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COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

IMPACT OF ROAD CONSTRUCTION ON ENVIRONMENT IN GHANA

(A CASE STUDY OF KINTAMPO MUNICIPAL)

BENJAMIN MANU OSEI

AUGUST, 2016

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BENJAMIN MANU OSEI

(7141190003)

A Dissertation in the DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, Submitted to the School of Graduate Studies, University of Education, Winneba in Partial Fulfillment of the Requirement for the Award of the Master of Technology Education (Construction Technology) Degree.

AUGUST, 2016

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DECLARATION

STUDENTS DECLARATION

I, **Benjamin Manu Osei** declare that this Dissertation, with the exception of quotation and reference contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE ……..……

DATE**:** …….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: **DR. PETER PAA-KOFI YALLEY**

SIGNATURE ……..……

DATE**:** …….

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DEDICATION

This work is dedicated to:

1. My loving and kindness parents – the late Op. Kwasi Amankwa and Madam Akua Attaa. Dad and Mon's prayers grew in frequency and were fervent for my upbringing.
2. I specially dedicate this work to my dear and loving wife Duako Floria and my children; Agyenim-Boateng Oscar, Osei-Antuwaah Angela, Osei-Amankwa Nana Agyapong and Osei-Agyenda Naa Akua,

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ABSTRACT

There is a growing awareness that road development has major environmental impact. The damage includes sensitive ecosystems, loss of productive agricultural lands, and resettlement of large numbers of people, permanent disruption of local economic activities, demographic change, accelerated urbanization, and introduction of disease. This dissertation presents the impact of road construction on the environment in the Kintampo Municipality of Ghana and the challenges the Environmental Protection Agency (EPA) faces in the enforcement of environmental mitigation measures. The researcher reached the goals of this research through a questionnaire and interview with 17 respondents and 2 participants respectively. The response rate was (85%) percent. The respondents are selected personnel from public institutions and road construction firms who are directly involved in road operations in the Kintampo Municipality and field observation from January to June 2016. The participants were the municipal officers and national service personnel from EPA. The Likert scale was used to rank the various environmental impacts. The data fed into computer was then analyzed using the Statistical Programme for Social Scientists (SPSS) version 21.0 and spreadsheet (Excel of Microsoft Office 2013). This study identified that useful mitigation measures for controlling noise and ground movement were poorly manage hence the accidents on the road. In conclusion, the gross of environmental impacts associated with road construction projects identified in this research such as accident, noise and ground movement and air pollution can assist road project managers and contractors to identify the most critical environmental impacts during road construction operations. It is therefore recommended that issues of pollution prevention be a priority to the Government and hence allocate more resources should be allocated to the EPA to intensify its monitoring duties.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The word 'environment' refers to our surroundings – the context within which we exist. All things, living or non-living, exist surrounded by other things, and therefore all things have an environment. The components of the environment are inseparably linked – segregation, and nothing can be changed without affecting something else (World, 1995).

The construction and building industry worldwide is experiencing expansion on an unprecedented scale because of a high demand from both developed and developing countries (Amoah & Dadzie, 2013). Time, cost and quality have been the base point for measuring construction project performance but lately the environment has been considered the fourth dimension (Shen & Zhang, 1999).

People are an integral part of the environment, and are active participants in many ecosystems. Indeed, every aspect of human interaction, be it social economic, or physical, can be considered to affect the ecosystems of which humans are a part. In other words, humans affect the functioning of the environment through our daily actions (World, 1995).

The impact of construction activities has been estimated to be the cause of more than 25% of the world's total global warming due to the release of greenhouse gases as construction activities go on (Brady et al., 1993). In the United Kingdom, approximately

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47% of CO_2 emissions originated from construction and its related activities (Amoah et al., 2013). In addition, Hajibabai et al. (2011) study reported that, the construction industry significantly contributes towards environmental pollution.

Road construction and traffic operations, if undertaken without a proper understanding of the relationships inherent in environmental function, can be accompanied by serious disruptions to the environment, from which it may take a long time to regain equilibrium. In human terms, this may mean that generations must function in a debilitated environment and suffer many possible associated socio-economic hardships and financial losses (Hajibabai et al., 2011). There is a growing awareness that road development has major environmental impacts including damage to sensitive ecosystems, loss of productive agricultural lands, resettlement of large numbers of people, permanent disruption of local economic activities, demographic change, accelerated urbanization, and introduction of disease (World, 1995).

According Chen et al. (2000) the sources of these pollution or hazards include erosion, dusts, harmful gases, noise, solid and liquid wastes, fallen objects, ground movements and others. Yet often little attention is paid to how environmental regulations work in practice and what can be done to strengthen them especially in lower-income countries (Ametepey & Asaah, 2013). In such countries, environmental regulation is often seen as secondary to other concerns such as economic growth. Yet poor environmental regulation can lead to serious costs in terms of human health and erosion of the natural resource base (Chen, Li , & Wong, 2000; Lieplapa et al., 2012; Ametepey & Asaah, 2013). This is

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issue is of particular concern in Africa, which is rapidly urbanizing and building infrastructure in an attempt to accommodate rapid urban growth (Lieplapa & Blumberga, 2012). These impacts of the road construction pose frequently irreversible consequences to the environment (Lieplapa et al., 2012). On every infrastructure project, environmental as occupational, health and safety issues need to be addressed (Lieplapa et al., 2012). Both authorities and local stakeholders demand minimization of the environmental impact during the design and construction of road projects. Focus is on optimizing the working environment and the safety for both the people constructing and maintaining roads and those using the facilities (COWI, 2013). Construction activities affect the environment throughout the life cycle of development (COWI, 2013). These impacts occur from initial work on-site through the construction period, operational period and to the final phase (Ametepey & Asaah, 2013).

1.2 Statement of the Problem

Transport infrastructure development is the basis for economic growth (Lieplapa et al., 2012). The GDP released for the third quarter of 2012 by the Ghana Statistical Service, indicates that the construction industry contributed 19.2% to the economy (Ghana Statistical Service , 2010). Incidentally, the construction and building industry is responsible for high levels of pollution on the environment (Hendrickson & Horvath, 2000). The focus of the Ghanaian construction industry is largely on economic growth and improving the quality of life of the people, whilst environmental protection is utterly downgraded. (Ametepey et al., 2013).

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Environmental deterioration has captured the world's attention and has been one of the most discussed subjects locally, nationally and globally (Chen, Li , & Wong, 2000; Lieplapa et al., 2012; Ametepey & Asaah, 2013). According to Li, (1998) these are no different from the situation in Ghana as pollution and hazards caused by road construction projects have become a serious problem deteriorating the quality of air in the country thereby endangering the lives of people living in the communities. United Nations, (1979) highlighted that, one major and obvious problem associated with all road construction is dust. To residents living along road construction the airborne dust can penetrate their homes causing a nuisance and health problems such as hay fevers and allergies (Chen, Li , & Wong, 2000; Lieplapa et al., 2012; Ametepey & Asaah, 2013). Dust can also be a conveyor of other diseases and accident rate is high because of the importance of road construction activities, several studies have been conducted to evaluate impacts on environment (Osei , 2014; Ametepey et al., 2013).

However, one obvious impact they did not include in their studies was accident caused by road construction operations. In order to address these limitations and expand the existing literature on "impacts of road construction on environment", the purpose of this present study is established. The Daily Guide Ghana's, (2012) reported on "the drowning of three teenagers at the Sofo-Line interchange project site in Kumasi'. Again, "construction works on that stretch of the road of Kintampo where a lot of accidents had been occurring, killing the 16th victim in 10 months" (Daily Guide, 2013). These attest to the impact of accidents due to road construction operations have on the lives of people.

