Appendix 1 Terms and definitions as used in this report

BKA - Bundeskriminalamt
CIM - Complex Analytical Procedure for Identification of the Nature and the Source of Origin of Precious Metals Containing Products of Mining and Metallurgical Operations
CIP - Complex Identification Procedure
ENFSI - European Network of Forensic Science Institutes
FCM - Fuzzy c-means clustering
GIREDMET - Russian Research and Projecting Institute of Rare Metals Industry
GOST - gosudarstvennyy standart (Russian:государственный стандарт), which means state standard
ICFSS - Institute of Criminalistics of the Federal Security Service of the Russian Federation
ICP-MS - Inductively coupled plasma mass spectrometry
ICP-OES - Inductively coupled plasma optical emission spectroscopy
IPA - International Platinum Group Metals Association, formerly International Platinum Association
ISO - International Organisation for Standardisation
PGE - Platinum Group Elements
RDB - Reference Data Base
XRD - X-ray diffractometry
SEM - Scanning Electron Microscopy with Energy Dispersive X-Ray Fluorescence
SKL - Swedish National Laboratory of Forensic Science
TNO - Netherlands Organisation for Applied Scientific Research
RFCFS - Russian Federal Centre of Forensic Science
XRD - X-Ray Diffraction

Anglo Platinum Rustenburg Base Metals Refinery is a Rustenburg plant where Waterval converter matte is processesed to produce a precious metals concentrate and base metal final products. The precious metals concentrate (in excess of 50% PGE) is further refined at Precious Metals Refinery (PMR).
Anglo Platinum Waterval Smelter Complex is a Rustenburg plant where PGE concentrate (100-400 g PGE/t) is first smelted to produce furnace matte. The furnace matte is then converted into a converter matte (0.2-0.6 % PGE) suitable for further processing by the Base Metal Refinery and Precious Metal Refinery.
Anglo Research (www.angloresearch.com/) are the research facilities of the Anglo American Group in South Africa resulting from the 2005 merger of Anglo American Research Laboratories (AARL - Crown Mines) and the Anglo Platinum Research Centre (ARC - Germiston). The two main locations are the Germiston and Crown Mines campuses, both in Johannesburg.
Beneficiation is a variety of processes whereby minerals or elements of interest are enriched during the production process.
Box whisker plot (www.en.wikipedia.org/wiki/Box_plot **)** is a convenient way of graphically depicting groups of numerical data through their five-number summaries (the smallest observation, lower quartile (Q1), median, upper quartile (Q3), and largest observation). A boxplot also indicates which observations, if any, might be considered outliers. Alternative names are boxplot, box-and-whisker diagram or plot or candlestick chart. Boxplots are able to visually show different types of populations, without making any assumptions of the underlying statistical distribution.

Bundeskriminalamt (BKA www.bka.de/profil/broschueren/profile2006.pdf) is the German Federal Criminal Police Office (4800 employees). In this Report the term BKA actually refers to the BKA Forensic Science Institute division (300 experts).
Bushveld Complex is a 66,000 km² area in South Africa that contains some of the richest ore deposits on Earth. The reserves of chromium, platinum, palladium, osmium, iridium, rhodium, and ruthenium are the world's largest, and there are vast quantities of iron, nickel, copper, titanium, and vanadium.
Closed universe is a situation where the collection of samples of known source is exhaustive - that is, if it *eg* includes all possible sources from all producers of PGE's in the World.
Complex Analytical Procedure for Identification of the Nature and the Source of Origin of Precious Metals Containing Products of Mining and Metallurgical Operations is a procedure using a set of analytical methods to determine characteristics for PGE-bearing intermediate products. As part of the procedure the results from these analyses are used in combination with the information in a Norilsk proprietary Reference Data Base (RDB) to make a statement on whether a questioned sample contains Norilsk PGE-bearing intermediate products.
Complex Identification Method is the abbreviation for 'Complex Analytical Procedure for Identification of the Nature and the Source of Origin of Precious Metals Containing Products of Mining and Metallurgical Operations'
Complex Identification Procedure is an alternative term for Complex Identification Method as used in this Report since it better describes the procedural character.
Converter Matte is an intermediate product in the PGE production that is both present in Norilsk and South African production processes. A converter matte is produced in the conversion process (to reduce Fe and S content) after smelting and consists mostly of Cu and Ni. For Bushveld and Great Dyke producers the PGE content will vary between 0.2-0.6%.
Cu-sludge is an intermediate product in the Norilsk PGE production process. It is a sludge that accumulates at the bottom of electrowinning tanks in the Copper Plant.
Energy Dispersive X-Ray Fluorescence is the combination of X-ray fluorescence (XRF) with an energy dispersive detector that allows the determination of the energy of the photon when it is detected.
European Network of Forensic Science Institutes (ENFSI www.enfsi.eu/page.php?uid=12) is an organisation that has been established with the purpose of sharing knowledge, exchanging experiences and coming to mutual agreements in the field of forensic science. ENFSI is recognised as an expert group in the field of forensic sciences. The aim of ENFSI is to ensure that the quality of development and delivery of forensic science throughout Europe is at the forefront of the world.
Executive Board of the Forensic Review Board is a subgroup of the Forensic Review Board to guide the decision process in the Board, prepare meetings and discussions, communicate with Board members, advisers and external partners to obtain and distribute information, assure involvement and commitment of other Board members, prepare concept reports based on the contributions of Board members and the Advisers to the Board.
Forensic Review Board is an independent group of nine members from national forensic institutes in Great Britain, Germany, Sweden, The Netherlands, The United States, South Africa and The Russian Federation. The group also includes one non-forensic member. The Board has been commissioned to review the CIP from a forensic perspective. The Board members have been officially invited by ENFSI to participate in this project. The analytical chemical review of CIP is performed by TNO and reported on separately.
Fuzzy c-means clustering (www.en.wikipedia.org/wiki/Cluster_analysis) is a method of data clustering which allows one piece of data to belong to two or more clusters.
Gosudarstvennyy standart (GOST Russian:государственный стандарт www.en.wikipedia.org/wiki/GOST) is a set of technical standards maintained by the Euro-Asian Council for Standardisation, Metrology and Certification (EASC), a regional standards

