297.670 | 58.810 | 24.00 | 25.00 | 10.63 | 1.14 | 8.48 | 8.48 | 0.50 |
| HE0608 | 3191136.920 | -91318.920 | 57.320 | 36.00 | 26.14 | 8.43 | 0.73 | 6.52 | 6.52 | 0.41 |
| HE0609 | 3191182.210 | -91339.930 | 57.110 | 33.00 | 25.25 | 7.54 | 0.57 | 5.19 | 5.19 | 0.48 |
| HE0610 | 3191227.500 | -91361.080 | 53.020 | 36.00 | 25.59 | 5.28 | 0.35 | 3.86 | 3.86 | 0.44 |
| HE0611 | 3191272.800 | -91382.280 | 48.310 | 30.00 | 25.91 | 6.14 | 0.52 | 4.29 | 4.29 | 0.32 |
| HE0626 | 3190866.050 | -91247.930 | 77.240 | 30.00 | 12.41 | 5.19 | 0.32 | 2.62 | 2.62 | 1.46 |
| HE0627 | 3190911.980 | -91269.070 | 72.400 | 69.00 | 8.62 | 4.63 | 0.24 | 2.02 | 2.02 | 2.67 |
| HE0628 | 3190954.810 | -91288.210 | 67.530 | 15.00 | 17.85 | 3.32 | 0.31 | 2.56 | 2.56 | 0.35 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0629 | 3191002.000 | -91311.390 | 64.200 | 18.00 | 20.35 | 4.33 | 0.44 | 3.28 | 3.28 | 0.36 |
| HE0630 | 3191048.040 | -91332.530 | 60.080 | 33.00 | 23.77 | 7.34 | 0.83 | 6.20 | 6.20 | 0.45 |
| HE0632 | 3191138.000 | -91374.730 | 54.980 | 36.00 | 26.66 | 7.48 | 0.59 | 5.81 | 5.81 | 0.33 |
| HE0633 | 3191184.650 | -91394.530 | 53.010 | 33.00 | 27.22 | 6.55 | 0.42 | 4.49 | 4.49 | 0.45 |
| HE0634 | 3191226.060 | -91422.280 | 48.340 | 30.00 | 24.38 | 5.11 | 0.40 | 3.87 | 3.87 | 0.38 |
| HE0640 | 3190822.990 | -91282.700 | 78.560 | 24.00 | 9.92 | 6.63 | 0.29 | 2.68 | 2.68 | 2.30 |
| HE0641 | 3190867.990 | -91303.830 | 74.380 | 12.00 | 20.26 | 5.19 | 0.33 | 2.82 | 2.82 | 1.24 |
| HE0642 | 3190912.940 | -91324.990 | 67.890 | 18.00 | 16.61 | 4.12 | 0.42 | 3.33 | 3.33 | 0.33 |
| HE0643 | 3190958.940 | -91346.150 | 63.070 | 24.00 | 22.92 | 6.21 | 0.69 | 4.80 | 4.80 | 0.43 |
| HE0644 | 3191004.360 | -91365.800 | 59.810 | 27.00 | 28.11 | 9.65 | 0.91 | 7.66 | 7.66 | 0.49 |
| HE0645 | 3191049.020 | -91388.320 | 56.980 | 36.00 | 23.86 | 8.19 | 0.80 | 6.23 | 6.23 | 0.43 |
| HE0646 | 3191095.050 | -91409.410 | 53.720 | 33.00 | 25.09 | 7.73 | 0.58 | 5.46 | 5.46 | 0.38 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0647 | 3191140.650 | -91431.580 | 51.770 | 33.00 | 26.08 | 5.20 | 0.35 | 4.49 | 4.49 | 0.33 |
| HE0648 | 3191184.130 | -91456.090 | 45.770 | 27.00 | 26.72 | 4.04 | 0.25 | 3.11 | 3.11 | 0.36 |
| HE0656 | 3190098.760 | -91306.310 | 62.060 | 48.00 | 9.85 | 6.57 | 0.41 | 2.35 | 2.35 | 3.28 |
| HE0657 | 3190196.890 | -91387.940 | 87.120 | 30.00 | 22.83 | 6.46 | 0.61 | 4.20 | 4.20 | 0.62 |
| HE0674 | 3190779.030 | -91317.490 | 78.960 | 27.00 | 9.33 | 10.23 | 0.58 | 3.67 | 3.67 | 4.00 |
| HE0675 | 3190824.010 | -91338.510 | 74.000 | 18.00 | 13.62 | 7.22 | 0.54 | 3.11 | 3.11 | 2.30 |
| HE0676 | 3190870.020 | -91359.670 | 67.700 | 21.00 | 18.99 | 4.16 | 0.90 | 4.01 | 4.01 | 0.65 |
| HE0677 | 3190915.020 | -91380.890 | 61.780 | 24.00 | 22.06 | 5.75 | 0.73 | 5.12 | 5.12 | 0.39 |
| HE0678 | 3190953.830 | -91406.910 | 57.310 | 57.00 | 21.20 | 4.75 | 0.86 | 5.81 | 5.81 | 0.39 |
| HE0679 | 3191005.040 | -91423.030 | 54.420 | 30.00 | 25.82 | 7.08 | 0.68 | 6.27 | 6.27 | 0.38 |
| HE0680 | 3191050.920 | -91444.150 | 52.640 | 33.00 | 25.75 | 7.70 | 0.53 | 6.70 | 6.70 | 0.49 |
| HE0681 | 3191095.980 | -91465.350 | 51.510 | 27.00 | 30.42 | 6.53 | 0.22 | 5.22 | 5.22 | 0.60 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0682 | 3191140.980 | -91486.410 | 45.750 | 27.00 | 29.99 | 4.51 | 0.11 | 3.39 | 3.39 | 0.61 |
| HE0688 | 3190735.030 | -91352.200 | 79.270 | 24.00 | 15.78 | 9.72 | 0.78 | 5.16 | 5.16 | 2.56 |
| HE0689 | 3190779.310 | -91376.880 | 75.120 | 27.00 | 17.71 | 7.29 | 0.80 | 4.63 | 4.63 | 1.71 |
| HE0690 | 3190825.990 | -91394.360 | 67.570 | 21.00 | 19.35 | 5.64 | 0.89 | 4.85 | 4.85 | 0.60 |
| HE0691 | 3190871.020 | -91415.510 | 61.540 | 18.00 | 26.85 | 7.35 | 0.78 | 6.13 | 6.13 | 0.39 |
| HE0692 | 3190915.940 | -91436.670 | 57.250 | 24.00 | 31.48 | 7.29 | 0.72 | 5.76 | 5.76 | 0.34 |
| HE0693 | 3190961.950 | -91457.860 | 53.730 | 24.00 | 27.20 | 7.62 | 0.72 | 6.26 | 6.26 | 0.29 |
| HE0694 | 3191007.020 | -91478.870 | 51.990 | 33.00 | 24.63 | 7.00 | 0.57 | 5.93 | 5.93 | 0.43 |
| HE0695 | 3191052.020 | -91500.100 | 50.600 | 30.00 | 26.25 | 5.57 | 0.19 | 4.46 | 4.46 | 0.32 |
| HE0696 | 3191098.000 | -91521.270 | 46.250 | 15.00 | 31.17 | 5.86 | 0.24 | 3.77 | 3.77 | 0.69 |
| HE0702 | 3190691.000 | -91387.000 | 75.610 | 48.00 | 18.04 | 3.74 | 0.45 | 3.30 | 3.30 | 0.78 |
| HE0703 | 3190736.270 | -91408.430 | 75.580 | 21.00 | 16.75 | 5.51 | 0.64 | 4.93 | 4.93 | 0.52 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0704 | 3190781.930 | -91429.210 | 68.450 | 21.00 | 25.25 | 8.88 | 1.20 | 5.60 | 5.60 | 0.73 |
| HE0705 | 3190830.370 | -91453.710 | 61.120 | 24.00 | 27.61 | 8.25 | 1.13 | 6.25 | 6.25 | 0.46 |
| HE0706 | 3190873.050 | -91471.520 | 57.580 | 21.00 | 29.96 | 8.45 | 0.88 | 6.57 | 6.57 | 0.73 |
| HE0707 | 3190918.020 | -91492.630 | 55.080 | 30.00 | 24.56 | 7.67 | 0.61 | 5.11 | 5.11 | 0.67 |
| HE0708 | 3190962.990 | -91513.740 | 52.100 | 30.00 | 25.80 | 7.23 | 0.53 | 5.36 | 5.36 | 0.63 |
| HE0709 | 3191008.950 | -91534.840 | 50.100 | 24.00 | 27.67 | 5.63 | 0.35 | 3.96 | 3.96 | 0.31 |
| HE0716 | 3190647.000 | -91421.300 | 74.990 | 30.00 | 21.78 | 4.48 | 0.62 | 3.48 | 3.48 | 0.43 |
| HE0717 | 3190691.950 | -91442.460 | 71.640 | 30.00 | 22.27 | 5.42 | 0.64 | 4.25 | 4.25 | 0.59 |
| HE0718 | 3190737.900 | -91463.620 | 69.720 | 36.00 | 20.39 | 5.91 | 0.65 | 3.85 | 3.85 | 0.46 |
| HE0719 | 3190782.980 | -91484.690 | 62.380 | 24.00 | 29.50 | 7.13 | 0.93 | 5.09 | 5.09 | 0.69 |
| HE0720 | 3190827.970 | -91505.760 | 56.760 | 24.00 | 30.61 | 8.48 | 0.92 | 5.32 | 5.32 | 0.80 |
| HE0721 | 3190874.030 | -91526.910 | 53.330 | 33.00 | 26.28 | 6.98 | 0.73 | 5.02 | 5.02 | 0.57 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0722 | 3190919.100 | -91548.010 | 50.470 | 30.00 | 24.60 | 5.87 | 0.40 | 4.55 | 4.55 | 0.31 |
| HE0723 | 3190963.990 | -91569.270 | 49.090 | 39.00 | 24.11 | 5.06 | 0.37 | 3.47 | 3.47 | 0.35 |
| HE0728 | 3190557.910 | -91434.910 | 79.030 | 27.00 | 12.64 | 8.09 | 1.09 | 4.43 | 4.43 | 1.65 |
| HE0729 | 3190603.170 | -91456.110 | 75.590 | 18.00 | 15.73 | 9.43 | 1.30 | 5.39 | 5.39 | 1.63 |
| HE0730 | 3190648.550 | -91477.150 | 69.900 | 18.00 | 17.64 | 4.22 | 0.57 | 2.71 | 2.71 | 0.33 |
| HE0731 | 3190693.880 | -91498.310 | 66.060 | 18.00 | 22.07 | 5.92 | 0.78 | 3.89 | 3.89 | 0.37 |
| HE0732 | 3190739.170 | -91519.440 | 61.070 | 21.00 | 23.06 | 6.02 | 1.02 | 4.11 | 4.11 | 0.67 |
| HE0733 | 3190784.520 | -91540.500 | 54.600 | 24.00 | 18.53 | 6.93 | 1.07 | 3.98 | 3.98 | 0.81 |
| HE0734 | 3190829.860 | -91561.680 | 51.100 | 27.00 | 25.04 | 5.77 | 0.66 | 4.43 | 4.43 | 0.30 |
| HE0735 | 3190875.170 | -91582.890 | 48.230 | 30.00 | 24.60 | 6.58 | 0.72 | 4.92 | 4.92 | 0.39 |
| HE0736 | 3190920.440 | -91603.890 | 47.830 | 36.00 | 24.97 | 5.12 | 0.56 | 3.68 | 3.68 | 0.57 |
| HE0738 | 3190423.570 | -91427.530 | 89.340 | 57.00 | 11.38 | 5.94 | 0.54 | 2.33 | 2.33 | 2.41 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0739 | 3190468.850 | -91448.580 | 87.660 | 30.00 | 13.37 | 11.95 | 1.19 | 5.75 | 5.75 | 3.89 |
| HE0740 | 3190514.050 | -91469.710 | 80.550 | 27.00 | 16.02 | 7.28 | 1.18 | 4.34 | 4.34 | 0.88 |
| HE0741 | 3190559.400 | -91490.880 | 76.010 | 24.00 | 20.60 | 7.00 | 1.07 | 3.99 | 3.99 | 0.84 |
| HE0742 | 3190604.700 | -91511.980 | 69.710 | 21.00 | 22.07 | 6.46 | 0.90 | 3.90 | 3.90 | 0.61 |
| HE0743 | 3190650.020 | -91533.020 | 64.110 | 27.00 | 20.31 | 5.06 | 0.75 | 2.98 | 2.98 | 0.51 |
| HE0744 | 3190695.300 | -91554.190 | 57.840 | 27.00 | 27.36 | 7.63 | 1.18 | 4.95 | 4.95 | 0.44 |
| HE0745 | 3190740.440 | -91575.320 | 53.200 | 24.00 | 24.91 | 8.25 | 1.07 | 5.43 | 5.43 | 0.46 |
| HE0746 | 3190785.940 | -91596.480 | 49.440 | 27.00 | 22.17 | 6.12 | 0.88 | 3.98 | 3.98 | 0.78 |
| HE0747 | 3190831.350 | -91617.610 | 47.570 | 21.00 | 25.95 | 7.84 | 0.99 | 5.10 | 5.10 | 0.50 |
| HE0748 | 3190876.690 | -91638.670 | 46.750 | 18.00 | 27.33 | 6.11 | 0.80 | 4.75 | 4.75 | 0.46 |
| HE0751 | 3190151.770 | -91336.730 | 69.660 | 12.00 | 11.77 | 5.40 | 0.45 | 2.15 | 2.15 | 2.17 |
| HE0752 | 3190243.880 | -91399.020 | 84.520 | 27.00 | 23.99 | 6.94 | 0.59 | 3.97 | 3.97 | 1.43 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0753 | 3190289.250 | -91419.970 | 83.270 | 24.00 | 38.85 | 5.92 | 0.48 | 4.03 | 4.03 | 0.42 |
| HE0754 | 3190334.580 | -91441.140 | 86.630 | 30.00 | 26.70 | 5.43 | 0.60 | 3.61 | 3.61 | 0.38 |
| HE0755 | 3190379.800 | -91462.240 | 86.400 | 18.00 | 19.31 | 6.61 | 1.13 | 4.05 | 4.05 | 0.51 |
| HE0756 | 3190425.130 | -91483.440 | 84.370 | 33.00 | 12.96 | 4.89 | 0.72 | 2.42 | 2.42 | 1.11 |
| HE0757 | 3190470.460 | -91504.430 | 80.380 | 42.00 | 16.15 | 4.41 | 0.67 | 2.82 | 2.82 | 0.52 |
| HE0758 | 3190515.610 | -91525.590 | 74.170 | 30.00 | 19.95 | 5.47 | 1.00 | 3.69 | 3.69 | 0.46 |
| HE0759 | 3190560.910 | -91546.720 | 68.020 | 21.00 | 23.49 | 6.01 | 1.09 | 4.47 | 4.47 | 0.41 |
| HE0760 | 3190606.300 | -91567.830 | 62.800 | 33.00 | 23.04 | 5.08 | 0.74 | 3.28 | 3.28 | 0.33 |
| HE0761 | 3190651.610 | -91589.000 | 57.990 | 33.00 | 22.06 | 4.83 | 0.74 | 3.06 | 3.06 | 0.33 |
| HE0762 | 3190697.070 | -91610.100 | 52.940 | 24.00 | 19.76 | 5.28 | 0.91 | 3.30 | 3.30 | 0.37 |
| HE0763 | 3190742.200 | -91631.330 | 49.520 | 24.00 | 23.26 | 6.12 | 0.78 | 4.06 | 4.06 | 0.33 |
| HE0764 | 3190787.580 | -91652.300 | 47.570 | 18.00 | 22.98 | 5.21 | 0.75 | 3.93 | 3.93 | 0.44 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0765 | 3190832.900 | -91673.530 | 45.820 | 24.00 | 29.89 | 4.97 | 0.40 | 3.51 | 3.51 | 0.65 |
| HE0770 | 3190245.370 | -91454.780 | 83.240 | 18.00 | 22.87 | 4.02 | 0.58 | 2.55 | 2.55 | 0.30 |
| HE0771 | 3190290.740 | -91475.900 | 82.940 | 21.00 | 22.47 | 4.40 | 0.56 | 2.82 | 2.82 | 0.36 |
| HE0772 | 3190336.110 | -91497.000 | 82.950 | 30.00 | 20.53 | 5.15 | 0.80 | 3.26 | 3.26 | 0.37 |
| HE0773 | 3190381.370 | -91518.100 | 81.480 | 33.00 | 18.35 | 8.57 | 1.23 | 5.03 | 5.03 | 1.24 |
| HE0774 | 3190426.490 | -91539.190 | 77.300 | 24.00 | 16.29 | 6.30 | 1.08 | 3.82 | 3.82 | 0.58 |
| HE0775 | 3190471.990 | -91560.420 | 71.870 | 24.00 | 22.24 | 7.35 | 1.28 | 5.19 | 5.19 | 0.60 |
| HE0776 | 3190517.310 | -91581.560 | 65.940 | 15.00 | 23.08 | 7.10 | 1.35 | 5.60 | 5.60 | 0.57 |
| HE0777 | 3190562.670 | -91602.620 | 60.650 | 33.00 | 20.35 | 4.31 | 0.92 | 4.01 | 4.01 | 0.39 |
| HE0778 | 3190607.930 | -91623.820 | 56.550 | 24.00 | 21.06 | 5.47 | 0.92 | 3.37 | 3.37 | 0.38 |
| HE0779 | 3190653.280 | -91644.800 | 52.190 | 18.00 | 21.11 | 6.17 | 0.87 | 4.01 | 4.01 | 0.39 |
| HE0781 | 3190743.970 | -91687.180 | 46.920 | 24.00 | 24.28 | 5.53 | 0.53 | 4.29 | 4.29 | 0.35 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0787 | 3190156.510 | -91467.780 | 81.490 | 27.00 | 24.25 | 6.12 | 0.72 | 3.98 | 3.98 | 0.49 |
| HE0788 | 3190201.530 | -91489.610 | 79.900 | 9.00 | 27.57 | 4.99 | 0.66 | 3.24 | 3.24 | 0.33 |
| HE0789 | 3190246.930 | -91510.640 | 79.680 | 12.00 | 20.93 | 7.21 | 1.03 | 4.65 | 4.65 | 0.50 |
| HE0790 | 3190292.250 | -91531.730 | 80.020 | 15.00 | 25.66 | 7.64 | 1.10 | 5.01 | 5.01 | 0.39 |
| HE0791 | 3190337.550 | -91552.900 | 78.630 | 12.00 | 28.45 | 8.87 | 1.38 | 5.61 | 5.61 | 0.61 |
| HE0792 | 3190382.800 | -91574.030 | 74.890 | 12.00 | 19.05 | 6.11 | 1.09 | 3.73 | 3.73 | 0.44 |
| HE0794 | 3190473.490 | -91616.330 | 63.760 | 12.00 | 19.83 | 6.85 | 1.09 | 4.37 | 4.37 | 0.39 |
| HE0796 | 3190564.170 | -91658.530 | 54.890 | 15.00 | 20.76 | 5.83 | 0.78 | 3.90 | 3.90 | 0.27 |
| HE0797 | 3190609.440 | -91679.580 | 51.540 | 6.00 | 20.65 | 8.35 | 1.37 | 5.10 | 5.10 | 0.63 |
| HE0798 | 3190654.810 | -91700.730 | 47.820 | 15.00 | 22.38 | 5.57 | 0.60 | 3.70 | 3.70 | 0.38 |
| HE0799 | 3190700.180 | -91721.860 | 45.270 | 9.00 | 23.94 | 4.22 | 0.47 | 2.61 | 2.61 | 0.43 |
| HE0801 | 3190112.770 | -91502.590 | 78.870 | 75.00 | 17.79 | 4.01 | 0.59 | 3.00 | 3.00 | 0.68 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0802 | 3190159.900 | -91520.550 | 77.950 | 30.00 | 27.10 | 5.65 | 0.67 | 3.80 | 3.80 | 0.35 |