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1.3 Purpose of the Study

The purpose of this work was to identify the negative environmental impacts on communities especially those living along the roadside during road construction projects in Ghana even with the implementation of Environmental Assessment Regualtion,1999 (LI 1652).

1.4 Research Questions

The research questions to guide the study are to:

- What are the major road construction activities that can lead to potentially serious impacts?
- What are the challenges the Environmental Protection Agency faces in the implementation of the mitigation measures by road developers in Ghana?
- What are some useful management actions that can be planned to prevent environmental impacts on road construction sites in Ghana?

1.5 Objectives of the Study

The objectives to escort this research are:

- To identify the severity of environmental impacts on road construction in Ghana during road construction operations.
- To identify the challenges the Environmental Protection Agency (EPA) faces in the enforcement of mitigation measures indicated in the Environmental Impact Statement in Ghana.

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- To identify the best practices to ensure effective management of environmental impacts on road construction sites

1.6 Significance of the Study

Construction industry is naturally complex because it contains large number of parties as clients, contractors, consultants, stakeholders, shareholders, environmental protection agencies regulators and the like. This dissertation evaluates the environmental impacts of contract policies in projects management in Ghana. This will intern create awareness for the road contractors, operatives and all the stakeholders to be responsive to the needs of environmental impact and help revamp their efforts. In order to control the environmental impacts which are generated because of road construction operations in the communities, it is important to place the statutory bodies and stakeholders in the road construction industry in the country at the heart of the study.

Therefore, road construction project managers/contractors who work on road construction projects in Kintampo Municipal of the Brong Ahafo region will be the focal point of study and could be used to identify and recommend measures to manage the road construction operations that generate environmental pollution and hazards, which affect the health and well-being of people in the Nation. It will also serve as a guide for instructors and facilitators in road construction industry to educate contractors and prospective workers on environmental Protection Agencies. Additionally, information gathered will be relevant for policy decisions and implementation to help sustain and improve environment on quality work performance ethics.

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1.7 Limitations of the Study

1. Difficulty in floating questionnaires was nearly depressed as few contractors identified were not ready to respond because they considered this instrument too much investigative. Some were not ready to receive the questionnaire because they doubted it was an academic exercise.
2. Some developers could not allow the researcher to conduct the study in their premises as a matter of policy. In some sites, only the managers or engineers accepted to be interviewed or questioned and this limited the number of questionnaires given out. This could probably be due to the fact that majority of them are dissenting with the requirement for implementation of mitigation measures as revealed by the study
3. Financial difficulties outweighed all others and it was the most frustrating, money for transport to and from sites was very strenuous.

1.8 Delimitations of the Study

The study focuses on the impact of road construction activities on the environment in Kintampo - North Municipality.

1.9 Definition of Terms

1.9.1 Environment

The word 'environment' refers to our surroundings – the context within which we exist. All things, living or non-living, exist surrounded by other things (WBTP, 1997).

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The environment as the component of the earth that includes land, water and all the layers of the atmosphere; all organic and inorganic matter and living organisms; and the interacting natural systems that include components of land and water (Gandu, 2005).

1.9.2 Construction

It is the process of assembling materials and erecting a capital structures such as roads and buildings. It also involved in activities that occur due to, create, removal of an existing road structure, the foundation and replacing it by the same or a different structure.

1.9.3 Environmental Impact Assessment or Environmental Protection Agency

EIA or EPA is an acronym for Environmental Impact Assessment or Environmental Protection Agency respectively. It was designed to identify and predict the impact of a project, process or activity on the biological, geographical, ecological, physical, chemical and/or socio-economic environment in order to recommend appropriate legislative measures, programs or operational procedures to minimize their negative impact.

1.10 Methodology

The choice of strategy used to collect the data depends on the purpose of the study. The methodology for this study adopted the concurrent mixed study design (Quantitative and Qualitative). First, a review of government and Agencies policy documents and published research reports is conduct. Second, a field survey helped in the identification of the

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mostly used best management practices on environmental impact on road construction sites in Ghana. The data collected will be organized and analyzed using and Microsoft Excel and the Statistical package for Social Sciences (SPSS).

1.11 Organisation of the Study

The study is structured into five chapters. Chapter 1 is the introductory chapter. It provides an overview of the context in which the research was conducted. Chapter 2 is the literature review and was based on other researchers' viewpoint on the topic. Research Methodology, which is chapter three and described the procedure of data collection and the techniques used in the survey with reference to the objectives of the study. Chapter 4 is the Data Collection and Analysis. Chapter 5 is about Conclusions and Recommendations.

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CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter includes the overview of the road construction and its environment, identification of environmental impacts, management of environmental impacts, environmental protection agency, environmental legislation in Ghana and sample contract clauses with basic construction mitigation measures.

2.1 The Road Construction and its Environment

The construction industry in Ghana, as in other parts of the world, is huge and a crucial segment in economic development (Osei, 2014). Therefore, no matter what one does, there is construction, as it cuts across all sectors (Osei, 2014). Moreover, construction being among the top drivers of the Ghanaian economy, including agriculture, manufacturing and mining, its importance cannot be over emphasized, especially as the country is one of the most economically active countries in West Africa (Ghana National Commission for UNESCO). However, construction project performance has traditionally been measured in terms of time, cost and quality neglecting the environment but lately the environment, health and safety have been considered the fourth dimension of construction project performance (Shen and Zhang, 1999; Khosravi, 2011).

According to United Nations Development Programme, (2003) gave reason that the Millennium Development Goals (MDGs) adopted by the United Nations (UN) in September 2000, committed the international community to an expanded vision of

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development. The MDGs promote human development as the key to sustainable social and economic progress in all countries and included ensuring environmental sustainability by the year 2015 (United Nations Development Programme, 2003). This is because the effect of construction on the environment is often irreversible (Ofori, 1992). Most of the topical issues which have implications for construction industry have so far only been discussed within the context of industrialized countries and yet to be considered seriously in developing countries (Ofori et al., 2000),

2.2 Definition of the Environment

The word 'environment' refers to our surroundings – the context within which we exist. All things, living or non-living, exist surrounded by other things, and therefore all have an environment (WBTP, 1997). The components of the environment are inseparably linked exists in total segregation, and nothing can be changed without affecting something else (World, 1995). In addition, the environment as the component of the earth that includes land, water and all layers of the atmosphere; all organic and inorganic matter and living organisms; and the interacting natural systems that include components of land and water (Gandu, 2005). The definition of the word "environment" as used in Environmental Impact Assessments (EIAs) includes not only the physical environment (land, water, air and soils) but also the biological environment (fauna and flora), the cultural environment, social environment, historical environment, economic environment etc. For example, the European Commission, the governing body of the European Community (EC), has defined the environment as 'the combination of elements whose complex inter-relationships make up the settings, the surroundings and the conditions of

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life of the individual and of society, as they are or as they are felt' (United Nations University, October, 2005).

The Nigerian Environmental Impact Assessment Decree Moreover, the environment was defined as the total outer physical and biological system within which human beings and other organisms live with many interacting components (Gandu, 2005). People are an integral part of the environment, and are active participants in many ecosystems we affect the functioning of our environment through our daily actions (World, 1995). Human activities and our actions have consequences not only for our immediate environment, but for us as well. This is because anything we do to degrade our environment will generally affect our well-being later on (WBTP, 1997). There is therefore a need to strike a balance between human requirement and environmental consideration in order to ensure environmental sustainability. To the sustainable construction industry activities need to be promoted both by legislation and by practitioners in the industry.