organisation operating under the auspices of the Commonwealth of Independent States (CIS). CIS is the international organisation, or alliance, consisting of Russia and ten other former Soviet Republics. GOST standards were originally developed by the government of the Soviet Union as part of its national standardisation strategy.

Great Dyke (www.en.wikipedia.org/wiki/Great_Dyke) is a 515 km long linear geological feature in Zimbabwe. The width varies from 3 to 12 km. The Great Dyke range is host to vast metal and mineral ore deposits, including PGE's.

Inductively coupled plasma optical emission spectroscopy (ICP-OES or ICP-AES www.icp-oes.net/) is a major technique for element analysis. The solid sample must be dissolved by inorganic acids or water. The solution usually is diluted by water and fed into the plasma. Atoms in the plasma emit light (photons) with characteristic wavelengths for each element. The light intensity is measured by optical spectrometry. For quantitative analysis the spectrometer should be calibrated by standard solutions..

Inductively coupled plasma mass spectrometry (ICP-MS www.en.wikipedia.org/wiki/ICP-MS) is an extremely sensitive type of mass spectrometry that can be used to determine a range of metals and several non-metals at concentrations below one part in 10^{12}. It is based on coupling together an inductively coupled plasma as a method of producing ions (ionization) with a mass spectrometer as a method of separating and detecting the ions.

Institute of Criminalistics of the Federal Security Service of the Russian Federation is the central Moscow forensic institute of the Federal Security Service

International Organization for Standardisation (ISO www.iso.org/iso/home.htm) is the world's largest developer and publisher of International Standards. ISO is a network of the national standards institutes of 157 countries. ISO is a non-governmental organization that forms a bridge between the public and private sectors. Many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. Other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

International Platinum Group Metals Association (IPA www.ipa-news.com/about/index.htm) is a non-profit association that represents the worldwide leading mining, production and fabrication companies in the global platinum group metals (PGMs) industry, comprising Platinum, Palladium, Iridium, Rhodium, Osmium and Ruthenium.

Match is the common practice in forensic science to express that an entity of questioned source is indistinguishable from an entity of known source when compared according to some set of methods and comparison criteria. The outcome of the comparison is commonly expressed as binary: the two entities are either distinguishable or indistinguishable.

Netherlands Organisation for Applied Scientific Research (TNO) is a Dutch public organisation, an independent knowledge organisation incorporated under law whose primary aim is to make scientific knowledge applicable in order to strengthen the innovative capacity of business and government. TNO is therefore primarily concerned with the development of innovative knowledge and its application in contract research and specialist consultancy for both the business world and government.

Ni sludge is an intermediate product in the Norilsk PGE production process. It is a sludge that accumulates at the bottom of electrowinning tanks in the Nickel Plant. This sludge is then transported to the Metallurgical Shop of the Copper Plant for further production of platinum metals concentrates.

Noril'sk area is a region in Siberia that contains some of the largest nickel deposits on Earth. PGE ores are associated with these Ni ores.

Norilsk Nickel (OJSC MMC Norilsk Nickel www.nornik.ru/en/about/) is the Open Joint Stock Company MMC Norilsk Nickel which is the world's largest producer of palladium and nickel, one of the leading platinum producers and one of the largest copper producers.