| HE0803 | 3190203.370 | -91544.800 | 77.210 | 21.00 | 20.58 | 3.85 | 0.55 | 2.69 | 2.69 | 0.41 |
| HE0804 | 3190248.480 | -91566.500 | 76.690 | 18.00 | 19.11 | 5.56 | 1.26 | 5.03 | 5.03 | 0.50 |
| HE0805 | 3190293.730 | -91587.670 | 75.790 | 27.00 | 17.00 | 8.19 | 1.02 | 4.36 | 4.36 | 1.81 |
| HE0806 | 3190339.060 | -91608.760 | 72.530 | 27.00 | 18.87 | 6.21 | 1.04 | 3.42 | 3.42 | 0.98 |
| HE0807 | 3190384.470 | -91629.930 | 67.480 | 24.00 | 24.60 | 6.99 | 1.16 | 4.33 | 4.33 | 0.55 |
| HE0808 | 3190429.890 | -91651.030 | 61.160 | 30.00 | 21.53 | 5.54 | 0.95 | 3.44 | 3.44 | 0.38 |
| HE0809 | 3190475.000 | -91672.270 | 56.540 | 27.00 | 22.16 | 5.73 | 0.66 | 3.85 | 3.85 | 0.33 |
| HE0810 | 3190520.390 | -91693.280 | 53.030 | 15.00 | 15.88 | 3.80 | 0.55 | 2.48 | 2.48 | 0.21 |
| HE0811 | 3190565.690 | -91714.310 | 49.480 | 24.00 | 21.29 | 3.96 | 0.51 | 2.60 | 2.60 | 0.27 |
| HE0812 | 3190611.080 | -91735.530 | 46.610 | 15.00 | 24.07 | 4.69 | 0.46 | 3.20 | 3.20 | 0.29 |
| HE0813 | 3190656.690 | -91756.630 | 44.420 | 18.00 | 27.37 | 4.26 | 0.34 | 2.72 | 2.72 | 0.45 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0814 | 3190023.630 | -91516.290 | 75.830 | 24.00 | 27.61 | 5.94 | 0.69 | 3.75 | 3.75 | 0.55 |
| HE0815 | 3190069.030 | -91537.330 | 76.960 | 21.00 | 28.20 | 6.62 | 0.85 | 4.21 | 4.21 | 0.56 |
| HE0816 | 3190114.060 | -91559.110 | 75.420 | 24.00 | 26.28 | 4.94 | 0.59 | 3.25 | 3.25 | 0.33 |
| HE0817 | 3190159.650 | -91579.530 | 74.710 | 18.00 | 32.17 | 5.25 | 0.61 | 3.57 | 3.57 | 0.27 |
| HE0818 | 3190204.750 | -91601.260 | 74.150 | 24.00 | 28.04 | 5.65 | 0.68 | 3.76 | 3.76 | 0.34 |
| HE0819 | 3190249.960 | -91622.400 | 73.020 | 48.00 | 16.77 | 4.42 | 0.70 | 2.75 | 2.75 | 0.80 |
| HE0821 | 3190340.710 | -91664.620 | 65.550 | 27.00 | 27.18 | 5.87 | 0.99 | 3.49 | 3.49 | 0.52 |
| HE0822 | 3190385.900 | -91685.810 | 59.080 | 24.00 | 26.39 | 6.35 | 0.96 | 3.94 | 3.94 | 0.50 |
| HE0823 | 3190431.260 | -91706.900 | 54.460 | 30.00 | 16.64 | 4.56 | 0.77 | 2.85 | 2.85 | 0.31 |
| HE0824 | 3190476.590 | -91728.030 | 50.910 | 21.00 | 24.52 | 4.37 | 0.49 | 2.99 | 2.99 | 0.21 |
| HE0825 | 3190521.910 | -91749.100 | 48.460 | 21.00 | 27.00 | 4.73 | 0.54 | 3.12 | 3.12 | 0.21 |
| HE0826 | 3190567.150 | -91770.300 | 45.740 | 24.00 | 18.51 | 2.07 | 0.32 | 1.30 | 1.30 | 0.13 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0827 | 3190612.610 | -91791.440 | 42.480 | 45.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HE0828 | 3189979.850 | -91550.980 | 75.890 | 75.00 | 14.92 | 4.82 | 0.45 | 2.36 | 2.36 | 1.54 |
| HE0829 | 3190024.800 | -91572.330 | 74.950 | 24.00 | 25.57 | 5.31 | 0.68 | 3.99 | 3.99 | 0.39 |
| HE0830 | 3190070.550 | -91593.270 | 73.560 | 24.00 | 26.47 | 4.45 | 0.55 | 2.89 | 2.89 | 0.31 |
| HE0831 | 3190115.540 | -91614.920 | 72.570 | 21.00 | 29.95 | 3.70 | 0.42 | 2.78 | 2.78 | 0.33 |
| HE0832 | 3190160.880 | -91636.030 | 71.820 | 21.00 | 25.80 | 3.94 | 0.60 | 3.10 | 3.10 | 0.27 |
| HE0833 | 3190206.310 | -91657.200 | 70.800 | 27.00 | 23.34 | 3.89 | 0.63 | 3.09 | 3.09 | 0.32 |
| HE0834 | 3190251.550 | -91678.280 | 68.030 | 18.00 | 20.78 | 8.53 | 1.54 | 5.35 | 5.35 | 0.54 |
| HE0835 | 3190296.850 | -91699.420 | 63.530 | 21.00 | 21.76 | 5.24 | 0.80 | 3.34 | 3.34 | 0.35 |
| HE0836 | 3190342.190 | -91720.500 | 57.610 | 27.00 | 21.48 | 5.08 | 0.76 | 3.20 | 3.20 | 0.37 |
| HE0837 | 3190387.490 | -91741.670 | 53.190 | 21.00 | 24.71 | 4.67 | 0.73 | 2.99 | 2.99 | 0.28 |
| HE0838 | 3190432.800 | -91762.850 | 49.630 | 21.00 | 25.15 | 4.45 | 0.63 | 3.39 | 3.39 | 0.28 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0839 | 3190478.110 | -91783.870 | 47.370 | 21.00 | 20.04 | 2.70 | 0.40 | 2.31 | 2.31 | 0.19 |
| HE0840 | 3190523.460 | -91805.110 | 44.340 | 15.00 | 17.52 | 2.26 | 0.43 | 1.54 | 1.54 | 0.24 |
| HE0841 | 3190568.810 | -91826.190 | 40.370 | 15.00 | 23.02 | 2.06 | 0.20 | 2.21 | 2.21 | 0.67 |
| HE0842 | 3190026.740 | -91628.030 | 71.750 | 24.00 | 24.86 | 3.69 | 0.40 | 2.35 | 2.35 | 0.25 |
| HE0843 | 3190072.070 | -91649.010 | 70.660 | 21.00 | 28.06 | 2.83 | 0.18 | 1.71 | 1.71 | 0.20 |
| HE0844 | 3190117.130 | -91670.840 | 69.760 | 18.00 | 20.48 | 4.01 | 0.52 | 2.34 | 2.34 | 0.49 |
| HE0845 | 3190162.600 | -91691.250 | 68.950 | 21.00 | 26.50 | 5.03 | 0.64 | 3.31 | 3.31 | 0.30 |
| HE0846 | 3190207.990 | -91712.400 | 66.510 | 15.00 | 29.04 | 6.37 | 1.01 | 3.95 | 3.95 | 0.43 |
| HE0847 | 3190253.120 | -91734.160 | 60.870 | 18.00 | 24.49 | 4.50 | 0.61 | 2.95 | 2.95 | 0.26 |
| HE0848 | 3190298.570 | -91754.620 | 56.330 | 18.00 | 23.13 | 4.95 | 0.60 | 3.27 | 3.27 | 0.28 |
| HE0849 | 3190343.990 | -91775.740 | 52.530 | 21.00 | 25.43 | 5.83 | 0.85 | 3.71 | 3.71 | 0.35 |
| HE0850 | 3190389.260 | -91796.960 | 49.210 | 18.00 | 29.80 | 3.86 | 0.53 | 2.44 | 2.44 | 0.32 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0851 | 3190434.390 | -91818.630 | 46.240 | 21.00 | 25.41 | 2.38 | 0.23 | 1.52 | 1.52 | 0.17 |
| HE0852 | 3190479.790 | -91839.150 | 42.360 | 18.00 | 30.70 | 3.61 | 0.37 | 2.23 | 2.23 | 0.35 |
| HE0854 | 3190028.240 | -91683.790 | 68.740 | 24.00 | 25.46 | 1.98 | 0.24 | 2.20 | 2.20 | 0.22 |
| HE0855 | 3190073.500 | -91704.970 | 67.920 | 24.00 | 28.15 | 2.91 | 0.32 | 2.59 | 2.59 | 0.25 |
| HE0856 | 3190118.900 | -91726.100 | 67.300 | 18.00 | 20.67 | 2.74 | 0.46 | 2.31 | 2.31 | 0.31 |
| HE0857 | 3190164.220 | -91747.170 | 65.560 | 15.00 | 19.14 | 3.84 | 0.77 | 2.75 | 2.75 | 0.39 |
| HE0858 | 3190209.800 | -91768.360 | 60.150 | 18.00 | 15.67 | 3.24 | 0.48 | 1.74 | 1.74 | 0.52 |
| HE0859 | 3190254.850 | -91789.480 | 54.920 | 18.00 | 16.01 | 3.11 | 0.45 | 1.89 | 1.89 | 0.29 |
| HE0860 | 3190300.220 | -91810.590 | 50.840 | 27.00 | 19.70 | 3.72 | 0.58 | 2.61 | 2.61 | 0.26 |
| HE0861 | 3190345.470 | -91831.660 | 47.960 | 15.00 | 17.64 | 2.74 | 0.47 | 1.69 | 1.69 | 0.19 |
| HE0862 | 3190390.890 | -91852.730 | 44.570 | 15.00 | 18.56 | 3.15 | 0.42 | 2.46 | 2.46 | 0.18 |
| HE0863 | 3190436.050 | -91873.880 | 41.000 | 15.00 | 17.40 | 1.23 | 0.22 | 1.28 | 1.28 | 0.11 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0864 | 3190075.120 | -91760.870 | 65.860 | 24.00 | 21.33 | 3.60 | 0.46 | 2.23 | 2.23 | 0.27 |
| HE0866 | 3190165.720 | -91803.040 | 57.280 | 36.00 | 13.29 | 7.13 | 0.74 | 3.28 | 3.28 | 2.33 |
| HE0867 | 3190211.090 | -91824.190 | 53.300 | 27.00 | 19.38 | 5.55 | 0.71 | 3.49 | 3.49 | 0.53 |
| HE0868 | 3190256.260 | -91845.330 | 48.890 | 21.00 | 18.78 | 3.49 | 0.47 | 2.18 | 2.18 | 0.27 |
| HE0869 | 3190301.750 | -91866.460 | 45.750 | 21.00 | 21.16 | 3.88 | 0.63 | 2.37 | 2.37 | 0.25 |
| HE0870 | 3190347.020 | -91887.580 | 40.240 | 18.00 | 22.78 | 3.33 | 0.33 | 2.11 | 2.11 | 0.22 |
| HE0871 | 3190392.300 | -91908.630 | 40.240 | 21.00 | 22.69 | 2.33 | 0.15 | 1.49 | 1.49 | 0.12 |
| HE0872 | 3189986.000 | -91774.570 | 64.880 | 69.00 | 21.07 | 3.95 | 0.48 | 2.78 | 2.78 | 0.39 |
| HE0873 | 3190076.590 | -91816.650 | 63.950 | 27.00 | 22.90 | 5.13 | 0.77 | 3.11 | 3.11 | 0.41 |
| HE0874 | 3190121.960 | -91837.900 | 56.310 | 27.00 | 18.42 | 5.33 | 0.80 | 3.27 | 3.27 | 0.51 |
| HE0875 | 3190165.150 | -91859.080 | 52.390 | 30.00 | 17.91 | 5.72 | 0.77 | 3.59 | 3.59 | 0.54 |
| HE0876 | 3190212.650 | -91880.040 | 47.870 | 18.00 | 18.30 | 4.94 | 0.79 | 3.78 | 3.78 | 0.40 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0877 | 3190257.910 | -91901.250 | 44.590 | 18.00 | 19.17 | 2.17 | 0.45 | 2.49 | 2.49 | 0.29 |
| HE0878 | 3190303.160 | -91922.430 | 42.110 | 18.00 | 22.63 | 3.30 | 0.53 | 3.49 | 3.49 | 0.25 |
| HE0879 | 3190348.440 | -91943.460 | 39.890 | 21.00 | 26.30 | 2.58 | 0.37 | 2.64 | 2.64 | 0.20 |
| HE0880 | 3189987.550 | -91830.300 | 65.270 | 27.00 | 23.49 | 3.05 | 0.38 | 1.83 | 1.83 | 0.25 |
| HE0881 | 3190032.900 | -91851.500 | 61.260 | 24.00 | 26.50 | 6.95 | 0.88 | 4.31 | 4.31 | 0.73 |
| HE0882 | 3190078.150 | -91872.620 | 54.960 | 30.00 | 17.77 | 6.26 | 1.01 | 3.35 | 3.35 | 1.11 |
| HE0883 | 3190123.440 | -91893.810 | 52.180 | 54.00 | 15.55 | 7.00 | 0.79 | 3.50 | 3.50 | 1.88 |
| HE0884 | 3190168.820 | -91914.850 | 49.180 | 33.00 | 21.99 | 4.92 | 0.63 | 3.14 | 3.14 | 0.31 |
| HE0885 | 3190211.580 | -91933.340 | 46.240 | 18.00 | 22.63 | 3.04 | 0.42 | 1.77 | 1.77 | 0.22 |
| HE0886 | 3190259.530 | -91957.070 | 42.830 | 18.00 | 20.51 | 2.58 | 0.25 | 1.52 | 1.52 | 0.25 |
| HE0887 | 3190304.820 | -91978.140 | 40.190 | 45.00 | 19.03 | 2.13 | 0.27 | 1.33 | 1.33 | 0.15 |
| HE0888 | 3189989.060 | -91886.150 | 57.850 | 27.00 | 22.32 | 4.44 | 0.57 | 2.82 | 2.82 | 0.39 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0889 | 3190034.450 | -91907.400 | 54.740 | 36.00 | 19.51 | 5.09 | 0.75 | 2.82 | 2.82 | 0.84 |
| HE0890 | 3190079.770 | -91928.460 | 52.120 | 39.00 | 20.93 | 5.17 | 0.76 | 3.23 | 3.23 | 0.43 |
| HE0891 | 3190125.010 | -91949.650 | 51.150 | 39.00 | 20.20 | 4.90 | 0.61 | 3.14 | 3.14 | 0.42 |
| HE0892 | 3190170.400 | -91970.770 | 49.220 | 24.00 | 22.79 | 3.19 | 0.35 | 2.03 | 2.03 | 0.17 |
| HE0893 | 3190215.670 | -91991.940 | 45.230 | 21.00 | 22.55 | 2.74 | 0.36 | 2.39 | 2.39 | 0.18 |
| HE0894 | 3190261.020 | -92013.030 | 42.330 | 18.00 | 24.59 | 2.43 | 0.34 | 1.93 | 1.93 | 0.18 |
| HE0895 | 3189987.480 | -91939.020 | 53.490 | 30.00 | 18.41 | 5.96 | 0.95 | 3.71 | 3.71 | 0.45 |
| HE0896 | 3190033.290 | -91960.590 | 52.970 | 39.00 | 21.07 | 5.71 | 0.83 | 3.67 | 3.67 | 0.41 |
| HE0897 | 3190078.670 | -91981.630 | 50.930 | 30.00 | 24.32 | 4.58 | 0.53 | 3.08 | 3.08 | 0.28 |
| HE0898 | 3190123.930 | -92002.790 | 49.660 | 33.00 | 20.49 | 3.99 | 0.46 | 2.61 | 2.61 | 0.27 |
| HE0899 | 3190169.240 | -92023.960 | 47.940 | 24.00 | 23.81 | 3.07 | 0.30 | 2.08 | 2.08 | 0.20 |
| HE0901 | 3189989.010 | -91994.950 | 51.800 | 54.00 | 22.11 | 4.82 | 0.69 | 3.11 | 3.11 | 0.33 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0902 | 3190034.810 | -92016.430 | 49.430 | 39.00 | 20.59 | 3.97 | 0.55 | 2.53 | 2.53 | 0.27 |
| HE0903 | 3190080.130 | -92037.560 | 47.840 | 27.00 | 22.59 | 3.94 | 0.45 | 2.55 | 2.55 | 0.24 |
| HE0904 | 3190125.530 | -92058.750 | 48.280 | 45.00 | 21.31 | 3.24 | 0.38 | 2.12 | 2.12 | 0.23 |
| HE0906 | 3191215.790 | -90801.040 | 79.930 | 30.00 | 5.77 | 23.62 | 1.12 | 8.81 | 8.81 | 12.06 |
| HE0907 | 3191209.100 | -90690.500 | 72.830 | 27.00 | 16.38 | 6.92 | 0.57 | 4.35 | 4.35 | 0.96 |
| HE0934 | 3189483.173 | -91374.948 | 39.882 | 90.00 | 14.60 | 8.73 | 0.47 | 3.49 | 3.49 | 3.56 |
| HE0996 | 3189196.642 | -91523.315 | 30.930 | 42.00 | 37.00 | 2.24 | 0.07 | 1.52 | 1.52 | 0.12 |
| HE0954 | 3189620.551 | -91494.471 | 62.999 | 90.00 | 20.56 | 5.71 | 0.59 | 3.67 | 3.67 | 0.57 |
| HE0955 | 3189666.245 | -91515.240 | 58.576 | 90.00 | 25.90 | 5.36 | 0.58 | 3.50 | 3.50 | 0.40 |
| HE0956 | 3189714.814 | -91539.691 | 67.054 | 108.00 | 23.08 | 5.88 | 0.69 | 3.77 | 3.77 | 0.52 |
| HE0967 | 3189576.331 | -91528.497 | 67.576 | 117.00 | 20.67 | 7.11 | 0.74 | 4.85 | 4.85 | 0.41 |
| HE0968 | 3189622.216 | -91549.656 | 59.194 | 117.00 | 23.36 | 6.53 | 0.78 | 4.34 | 4.34 | 0.38 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0969 | 3189667.328 | -91570.776 | 63.690 | 117.00 | 24.68 | 6.72 | 0.91 | 4.29 | 4.29 | 0.50 |
| HE0625 | 3189832.544 | -91271.713 | 53.891 | 162.00 | 11.59 | 11.40 | 0.64 | 5.26 | 5.26 | 4.03 |
| HE0699 | 3189614.402 | -91270.783 | 39.058 | 108.00 | 18.66 | 3.85 | 0.35 | 1.93 | 1.93 | 0.88 |
| HE0916 | 3189526.902 | -91340.138 | 40.030 | 99.00 | 18.15 | 9.41 | 0.49 | 3.75 | 3.75 | 3.85 |
| HE0919 | 3189667.269 | -91405.317 | 65.434 | 141.00 | 17.65 | 10.31 | 0.94 | 5.61 | 5.61 | 2.28 |
| HE0937 | 3189627.210 | -91440.395 | 65.489 | 153.00 | 17.27 | 9.29 | 0.90 | 5.64 | 5.64 | 1.35 |
| HE0667 | 3189658.232 | -91235.941 | 35.779 | 90.00 | 17.82 | 7.61 | 0.48 | 3.52 | 3.52 | 2.51 |
| HE0768 | 3189570.641 | -91305.425 | 40.359 | 90.00 | 12.56 | 7.76 | 0.45 | 3.35 | 3.35 | 2.82 |
| HE0950 | 3189439.557 | -91409.086 | 38.451 | 90.00 | 19.72 | 9.69 | 0.51 | 3.93 | 3.93 | 3.86 |
| HE0666 | 3189612.968 | -91214.861 | 29.057 | 108.00 | 25.29 | 2.16 | 0.14 | 1.19 | 1.19 | 0.18 |