2.3 Identification of Environmental Impacts from Road Construction Activities

According to Chen et al. (2000), sources of environmental impacts from construction activities can be divided into seven major types: dust, harmful gases, noises, solid and liquid wastes, fallen objects, ground movements and others. Chen et al. (2000) considered construction impacts under eight categories: soil and ground contamination, underground water contamination, construction and demolition waste, noise and vibration, dust, hazardous emissions and odours, wildlife and natural features impacts and archaeology

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impacts. On the other hand, Cole (2000) stated that the environmental impacts of the construction process embrace resource uses, ecological loadings and human health issues. March (1992) observed the construction industry's environmental impacts under the categories of ecology, landscape, traffic, water, energy, timber consumption, noise, dust, sewage, and health and safety hazards. Shen and Tam, (2002) classified construction environmental impacts as the extraction of environmental resources such as fossil fuels and minerals; extending consumption of generic resources namely: land, water, air, and energy; the production of waste that require the consumption of land for disposal; and pollution of the living environment with noise, odours, dust, vibrations, chemical and particulate emissions, and solid and sanitary waste. According to Cardoso (2005), typical negative impacts of the construction activities include waste production, mud, dust, soil and water contamination and damage to public drainage systems, destruction of plants, visual impact, noise, traffic increase and parking space shortage and damage to public space.

The impact of the activities of the road construction industry is very severe and hence there have been many researches done related to pollution and hazard control in construction, for instance a study on noise pollution, air pollution, solid and liquid waste from construction sites was conducted in early 1970s (Osei, 2014). Road construction activities while meeting societal needs of development, impact the environment before, during and after the creation of the construction products and these impacts have adverse effects on the environment (Jones; 1973 cited in Osei, 2014).

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Some of the negative effects of road construction activities are pollution and hazards which include land misuse (erosion, desertification), destruction of natural resources and vegetation, change in direction of flow of underground water, loss of wild life and their habitat, air and noise pollution, waste or effluent discharges, on-site wastage, health and safety impairment, generation of solid and gaseous wastes and resource depletion (Gandu, 2005; Kolawole & Anigbogu, 2005; Owoyale, 2005).

Pollution is the release of any substance that can harm people or animals, plants, soil, water or air; for example, an oil spill, silty water getting into a river or smoke into the air (U.K. EPA; 2010) . Pollution control in road construction projects is the control of all human activities that have either significant or small negative impact on the environment during the whole construction process (Osei, 2014). The impact of the construction industry on the environment has been recognized the world over. The harm caused by road construction activities maybe classified according to their impacts such as dust, noise, solid and liquid waste, soil erosion and ground movement, fallen objects etc. (Chen , Li , & Wong , 2000).

2.3.1 Air Pollution (Dust and Harmful Gases)

Dust: Dust and sand storms are very common phenomena in arid and semi-arid parts of world (Mohammed-Shafi, 1989). Kintampo and its surrounding areas, as part of this, suffer from dust and sand storms more especially during dry season, which is the driest season. The two factors that play the most significant role in dust and sand storm occurrence are strong winds and absence of vegetation cover (Mohammed-Shafi , 1989).

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Human activities may also play an important role. Definition of dust phenomena is not simple. However it has been agreed internationally that visibility of less than 1000 metres due to dust reported as a dust storm day (Mohammed-Shafi , 1989). Such storms, as reported by Mohammed-Shafi, (1989) mostly associated with northwesterly winds have a harmful impact on environment. As a result, there is a reduction in visibility and safety in transportation.

Road dust is often seen to be a non-significant hazard by many practitioners. However, models developed by the United States Environmental Protection Agency and calibrated in various countries has shown that millions of tons of dust are generated on our unsealed road ways per year and its effect on the urban environment is higher on developing countries like Ghana (Osei, 2014). Dust generation may result from several road construction operations which may include vehicle and equipment traffic on paved and unpaved roads, earthmoving vehicles and equipment during construction, wind erosion from disturbed and exposed soils, including stockpiles, materials handling, conveyance and transport within site boundaries including the material site and main access road outside the Project boundary (BP Statistical Review of World Energy, 2013 *cited in* Osei, 2014).

Osei (2014) opines that, it is necessary to manage dust evolved on road construction sites that put the lives of both the road operators and the environment in danger. The construction of a road affects the roadside soil and vegetation through the availability of sunlight, change in leaf litter accumulation, exposure to weather, traffic, mowing, and initial erosion-control seeding (Osei, 2014).

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Harmful Gases: National science academies throughout the world agree that there is strong evidence that significant global warming is occurring and that it is attributable to human activities (Hansen & Barnett, 2005). A study that analyzed more than 900 scientific articles concluded that there is a consensus among scientists that humans are contributing to global warming (Oreskes, 2004). Recent measurements of the accumulation of heat in the earth's oceans confirm that heat-trapping pollution is the primary cause of global warming (Wargo, Wargo, & Alderman, 2004; Hansen & Barnett, 2005). Carbon dioxide (CO2), considered the largest environmental contributor to greenhouse gases, is released into the atmosphere when diesel and gasoline fuels are burned Osei (2014). Nearly all CO_2 emissions are generated by the combustion of fossil fuels. CO_2 has been responsible for more than 80 percent of greenhouse gas emissions nationwide (U.S. Environmental Protection Agency, 2004; Intergovernmental Panel on Climate Chang, 1997). Road construction also generates harmful gases into the environment. Osei (2014) however identified in his research on the impact of construction equipment on the environment that harmful emissions are generated because of the use of road construction equipment. NH3 and NO2. The levels detected at the roadside are directly proportional to the traffic volume. These nitrogenous compounds contribute to soil enrichment after they settle as the ionic forms NO3- and NH4+. In gaseous form, they will be spread primarily by prevailing winds, though the presence of vegetation on the roadside can significantly reduce their distribution (Kirchner et al. 2005).

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These emissions are harmful to the health and well-being of people in the communities where the construction takes place. These damages come in the form of premature death, increased hospital admissions for respiratory and cardiovascular diseases, asthma attacks, and lost productivity through school absences and missed workdays and hence the impact of several pollutants that come from the use of road construction equipment should be carefully looked at (Lieplapa et al., 2012). There are also a number of indirect impacts on human health and safety resulting from road building as the emission of a higher concentration of particulate matter, which is associated with the increase of respiratory tract and cardiovascular diseases and mortality rate (USAID, 2003). These particulate matters are twenty five (25) times smaller than the width of a human hair and can penetrate deeply into the lungs, causing or worsening a variety of respiratory and cardiovascular illnesses and even leading in some cases to premature death (Kupiainen . & Pirjola, 2011). Moreover, smog-forming pollutants also have great adverse effect on the environment. Nitrogen Oxides (NOx) and hydrocarbons react in the presence of sunlight to form ozone (smog), which can damage the respiratory tract, reduce lung function, exacerbate asthma, aggravate chronic lung diseases, and also cause premature death (Lieplapa et al., 2012)

2.3.2 Solid and Liquid Waste

Road construction generates both liquid and solid waste that may have adverse effect on the land and the water bodies (Teixeira, 2005). Road construction project may generate waste during the construction phase. The source of waste may include the following;

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- Regulated waste including hydrocarbon waste such as waste oil, oily water, oily sludge, grease, coolant, oil rags, oil filters, drums, detergents, solvents, batteries, tyres, paints and resins.
- General waste including food waste, packaging and food containers.
- Recyclable waste including paper, cardboard, plastics, glass and aluminum cans.
- Wood waste including timber, pallets, and off-cuts.
- Sewage effluent and sludge (BHP Billiton Mitsubishi Alliance)

2.3.3 Erosion

According to Israelsen (1980) road construction projects come along with extensive land erosion, which comes because of removing vegetation and reshaping topography. These road construction activities make the soil easily prone to erosion. The top soil carried away by erosion may become airborne and create dust problem or be carried by water into natural waterways and pollute them (Goodland & Irwin, 1975).

