DALMANUTHA WIND ENERGY FACILITY

ENVIRONMENTAL ACOUSTIC SCOPING REPORT INPUT

INTRODUCTION

ENERTRAG South Africa (ENERTRAG), a subsidiary of the German-based renewable energy company ENERTRAG SE, proposes to establish the Dalmanutha Wind Energy Facility (WEF) and associated infrastructure near Belfast, in the Mpumalanga Province. The Project is being developed in the context of the Department of Mineral Resources and Energy (DMRE) Integrated Resource Plan and the Countries plan for a Just Transition.

The Dalmanutha WEF will include the following:

— Dalmanutha Wind Energy Facility (up to 300 MW).
— Dalmanutha Wind Energy Facility Grid infrastructure (up to 132 kV).
— Common Collection Substation and Powerline (up to 132 kV) – to be shared with the Dalmanutha West WEF that is also being proposed.

This report presents the environmental acoustic baseline assessment for the Dalmanutha WEF, to be used as input into the scoping report, which will be submitted in fulfilment of the Environmental Impact Assessment (EIA) application process. For the proposed Dalmanutha WEF, noise impacts are anticipated from the wind turbines, however, noise from the powerlines and substation will be negligible, and as such impacts for these will not be assessed.

PROJECT DESCRIPTION

ENERTRAG is proposing to construct the Dalmanutha WEF, near Belfast in the Mpumalanga Province. The WEF will be located ~7 km southeast of the town of Belfast. Access to the site will be via the N4 National Road, situated ~220 m from the WEF. The site itself will extend across eighteen existing farms, covering an area of ~4,370 ha. The energy produced will be fed via underground cables to a 132 kV Independent Power Producer (IPP) substation, located adjacent to the common grid infrastructure. The details of the Dalmanutha WEF, as applicable to the acoustic impact assessment, are outlined in **Table 1**. A map indicating the location of the wind turbines is presented in **Figure 1**.

Table 1: Project summary of the Dalmanutha WEF

Municipality	Emakhazeni Local Municipality of the Nkangala District Municipality
Extent	4,370 ha
Capacity	Up to 300 MW
Number of Turbines	Up to 77
Turbine Hub Height	Up to 200 m
Rotor Diameter	Up to 200 m

Figure 1: Location of the wind turbines for the Dalmanutha WEF

LEGISLATIVE FRAMEWORK

SOUTH AFRICA

In South Africa, environmental noise control has been in place for three decades, beginning in the 1980s with codes of practice issued by the South African National Standards (formerly the South African Bureau of Standards, SABS) to address noise pollution in various sectors of the country. Under the previous generation of environmental legislation, specifically the Environmental Conservation Act 73 of 1989 (ECA), provisions were made to control noise from a National level in the form of the Noise Control Regulations (GNR 154 of January 1992). In later years, the ECA was replaced by the National Environmental Management Act 107 of 1998 (NEMA) as amended. The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA) was published in line with NEMA and contains noise control provisions under Section 34.

Under the NEMAQA, the Noise Control Regulations were updated and are to be applied to all provinces in South Africa. The Noise Control Regulations give all the responsibilities of enforcement to the Local Provincial Authority, where location-specific by-laws can be created and applied to the locations with the approval of the Provincial Government. Where province-specific regulations have not been promulgated, acoustic impact assessments must follow the Noise Control Regulations. Furthermore, the NEMAQA prescribes that the Minister must publish maximum allowable noise levels for different districts and National noise standards. These have not yet been accomplished and as a result, all monitoring and assessments are done in accordance with the South African National Standards (SANS) 10103:2008 and 10328:2008.

The SANS 10328:2008 (*Methods for Environmental Noise Impact Assessment*s) presently inform environmental acoustic impact assessments in South Africa. This standard defines that the purpose of an Environmental Acoustic Impact Assessment is to determine and quantify the acoustical impact of, or on, a proposed development. It also stipulates the methods used to assess impacts as well as the minimum requirements to be investigated and included in the Environmental Acoustic Impact Assessment report as part of the EIA.

The SANS 10103:2008 document (*The measurement and rating of environmental noise with respect to speech communication*) provides methods and guidelines to assess working and living environments with respect to acoustic comfort as well as respect to possible annoyance by noise. As applicable to this assessment, the SANS 10103 provides the typical rating levels for noise in different districts. These rating levels are presented in **Table 2**.