| HE0698 | 3189523.602 | -91228.421 | 30.421 | 117.00 | 21.83 | 5.47 | 0.27 | 2.44 | 2.44 | 1.79 |
| HE0766 | 3189480.147 | -91263.232 | 32.456 | 108.00 | 26.68 | 4.70 | 0.31 | 2.44 | 2.44 | 1.06 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0767 | 3189528.741 | -91281.950 | 35.829 | 81.00 | 18.18 | 8.59 | 0.44 | 2.52 | 2.52 | 3.67 |
| HE0914 | 3189436.375 | -91298.296 | 33.087 | 81.00 | 34.67 | 5.10 | 0.30 | 2.63 | 2.63 | 1.27 |
| HE0932 | 3189392.263 | -91332.481 | 33.600 | 90.00 | 35.19 | 5.24 | 0.34 | 3.05 | 3.05 | 0.95 |
| HE0930 | 3189301.739 | -91290.377 | 23.674 | 63.00 | 36.74 | 6.20 | 0.21 | 4.56 | 4.56 | 0.28 |
| HE0947 | 3189303.342 | -91346.267 | 25.920 | 90.00 | 41.32 | 3.70 | 0.24 | 2.50 | 2.50 | 0.16 |
| HE0948 | 3189348.889 | -91366.759 | 29.349 | 72.00 | 29.06 | 6.77 | 0.51 | 4.61 | 4.61 | 0.62 |
| HE0949 | 3189395.778 | -91388.680 | 34.467 | 81.00 | 20.77 | 9.55 | 0.92 | 5.43 | 5.43 | 1.84 |
| HE0951 | 3189484.680 | -91430.706 | 42.896 | 99.00 | 12.79 | 7.63 | 0.43 | 2.92 | 2.92 | 3.10 |
| HE0962 | 3189350.473 | -91422.768 | 29.656 | 90.00 | 33.39 | 6.01 | 0.52 | 4.10 | 4.10 | 0.32 |
| HE0964 | 3189441.178 | -91464.730 | 38.324 | 90.00 | 23.45 | 5.88 | 0.54 | 3.52 | 3.52 | 0.82 |
| HE0965 | 3189485.108 | -91486.851 | 47.262 | 117.00 | 24.20 | 7.38 | 0.60 | 4.21 | 4.21 | 1.41 |
| HE0920 | 3189708.436 | -91424.536 | 56.211 | 45.00 | 15.61 | 11.33 | 0.96 | 6.78 | 6.78 | 2.14 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0921 | 3189754.353 | -91445.775 | 51.242 | 33.00 | 17.44 | 10.57 | 1.07 | 6.91 | 6.91 | 1.02 |
| HE0938 | 3189663.680 | -91462.963 | 59.271 | 36.00 | 18.39 | 7.33 | 0.78 | 4.95 | 4.95 | 0.49 |
| HE0939 | 3189710.343 | -91480.325 | 57.006 | 33.00 | 17.64 | 6.31 | 0.76 | 4.14 | 4.14 | 0.43 |
| HE0940 | 3189754.464 | -91489.809 | 59.896 | 39.00 | 19.26 | 5.67 | 0.70 | 3.38 | 3.38 | 0.68 |
| HE0616 | 3190057.450 | -91303.684 | 52.300 | 54.00 | 13.11 | 2.94 | 0.23 | 1.17 | 1.17 | 0.91 |
| HE0685 | 3190066.206 | -91426.067 | 49.189 | 51.00 | 9.49 | 4.90 | 0.29 | 1.28 | 1.28 | 2.36 |
| HE0724 | 3189984.007 | -91441.490 | 39.606 | 39.00 | 12.48 | 4.68 | 0.38 | 1.77 | 1.77 | 1.58 |
| HE0725 | 3190015.880 | -91453.769 | 49.250 | 78.00 | 10.28 | 5.32 | 0.37 | 1.66 | 1.66 | 2.46 |
| HE0865 | 3189887.983 | -91457.598 | 49.929 | 51.00 | 11.13 | 3.47 | 0.24 | 1.29 | 1.29 | 1.23 |
| HE0909 | 3189932.153 | -91475.736 | 51.593 | 51.00 | 10.82 | 6.73 | 0.39 | 2.52 | 2.52 | 2.98 |
| HE0655 | 3190190.341 | -91396.571 | 86.992 | 69.00 | 18.15 | 4.69 | 0.49 | 2.70 | 2.70 | 0.64 |
| HE0923 | 3189838.218 | -91492.991 | 70.880 | 60.00 | 16.34 | 6.57 | 0.48 | 3.38 | 3.38 | 1.54 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0925 | 3189935.384 | -91530.224 | 74.839 | 63.00 | 18.83 | 5.97 | 0.56 | 3.34 | 3.34 | 1.12 |
| HE0942 | 3189838.376 | -91539.808 | 71.538 | 60.00 | 16.91 | 7.10 | 0.41 | 2.79 | 2.79 | 2.62 |
| HE0917 | 3189572.128 | -91361.305 | 46.930 | 33.00 | 14.01 | 10.19 | 0.64 | 4.96 | 4.96 | 3.40 |
| HE0935 | 3189528.344 | -91395.936 | 44.785 | 33.00 | 20.03 | 8.62 | 0.61 | 4.47 | 4.47 | 2.22 |
| HE0936 | 3189562.885 | -91411.733 | 50.287 | 33.00 | 10.73 | 12.40 | 0.86 | 6.21 | 6.21 | 3.87 |
| HE0952 | 3189530.098 | -91451.215 | 49.332 | 30.00 | 14.78 | 9.70 | 0.87 | 5.49 | 5.49 | 2.01 |
| HE0712 | 3189799.696 | -91357.188 | 54.644 | 42.00 | 18.62 | 8.88 | 0.80 | 5.19 | 5.19 | 1.70 |
| HE0793 | 3189752.396 | -91389.900 | 56.103 | 48.00 | 16.95 | 9.38 | 0.79 | 5.29 | 5.29 | 1.97 |
| HE0926 | 3189980.400 | -91551.427 | 75.772 | 60.00 | 17.63 | 5.47 | 0.41 | 2.44 | 2.44 | 2.03 |
| HE0927 | 3190016.432 | -91571.252 | 74.978 | 60.00 | 18.08 | 3.35 | 0.41 | 1.90 | 1.90 | 0.37 |
| HE0943 | 3189891.506 | -91564.842 | 73.568 | 63.00 | 16.84 | 3.99 | 0.39 | 2.25 | 2.25 | 0.67 |
| HE0621 | 3190104.589 | -91339.322 | 57.017 | 57.00 | 10.36 | 4.37 | 0.34 | 1.63 | 1.63 | 1.66 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0910 | 3189985.874 | -91500.138 | 61.122 | 63.00 | 13.19 | 4.24 | 0.39 | 1.86 | 1.86 | 1.14 |
| HE0613 | 3190146.798 | -91306.232 | 56.808 | 60.00 | 8.89 | 5.88 | 0.30 | 2.00 | 2.00 | 2.60 |
| HE0980 | 3189576.828 | -91582.019 | 60.183 | 60.00 | 24.47 | 4.97 | 0.61 | 3.01 | 3.01 | 0.47 |
| HE1000 | 3189399.991 | -91611.735 | 48.624 | 54.00 | 29.41 | 6.09 | 0.63 | 2.82 | 2.82 | 1.53 |
| HE1002 | 3189490.728 | -91653.894 | 51.447 | 60.00 | 31.99 | 5.36 | 0.62 | 3.20 | 3.20 | 0.55 |
| HE1010 | 3189401.775 | -91667.671 | 45.660 | 51.00 | 29.80 | 5.49 | 0.61 | 3.05 | 3.05 | 0.84 |
| HE1011 | 3189447.023 | -91688.750 | 47.274 | 54.00 | 34.89 | 4.99 | 0.50 | 3.25 | 3.25 | 0.34 |
| HE1016 | 3189264.824 | -91657.198 | 36.668 | 39.00 | 44.02 | 4.68 | 0.49 | 3.04 | 3.04 | 0.34 |
| HE1007 | 3189265.837 | -91604.101 | 39.390 | 39.00 | 42.33 | 5.28 | 0.44 | 3.62 | 3.62 | 0.31 |
| HE1008 | 3189298.333 | -91614.035 | 41.435 | 48.00 | 42.86 | 5.36 | 0.54 | 3.05 | 3.05 | 0.78 |
| HE1021 | 3189216.210 | -91689.839 | 31.569 | 33.00 | 43.35 | 4.37 | 0.34 | 2.97 | 2.97 | 0.31 |
| HE1028 | 3189206.256 | -91742.774 | 29.418 | 33.00 | 43.91 | 4.13 | 0.29 | 2.74 | 2.74 | 0.22 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0978 | 3189484.639 | -91524.079 | 53.140 | 36.00 | 11.89 | 11.71 | 1.02 | 5.21 | 5.21 | 4.02 |
| HE1030 | 3189342.461 | -91811.262 | 41.495 | 36.00 | 31.64 | 8.34 | 0.65 | 3.76 | 3.76 | 2.76 |
| HE1052 | 3189182.906 | -91952.973 | 24.832 | 33.00 | 45.21 | 1.41 | 0.06 | 0.75 | 0.75 | 0.15 |
| HE1056 | 3189177.041 | -92008.459 | 24.514 | 33.00 | 43.80 | 1.49 | 0.09 | 0.93 | 0.93 | 0.06 |
| HE1014 | 3189174.205 | -91614.887 | 32.400 | 36.00 | 40.49 | 2.95 | 0.17 | 1.93 | 1.93 | 0.14 |
| HE1034 | 3189168.510 | -91772.226 | 26.444 | 39.00 | 41.50 | 4.98 | 0.38 | 3.39 | 3.39 | 0.28 |
| HE1040 | 3189133.526 | -91806.791 | 23.059 | 39.00 | 49.22 | 2.92 | 0.15 | 1.99 | 1.99 | 0.16 |
| HE0638 | 3190018.909 | -91347.571 | 30.837 | 33.00 | 13.14 | 3.16 | 0.22 | 1.15 | 1.15 | 0.99 |
| HE0960 | 3189257.391 | -91370.052 | 26.102 | 42.00 | 38.19 | 3.52 | 0.28 | 2.38 | 2.38 | 0.17 |
| HE0972 | 3189206.109 | -91402.515 | 27.050 | 33.00 | 40.54 | 3.63 | 0.14 | 2.49 | 2.49 | 0.14 |
| HE0983 | 3189161.667 | -91451.921 | 27.014 | 39.00 | 44.74 | 2.01 | 0.10 | 1.24 | 1.24 | 0.12 |
| HE0992 | 3189579.653 | -91640.203 | 55.027 | 99.00 | 24.81 | 7.14 | 0.94 | 4.74 | 4.74 | 0.38 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0961 | 3189307.381 | -91421.007 | 30.451 | 45.00 | 33.03 | 3.46 | 0.26 | 2.22 | 2.22 | 0.14 |
| HE0973 | 3189263.509 | -91430.097 | 30.992 | 48.00 | 40.81 | 3.51 | 0.21 | 2.25 | 2.25 | 0.32 |
| HE0981 | 3189623.577 | -91605.467 | 58.396 | 90.00 | 24.75 | 11.32 | 1.36 | 7.08 | 7.08 | 1.41 |
| HE1013 | 3189122.451 | -91574.339 | 25.289 | 36.00 | 43.59 | 2.95 | 0.20 | 1.42 | 1.42 | 0.61 |
| HE0974 | 3189308.029 | -91469.580 | 35.207 | 42.00 | 33.40 | 5.98 | 0.66 | 3.68 | 3.68 | 0.51 |
| HE0975 | 3189357.234 | -91488.351 | 34.433 | 42.00 | 34.80 | 7.76 | 0.72 | 4.63 | 4.63 | 1.18 |
| HE0985 | 3189262.967 | -91492.085 | 35.180 | 42.00 | 36.33 | 4.76 | 0.44 | 3.19 | 3.19 | 0.14 |
| HE0997 | 3189225.484 | -91557.627 | 35.134 | 42.00 | 42.87 | 5.37 | 0.36 | 3.81 | 3.81 | 0.17 |
| HE0713 | 3189839.114 | -91374.257 | 35.842 | 45.00 | 14.12 | 3.46 | 0.28 | 1.61 | 1.61 | 0.72 |
| HE0715 | 3189920.421 | -91407.801 | 33.181 | 36.00 | 12.25 | 4.37 | 0.22 | 1.24 | 1.24 | 2.17 |
| HE0795 | 3189793.582 | -91435.945 | 49.259 | 48.00 | 16.30 | 6.87 | 0.60 | 3.98 | 3.98 | 1.06 |
| HE0977 | 3189441.717 | -91530.609 | 45.580 | 51.00 | 29.40 | 8.20 | 0.80 | 3.44 | 3.44 | 2.70 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0986 | 3189308.798 | -91513.326 | 40.982 | 45.00 | 36.92 | 6.74 | 0.65 | 4.41 | 4.41 | 0.51 |
| HE0987 | 3189347.737 | -91536.092 | 39.487 | 45.00 | 35.47 | 8.14 | 0.66 | 3.59 | 3.59 | 2.66 |
| HE0673 | 3189963.419 | -91352.177 | 24.451 | 24.00 | 15.47 | 4.92 | 0.35 | 2.62 | 2.62 | 1.11 |
| HE0683 | 3189975.889 | -91383.792 | 30.114 | 30.00 | 12.01 | 3.91 | 0.23 | 1.31 | 1.31 | 1.52 |
| HE0988 | 3189398.479 | -91555.847 | 42.469 | 42.00 | 33.57 | 8.43 | 0.49 | 4.07 | 4.07 | 2.87 |
| HE0989 | 3189314.478 | -91557.045 | 42.967 | 45.00 | 21.65 | 8.86 | 0.93 | 4.91 | 4.91 | 1.84 |
| HE0749 | 3189389.423 | -91220.804 | 24.166 | 27.00 | 39.43 | 4.59 | 0.30 | 3.10 | 3.10 | 0.27 |
| HE0750 | 3189434.496 | -91242.038 | 29.061 | 42.00 | 38.80 | 2.53 | 0.15 | 1.48 | 1.48 | 0.18 |
| HE0913 | 3189391.044 | -91276.813 | 28.028 | 42.00 | 37.71 | 3.22 | 0.19 | 2.12 | 2.12 | 0.15 |
| HE0931 | 3189347.184 | -91311.674 | 28.195 | 42.00 | 34.33 | 4.80 | 0.25 | 3.16 | 3.16 | 0.15 |
| HE0990 | 3189440.662 | -91625.383 | 50.817 | 45.00 | 27.65 | 8.12 | 0.90 | 4.12 | 4.12 | 1.89 |
| HE0924 | 3189889.459 | -91509.045 | 73.633 | 60.00 | 12.90 | 9.78 | 0.51 | 3.78 | 3.78 | 4.08 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE1093 | 3192007.142 | -90108.618 | 50.541 | 117.00 | 22.39 | 4.62 | 0.47 | 2.99 | 2.99 | 0.23 |
| HE1062 | 3191876.056 | -90714.029 | 43.609 | 126.00 | 22.92 | 3.74 | 0.35 | 2.18 | 2.18 | 0.34 |
| HE1065 | 3191971.216 | -90704.064 | 40.389 | 126.00 | 23.45 | 3.18 | 0.31 | 1.94 | 1.94 | 0.19 |
| HE1066 | 3191926.788 | -90631.831 | 40.988 | 126.00 | 23.57 | 2.91 | 0.27 | 1.71 | 1.71 | 0.19 |
| HE1067 | 3191967.647 | -90496.444 | 40.695 | 126.00 | 23.35 | 2.76 | 0.22 | 1.61 | 1.61 | 0.16 |
| HE1079 | 3191957.487 | -90255.287 | 45.317 | 96.00 | 19.79 | 3.95 | 0.42 | 2.64 | 2.64 | 0.19 |
| HE1084 | 3192004.932 | -90225.825 | 47.044 | 90.00 | 19.81 | 4.08 | 0.42 | 2.69 | 2.69 | 0.26 |
| HE1087 | 3192003.385 | -90167.439 | 48.473 | 108.00 | 21.93 | 2.46 | 0.17 | 1.58 | 1.58 | 0.12 |
| HE1088 | 3192061.820 | -90190.522 | 44.217 | 90.00 | 22.46 | 2.86 | 0.31 | 1.83 | 1.83 | 0.19 |
| HE1094 | 3192061.164 | -90137.821 | 45.624 | 90.00 | 23.56 | 2.71 | 0.19 | 1.78 | 1.78 | 0.13 |
| HE1110 | 3192061.042 | -90080.415 | 47.931 | 108.00 | 24.78 | 3.62 | 0.26 | 2.40 | 2.40 | 0.17 |
| HE1090 | 3192164.236 | -90240.980 | 38.578 | 90.00 | 27.86 | 3.89 | 0.37 | 2.39 | 2.39 | 0.23 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE1098 | 3192265.647 | -90229.596 | 40.347 | 90.00 | 24.25 | 3.78 | 0.27 | 2.40 | 2.40 | 0.27 |
| HE1091 | 3192213.626 | -90266.402 | 37.506 | 90.00 | 26.62 | 3.07 | 0.25 | 1.91 | 1.91 | 0.18 |
| HE1096 | 3192161.486 | -90185.366 | 40.820 | 90.00 | 21.04 | 2.93 | 0.27 | 1.82 | 1.82 | 0.21 |
| HE1068 | 3192013.094 | -90510.681 | 39.223 | 126.00 | 24.53 | 4.08 | 0.17 | 2.64 | 2.64 | 0.34 |
| HE1076 | 3192010.421 | -90336.677 | 39.483 | 108.00 | 24.26 | 3.49 | 0.38 | 2.11 | 2.11 | 0.24 |
| HE1081 | 3192162.872 | -90356.960 | 36.634 | 111.00 | 22.72 | 2.58 | 0.16 | 1.52 | 1.52 | 0.17 |
| HE1082 | 3192219.990 | -90374.047 | 36.576 | 108.00 | 27.24 | 2.00 | 0.09 | 1.13 | 1.13 | 0.14 |
| HE1095 | 3192111.883 | -90165.369 | 42.475 | 90.00 | 22.54 | 3.32 | 0.34 | 2.12 | 2.12 | 0.24 |
| HE1111 | 3192108.533 | -90107.801 | 48.441 | 108.00 | 22.11 | 4.57 | 0.42 | 2.85 | 2.85 | 0.26 |
| HE1112 | 3192160.085 | -90131.255 | 43.644 | 90.00 | 23.74 | 2.93 | 0.27 | 1.84 | 1.84 | 0.20 |
| HE1113 | 3192212.614 | -90158.821 | 42.908 | 99.00 | 24.21 | 3.45 | 0.27 | 2.20 | 2.20 | 0.25 |
| HE1114 | 3192261.365 | -90180.382 | 42.452 | 108.00 | 25.82 | 3.47 | 0.29 | 2.12 | 2.12 | 0.26 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE1116 | 3192110.724 | -90051.399 | 46.398 | 117.00 | 27.68 | 2.69 | 0.18 | 1.75 | 1.75 | 0.15 |
| HE1117 | 3192159.130 | -90074.279 | 43.489 | 108.00 | 25.16 | 3.58 | 0.34 | 2.16 | 2.16 | 0.27 |
| HE1118 | 3192209.722 | -90101.515 | 43.856 | 99.00 | 25.19 | 3.98 | 0.39 | 2.52 | 2.52 | 0.22 |
| HE1119 | 3192259.567 | -90123.608 | 39.709 | 90.00 | 23.90 | 3.16 | 0.26 | 2.01 | 2.01 | 0.17 |
| HE1121 | 3192208.515 | -90042.440 | 41.136 | 84.00 | 21.53 | 5.32 | 0.71 | 3.18 | 3.18 | 0.43 |
| HE1122 | 3192258.149 | -90067.234 | 39.377 | 90.00 | 23.60 | 3.59 | 0.37 | 2.20 | 2.20 | 0.22 |