One-time physical disturbances include the clearing of the road corridor and the construction of the roadbed. The clearing of the road corridor is the initial disturbance, which will establish the base age of woody species next to the road (Spooner & Smallbone, 2008). The remaining vegetation that exists nearby has a large influence on the species richness of the vegetation that repopulates the cleared areas (Cilliers & Bredenkamp, 1999; Sullivan et al.,2009). This wide clearing is what initially establishes the increased light levels and classical edge effects that define a great deal of vegetation as plants become established (Teixeira, 2005).

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2.3.4 Noise and Ground Movement (Vibration)

Noise: Harris (1991) defined sound as a physical disturbance in a medium that is capable of being detected by the human ear. Noise generated at road construction sites may affect the right to silence, comfort and health of residents and the visiting population and may thereby affect normal activities of nearby schools, hospitals and other services (Teixeira, 2005). The background noise or ambient noise is any sound other than the sound being monitored (primary sound) and is a form of noise pollution or interference that call for an important concept in setting noise regulations. Examples of background noises are environmental noise such as waves, traffic noise, alarms people talking and bioacoustics noise from animals while mechanical noise from devices such as waves refrigerators or air conditioning, power supplies or motors (Yalley, 2013). The sensitivity of the human ear to sounds of different frequencies is measured by the A – weighted decibel scale (dBA). A 10 – most people as a doubling of sound level judge dBA change in noise levels (Yalley, 2013).

Ground Movement (Vibration): Construction of the roadbed is a one-time impact that generally involves importing large amounts of material and increasing the soil bulk density to allow heavy vehicles on the road. The physical compaction changes the local soil structure and water holding capacity. Nearby grading, change the hydrology of the roadside environment, resulting in channelization of streams and the draining or creation of wetlands, which can create or destroy habitat for various plants (Forman & Deblinger, 2000; Jodoin, et al., 2008). The physical presence of a road has wide reaching effects by fragmenting habitat for wildlife and could be considered a one-time or a recurring

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physical crossing the wide expanse of a multilane road to reach resources is a formidable challenge, exacerbated by traffic (Forman & Deblinger, 2000). Vehicles on the road also create vibrations that may contribute to soil compaction after the initial construction of the roadbed (Hildebrand, Keskinen, & Navarrete, 2008).

2.3.5 Accidents and Incidents

Road construction poses environmental impacts on people in the environment and the workers as they are exposed to risk of being injured by fallen objects. The accident may result from the failure to adherence of EPA mitigations measures, interference in road traffic and poor supervisions of road construction by engineers and EPA (EPA, 2002). The fallen object may result from the following; solid-state waste-building material waste, building material package, mud / building material waste, construction water and bitumen, scaffold and board, model plate, building material etc (Osei, 2014). Therefore, recycling waste, improving technology on site, applying good safety control and recovery measures could help to manage fallen objects on road construction site (Chen et al., 2000)

2.4 Environmental Protection Agency or Environmental Impact Assessment

This designed to identify and predict the impact of a project, process or activity on the biological, geographical, ecological, physical, chemical and/or socio-economic environment in order to recommend appropriate legislative measures, programs or operational procedures to minimize their negative impact.

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2.4.1 Environmental Legislation in Ghana

Ghana's Environmental Protection Agency traced its history from 1974. The Government of Ghana established the Environmental Protection Council (EPC) by NRC Decree 239 (Ghana, 1994). The EPC obliges the proponent to carry out environmental matters. Nevertheless, the Environmental Protection Agency Act 490 converted the EPC into an Agency having inter alia, regulatory and enforcement roles in 1994 (Ghana, 1994). The EPA is given full mandate and responsibilities for regulating the environment and ensuring the implementation of Government policies (EPA, 1996). Environmental Assessment (EA) or Environmental Impact Assessment (EIA) has been an important environmental prevention, planning and management tool in Ghana since the 1980s, in ensuring sound and sustainable investments and developments.

The EPA Act 490, (1994) and the Environmental Assessment Regulations, 1999 (LI 1652) are the main legal basis for Environmental Assessment application in Ghana (EPA, 2002). Its key objectives are firstly ensuring that the implementation of environmental policy and planning are integrated and consistent with the country's desire for effective, long-term maintenance of environmental quality; providing technical assistance to the District Assemblies to enable them meet their responsibilities for managing the local environment; working in partnership with stakeholders; guiding development with the aim of preventing, reducing and as far as possible eliminating pollution and nuisances; initiating and pursuing formal and non-formal environmental education programmes; collecting, collating and disseminating information and promoting and supporting research programmes needed to ensure sound environmental management and use of environmental and natural resources; applying the legal processes in a fair, equitable and

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efficient manner to ensure responsible environmental behaviour in the country; and continuously improving EPA's performance to meet changing environmental trends and community aspirations (EPA, 1996).

2.4.2 Environmental Assessment Regulation 1999 (Li 1652)

Under the section 28 of the Environmental Protection Agency Act, 1994 (Act 490) the environmental assessment regulation were made to help control the adverse effect all undertakings might have on the Ghanaian environment. This environmental regulation requires every developer yet to commence any development (regulation one) or who has an existing undertaking (regulation two) which has adverse effect on the environment to obtain an environmental permit from the Environmental Protection Agency (Arts & Nooteboom, 1999).

2.4.3 Environmental Permit and Certificate Procedure

According to the Environmental Assessment Regulation (1999), a person required under either regulation one or two to obtain a permit has to do so through an application in a format determined by the Environmental Protection Agency. The submitted application by the developer goes through an initial assessment screening which then comes out with a screening report by the Agency. Again, according to Arts et al., (1999), in the screening report, it will be stated whether the application is approved, objected to, requires the submission of a preliminary environmental report (PER) or requires the submission of an environment impact statement (EIS). The scoping report shall set out the extent of environmental impact assessment to be carried out by the developer not forgetting a draft of terms of reference, which shall indicate the essential issues to be addressed in the

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environmental impact statement (Arts et al., 1999). The draft of terms of reference in the scoping report may include:

- Proposal to mitigate any potential negative socio- economic, cultural and public health influences the environment.
- Proposals to be developed to monitor predictable environmental impact and proposed mitigating measures.
- Contingency plans existing or to be evolved to address any unpredictable negative environmental impact and proposed mitigating measures.
- Upon the approval of the scoping report by the Agency, the developer shall be required to submit the environmental impact statement based on the scoping report that was accepted by the Agency.
- The environmental permit is granted to the developer or contractor after the environmental impact statement is approved by the Agency.
- The Agency will in addition to the permit award the developer an environmental certificate within twenty-four months from commencement of the undertaking.
- An environmental certificate may be issued subject to such conditions as the Agency shall determine except that no such certificate shall be issued.
- Unless the person responsible has submitted to the Agency confirmation of actual commencement of operations.
- Acquisition of other permits and approval where applicable, compliance with the mitigation commitments indicated in the environmental impact statement and lastly has submitted to the Agency its first annual environmental report to the Agency

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2.4.4 Environmental Impact Assessment and Environmental Audit

How does environmental audit relate to environmental impact assessment (EIA)? Clearly, it depends on the type of environmental audit referred to, and the definition adopted. The various types of environmental planning audits are means to improve the overall public policy, regulatory and administrative framework for environmental management, including EIA (EIR, 2012). Therefore, it can be said that these type of environmental audits are extensions of EIA. Corporate environmental audits are intended to ensure that the corporations concerned are complying with that framework, including requirement plans. Corporate environmental audits are an extension of environmental compliance commitments or requirements, but not EIA as such (EIR, 2012). Even so, there are many links between EIA and corporate environmental audit. Corporate environmental audits are generally concerned with addressing potential future impacts and audits are generally carried out on operating facilities, whereas EIA is generally carried out before a project commences. Both EIA and corporate environmental audit, however, commonly describe the status of defined environmental parameters at a given site; EIA as a baseline, audit as a benchmark (Roy, 2002).