Table 2: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Classification	Equivalent Continuous Rating Level for Noise ($L_{Req,T}$) (dB(A)) Outdoors	
		Daytime ($L_{Req,d}$)	Night-Time ($L_{Req,n}$)
a) Rural	A	45	35
b) Suburban (with little road traffic)	B	50	40
c) Urban	C	55	45
d) Urban (with one or more of the following: workshops, business premises and main roads)	D	60	50
e) Central Business Districts	E	65	55
f) Industrial District	F	70	60

* Guidelines highlighted in red are applicable to this assessment

As stipulated in the SANS 10103:2008, noise can pose as an annoyance to a community if the increase in average noise levels exceeds the ambient noise by a certain degree. These specified increases together with the relevant estimated community responses are presented in **Table 3**.

Table 3: Categories of community/group response (adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dB(A)	Estimated Community or Group Response	
	Category	Description
0 – 10 5 – 15 10 – 20 **>15**	Little Medium Strong Very Strong	Sporadic Complaints Widespread Complaints Threats of Community/Group Action Vigorous Community/Group Action

Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.
[a] $\Delta L_{Req,T}$ should be calculated from one of the following methods:
1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);
2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;
3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or
4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

Since there is no specific guidance or legislation governing the acoustic impacts of WEFs in South Africa, for this assessment the International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines for Wind Energy will be followed. Such guidelines are primarily based on the Energy Technology Support Unit's (ETSU) ETSU-R-97 report.

THE ASSESSMENT AND RATING OF NOISE FROM WIND FARMS (ETSU)

The ETSU-R-97 report describes the framework for the measurement of noise associated with wind farms and provides indicative noise levels that offer a reasonable degree of protection to communities surrounding wind farm developments, without placing unreasonable restrictions on the wind farm developers. The assessment was developed by a Working Group on Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. The key findings identified in the assessment include:

- Absolute noise limits applied at all wind speeds are not suited to wind farms. Limits set relative to background noise are more appropriate.
- The L_{A90} descriptor is much more accurate when monitoring and assessing wind turbine noise.
- Limits should be set on noise over a range of wind speeds up to 12 m/s when measured at a 10 m height.
- The effects of other wind energy facilities in a specific area should be added to the effect of the proposed wind energy facility in order to determine the cumulative effect.
- Increases in noise levels as a result of a wind energy facility should be restricted to 5 dB(A) above the current ambient noise level at a specified receptor location.
- Noise from wind farms should be limited to a range between 35 and 40 dB(A) (daytime) in a low noise environment. A fixed limit of 43 dB(A) should be implemented during the nighttime. This should increase to 45 dB(A) (day and night) if the potential receptors have financial investments in the facility.
- For turbines spaced further apart, if noise is limited to an L_{A90} of 35 dB(A) at wind speeds up to 10 m/s (at a 10 m height), then this condition alone offers sufficient protection of amenity, and background noise surveys would not be necessary.

SENSITIVE RECEPTORS

Sensitive receptors are identified as areas that may be impacted negatively due to noise associated with the proposed WEF. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. Being such a remotely located site, dominant receptors in the area surrounding the site include small farmsteads and farmhouses. The specific sensitive receptors (farmhouses) considered in this study are presented in **Figure 2**.

EXISTING NOISE CLIMATE

The existing noise climate surrounding the Dalmanutha WEF is predominantly rural with very low baseline noise levels anticipated. Noise sources may include birds, insects, livestock and the activities of resident farmers. Vehicular influences may include traffic on local roads and the nearby N4 National Road and R33 Regional Road.