## 12 Addendum D

Reverse Circulation drillhole information

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0293 | 3191748.71 | -90831.80 | 44.61 | 21.00 | 35.37 | 5.28 | 0.29 | 3.66 | 0.35 | 0.95 |
| HE0296 | 3191794.01 | -90852.98 | 40.88 | 24.00 | 39.02 | 3.60 | 0.21 | 2.51 | 0.46 | 0.76 |
| HE0297 | 3191509.820 | -90279.180 | 0.000 | 33.00 | 29.44 | 6.96 | 1.41 | 5.71 | 0.52 | 1.35 |
| HE0313 | 3191839.330 | -90874.050 | 38.830 | 27.00 | 35.91 | 3.25 | 0.20 | 2.08 | 0.56 | 0.68 |
| HE0331 | 3191690.620 | -90422.200 | 58.510 | 18.00 | 36.25 | 2.58 | 0.31 | 2.31 | 0.22 | 0.55 |
| HE0343 | 3191467.600 | -90369.780 | 63.910 | 27.00 | 29.04 | 4.10 | 0.43 | 2.94 | 0.24 | 0.82 |
| HE0347 | 3191514.350 | -90388.050 | 62.703 | 24.00 | 31.59 | 3.28 | 0.43 | 2.75 | 0.26 | 0.70 |
| HE0348 | 3191693.940 | -90475.420 | 56.060 | 21.00 | 35.08 | 3.67 | 0.76 | 2.95 | 0.33 | 0.76 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0349 | 3191739.020 | -90496.630 | 51.676 | 9.00 | 33.70 | 3.12 | 0.77 | 3.55 | 0.32 | 0.82 |
| HE0359 | 3191423.780 | -90404.580 | 61.381 | 24.00 | 30.54 | 3.85 | 0.51 | 3.83 | 0.31 | 1.04 |
| HE0360 | 3191472.760 | -90421.480 | 63.990 | 30.00 | 29.66 | 2.55 | 0.38 | 1.76 | 0.24 | 0.55 |
| HE0361 | 3191514.000 | -90446.880 | 61.600 | 21.00 | 32.50 | 3.15 | 0.50 | 2.23 | 0.26 | 0.56 |
| HE0363 | 3191604.950 | -90489.100 | 61.008 | 21.00 | 31.35 | 3.73 | 0.71 | 2.99 | 0.39 | 0.83 |
| HE0364 | 3191650.040 | -90510.160 | 58.470 | 24.00 | 31.40 | 4.95 | 0.63 | 3.04 | 0.36 | 0.91 |
| HE0377 | 3191425.580 | -90460.500 | 65.430 | 21.00 | 31.81 | 3.09 | 0.46 | 2.27 | 0.22 | 0.58 |
| HE0378 | 3191470.650 | -90481.610 | 64.000 | 18.00 | 35.42 | 3.90 | 0.65 | 3.29 | 0.35 | 0.79 |
| HE0379 | 3191515.940 | -90502.760 | 63.956 | 21.00 | 27.60 | 3.02 | 0.80 | 2.10 | 0.33 | 0.54 |
| HE0381 | 3191607.020 | -90544.970 | 61.625 | 24.00 | 31.78 | 5.46 | 0.99 | 3.45 | 0.49 | 1.10 |
| HE0391 | 3191384.130 | -90490.480 | 66.620 | 18.00 | 31.68 | 3.92 | 0.67 | 2.80 | 0.31 | 0.73 |
| HE0392 | 3191426.890 | -90516.310 | 66.204 | 18.00 | 32.60 | 2.30 | 0.42 | 3.27 | 0.55 | 0.81 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0398 | 3191471.430 | -90539.310 | 66.380 | 18.00 | 26.52 | 4.00 | 0.58 | 2.48 | 0.30 | 0.62 |
| HE0399 | 3191518.050 | -90558.610 | 66.598 | 30.00 | 29.88 | 3.88 | 0.76 | 2.86 | 0.36 | 0.70 |
| HE0400 | 3191563.010 | -90579.790 | 62.994 | 24.00 | 29.03 | 3.84 | 0.72 | 2.47 | 0.33 | 0.66 |
| HE0408 | 3191390.260 | -90541.360 | 67.656 | 18.00 | 28.95 | 1.69 | 0.23 | 1.94 | 0.19 | 0.51 |
| HE0409 | 3191434.120 | -90562.930 | 67.111 | 18.00 | 31.19 | 1.86 | 0.29 | 1.25 | 0.20 | 0.34 |
| HE0410 | 3191480.780 | -90583.710 | 68.690 | 24.00 | 29.12 | 3.46 | 0.52 | 2.10 | 0.56 | 0.58 |
| HE0411 | 3191524.460 | -90606.810 | 66.550 | 24.00 | 27.86 | 3.95 | 0.50 | 2.54 | 0.44 | 0.79 |
| HE0412 | 3191560.670 | -90623.100 | 63.100 | 24.00 | 28.82 | 3.23 | 0.27 | 2.28 | 0.37 | 0.61 |
| HE0413 | 3191610.150 | -90660.940 | 59.560 | 24.00 | 24.99 | 4.08 | 0.37 | 2.71 | 0.31 | 0.67 |
| HE0421 | 3191339.240 | -90585.920 | 70.280 | 21.00 | 27.02 | 0.98 | 0.44 | 1.97 | 0.26 | 0.50 |
| HE0422 | 3191384.690 | -90606.990 | 71.278 | 15.00 | 25.59 | 4.67 | 0.91 | 3.43 | 0.40 | 0.86 |
| HE0425 | 3191520.480 | -90670.400 | 64.959 | 30.00 | 20.50 | 2.87 | 0.22 | 1.32 | 0.89 | 0.43 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0426 | 3191565.870 | -90691.390 | 61.651 | 29.00 | 22.36 | 3.61 | 0.37 | 1.91 | 0.77 | 0.54 |
| HE0435 | 3191340.830 | -90641.710 | 75.302 | 18.00 | 24.10 | 3.43 | 0.86 | 3.22 | 0.46 | 0.81 |
| HE0502 | 3191392.010 | -90886.460 | 69.800 | 30.00 | 27.21 | 6.05 | 0.97 | 3.92 | 0.61 | 1.03 |
| HE0503 | 3191438.030 | -90907.480 | 63.184 | 30.00 | 29.28 | 6.32 | 0.84 | 4.74 | 0.51 | 1.48 |
| HE0516 | 3191348.990 | -90921.150 | 72.930 | 30.00 | 26.35 | 7.12 | 0.81 | 4.00 | 0.92 | 1.37 |
| HE0517 | 3191394.010 | -90942.250 | 67.270 | 30.00 | 27.34 | 7.59 | 1.05 | 5.92 | 0.67 | 1.66 |
| HE0518 | 3191439.010 | -90963.470 | 60.478 | 30.00 | 33.33 | 6.00 | 0.52 | 4.11 | 0.30 | 1.05 |
| HE0519 | 3191483.930 | -90984.490 | 55.942 | 30.00 | 33.52 | 5.99 | 0.58 | 4.03 | 0.31 | 1.05 |
| HE0520 | 3191530.040 | -91005.570 | 51.570 | 27.00 | 34.29 | 4.85 | 0.48 | 3.18 | 0.30 | 0.86 |
| HE0521 | 3191575.030 | -91026.850 | 47.378 | 30.00 | 35.62 | 3.82 | 0.31 | 2.85 | 0.23 | 0.77 |
| HE0522 | 3191620.010 | -91047.840 | 44.576 | 24.00 | 35.04 | 3.96 | 0.31 | 2.66 | 0.26 | 0.72 |
| HE0526 | 3191304.990 | -90955.880 | 71.533 | 24.00 | 31.09 | 7.19 | 0.77 | 3.98 | 1.26 | 1.15 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0527 | 3191350.050 | -90976.970 | 64.470 | 27.00 | 31.54 | 7.56 | 0.72 | 5.02 | 0.48 | 1.31 |
| HE0528 | 3191395.060 | -90998.090 | 59.630 | 27.00 | 34.30 | 8.14 | 0.56 | 5.63 | 0.43 | 1.48 |
| HE0529 | 3191440.960 | -91019.340 | 55.143 | 27.00 | 33.16 | 6.57 | 0.58 | 4.53 | 0.34 | 1.09 |
| HE0530 | 3191485.910 | -91040.360 | 51.449 | 30.00 | 32.49 | 6.07 | 0.58 | 4.17 | 0.31 | 0.99 |
| HE0531 | 3191531.020 | -91061.520 | 48.838 | 30.00 | 31.02 | 5.23 | 0.42 | 3.58 | 0.28 | 0.94 |
| HD0072 | 3192202.900 | -90357.760 | 37.500 | 20.00 | 23.27 | 4.03 | 0.60 | 3.65 | 0.78 | 0.87 |
| HD0073 | 3192104.700 | -90324.300 | 38.500 | 19.00 | 26.87 | 4.14 | 0.43 | 2.78 | 0.72 | 0.70 |
| HD0018A | 3191913.400 | -90486.030 | 45.080 | 26.60 | 34.38 | 5.28 | 0.56 | 3.53 | 0.85 | 0.85 |
| HD0074 | 3192082.400 | -90574.230 | 35.000 | 19.00 | 26.91 | 3.27 | 0.22 | 2.64 | 0.62 | 0.62 |
| H0018A | 3191673.800 | -90832.520 | 47.000 | 18.00 | 26.89 | 6.43 | 0.58 | 4.52 | 1.02 | 0.99 |
| H0019A | 3191743.600 | -90898.590 | 41.500 | 12.25 | 31.30 | 5.30 | 0.24 | 3.32 | 0.84 | 0.83 |
| HD0079 | 3191886.500 | -90823.260 | 40.000 | 16.50 | 23.05 | 6.57 | 0.70 | 3.62 | 1.35 | 0.93 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HD0080 | 3191800.800 | -90794.010 | 42.500 | 16.00 | 26.93 | 5.57 | 0.48 | 3.20 | 0.78 | 0.78 |
| HD0005A | 3191812.100 | -89985.990 | 71.500 | 40.00 | 6.86 | 23.67 | 3.04 | 8.77 | 9.61 | 1.79 |
| HD0081 | 3191963.900 | -89925.200 | 64.000 | 30.00 | 16.34 | 15.91 | 2.43 | 8.22 | 2.95 | 1.78 |
| HD0017A | 3192002.590 | -90271.530 | 44.000 | 27.00 | 22.62 | 4.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| HD0017B | 3192002.590 | -90271.530 | 44.000 | 21.00 | 22.91 | 6.73 | 1.29 | 3.76 | 0.76 | 0.91 |
| HD0086 | 3192237.500 | -89939.500 | 46.000 | 25.00 | 25.42 | 4.43 | 0.63 | 3.70 | 0.72 | 0.85 |
| HD0088 | 3192078.100 | -90038.250 | 49.000 | 28.00 | 28.24 | 6.54 | 0.75 | 4.94 | 0.93 | 1.03 |
| HD0089 | 3192169.200 | -90132.410 | 41.500 | 19.00 | 27.69 | 4.26 | 0.48 | 3.36 | 0.66 | 0.74 |
| HD0118 | 3191759.200 | -89936.780 | 77.830 | 56.00 | 5.86 | 19.39 | 1.72 | 6.82 | 9.45 | 1.32 |
| HD0120 | 3191046.100 | -90704.790 | 41.190 | 20.00 | 9.94 | 3.21 | 0.60 | 4.70 | 0.60 | 1.08 |
| HD0121 | 3191647.600 | -90628.950 | 56.310 | 28.00 | 23.98 | 4.44 | 0.68 | 3.88 | 0.59 | 0.85 |
| HD0122 | 3191800.600 | -90915.750 | 38.940 | 34.00 | 27.70 | 2.68 | 0.30 | 2.52 | 0.52 | 0.62 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HD0123 | 3191579.300 | -90989.570 | 46.900 | 32.00 | 26.79 | 5.17 | 0.54 | 4.66 | 0.45 | 1.08 |
| HD0149 | 3191937.900 | -89801.680 | 69.850 | 24.00 | 16.43 | 11.58 | 1.81 | 6.20 | 1.90 | 1.52 |
| HD0129 | 3191674.990 | -90029.230 | 76.470 | 32.00 | 16.65 | 16.54 | 2.49 | 7.06 | 5.00 | 1.80 |
| HD0130 | 3191712.380 | -90061.250 | 70.780 | 31.00 | 18.55 | 18.41 | 3.61 | 9.54 | 3.01 | 2.14 |
| HD0131 | 3191749.310 | -90094.520 | 67.300 | 33.00 | 24.92 | 16.08 | 2.67 | 9.09 | 2.09 | 2.03 |
| HD0134 | 3191862.030 | -90191.750 | 53.760 | 33.00 | 22.92 | 5.99 | 0.68 | 3.61 | 0.90 | 0.87 |
| HD0140 | 3191718.860 | -90131.660 | 67.260 | 30.00 | 25.76 | 17.56 | 2.40 | 10.73 | 1.83 | 2.37 |
| HE0068 | 3191577.740 | -91039.430 | 45.810 | 21.00 | 31.65 | 5.79 | 0.46 | 3.91 | 0.59 | 0.75 |
| HE0004 | 3191257.380 | -91030.024 | 66.820 | 21.00 | 31.76 | 5.44 | 0.47 | 3.48 | 0.46 | 0.77 |
| HE0037 | 3191995.840 | -90074.541 | 52.040 | 24.00 | 27.14 | 6.96 | 0.65 | 4.02 | 0.97 | 0.95 |
| HE0040 | 3191799.760 | -89660.806 | 34.640 | 20.00 | 16.46 | 2.99 | 0.23 | 1.12 | 0.53 | 0.46 |
| HE0060 | 3191132.580 | -90860.686 | 58.160 | 30.00 | 5.96 | 6.28 | 0.22 | 1.23 | 4.10 | 0.26 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0256 | 3192046.320 | -90082.259 | 48.590 | 21.00 | 31.71 | 5.76 | 0.47 | 3.66 | 0.46 | 0.87 |
| HE0257 | 3192093.440 | -90104.075 | 46.110 | 24.00 | 31.71 | 4.26 | 0.34 | 2.04 | 0.81 | 0.59 |
| HE0258 | 3192136.300 | -90124.642 | 43.410 | 15.00 | 35.74 | 5.26 | 0.68 | 2.50 | 1.32 | 0.82 |
| HE0259 | 3192229.840 | -90165.914 | 37.200 | 21.00 | 26.50 | 3.54 | 0.28 | 1.91 | 0.32 | 0.52 |
| HE0229 | 3192170.000 | -90036.000 | 45.000 | 21.00 | 24.16 | 4.69 | 0.33 | 3.04 | 0.25 | 0.79 |
| HE0228 | 3192135.910 | -90014.163 | 48.090 | 24.00 | 30.33 | 5.08 | 0.36 | 3.36 | 0.35 | 0.85 |
| HE0196 | 3192224.130 | -89945.333 | 47.400 | 18.00 | 28.78 | 5.62 | 0.48 | 3.67 | 0.49 | 0.98 |
| HE0163 | 3192220.200 | -89833.909 | 53.880 | 33.00 | 27.13 | 7.29 | 0.94 | 4.38 | 0.69 | 1.20 |
| HE0162 | 3192174.900 | -89810.831 | 55.880 | 33.00 | 31.34 | 7.71 | 0.92 | 4.48 | 0.86 | 1.31 |
| HE0161 | 3192130.000 | -89788.285 | 59.280 | 33.00 | 28.72 | 12.14 | 1.69 | 6.87 | 1.04 | 2.11 |