Similarly, corporate environmental audits generally involve some form of objective verification, usually to a third party; and EIA documents are subject to external cutting by government agencies and the public (Roy, 2002). It should be noted that many individuals and firms who do not generally conduct EIA like environmental law and accounting firms in particular also carry the same audit.

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2.4.5 Challenges to the Implementation of EPA/EIA Mitigation Measures for Road Construction Projects

Ahmad & Sammy, (1987); Clare Harmer, (2005) provide that, EPA is a relatively new and growing technology and as a result, problems are constantly being encountered and solutions sought, both for predicting and mitigating impacts. These EPA implementation problems include; too many alternatives, too many impacts, lack of expertise and quantifying impacts. Ahmad and Sammy (1987) argue that, too many alternatives are unmanageable and too large to handle effectively. Large numbers of unmanageable alternatives can be reduced by defining the problem in terms of a series of choices. This will reduce the cost and time of the EPA process while ensuring that all alternatives are considered.

A project may also have hundreds of potential impacts, and there may not be enough money to study them all to provide mitigation. The remedy to this is to optimize the use of available funds by channeling them into a study of the more relevant impacts as against the less relevant. The scoping exercise of the EPA process may also concern itself with the degree of accuracy to which impacts should be quantified. The idea is to avoid the expense of using highly advanced predictive techniques if in fact such degree of accuracy is not essential to the judgmental decision-making process (Ahmad & Sammy, 1987).

In addition to too many alternatives and impacts as provided by Ahmad and Sammy (1987), lack of expertise in many countries, particularly the poorest is also a problem to EIA implementation. This is because of shortage of trained technologists and experts to

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do the work of predicting the changes in environmental quality, which would result from a programme or project. It is therefore important that, even where the hiring of foreign expertise is inevitable, the host country should retain management control of the EIA. Too often in the past, an EIA has simply been handed over to a firm of foreign consultants and local input has ceased. This is a dangerous error, especially when impacts on the human environment are involved. A more effective approach is to place the management of the EIA firmly in the hand of a local coordinator, who should make decisions as to what can be done locally and what must be hired from outside (Ahmad & Sammy (1987).

There are also several cases where impacts cannot be quantified because the theoretical basis for computing the magnitude of an impact does not exist. Thus, there is no available formula or model for calculating the degree to which a proposed action will modify an environmental parameter. Many of these cases pertain to parameters of the human environment such as migration and culture. Questions are always asked whether such impacts should be ignored or addressed in a qualitative form. To Ahmad and Sammy (1987), if an impact has been identified as important during the scoping step, then it should not be ignored simply because its magnitude cannot be quantified. There are several methods, which permit the qualitative assessment of an impact based on expert opinions leading to a prediction of its magnitude.

While it is preferable to prevent the generation of impacts rather than to reduce or control their effects, it was noted that, most of the recommended mitigation measures did not focus on how to prevent adverse impacts on the environment from occurring Mitchell,

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1997). The mitigation measures rather focused on reducing the impacts. It could therefore have been better for the EIA practitioners to put more emphasis on prevention of impacts. This view is supported by Mitchell (1997) mitigation hierarchy, which suggests that, mitigation should be based on the principle that it is preferable to prevent the generation of an impact rather than counteract its effects. Lee, (1987) further provides that inadequately developed means to achieve the mitigation objectives, use of mitigation as a means to access resources and lack of project continuity are among the reasons for lack of success in mitigation implementation. Arts & Nooteboom, (1999) (as cited in Harmer, 2005), also provide that the importance of EIA follows up to implement mitigation measures has been recognized in many countries. However, it has proved difficult to employ follow up in practice for a number of reasons including the use of vague, imprecise and immeasurable terms such as "slight reduction or minor effect", making it difficult to evaluate and verify the accuracy of impact predictions.

Other reasons why follow-up to implement mitigation measures has been difficult in practice have been summarized by Arts et al., (1999) (as cited in Harmer, 2005), as; Uncertainty and limited information during the pre-decision stages of EIA, deficiencies in Environmental Impact Statements (EISs), lack of guidance on how to conduct follow-up studies, legislation deficiencies, and demands on financial and staff resources.

2.5 Management of Environmental Impact Resulting from Road Construction

According to the British Standard 77502 and ISO 14000 series, in other to efficiently manage the environment during construction activities, it is necessary to adopt an environmental management system. The environmental management system establishes

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quality systems to ensure consistently high environment outcomes for the project as a whole. In other to control environmental impact during road construction, the following are some management practices that could be adopted.

2.5.1 Management of Air Pollution (Dust and Harmful Gases)

Dust: Agreeing to the Australian Environmental Protection Agency (1996) soil erosion contributes to dust generation however the following are additional measures, not mentioned in the sections of managing erosion. However according to EPA, (1996), Stäubli and Kropf (2004), the following measures could be used to manage dust evolvement during road construction:

Firstly, dust generation should be prevented in preference to applying dust suppression measures. One must ensure in the project schedule that the area of cleared land is minimized during the drier months of the year, when dust generation is at its greatest.

Again, as much as possible the cleared roads should be watered and the frequency of watering dependent on the weather conditions and erodible of the soil. However, additives could be used in the water to increase its dust suppression properties but the chemical should have no adverse environmental impact on adjacent water bodies. Moreover, the project manager should ensure that smooth surfaces are deep ripped and left rough and cloddy to reduce the wind velocity at the soil surface. Wind fences should be constructed if it is appropriate for the site (EPA, 199; Stäubli and Kropf, 2004).

Furthermore, as a contingency measure, in areas that do not have access to a reticulated water supply, the project manager should make sure that water stored on-site should never be less than 2,000 litres per hectare of disturbed land surface and he or she ensure

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that wherever watering is used to suppress dust it does not create contaminated run-off that will contaminate surface waters (EPA, 199; Stäubli and Kropf, 2004).

Additionally, the number of stockpiles, the area of stockpiling and the time stockpiles are expose in the environment should be minimized. The stockpiles for road building should be located away from drainage lines, at least 10 metres away from natural waterways and where they will be least susceptible to wind erosion. The stockpiles and batters on road construction site should be design to ensure that the slopes are not steeper than 2:1 (horizontal/vertical). Stockpiles and batters that will remain bare for more than 28 days should be stabilize by covering with mulch or anchored fabrics or seeding with sterile grass. In addition, sediment controls should be established by the manager around not stabilized stockpiles and batters (EPA, 199; Stäubli and Kropf, 2004).

Harmful Gases: There are three potential sources of air pollution on road construction sites. They are exhaust gases from vehicles and machinery and exhaust material from chippers. The exhaust gases from vehicles and machinery on the construction site can be controlled by ensuring that all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturers' specifications. Finally, Smoke from internal combustion engines should not be visible for more than ten seconds (EPA, 1996).