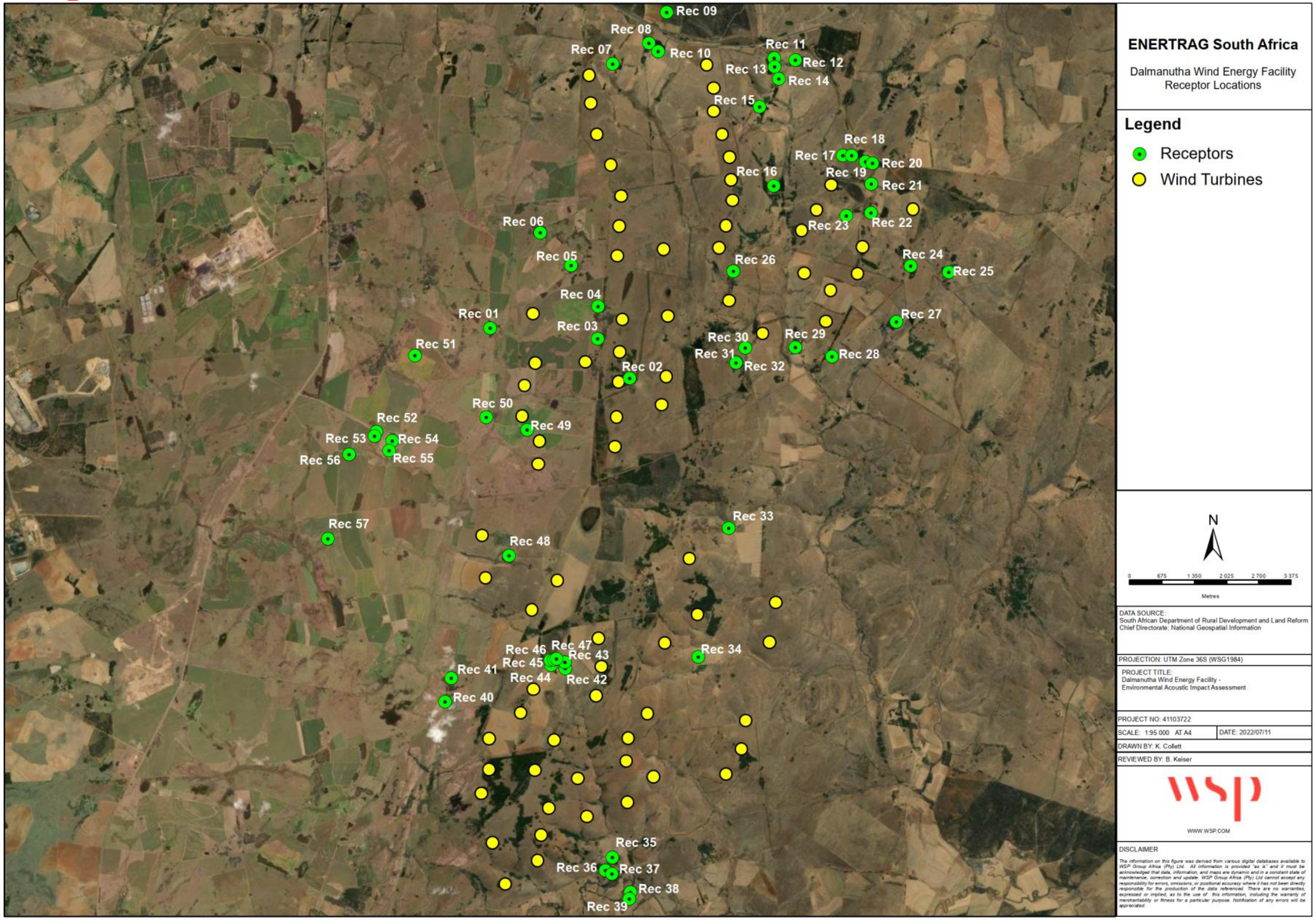

Figure 2: Sensitive receptors surrounding the Dalmanutha WEF

WIND TURBINES AND NOISE

Noise from wind turbines can be classified into two categories, namely mechanical noise generated from the turbine's mechanical components and aerodynamic noise, produced by the flow of air over the turbine blades.

MECHANICAL NOISE

The mechanical noise generated by a wind turbine is predominantly tonal (dominated by a narrow range of frequencies), but may also be broadband in character, displaying a wide range of frequencies (Council of Canadian Academics, 2015). Such noise is produced by the physical movement of the following components:

- Gearbox
- Generator
- Yaw drives
- Cooling fans
- Auxiliary equipment

Over time, appropriate design and manufacturing have reduced the mechanical noise produced by wind turbines. As such, the aerodynamic noise from the blades has become the dominant source of noise for modern turbines, however, low-frequency tones associated with mechanical sources are audible for some turbines (Hau, 2006; Manwell *et al*., 2009; Oerlemans, 2011).