| HE0194 | 3192132.300 | -89901.103 | 54.220 | 30.00 | 27.37 | 10.11 | 1.01 | 6.67 | 0.86 | 1.56 |
| HE0227 | 3192088.790 | -89993.983 | 52.040 | 24.00 | 27.94 | 8.59 | 0.89 | 5.70 | 0.46 | 1.53 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0226 | 3192042.140 | -89971.496 | 56.650 | 30.00 | 29.12 | 12.54 | 1.49 | 8.30 | 0.72 | 2.05 |
| HE0195 | 3192178.720 | -89924.099 | 49.260 | 27.00 | 29.72 | 5.57 | 0.57 | 3.71 | 0.35 | 0.93 |
| HE0197 | 3192269.480 | -89966.138 | 43.120 | 15.00 | 27.34 | 5.00 | 0.41 | 3.42 | 0.30 | 0.86 |
| HE0230 | 3192226.590 | -90057.105 | 42.410 | 24.00 | 29.89 | 4.29 | 0.40 | 2.79 | 0.27 | 0.72 |
| HE0231 | 3192271.280 | -90077.334 | 40.230 | 18.00 | 30.65 | 4.75 | 0.45 | 3.01 | 0.38 | 0.86 |
| HE0260 | 3192272.880 | -90187.729 | 36.780 | 18.00 | 32.53 | 3.40 | 0.28 | 1.90 | 0.46 | 0.53 |
| HE0261 | 3192318.560 | -90208.579 | 35.050 | 18.00 | 31.88 | 3.07 | 0.15 | 1.59 | 0.29 | 0.40 |
| HE0294 | 3192274.990 | -90300.644 | 36.380 | 18.00 | 27.53 | 4.83 | 0.65 | 2.26 | 1.17 | 0.56 |
| HE0102 | 3192286.750 | -89587.349 | 57.900 | 18.00 | 22.87 | 7.00 | 0.69 | 4.33 | 0.69 | 0.98 |
| HE0220 | 3192091.170 | -90274.270 | 39.140 | 27.00 | 28.22 | 3.39 | 0.58 | 3.46 | 0.42 | 0.85 |
| HE0221 | 3192136.820 | -90295.270 | 38.250 | 27.00 | 29.92 | 3.83 | 0.53 | 3.38 | 0.43 | 0.77 |
| HE0222 | 3192182.050 | -90316.410 | 36.660 | 27.00 | 27.01 | 3.17 | 0.39 | 2.79 | 0.35 | 0.68 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0223 | 3192227.120 | -90337.660 | 36.570 | 27.00 | 28.03 | 2.58 | 0.38 | 2.80 | 0.28 | 0.55 |
| HE0075 | 3192226.800 | -90282.510 | 36.840 | 18.00 | 33.27 | 3.00 | 0.37 | 2.06 | 0.46 | 0.54 |
| HE0237 | 3192045.190 | -90307.790 | 39.160 | 21.00 | 31.57 | 4.47 | 0.57 | 3.25 | 0.48 | 0.78 |
| HE0238 | 3192137.470 | -90352.770 | 37.550 | 21.00 | 27.47 | 4.20 | 0.61 | 3.45 | 0.52 | 0.75 |
| HE0255 | 3192050.650 | -90367.790 | 38.860 | 21.00 | 31.97 | 5.07 | 1.74 | 2.88 | 0.36 | 0.68 |
| HE0262 | 3192092.410 | -90385.500 | 38.420 | 18.00 | 27.70 | 4.12 | 0.62 | 2.48 | 0.51 | 0.78 |
| HE0263 | 3192139.860 | -90407.010 | 36.290 | 18.00 | 33.55 | 3.45 | 0.31 | 2.65 | 0.34 | 0.64 |
| HE0264 | 3192186.240 | -90430.120 | 36.100 | 18.00 | 33.10 | 3.13 | 0.08 | 2.08 | 1.16 | 0.85 |
| HE0287 | 3192099.760 | -90443.840 | 36.090 | 21.00 | 30.02 | 3.16 | 0.38 | 2.98 | 0.52 | 0.76 |
| HE0288 | 3192140.250 | -90462.440 | 36.180 | 18.00 | 32.52 | 3.10 | 0.15 | 2.07 | 0.70 | 0.59 |
| HE0326 | 3192052.050 | -90532.210 | 36.410 | 27.00 | 26.71 | 2.06 | 0.22 | 2.00 | 0.29 | 0.51 |
| HE0218 | 3192001.070 | -90232.460 | 46.760 | 30.00 | 23.62 | 2.60 | 0.34 | 2.38 | 0.36 | 0.55 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0324 | 3191962.570 | -90484.230 | 41.610 | 30.00 | 26.71 | 3.03 | 0.30 | 2.03 | 0.44 | 0.53 |
| HE0325 | 3192007.460 | -90507.920 | 39.060 | 21.00 | 27.24 | 4.17 | 0.45 | 2.99 | 0.53 | 0.75 |
| HE0217 | 3191955.890 | -90211.290 | 48.590 | 30.00 | 25.46 | 2.53 | 0.40 | 3.19 | 0.44 | 0.74 |
| HE0216 | 3191910.700 | -90190.280 | 51.320 | 30.00 | 25.81 | 3.09 | 0.60 | 3.85 | 0.53 | 0.94 |
| HE0199 | 3191772.600 | -90071.140 | 67.000 | 57.00 | 19.94 | 13.86 | 2.46 | 7.88 | 1.70 | 1.83 |
| HE0170 | 3191949.630 | -89987.760 | 61.070 | 48.00 | 26.98 | 10.44 | 2.00 | 7.57 | 1.23 | 1.81 |
| HE0076 | 3191994.960 | -90008.710 | 56.550 | 39.00 | 23.17 | 10.86 | 1.44 | 6.81 | 0.91 | 1.69 |
| HE0175 | 3191950.360 | -90041.790 | 57.250 | 33.00 | 23.27 | 8.52 | 1.39 | 5.53 | 0.85 | 1.45 |
| HE0187 | 3191951.890 | -90099.230 | 55.030 | 33.00 | 25.85 | 8.05 | 1.04 | 5.08 | 0.67 | 1.27 |
| HE0186 | 3191907.090 | -90077.720 | 57.720 | 33.00 | 25.37 | 9.72 | 1.20 | 6.20 | 0.73 | 1.59 |
| HE0188 | 3191997.140 | -90120.660 | 51.800 | 30.00 | 24.47 | 4.40 | 0.56 | 4.55 | 0.43 | 1.09 |
| HE0189 | 3192086.320 | -90162.590 | 43.610 | 21.00 | 24.50 | 4.41 | 0.55 | 3.34 | 0.45 | 0.78 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0201 | 3191863.260 | -90112.670 | 58.200 | 33.00 | 26.10 | 8.25 | 1.02 | 5.82 | 0.68 | 1.34 |
| HE0200 | 3191817.850 | -90091.670 | 63.030 | 45.00 | 25.61 | 11.51 | 1.90 | 7.32 | 1.22 | 1.81 |
| HE0202 | 3191908.800 | -90132.440 | 54.420 | 27.00 | 22.49 | 6.30 | 0.84 | 4.53 | 0.55 | 1.07 |
| HE0204 | 3191999.350 | -90174.170 | 48.480 | 30.00 | 21.25 | 3.09 | 0.46 | 3.97 | 0.50 | 0.94 |
| HE0205 | 3192045.160 | -90195.240 | 45.440 | 21.00 | 25.43 | 4.37 | 0.44 | 2.87 | 0.36 | 0.71 |
| HE0203 | 3191954.660 | -90152.750 | 52.440 | 30.00 | 21.68 | 5.14 | 0.72 | 5.26 | 0.61 | 1.23 |
| HE0327 | 3192097.460 | -90555.240 | 34.660 | 18.00 | 25.93 | 3.32 | 0.23 | 2.52 | 0.53 | 0.63 |
| HE0158 | 3191992.480 | -89952.850 | 61.970 | 44.00 | 22.33 | 14.08 | 1.94 | 8.90 | 1.30 | 1.94 |
| HE0300 | 3191734.810 | -90328.860 | 57.730 | 21.00 | 20.77 | 3.26 | 0.40 | 2.69 | 0.44 | 0.67 |
| HE0303 | 3191871.590 | -90397.880 | 47.510 | 24.00 | 19.69 | 5.25 | 0.95 | 4.09 | 0.79 | 1.01 |
| HE0323 | 3191917.600 | -90469.340 | 45.670 | 24.00 | 26.50 | 5.43 | 0.54 | 3.90 | 0.66 | 0.90 |
| HE0317 | 3191645.800 | -90342.480 | 57.540 | 24.00 | 28.45 | 1.94 | 0.19 | 2.24 | 0.31 | 0.55 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0318 | 3191691.180 | -90363.520 | 58.040 | 24.00 | 28.15 | 2.26 | 0.26 | 2.69 | 0.43 | 0.70 |
| HE0319 | 3191736.340 | -90384.850 | 58.070 | 24.00 | 26.06 | 2.50 | 0.40 | 3.36 | 0.56 | 0.81 |
| HE0320 | 3191781.730 | -90406.010 | 53.600 | 21.00 | 26.94 | 2.16 | 0.42 | 2.79 | 0.34 | 0.63 |
| HE0321 | 3191826.980 | -90427.100 | 49.510 | 24.00 | 23.98 | 4.44 | 1.05 | 3.33 | 0.69 | 0.79 |
| HE0322 | 3191872.210 | -90448.190 | 48.210 | 24.00 | 26.60 | 5.89 | 0.76 | 4.22 | 0.65 | 1.03 |
| HE0274 | 3191730.350 | -90269.940 | 59.280 | 18.00 | 23.42 | 5.02 | 0.41 | 3.31 | 0.45 | 0.85 |
| HE0299 | 3191689.620 | -90307.650 | 57.730 | 21.00 | 23.29 | 2.86 | 0.22 | 2.48 | 0.42 | 0.64 |
| HE0282 | 3191868.900 | -90336.410 | 44.620 | 21.00 | 26.63 | 3.49 | 1.16 | 5.72 | 0.72 | 1.10 |
| HE0245 | 3191731.820 | -90217.160 | 59.110 | 36.00 | 25.78 | 6.99 | 0.79 | 4.59 | 0.55 | 1.06 |
| HE0273 | 3191688.100 | -90251.820 | 59.280 | 24.00 | 19.86 | 8.55 | 0.76 | 5.97 | 0.51 | 1.33 |
| HE0298 | 3191644.240 | -90286.670 | 57.860 | 24.00 | 26.19 | 5.04 | 0.44 | 3.88 | 0.99 | 0.90 |
| HE0174 | 3191860.210 | -90001.070 | 66.040 | 41.00 | 25.55 | 15.08 | 2.52 | 8.25 | 2.65 | 1.64 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0185 | 3191816.360 | -90035.880 | 66.190 | 60.00 | 25.39 | 11.64 | 1.95 | 6.71 | 1.49 | 1.49 |
| HE0235 | 3191684.910 | -90140.070 | 67.260 | 57.00 | 24.75 | 13.30 | 2.16 | 8.25 | 1.03 | 1.85 |
| HE0244 | 3191686.500 | -90196.030 | 63.120 | 48.00 | 23.66 | 7.16 | 1.02 | 4.55 | 0.56 | 1.03 |
| HE0243 | 3191591.430 | -90151.420 | 71.010 | 48.00 | 23.38 | 13.81 | 2.60 | 8.57 | 0.95 | 1.69 |
| HE0198 | 3191727.190 | -90049.410 | 70.300 | 48.00 | 20.33 | 15.82 | 2.83 | 9.25 | 1.95 | 1.79 |
| HE0184 | 3191771.020 | -90014.790 | 70.370 | 51.00 | 15.58 | 15.44 | 2.63 | 7.38 | 3.99 | 1.44 |
| HE0082 | 3191813.300 | -89924.090 | 75.550 | 42.00 | 10.69 | 26.95 | 2.94 | 12.37 | 9.29 | 2.34 |
| HE0137 | 3192035.100 | -89862.100 | 62.110 | 37.00 | 11.35 | 19.38 | 2.26 | 9.86 | 5.14 | 2.10 |
| HE0169 | 3191903.850 | -89966.360 | 65.510 | 45.00 | 15.57 | 14.49 | 2.83 | 7.81 | 2.08 | 1.77 |
| HE0236 | 3191956.650 | -90263.080 | 44.360 | 24.00 | 25.86 | 3.18 | 0.43 | 2.78 | 0.31 | 0.65 |
| HE0253 | 3191909.940 | -90303.820 | 44.640 | 15.00 | 28.58 | 4.96 | 0.67 | 3.18 | 0.40 | 0.73 |
| HE0281 | 3191822.830 | -90315.120 | 49.710 | 24.00 | 25.30 | 2.10 | 0.39 | 2.38 | 0.39 | 0.56 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0285 | 3192005.620 | -90400.430 | 39.860 | 24.00 | 25.36 | 4.54 | 0.63 | 3.89 | 0.48 | 0.82 |
| HE0306 | 3192005.480 | -90456.760 | 39.340 | 24.00 | 24.30 | 3.51 | 0.41 | 2.83 | 0.42 | 0.70 |
| HE0254 | 3191956.950 | -90319.340 | 43.160 | 24.00 | 30.29 | 3.58 | 0.52 | 3.02 | 0.39 | 0.73 |
| HE0283 | 3191916.210 | -90358.820 | 44.550 | 24.00 | 23.39 | 4.18 | 0.82 | 4.19 | 0.56 | 0.91 |
| HE0304 | 3191914.580 | -90415.270 | 44.600 | 18.00 | 24.57 | 6.50 | 0.77 | 4.08 | 0.69 | 0.96 |
| HE0305 | 3191959.080 | -90433.010 | 44.580 | 24.00 | 23.05 | 5.51 | 0.61 | 4.09 | 0.62 | 0.97 |
| HE0307 | 3192056.960 | -90479.540 | 36.600 | 24.00 | 22.76 | 2.76 | 0.19 | 1.79 | 1.02 | 0.46 |
| HE0316 | 3191600.410 | -90321.480 | 60.040 | 24.00 | 27.90 | 4.61 | 0.40 | 3.38 | 0.41 | 0.82 |
| HE0333 | 3191647.340 | -90398.330 | 58.330 | 24.00 | 24.89 | 1.91 | 0.26 | 2.08 | 0.26 | 0.52 |
| HE0168 | 3191858.640 | -89945.220 | 71.020 | 48.00 | 15.01 | 21.31 | 2.82 | 9.35 | 7.24 | 1.89 |
| HE0334 | 3191601.980 | -90377.290 | 57.540 | 21.00 | 27.70 | 2.31 | 0.24 | 1.90 | 0.35 | 0.48 |
| HE0119 | 3192077.670 | -89771.700 | 63.290 | 33.00 | 21.95 | 9.60 | 1.15 | 6.09 | 1.01 | 1.33 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0118 | 3192032.180 | -89750.460 | 67.520 | 24.00 | 19.04 | 6.89 | 1.01 | 4.22 | 0.74 | 0.92 |
| HE0136 | 3191989.820 | -89840.990 | 67.290 | 42.00 | 14.28 | 23.56 | 2.90 | 13.04 | 5.16 | 2.47 |
| HE0099 | 3191983.940 | -89616.990 | 33.000 | 15.00 | 17.08 | 3.94 | 0.48 | 3.03 | 0.51 | 0.71 |
| HE0104 | 3191897.390 | -89630.670 | 29.290 | 15.00 | 17.92 | 3.18 | 0.33 | 1.81 | 0.59 | 0.47 |
| HE0111 | 3191806.050 | -89645.030 | 33.480 | 18.00 | 21.63 | 5.23 | 0.58 | 3.47 | 1.03 | 0.93 |