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2.5.2 Management of Solid and Liquid Waste

Road construction comes along with so much waste that affects the environment and so when choosing between waste controls measures, the following hierarchy for waste management is preferred, firstly waste avoidance, then reduction in reuse and finally recycling (Teixeira, 2005; Chen et al., 2000). Adhering to these control measures means that waste treatment and waste disposal options can be reduced. Road construction sites should pursue this hierarchy and seek out waste reduction opportunities Chen et al., 2000). Therefore, to identify opportunities it is necessary to consider all aspects of the project and the wastes it generates. Waste can be minimized by using improved technology, recycling or reusing on-site, or by making purchasing decisions that favour recycled products. Wherever possible, performance measures and targets for reduction reuse and recycling options should be included in the environmental management plan (EPA, 1996). The following is a summary of management of solid and liquid waste on road construction site;

- Waste control measures may include obtaining construction materials, paints, lubricants and other liquids in reusable packaging or containers.
- Noise barriers used should be made from recycled materials,
- Contaminated water from sediment dams should be used for dust suppression and irrigating adjacent vegetated land.
- Waste concrete from demolition activities should be sent to a concrete recycler instead of landfill.

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- All contaminated material uncovered on a construction site should be excavated and disposed of in an environmentally responsible manner (EPA, 1996, Chen et al. 2000)

2.5.3 Management of Erosion

The following measures may be taken to minimize erosion. Firstly, land clearance should be kept to a minimum in other to minimize erosion. Moreover, clearing of areas with soils that are prone to erosion, steep slopes that are prone to water and wind erosion should be avoided wherever possible. Again, re-vegetate and mulch progressively as each section of works is completed. The interval between clearing and re-vegetation should be kept to an absolute minimum. Adding to the above, road construction activities should be properly coordinated, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining not stabilised (EPA, 1996).

Secondly, construction activities should be programmed so that the area of exposed soil is minimized during times of the year when the potential for erosion is high, for example during rainy season when intense rainstorms are common. The site should be stabilized, installed and erosion controls maintained so that they remain effective during any pause in construction and this becomes particularly important if a project stops during the wetter months.

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Finally, vehicles should be kept to well-defined haul roads. Haul roads should be kept off sloping terrain wherever practical. The slope should be designed of a cut to minimize the angle of incline. The cut surface should be cultivated in other to increase infiltration of rainfall and decrease the velocity of water across the slope during rain and therefore reduce erosion.

2.5.4 Management of Noise and Ground Movement (Vibration)

According to Martin, (1980) there are no strong laws controlling the noise from road construction sites and recommends that there is a need to control this environmental impacts in the environment. The EPA Act 490, 1994 of Ghana thereby recommends that environmental impact assessment should be provided on how to control noise and vibration involved in road construction.

Construction noise varies greatly depending on the construction process, type, and condition of equipment used, and layout of the construction site. Many of these factors are traditionally left to the contractor's discretion, which makes it difficult to accurately forecast levels of construction noise.

In acoustics and specifically in acoustic engineering, background noise or ambient noise is any sound other than the sound being monitored (primary sound). Background noise is a form of noise pollution or interference that call for an important concept in setting noise regulations (Yalley, 2013). Reynolds, (1981); Yalley, (2013) agreed that the prevention or reduction of background noise is important in the field of active noise control. It is an important consideration with the use of ultra-sound (medical diagnosis or imaging) sonar

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and sound reproduction. The effectiveness of a barrier depends on the distance from the source to the barrier, the distance from the receiver to the barrier, and the relative height of the barrier above the line-of-sight between the source and receiver.

Therefore, according to EPA (1996), to control noise and vibration on road constructions the following suggested measures could be applied:

Firstly, appropriate mufflers should be fitted on earth-moving and other vehicles on the site to enclose noisy equipment. Moreover, noise attenuation screens should be provided where appropriate. Again, where an activity is likely to cause a noise nuisance to nearby residents, the operating hours should be restricted to between the hours of 7 am and 6 pm weekdays and 7 am to 1 pm Saturday, except where, for practical reasons, the activity is unavoidable.

Moreover, the noise on road construction site should not be above background levels inside any adjacent residence between 10 pm and 7 am. Local residents should be informed when unavoidable out-of-hours' work will occur. Furthermore, a study should be conducted on the impact of ground vibration from construction activities, where these operations occur within 50 metres of a building and appropriate action should be taken and finally minimize air vibrations as much as possible.

In addition, to avoid unnecessary annoyance from construction noise, the following construction noise control measures should be implemented by (EIR, 2012):

- Perform all construction in a manner to minimize noise and vibration.
- The contractor should be required to select construction processes and techniques that create the lowest noise levels.

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- Equip all internal combustion engines with a muffler of a type recommended by the manufacturer.
- Turn off idling equipment.
- Perform noisier operation during the times least sensitive to receptors.
- Locate laydown areas at least 300 feet from any residence or noise-sensitive receptor.
- Implement a noise control-monitoring program to limit the impacts.
- The construction contractor should be required by contract specification to comply with all local noise ordinances and obtain all necessary permits and variances (EIR, 2012).

2.5.5 Management of Accidents and Incidents

The clear signage provided for construction workers and road users at all access points. All vehicle speeds on unpaved roads limited to 15mph, bypass and stoppage point introduce to control the traffic. The incident may result from the following; solid-state waste-building material waste, building material package, mud / building material waste, construction water and bitumen, scaffold and board, model plate, building material. Therefore, recycling waste, improving technology on site, applying good safety control and recovery measures could help to manage fallen objects on road construction site (Chen et al., 2000)

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2.6 Sample Contract Clauses for Environment: A Handbook

Perhaps the most important mitigate measure related to road construction projects is to ensure that construction measures, included in the road design, operate effectively. Construction of a road also involves occupational health and safety risks to road workers, primarily in the areas of the storage and in the handling of dangerous materials, and in the operation of heavy machinery close to traffic, slopes, power lines, and watercourses. (Christopher & Koji , 1997)

2.6.1 Documents to be submitted by the consultant

The construction works study document shall include the route plans, with the physical, geometric and geotechnical data, and the structures and drainage systems; the following complementary information on the road environment shall be specified in it:

Road environment data*:* Indication of land areas reserved for villages, classified sites, and wooded areas; existing tree plantations and areas suitable for such plantations; existing quarries and borrow pita (location, depth, surface area, water retention issues, site to be improved); positions of existing side and diverging ditches; areas suitable for construction of diverging ditches or laying-up basins.

Data on the state of the road and its deterioration: Location of eroded areas along the road: slopes, ditches, and approaches to structures; location of drainage areas, which have become silted up; general state of structures; erosion or siltation of watercourses.

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Special clause: Preparation of the content of the priced bill of quantities. The consultant shall establish the preliminary estimates of quantities and prepare the special conditions by: (a) Separating the opening and closing of quarries and borrow pits from the haulage and application of the materials; and (b) including the cost of a diverging ditch and, if necessary, a laying-up basin. The consultant shall propose construction of the laying-up basins wherever the natural site is suitable, avoiding tree cutting. The consultant shall specify the dimensions, volume, and location of the basin with respect to the road and stipulations regarding protection of the environment (Christopher & Koji , 1997).

2.6.2 Road Construction Supervision Contracts

The consultant responsible for supervision shall keep the following records: site report; route report updated to record work done; and proposals with a view to future studies.

Site report. A monthly report on execution of the works shall be submitted by the consultant and shall summarize information regarding environmental improvements effected by the work performed during the month: steps taken by the contractor to preserve the environment and improvements observed upon closing down the site; trees planted (location, number, method of protection, maintenance, monitoring); data on quarries and borrow pits used (location, area, depth, improvements made); length of diverging ditches (partial and cumulative for all new and old ditches); position and volume of laying-up basins constructed; position of strengthening works carried out on approaches to structures.

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Updating of route plans. The supervisor shall update the route plans, on which shall be shown all environ- mental data reported in the monthly reports, specifically: location of tree plantations; locations of quarries and pits used, with updated characteristics of each; location of diverging ditches; state of structures after sand removal upstream and downstream; location, type, and number of anti-erosion devices in the drainage system.