AERODYNAMIC NOISE

Aerodynamic noise is typically broadband in nature and is generated by the interaction between airflow and different parts of the turbine blades. These interactions depend on the speed and turbulence of the wind; the shape of the blade; the angle between the blade and relative wind velocity flowing over the blade; and the distance from the hub. The noise levels produced are relative to the velocity of the airflow, with higher rotor speeds resulting in higher noise levels. Specifically, parts of the blade closer to the tips move faster than those closer to the hub, resulting in faster relative air velocities and creating higher aerodynamic noise levels. As such, most of the aerodynamic noise is produced near (but not at) the blade tips. This is partly why turbines with longer blades have a higher sound power level (Oerlemans, 2011).

Aerodynamic noise from wind turbines also has a strong directional component, projecting primarily downward, upward, or even perpendicular depending on the dominant mechanism (Oerlemans, 2011). As such, noise levels measured at a particular location can vary depending on the direction, speed and turbulence of the prevailing wind. Furthermore, as the rotor turns, the orientation of each blade changes in relation to a stationary receiver. As such, the noise levels at the receiver will vary as the blades rotate, resulting in periodic regular changes in noise levels over time (Renewable UK, 2013).

As wind speed increases, the aerodynamic noise of the turbines also increases. At low speeds, the noise created is generally low and increases to a maximum at a certain speed (around 10 m/s) where it either remains constant or can even slightly decrease.

LOW FREQUENCY NOISE AND INFRASOUND

Wind turbines also produce some steady, deep, low-frequency sounds (between 1 – 100 Hz), particularly under turbulent wind conditions. Sound waves below 20 Hz are called infrasound. These infrasound levels are only audible at very high sound pressure levels. Older wind turbines that had downwind rotors created noticeable amounts of infrasound. Levels produced by modern-day, up-wind style turbines are below the hearing threshold for most people (Jakobsen, 2005).

The human ear is substantially less sensitive to sound at very low or very high frequencies. For most people, a very low-pitch sound (20 Hz) must have a sound pressure level of 70 dB to be audible. Levels of infrasound near modern commercial wind turbines are far below this level and are generally not perceptible to people (Leventhall, 2006).

Low-frequency sound, like all other sound, decreases as it travels away from the source. Siting wind turbines further away from sensitive receptors will therefore decrease the risk of infrasound. It is, however, important to note that in flat terrain, low-frequency sound can travel more effectively than high-frequency sound. Most environmental sound measurements and noise regulations are based on the A-weighed decibel scale (dB(A)), which under-weights low frequency sounds in order to mimic the human ear. Thus, noise limits based on the dB(A) levels do not fully regulate infrasound. The dB(C) scale offers an alternative to measuring sound that provides more weight to lower frequencies (Jakobsen, 2005; Bolin *et al.*, 2011).

SANS 10103 proposes a methodology to identify whether low-frequency noise could be an issue. The method suggests that if the difference between L_{Aeq} and L_{Ceq} is greater than 10 dB, then a predominantly low-frequency component may be present. However, in all cases, the existing acoustic energy in low frequencies associated with wind must be considered.

SUBSTATION AND TRANSFORMER NOISE

In addition to the noise from wind turbines, wind farms require a substation and transformers, which produce a characteristic "hum" or "crackle" noise. Utility companies have experience with building and siting such sources to minimise their impact. Substation-related noise is relatively easy to mitigate should this be required, based on the use of acoustic shielding and careful planning regarding placement away from sensitive receptors. As such, noise associated with this source is not considered in this assessment.

ASSUMPTIONS AND LIMITATIONS

For this Environmental Acoustic Impact Assessment, various assumptions will be made that may impact the results obtained. These include:

- The turbine specifications provided are assumed to be representative of what will be installed in reality.
- The turbine locations provided are assumed to be an accurate representation of where these will be located in reality.
- Identification of sensitive receptors is based on a desktop assessment and it is assumed that all key receptors have been included.

HIGH-LEVEL SCREENING OF IMPACTS

Appendix 2 of GNR 982, as amended, requires the identification of the significance of potential impacts during scoping. To this end, an impact screening tool has been used in the scoping phase. The screening tool is based on two criteria, namely probability and consequence, where the latter is based on general consideration of the intensity, extent, and duration. The scales and descriptors used for scoring probability and consequence are further detailed in **Appendix A**.