| HE0110 | 3191770.770 | -89620.880 | 29.120 | 15.00 | 28.90 | 2.58 | 0.21 | 1.58 | 0.37 | 0.43 |
| HE0120 | 3191722.620 | -89652.980 | 28.920 | 15.00 | 20.98 | 1.64 | 0.37 | 1.89 | 0.32 | 0.46 |
| HE0140 | 3191629.380 | -89727.750 | 33.180 | 15.00 | 22.28 | 3.14 | 0.48 | 1.85 | 0.36 | 0.47 |
| HE0151 | 3191584.260 | -89763.260 | 30.910 | 18.00 | 17.77 | 3.97 | 0.58 | 2.16 | 0.70 | 0.54 |
| HE0344 | 3191558.180 | -90412.050 | 59.880 | 21.00 | 27.37 | 3.16 | 0.62 | 2.63 | 0.30 | 0.59 |
| HE0345 | 3191603.480 | -90433.200 | 58.850 | 18.00 | 27.00 | 3.32 | 0.57 | 1.93 | 0.36 | 0.47 |
| HE0346 | 3191648.870 | -90454.240 | 59.070 | 21.00 | 25.77 | 4.89 | 1.15 | 3.64 | 0.48 | 0.85 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0362 | 3191559.710 | -90467.950 | 60.580 | 21.00 | 21.97 | 3.53 | 0.54 | 2.33 | 0.45 | 0.58 |
| HE0380 | 3191561.250 | -90523.710 | 63.630 | 21.00 | 25.37 | 8.04 | 1.87 | 5.28 | 0.71 | 1.16 |
| HE0143 | 3191765.110 | -89791.350 | 54.990 | 27.00 | 23.69 | 1.33 | 0.20 | 0.70 | 0.22 | 0.22 |
| HE0144 | 3191810.440 | -89812.240 | 62.280 | 21.00 | 15.74 | 7.99 | 1.00 | 4.94 | 1.00 | 1.05 |
| HE0154 | 3191721.380 | -89825.870 | 55.230 | 24.00 | 30.05 | 2.45 | 1.41 | 7.73 | 0.60 | 1.77 |
| HE0155 | 3191766.620 | -89847.010 | 60.580 | 24.00 | 16.84 | 8.03 | 1.21 | 5.68 | 0.87 | 1.22 |
| HE0142 | 3191719.660 | -89770.000 | 48.960 | 27.00 | 21.01 | 1.34 | 0.26 | 0.93 | 0.27 | 0.26 |
| HE0153 | 3191676.030 | -89804.860 | 49.070 | 27.00 | 25.48 | 3.08 | 0.52 | 2.30 | 0.35 | 0.60 |
| HE0164 | 3191632.210 | -89839.760 | 46.060 | 30.00 | 19.89 | 6.55 | 0.99 | 4.15 | 0.58 | 0.85 |
| HE0165 | 3191677.410 | -89860.680 | 52.410 | 27.00 | 27.58 | 7.17 | 1.37 | 6.78 | 0.66 | 1.33 |
| HE0145 | 3191855.590 | -89833.430 | 69.000 | 33.00 | 15.29 | 8.82 | 1.02 | 4.00 | 2.89 | 0.90 |
| HE0156 | 3191812.130 | -89867.630 | 65.620 | 33.00 | 13.45 | 11.52 | 1.38 | 5.02 | 4.13 | 0.99 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0128 | 3191718.370 | -89714.090 | 42.040 | 24.00 | 21.80 | 4.49 | 0.47 | 2.70 | 0.64 | 0.66 |
| HE0129 | 3191763.610 | -89735.260 | 48.770 | 21.00 | 21.57 | 5.19 | 0.95 | 4.99 | 0.62 | 1.26 |
| HE0141 | 3191674.790 | -89748.880 | 41.150 | 21.00 | 18.23 | 2.16 | 0.42 | 1.14 | 0.30 | 0.30 |
| HE0152 | 3191630.490 | -89783.700 | 42.580 | 21.00 | 16.47 | 4.41 | 0.61 | 2.42 | 0.78 | 0.59 |
| HE0166 | 3191722.920 | -89881.770 | 61.080 | 21.00 | 18.27 | 6.30 | 0.63 | 3.00 | 1.98 | 0.66 |
| HE0159 | 3191540.460 | -89794.480 | 25.900 | 15.00 | 19.26 | 2.80 | 0.30 | 1.34 | 0.70 | 0.47 |
| HE0172 | 3191588.390 | -89872.950 | 39.110 | 27.00 | 19.27 | 10.51 | 1.44 | 6.23 | 1.26 | 1.57 |
| HE0173 | 3191679.900 | -89915.980 | 60.910 | 39.00 | 17.52 | 8.74 | 1.00 | 5.16 | 1.49 | 1.09 |
| HE0180 | 3191544.620 | -89908.980 | 36.250 | 24.00 | 19.76 | 11.39 | 1.54 | 6.46 | 1.80 | 1.59 |
| HE0171 | 3191497.380 | -89832.227 | 23.690 | 21.00 | 18.54 | 9.50 | 1.53 | 4.91 | 1.05 | 2.01 |
| HE0191 | 3191501.750 | -89943.690 | 34.830 | 27.00 | 18.06 | 7.28 | 0.89 | 4.38 | 0.97 | 1.04 |
| HE0208 | 3191457.670 | -89978.530 | 33.390 | 24.00 | 14.79 | 4.14 | 0.45 | 2.13 | 0.90 | 0.67 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0108 | 3191499.380 | -89887.840 | 27.510 | 26.00 | 22.99 | 9.10 | 1.24 | 4.90 | 1.63 | 1.32 |
| HE0190 | 3191455.590 | -89922.890 | 26.420 | 21.00 | 19.85 | 3.97 | 0.47 | 1.99 | 0.90 | 0.63 |
| HE0266 | 3191453.600 | -89866.350 | 21.290 | 30.00 | 26.22 | 4.94 | 0.68 | 2.91 | 0.90 | 0.91 |
| HE0234 | 3191549.220 | -90076.614 | 59.430 | 53.00 | 11.66 | 15.12 | 1.39 | 5.54 | 6.88 | 1.37 |
| HE0329 | 3191367.880 | -90258.006 | 21.170 | 10.00 | 20.90 | 5.10 | 0.80 | 2.97 | 0.58 | 0.76 |
| HE0335 | 3191781.670 | -90458.611 | 50.100 | 24.00 | 25.34 | 3.49 | 0.41 | 2.22 | 0.31 | 0.55 |
| HE0336 | 3191873.840 | -90504.010 | 44.120 | 24.00 | 26.28 | 6.48 | 0.76 | 3.98 | 0.70 | 1.03 |
| HE0337 | 3191919.120 | -90525.120 | 41.610 | 24.00 | 27.21 | 5.75 | 0.57 | 3.68 | 0.58 | 0.94 |
| HE0338 | 3191965.330 | -90543.250 | 41.600 | 39.00 | 29.00 | 3.26 | 0.31 | 1.99 | 0.36 | 0.60 |
| HE0394 | 3191604.420 | -90596.739 | 59.340 | 30.00 | 26.42 | 3.50 | 0.42 | 2.29 | 0.46 | 0.66 |
| HE0396 | 3191834.730 | -90706.918 | 45.020 | 30.00 | 28.64 | 4.55 | 0.49 | 3.06 | 0.45 | 0.94 |
| HE0395 | 3191744.170 | -90663.949 | 49.100 | 27.00 | 27.29 | 5.44 | 0.78 | 3.27 | 0.51 | 0.86 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0397 | 3191925.510 | -90748.872 | 40.510 | 30.00 | 32.11 | 4.71 | 0.43 | 3.00 | 0.43 | 0.86 |
| HE0427 | 3191746.730 | -90775.710 | 46.410 | 36.00 | 27.95 | 4.37 | 0.39 | 2.82 | 0.41 | 0.73 |
| HE0291 | 3191989.140 | -89901.520 | 63.660 | 57.00 | 15.94 | 8.34 | 1.23 | 5.25 | 0.86 | 1.38 |
| HE0373 | 3191775.960 | -90182.354 | 59.940 | 45.00 | 25.30 | 7.28 | 1.02 | 4.54 | 0.54 | 1.19 |
| HE0081 | 3192227.000 | -90395.840 | 35.990 | 18.00 | 40.57 | 2.62 | 0.07 | 1.83 | 0.51 | 0.45 |
| HE0003 | 3191307.430 | -90837.988 | 78.990 | 45.00 | 23.23 | 9.71 | 1.11 | 4.56 | 2.82 | 1.21 |
| HE0007 | 3191665.660 | -91064.545 | 44.140 | 39.00 | 26.49 | 2.65 | 0.25 | 2.13 | 0.25 | 0.58 |
| HE0310 | 3191684.440 | -90025.779 | 76.460 | 60.00 | 20.18 | 12.26 | 1.64 | 6.55 | 2.79 | 1.29 |
| HE0328 | 3191728.580 | -90105.598 | 66.750 | 56.00 | 28.09 | 11.39 | 1.95 | 7.01 | 0.84 | 1.59 |
| HE0239 | 3191611.170 | -90712.500 | 57.710 | 30.00 | 30.22 | 7.56 | 1.06 | 6.15 | 0.55 | 1.55 |
| HE0240 | 3191703.370 | -90810.690 | 47.920 | 24.00 | 34.78 | 5.30 | 0.39 | 3.66 | 0.30 | 0.92 |
| HE0532 | 3191577.000 | -91082.640 | 46.099 | 27.00 | 28.63 | 4.80 | 0.37 | 3.28 | 0.27 | 0.86 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0533 | 3191621.990 | -91103.780 | 44.424 | 36.00 | 31.56 | 2.58 | 0.26 | 2.47 | 0.19 | 0.69 |
| HE0538 | 3191261.070 | -90990.700 | 69.118 | 48.00 | 24.86 | 2.51 | 0.40 | 2.56 | 0.62 | 0.84 |
| HE0539 | 3191305.970 | -91011.800 | 64.423 | 24.00 | 33.49 | 4.94 | 0.48 | 4.47 | 0.35 | 1.13 |
| HE0540 | 3191352.030 | -91032.970 | 60.070 | 27.00 | 33.03 | 6.45 | 0.60 | 5.57 | 0.48 | 1.40 |
| HE0541 | 3191397.070 | -91053.990 | 57.310 | 30.00 | 34.45 | 7.52 | 0.71 | 5.09 | 0.41 | 1.29 |
| HE0542 | 3191442.000 | -91075.100 | 54.910 | 30.00 | 35.10 | 6.98 | 0.61 | 4.72 | 0.36 | 1.26 |
| HE0543 | 3191487.950 | -91096.350 | 49.869 | 30.00 | 32.37 | 5.84 | 0.49 | 4.01 | 0.28 | 1.04 |
| HE0544 | 3191532.980 | -91117.410 | 48.543 | 27.00 | 36.28 | 4.46 | 0.34 | 2.98 | 0.25 | 0.87 |
| HE0545 | 3191577.970 | -91138.540 | 46.216 | 51.00 | 31.37 | 2.52 | 0.28 | 2.01 | 0.21 | 0.60 |
| HE0551 | 3191308.000 | -91067.750 | 61.123 | 30.00 | 31.95 | 7.11 | 0.83 | 5.07 | 0.52 | 1.34 |
| HE0552 | 3191352.960 | -91088.830 | 57.040 | 30.00 | 30.19 | 6.53 | 0.69 | 4.17 | 0.48 | 1.17 |
| HE0553 | 3191397.990 | -91109.940 | 54.742 | 48.00 | 31.31 | 4.14 | 0.49 | 3.56 | 0.28 | 0.99 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0554 | 3191444.020 | -91130.950 | 51.570 | 30.00 | 30.91 | 5.13 | 0.43 | 3.38 | 0.32 | 0.98 |
| HE0555 | 3191489.010 | -91152.230 | 49.016 | 30.00 | 33.68 | 3.91 | 0.33 | 2.58 | 0.20 | 0.79 |
| HE0568 | 3192082.190 | -89884.020 | 56.410 | 39.00 | 28.29 | 9.48 | 1.36 | 5.98 | 0.67 | 1.43 |
| HE0100 | 3192072.500 | -89659.330 | 55.370 | 27.00 | 20.03 | 2.92 | 0.21 | 1.70 | 0.52 | 0.48 |
| HE0106 | 3191986.610 | -89668.760 | 44.350 | 27.00 | 16.54 | 5.23 | 0.52 | 3.27 | 0.60 | 0.86 |
| HE0107 | 3192034.690 | -89697.760 | 59.370 | 27.00 | 19.72 | 2.86 | 0.29 | 2.57 | 0.58 | 0.76 |
| HE0114 | 3191845.860 | -89661.820 | 36.390 | 18.00 | 19.70 | 3.38 | 0.39 | 1.69 | 0.71 | 0.58 |
| HE0115 | 3191900.540 | -89683.720 | 41.850 | 24.00 | 19.63 | 2.78 | 0.35 | 1.78 | 0.47 | 0.49 |
| HE0116 | 3191945.270 | -89709.340 | 51.500 | 24.00 | 15.18 | 2.91 | 0.32 | 1.65 | 0.47 | 0.46 |
| HE0123 | 3191942.650 | -89767.680 | 67.730 | 42.00 | 12.21 | 4.22 | 0.45 | 1.43 | 1.72 | 0.63 |
| HE0124 | 3191993.850 | -89786.510 | 68.680 | 45.00 | 8.60 | 11.27 | 0.96 | 3.83 | 5.27 | 1.23 |
| HE0127 | 3192037.200 | -89807.310 | 65.200 | 42.00 | 13.63 | 12.74 | 1.74 | 5.72 | 3.61 | 1.67 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0130 | 3191808.100 | -89754.830 | 56.610 | 39.00 | 19.82 | 2.69 | 0.36 | 1.97 | 0.49 | 0.55 |
| HE0131 | 3191856.630 | -89780.440 | 67.350 | 42.00 | 15.61 | 3.41 | 0.63 | 3.48 | 0.97 | 0.96 |
| HE0132 | 3191896.830 | -89797.370 | 70.410 | 48.00 | 14.54 | 4.95 | 0.59 | 2.08 | 1.60 | 0.68 |
| HE0133 | 3191943.740 | -89817.700 | 71.420 | 42.00 | 11.29 | 14.52 | 2.07 | 6.62 | 4.72 | 2.13 |
| HE0146 | 3191946.230 | -89874.950 | 69.010 | 45.00 | 12.61 | 17.21 | 2.18 | 10.10 | 2.99 | 1.94 |
| HE0157 | 3191902.660 | -89910.620 | 70.120 | 51.00 | 10.62 | 17.05 | 2.12 | 7.01 | 5.87 | 2.06 |
| HE0160 | 3191582.650 | -89816.860 | 35.280 | 30.00 | 20.67 | 3.36 | 0.60 | 2.81 | 0.80 | 0.78 |
| HE0167 | 3191768.610 | -89897.660 | 71.500 | 51.00 | 13.46 | 8.26 | 0.73 | 2.27 | 4.41 | 0.84 |
| HE0181 | 3191580.680 | -89926.830 | 47.260 | 42.00 | 16.04 | 9.74 | 1.04 | 4.90 | 2.23 | 1.59 |
| HE0182 | 3191631.370 | -89948.790 | 62.090 | 48.00 | 11.44 | 8.35 | 0.85 | 3.56 | 2.61 | 1.32 |
| HE0183 | 3191676.740 | -89969.800 | 74.020 | 42.00 | 12.13 | 18.64 | 2.05 | 6.20 | 8.27 | 2.12 |
| HE0192 | 3191544.940 | -89963.970 | 43.600 | 27.00 | 19.19 | 8.19 | 0.84 | 3.88 | 1.77 | 1.71 |