Open universe is a situation where the collection of samples of known source is not exhaustive - that is, if it does not include all possible sources from all producers of PGE's in the World.
PGE-bearing intermediate products are the products from the PGE production process in between the ore materials and the final PGE products.
Platinum Group Elements (PGE) are the chemical elements Platinum, Palladium, Iridium, Rhodium, Osmium and Ruthenium. Also named Platinum Group Metals (PGM). They occur together in nature and are produced from the same ore. Physically, chemically and atomically similar, they are grouped together as elements in the periodic table.
Precious Metal Refinery is a plant in which the final processing of the PGE precious metals concentrate to the final product is performed. It is the step in the process after the possessing of converter matte to produce a precious metals concentrate and base metal final products in the Rustenburg Base Metal Refinery.
Quality assurance (www.en.wikipedia.org/wiki/Quality_assurance) is the activity of providing evidence needed to establish quality in work, and that activities that require good quality are being performed effectively. All those planned or systematic actions necessary to provide enough confidence that a product or service will satisfy the given requirements for quality. Quality Assurance is a formal methodology designed to assess the quality of products or services provided, in this project the Complex Identification Procedure. Quality assurance includes formal review of care, problem identification, corrective actions to remedy any deficiencies and evaluation of actions taken. Quality assurance implies that necessary precautions have been taken so that eg the entire Complex Identification Procedure is within specifications under a wide conditions of operation.
Questioned sample is a sample of questioned source for which needs to be determined if it can originate from a number of known sources. This is the most common situation in forensic science where an entity of questioned source is compared with an entity of known source according to some set of methods and comparison criteria.
Reference Data Base is the database with data on Norilsk PGE-bearing intermediate products that is used in the 'Complex Analytical Procedure for Identification of the Nature and the Source of Origin of Precious Metals Containing Products of Mining and Metallurgical Operations'.
Russian Federal Center of Forensic Science (RFCFS) is the Russian federal forensic science institute that is part of the Ministry of Justice of the Russian Federation
Russian Research and Design Institute of Rare Metals Industry (GIREDMET) is a scientific research and manufacturing facility for semiconductors, rare metals and titanium. The test, analytical and certification center with RF Gosstandard accreditation is used for certification and quality control of rare metals high purity substances and semiconductor materials. For titanium and semi-conductors a full range cycle "science-technique-production" is implemented.
Scanning Electron Microscopy with X-Ray microanalysis (SEM-XRSMA www.en.wikipedia.org/wiki/Scanning_electron_microscope) is a type of electron microscopy capable of producing high-resolution images of a sample surface and providing chemical information on elements present on this surface. X-rays, which are also produced by the interaction of electrons with the sample and provide characteristic spectra for the (heavier) elements present, may be detected in a SEM equipped for energy-dispersive X-ray spectroscopy (SEM-EDX) or wavelength dispersive X-ray spectroscopy (SEM-WDX).
Swedish National Laboratory of Forensic Science (SKL) is the Swedish National Forensic Insitute that is part of the Swedish police organisation but also an agency in its own right. As an impartial expert agency, its main objective is to perform forensic analyses of criminal cases for the judicial system.
Validation is the process of checking if something satisfies a certain criterion. In a quality management system, validation usually relates to meeting the needs of an external customer or

user of a product, service, or system. Validation is testing to confirm that it satisfies stakeholder needs.
Limited to chemical analysis: The process of establishing the suitability of an analytical procedure for the proper analysis of the chemical composition of a particular specimen. This includes determination of the precision, accuracy, linearity, interference, detection and quantitation limits as well as determining the robustness of an analytical procedure.
Verification is the act of reviewing, inspecting, testing, etc. within a quality management system in order to establish and document that a product, service, or system meets the regulatory or specification requirements. Within this project TNO reproduced the analytical CIP procedures in their laboratory using samples as provided. The translated CIP documentation was studied and reworked into protocols. The information contained in the passports of the 69 Norilsk products was analysed to determine whether the individual identification characteristics of each product allow its differentiation from all of the other products included into the RDB.
X-ray Fluorescence (XRF) is a non-destructive analytical technique used to identify and determine the concentrations of elements present in solid, powdered and liquid samples. XRF is capable of measuring elements from Beryllium (Be) to Uranium (U) and in concentration ranges from trace levels up to 100%. The technique is based on the emission of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombarding with high-energy X-rays or gamma rays.
X-ray Diffraction (XRD www.en.wikipedia.org/wiki/XRD) is a set of techniques based on the elastic scattering of x-rays from structures that have long range order. Powder diffraction XRD as used within this project is a technique to characterize the crystallographic structure, crystallite size (grain size), and preferred orientation in polycrystalline or powdered solid samples. Powder diffraction is commonly used to identify unknown substances, by comparing diffraction data against an international reference database. It may also be used to characterize heterogeneous solid mixtures to determine relative abundance of crystalline compounds.