In terms of the potential acoustic impacts of the proposed Project, **Table 4** outlines the impact of each parameter and the resulting risk level. Based on the close proximity (< 500 m) of many of the wind turbines to sensitive receptors (namely Rec 02, Rec 30 and Rec 49), the resultant acoustic impacts are anticipated to be high. From previous experience, turbines within such a close distance of sensitive receptors may cause impacts and complaints. Additionally, based on the number of wind turbines being proposed, the cumulative impact of many turbines on other receptor locations may result in impacts and complaints. Specific impacts can, however, only be determined during the modelling exercise in the EIA phase of the project.

Table 4: Impact assessment of risks associated with the operation of the Dalmanutha WEF

Description	Probability	Consequence	Impact Significance
Acoustic impacts on surrounding sensitive receptors, namely Rec 02, Rec 30 and Rec 49	4 (definite)	3 (negative)	High

TERMS OF REFERENCE – ACOUSTIC SPECIALIST STUDY

The environmental acoustic specialist study for the Dalmanutha WEF as part of the EIA phase will comprise the following:

PRELIMINARY MODELLING

A preliminary modelling exercise will be carried out using a simple model, which assumes hemispherical propagation of noise from each turbine. Such modelling will focus on receptors located within a 2 km radius of the turbines.

If the preliminary model suggests that turbine noise at all sensitive receptors is likely to be below an L_{A90} level of 35 dB(A) at a wind speed of 10 m/s (at a 10 m height) during the daytime and night-time, then this preliminary modelling is likely to be sufficient to assess the noise impact of the proposed project. If the L_{A90} levels at any receptor location are above 35 dB(A) then a more detailed acoustic study may need to be carried out, which includes comprehensive baseline monitoring. Alternatively, input into the micro-siting of the turbines will be provided to avoid unwanted impacts or further detailed studies.

ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT REPORT

A detailed Environmental Acoustic Impact Assessment report will be provided detailing the findings of the preliminary modelling, associated impacts, any inputs into micro-siting, as well as detailed recommendations, including mitigation measures if deemed necessary.

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APPENDIX A

Appendix 2 of GNR 982, as amended, requires the identification of the significance of potential impacts during scoping. To this end, an impact screening tool has been used in the scoping phase. The screening tool is based on two criteria, namely probability; and, consequence (**Table 0-3**), where the latter is based on general consideration to the intensity, extent, and duration.

The scales and descriptors used for scoring probability and consequence are detailed in **Table 0-1** and **Table 0-2** respectively.

Table 0-1: Significance screening tool

		CONSEQUENCE SCALE			
PROBABILITY SCALE		**1**	**2**	**3**	**4**
	1	Very Low	Very Low	Low	Medium
	2	Very Low	Low	Medium	Medium
	3	Low	Medium	Medium	High
	4	Medium	Medium	High	High

Table 0-2: Probability scores and descriptors

SCORE	DESCRIPTOR
4	**Definite**: The impact will occur regardless of any prevention measures.
3	**Highly Probable**: It is most likely that the impact will occur.
2	**Probable**: There is a good possibility that the impact will occur.
1	**Improbable:** The possibility of the impact occurring is very low.

Table 0-3: Consequence Score Descriptions

SCORE	NEGATIVE	POSITIVE
4	Very severe: An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	Very beneficial: A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	Severe: A long term impact on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	Beneficial: A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	Moderately severe: A medium to long term impact on the affected system(s) or party (ies) that could be mitigated.	Moderately beneficial: A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	Negligible: A short to medium term impact on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	Negligible: A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

The nature of the impact must be characterised as to whether the impact is deemed to be positive (+ve) (i.e. beneficial) or negative (-ve) (i.e. harmful) to the receiving environment/receptor. For ease of reference, a colour reference system (**Table 0-4**) has been applied according to the nature and significance of the identified impacts.

Table 0-4: Impact Significance Colour Reference System to Indicate the Nature of the Impact

NEGATIVE IMPACTS (-VE)	POSITIVE IMPACTS (+VE)
Negligible	**Negligible**
Very Low	**Very Low**
Low	**Low**
Medium	**Medium**
High	**High**