Proposals with a view to future maintenance studies. Once the work is completed, the supervisor shall propose, for the road sections covered, specific arrangements with a view to studying the subsequent maintenance program. These proposals shall cover improvement of the contract environmental clauses; special features of the road environment; urgent tasks to be undertaken to improve the environment; and any comments of supplementary data regarding the state of quarries, pits, and drainage.

Special clauses. The supervisor shall ensure proper utilization, by the contractor, of the quarries and pits designated by the detailed design with the aim of lessening the impact on the environment. Preparation of materials in the quarry or pit. The supervisor shall designate trees to be protected and oversee storage of stripped material where it will not hinder water drainage; the supervisor shall oversee restoration to a natural state, including spreading of stored stripped material to facilitate water percolation and natural re- plant growth. Volume of stocks of material stored in each quarry or pit.

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Article . . . Supervision of the construction and maintenance of drainage works. The supervisor shall specify location and technical detail of drainage works and debris placement. Construction of diverging ditches l Construction of laying-up basins l cleansing of side ditches, diverging ditches, and summit slope and foot slope ditches.

Article . . . Tree planting. The supervisor shall instruct the contractor where trees are to be planted and the type of protection to be provided. The supervisor shall ensure that the contractor makes provision for the water needed for the trees to grow, and promptly replaces any dead trees. The supervisor shall draw up a report stating the number and good condition of the plantings at the time of final acceptance.

Article . . . Work-site installations. The contractor shall propose to the supervisor the location of work site installations and detail proposed measures to reduce impacts on the environment of these sites and the people living in the immediate vicinity, as regards both the surface area used (clearing, brush and tree removal, drainage, trash dumping) and underground impacts (disruption or pollution of the water table). On completion of the work, the contractor shall do everything necessary to restore the sites to their original state. The supervisor shall draw up a report confirming the restoration before acceptance of the works.

Article. Preparation and supply of gravel materials in pit or quarry. During works execution, the contractor shall ensure: preservation of trees during piling of materials; spreading of stripped material to facilitate water percolation and allow natural vegetation growth; re-establishment of previous natural drainage flows;

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improvement of site appearance; digging of ditches to collect runoff; and maintenance of ramps where a pit or quarry is declared a usable water source for livestock or people living nearby. Once the works are completed, and at own expense, the contractor shall restore the environment around the work site to its original state. The supervisor shall provide the contractor with a report confirming the restoration before acceptance of the works.

Article... Cleaning of side ditches, diverging ditches, and summit slope or foot slope ditches. Debris shall be dumped upstream of the ditch at a sufficient distance from the roadside and spread with a counter slope, with respect to the ditch, to prevent surface water runoff from being polluted with fine materials.

Article... Tree planting. The contractor shall plant trees in the locations fixed by the supervisor, with protection as specified (mud, brick walls, wire netting, etc.) and provision of the necessary water, and shall remove any dead trees. The contractor shall take care of all required maintenance for one year from the time of planting, including watering, cleaning the area at the base of the tree, and maintaining protection in good condition. The number of trees planted with the installation of protection and the supervisor in the site record shall enter the digging of a basin at the base of the tree. This record will be the basis for payment for work actually done at the time of final acceptance. When the road maintenance is completed, the contractor shall enter the plantings made (position, number) on the route plan.

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Article... Documents to be furnished by the contractor. Upon completion of works, the contractor shall provide the route plan with the work performed marked on it and showing the environmental improvements made (description, location, and numbers).

2.6.3 Clearing of Site (Construction Contract, 2012)

The Contractor shall maintain the work and its site in a tidy condition and free from the accumulation of waste material and debris, in accordance with any directions of the Engineer. Before issuing of a Certificate of Substantial Completion referred to in GC43.2, the Contractor shall remove all the plant and material not required for the performance of the remaining work, and all waste material and other debris, and shall cause the work and its site to be clean and suitable for occupancy or use by the Owner's servants, unless otherwise stipulated in the contract. The Contractor shall, as directed by the Owner, take down all signs erected during construction. Before issuing of a Final Certificate referred to in GC43.1, the Contractor shall remove from the work and its site all of the surplus plant and material and any waste material and other debris. The Contractor's obligations described in GC17.1 to GC17.3 do not extend to waste material and other debris caused by the Owner's servants or contractors and workers referred to in GC15.1 (Ofori G. , 2007).

2.6.4 Basic Construction Mitigation Measures

The following controls should be implemented at all construction sites.

- All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day.

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- All haul trucks transporting soil, sand, or other loose material off-site shall be covered.
- All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.
- All vehicle speeds on unpaved roads shall be limited to 15 mph.
- All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.
- Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points.
- All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.
- Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number also shall be visible to ensure compliance with applicable regulations (EIR, 2012).

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- Use low volatile organic compound (VOC) (i.e., reactive organic gases) coatings beyond the local requirements (i.e., Regulation 8, Rule 3: Architectural Coatings).
- All construction equipment, diesel trucks, and generators shall be equipped with best available control technology for emission reductions of NOx and PM.
- All contractors shall use equipment that meets California Air Resources Board's most recent certification standard for off-road heavy duty diesel engines (EIR, 2012)

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CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter presents a set of methods that were used during the study. It describes the research design, the population, sampling size, research methods and instruments used data collection techniques and the methods of data analysis and management. The data collect is organized and analyzed using and Microsoft Excel and the Statistical package for Social Sciences (SPSS). To solve this problem, the choice is to narrow down the population of this study to road construction managers of Kintampo - North Municipal in the Brong Ahafo Region.

3.1 Study Area

The study was conducted in Kintampo, located in the Brong-Ahafo Region (BAR) of Ghana, between June 2015 and December 2016 about environmental impact resulting from road construction in the Kintampo-North Municipality. The Municipality shares boundaries with five districts in the country, namely; Central Gonja District to the North; Bole District to the West; East Gonja District to the North-East (all in the Northern Region); Kintampo South District to the South; and Pru District to the South-East (all in the Brong Ahafo Region). The Municipal has a surface area of about 5,108km^2, thus occupying a land area of about 12.9% of the total land area of BAR (39,557km^2).

The main indigenous ethnic groups are of the Bono, and the Deg (Mo) origin. There is however a large permanent immigrant population from the Northern Regions of Ghana (*Dagarbas*, *Dagombas* and *Konkombas*) who are mostly farmers. A few Dangbes and

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Ewes who are mainly fishermen are settled along the banks of the Black Volta. Settlements are mainly concentrated along the main trunk road linking the district capitals (Kintampo/Jema) to northern Region.