| BHID | XCOORD | YCOORD | ZCOORD | COMPOSITE LENGTH | SLIME % | THM % | MAGN % | MAGS % | MAGO % | NMAG % |
|---|---|---|---|---|---|---|---|---|---|---|
| HE0193 | 3191590.180 | -89983.580 | 55.470 | 42.00 | 11.57 | 7.14 | 0.55 | 2.43 | 3.07 | 1.11 |
| HE0215 | 3191547.030 | -90019.530 | 52.240 | 45.00 | 14.63 | 7.01 | 0.56 | 2.57 | 3.02 | 0.86 |
| HE0242 | 3191545.610 | -90143.950 | 67.380 | 48.00 | 12.77 | 12.81 | 1.59 | 5.01 | 4.50 | 1.71 |
| HE0252 | 3191773.100 | -90230.950 | 57.170 | 36.00 | 19.09 | 4.93 | 0.78 | 4.27 | 0.41 | 1.02 |
| HE0270 | 3191542.580 | -90177.630 | 70.000 | 42.00 | 18.96 | 13.24 | 1.99 | 8.04 | 1.47 | 1.74 |
| HE0271 | 3191592.130 | -90208.390 | 66.760 | 33.00 | 24.03 | 14.45 | 2.46 | 8.35 | 1.55 | 2.09 |
| HE0272 | 3191638.140 | -90229.170 | 62.150 | 33.00 | 21.24 | 7.60 | 1.02 | 4.70 | 1.22 | 1.34 |
| HE0280 | 3191771.400 | -90290.020 | 56.600 | 24.00 | 21.98 | 3.56 | 0.33 | 2.72 | 0.32 | 0.62 |
| HE0286 | 3191770.360 | -89677.440 | 37.260 | 18.00 | 17.65 | 2.57 | 0.47 | 2.25 | 0.71 | 0.62 |
| HE0292 | 3191861.740 | -90057.440 | 63.700 | 48.00 | 22.49 | 13.03 | 2.07 | 8.37 | 1.45 | 1.96 |

## 13 Addendum E

Risk Workshop Outcome

| | | |
|---|---|---|
| Method | Expert Panel | Experience Level |
| | | Exploration |
| | | Mineral Resource Management |
| | | Production |

Problem Does the geological model predict resource estimates within 10%

What influence the level of accuracy of the data?

What can Influence the 'Problem' in current Exploration

SAMPLE

METHODOLOGY

| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drilling | Method | IS THE INITIAL DRILLING METHOD USED AT HILLENDALE ADEQUATE FOR PRODUCTION PURPOSES | ADDITIONAL DRILLING HAS BEEN REQUIRED DUE TO THE HIGH VARIABLILITY INTRODUCED WITH THE INITIAL DRILLING METHOD | HILLENDALE MINE CURRENTLY REDRILLED AT MORE THAN 50% | 50% | UNDERSTANDING AND REVIEWING DRILL TECHNOLOGIES | ALL | 20% | | |
| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING | |
| | | HAS THERE BEEN ADDITIONAL DRILLING AT HILLENDALE | MORE THAN 50 PERCENT OF THE OREBODY HAS BEEN REDRILLED | RECONCILIATION OF RCN WITH PWP VARIES BETWEEN 70% AND 10% WITH AN AVERAGE OF 40% | | | | | | |
| | | WHAT IS THE EXTEND OF THE ADDITIONAL DRILLING | | | | | | | | |
| | Spacing | IS THE DRILLHOLE SPACING AT HILLENDALE ADEQUATE FOR THE 'LEVEL' THE INFORMATION IS | ADEQUATE INFORMATION FOR LEVEL OF INFORMATION REQUIRED | LOCALISED MINERALISATION | 40% | CONTINOUS EVALUATION AND UPDATE | Project Leader (Exploration) | 10% | Current reconcilation at Hillendale withing 10%. Not only contributing factor | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | REQUIRED FOR | | | | | | | therefore used as guideline | |
| | | IS THERE CERTAINTY IN THE CONTINUIATION OF THE OREBODY | LOCALISED VARIATION NOT SEEN IN DRILLHOLE SPACING | LOCALISED FLOOR VARIATION | | | MRM (Production) | | | |
| | | WHAT POTENTIAL PROBLEMS ARE ENVISAGED IF THE DRILLHOLE SPACING IS NOT ADEQUATE | | | | | | | | |

| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sampling | Sample Preparation | IS THE SAMPLE PREPARATION AND ANALYSES METHOD ADEQUATE FOR THE EVALUATION OF THE ORE DEPOSIT | SAMPLE METHOD IS ADEQUATE WITH A MONITORING SYSTEM | THE AMOUNT OF HANDLING OF THE SPECIFIC SAMPLE | 60% | QAQC | Project Leader | 15% | Laboratory QAQC - ISO accredited | |
| | Sample intervals | IS THE SAMPLE PREP AND ANALYSES | SAMPLE HANDLING FROM DRILLRIG TO LABORATORY | THE INACCURACIES OF EACH INDIVIDUAL STEP | | MONITORING | | | Laboratory final product accredited | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MONITORED | ANALYSES | FOR ANALYSES | | | | | | |
| | Sample Size | HOW MUCH SAMPLE HANDLING TAKES PLACE | •LOCAL LABOUR | | | TRAINING | | | Exploration QAQC | |
| | Sample Analyses | IS THERE CONTROL SYSTEMS IN PLACE | •SHIFT WORKERS | | | | | | Duplicates | Control Limit within 10% |
| | QAQC | IS THE ANALYTICAL METHOD ADEQUATE FOR HM SAND ANALYSES | SAMPLES HANDLED AT | | | | | | Control Samples | Control limit within 2 Standard Deviation |
| | | AT WHAT STAGE OF ANALYSES CAN PROBLEMS ARISE | •DRILLRIG | | | | | | External laboratory checks | Similar control limtis as above |
| | | | •SAMPLE PREPARATION FACILITY | | | | | | | |
| | | | | | | | | | | |
| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING | |
| | | | SAMPLE TRANSPORATION | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | - SEGGREGATION | | | | | | | |
| | | | WEIGHIN | | | | | | | |
| | | | DRYING | | | | | | | |
| | | | LIBERATING | | | | | | | |
| | | | SPLITTING | | | | | | | |
| | | | •SAMPLE DISPATCH | | | | | | | |
| | | | •LABORATORY RECEIVED | | | | | | | |
| | | | •LABORATORY ANALYSES | | | | | | | |
| | | | WEIGING | | | | | | | |
| | | | DRYING | | | | | | | |
| | | | CRUSHING | | | | | | | |
| | | | SPLITTING | | | | | | | |
| | | | DESLIMING | | | | | | | |
| | | | TBE | | | | | | | |
| | | | CARPCO (MAGNETIC SEPARATION) | | | | | | | |
| | | | | | | | | | | |

| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING | |
|---|---|---|---|---|---|---|---|---|---|---|
| Geodata | Database Accuracy | IS THE DATABASE SECURED IN TERMS OF NETWORK ACCESSIBILITY | DATABASE IS ON SECURED SQL SERVER BACKED UP DAILY BY IT | LARGE AMOUNT OF DATA ENTRY | 40% | STANDARD PROCEDURES | Project Leader | | Low likelihood of risk due to validations set up and tracking options in database | |
| | | IS THERE ONE RESPONSIBLE PERSON | ONE SUPERUSER, ONE DATAMANAGER AND 4 DATA CAPTURES (EACH INDIVUDUAL CAN BE TRACED) | NON CONTINOUS ENTRY OF DATA (ENTER IF YOU HAVE TIME) | | VALIDATION PROCESS | Database superuser/ manageer | 40% | | |
| | | IS THE DATABASE BACKED UP AS PART OF AN IT STRATEGY | SPECIFIC DATA VALIDATIONS ON DATA ENTRY (LOOKUPS, MANDATORY FIELDS) | IMPORTING OF DATA FROM EXCEL | | SIGNOFF PROCESS | | | | |
| | | IS THE DATA ENTERED CONTROLED AND MONITORED | DATA ENTRY NOT PRIORITY AND IMPORTING OF DATA CAN CONTRIBUTE TO ERRONEOUS | | | CROSS CHECK | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | DATA VALUES IN DATABASE | | | | | | | |
| | | IS THE DATA ENETERED VALIDATED | VALIDATION 'IN USE' OF DATA | | | TRAINING AND DEVELOPMENT | | | | |
| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING | |
| | | WHAT ARE THE POTENTIAL PROBLEMS THAT CAN ARISE FROM THE DATABASE, DATA ENTRY AND VALIDATION? | | | | | | | | |
| | Estimation Methodology | IS THE BEST SUITED METHOD USED | ESTIMATION METHODOLOGY IS CONTINOUSLY CHECKED | INADEQUATE INTERPOLOATION METHOD AND SUBSEQUENT WRONGFUL ESTIMATION | 10% | STANDARD PROCEDURES | Specialist | | | |
| | | IS THE METHOD TRANSPARENT AND AUDITED | SYSTEM OF VALIDATION AND ANALYSES THROUGH HEAD OFFICE | DEPENDANT ON SOURCE DATA ALREADY CONSIDERED IN RISK AND MITIGATION | | CROSS CHECK | | 10% | | |
| | | WHAT POTENTIAL PROBLEM CAN | POTENTIAL PROBLEMS: | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ARISE FROM THE ESTIMATION METHOD | | | | | | | | |
| | | | •INITIAL DATA VALIDATION FROM SOURCE DATA | | | | | | | |
| | | | •RECEIVING SECONDARY DATA (ALREADY INTERPRETED DATA) | | | | | | | |
| EXPLORATION ITEM | POTENTIAL RISK | RISK IDENTIFICATION AND ANALYSES | POTENTIAL RISK PROBABILITY | FACTORS INFLUENCING PROBABILITY | RISK | MITIGATION | RESPONSIBLE PERSON | ACCEPTABLE RISK | REASONING | |
| | | | •INADEQUATE INTERPOLATION METHOD | | | | | | | |