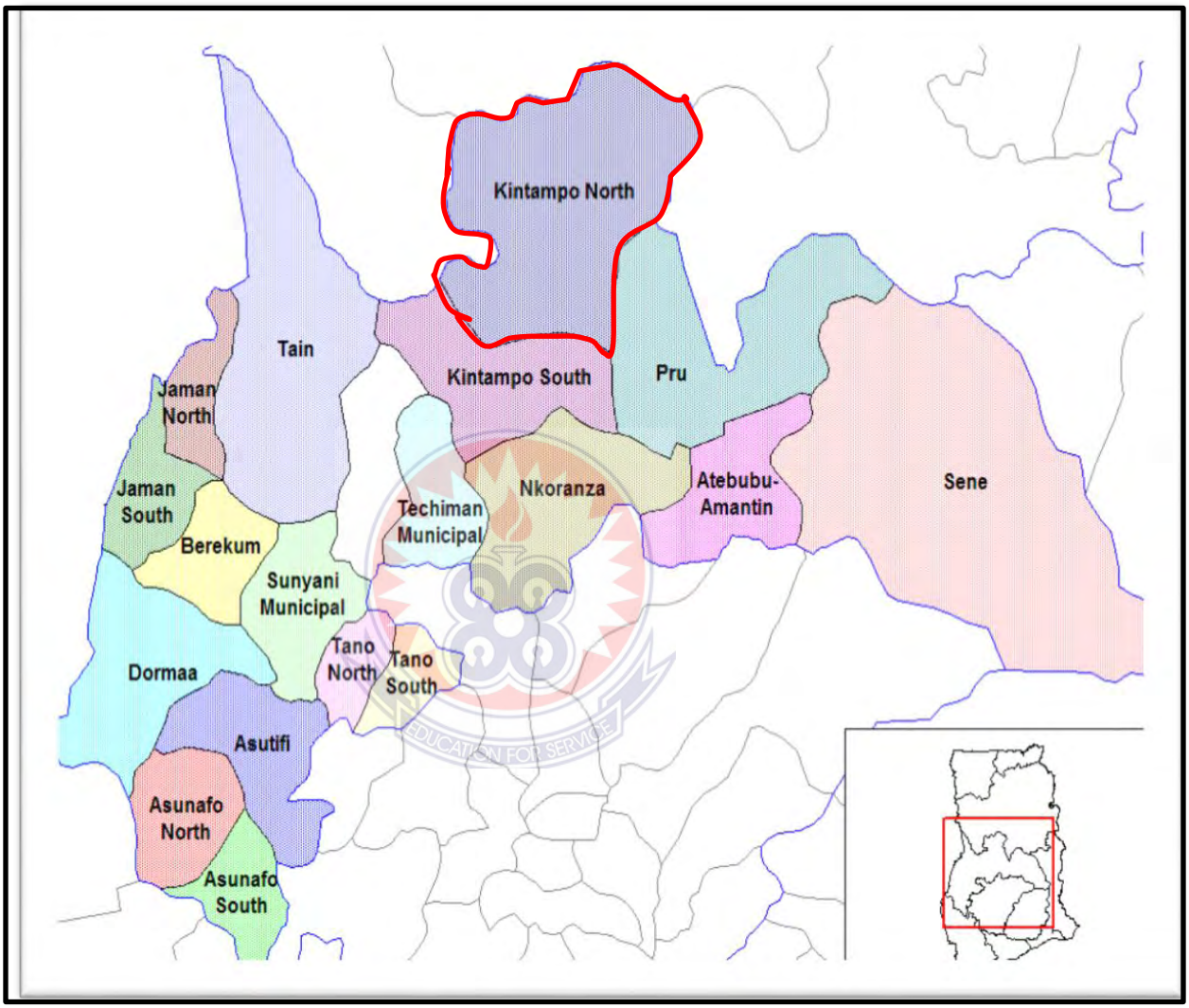

Figure 3.1: Map of Brong Ahafo (Kintampo-North)

3.2 Research Design

The study adopted the concurrent mixed study method (Quantitative and Qualitative). Quantitative research investigates facts and tries to establish relationships between these facts while qualitative research is a subjective assessment of a situation or problem, and

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takes the form of an opinion, view, perception or attitude towards objects (Barbbie, 2001). A combination of quantitative and qualitative approach was selected because it takes advantage of the strengths in the two approaches while limiting the weaknesses. Quantitative study of human phenomena can only give frequencies of occurrences of certain observable manifestations of the phenomena without explaining why they occur. Therefore, it is important to also adopt a qualitative research paradigm to compensate for the limitations of using quantitative approach for a study.

3.3 Population of the Study

The research was conducted in the Kintampo- North municipality in the Brong-Ahafo region of Ghana on the issue of impact of road construction on environment in the municipality. The target population for the study were personnel in public construction institutions and road construction firms in Kintampo- North municipality in the Brong-Ahafo region of Ghana. But the considerations of institutions and firms that comprises of two personnel from EPA, Municipal Assembly, Roads and Highway Authority, Urban Roads Departments, Feeder Roads Departments and four personnel each from three selected construction firms, that are SAECO company Ltd (Kintampo Magazine – New Market Road), CIEMAN company Ltd (Kintampo – Bambio Road) and J. Adom Construction company Ltd. (Kintampo Town Roads) who were typical involved the road constructions respectively. There are about Four (4) public construction institutions and twenty road construction firms (20) in the municipality but only three (3) firms found to be working for past five years up-to-now according to the Kintampo-North Municipal engineer as at 2016 (oral communication).

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3.4 Sample Size Selection and Techniques

3.4.1 Sampling Technique

The simple random sampling was used to collect qualitative data through unstructured interviews administered to EPA. Simple random was used to overcome issues of sampling biases. Purposive sampling was used for the quantitative strand of the study. Purposive sampling was used to deliberately identifies characteristics of researcher interest on the subject. In addition, selection of study participants was voluntary but must be personnel from public construction institutions or personnel from three selected firms that found of operating in the Kintampo municipality for about five years.

3.4.2 Sample Size

To determine the minimum sample size to recruit for the study, method or formula described by Kish (1965) was used in estimating the minimum sample size.

$$n = \frac{K}{1 + \frac{K}{N}}$$

Where: n = Sample Size

N= Population Size

But $K = S^2/V^2$

S = Maximum standard deviation in the population element (total error = 0.1 at a confidence level of 95%)

V = Standard error of sampling distribution = 0.05

P = the population elements.

S = P (1-P) = 0.5(1-0.5) = 0.25

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Therefore, in determining the minimum sample size of public construction institutions and road construction firms in Kintampo Municipality is given that N = 50.

But $K = S^2/V^2$

$K = 0.0625 / O.0025$

$K = 25$

$n = K/ (1+K/N)$

$n = 25 / (1+25 / 50)$

$n = 16.67$

$n \approx 17$

The minimum sample size calculated for the study is seventeen (17). However, twenty (20) respondents were targeted to ensure a high participation in the study and to resolve cases of respondents who might drop out from the study.

3.5 The Instruments Used for Study

The important feature of any research was to gather data that would be used to solve the problem(s). To achieve this, systematic methods and instruments of collecting data were use. The accuracy of these processes determines the validity of the study was carried out, the population, the instruments and the methods employed the study**.** In the course of the research, the instruments used to collect, assess the progress of the use of EPA guidelines as interventions were implemented and judged. These are Questionnaire, Semi-structured Interview and Field Observation.

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3.5.1 Questionnaire Design

This was designed to collect data from workers of road projects. The questionnaire was designed in such a way that each question was related to the objectives of the study and they were close ended and open-ended questions. In the close-ended questions, respondents were subjected to questions based on a Likert scale, and they were required to specify their level of agreement to statements regarding the research topic. The questionnaire was chosen for this group of people to enable the researcher to collect data from them within a short time. Also, data collected using questionnaires is easy to analyze especially with the use of the computer. A questionnaire was prepared in four sections. The first section seeks to acknowledge the demographic profile data of respondents. The second section of the questionnaire also seeks to identify major road construction activities that can lead to potentially serious of environmental impacts even with the implementation of the Environmental Assessment Regulation, 1999. The questionnaire consists of 5 factors that were identified from the literature review. The third section is about the challenges the EPA faces in the implementation of the mitigation measures. The final section seeks to outline some useful management actions that planned to prevent environmental impacts on road.

3.5.2 Interview Guide

Meanwhile, an unstructured interview guide was used to elicit both short and detailed answers from the EPA officials. The interview guide was used because it is flexible and data got through unstructured interviews usually provide details that are well explained and substantiated.

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3.5.3 Observation Guide

The researcher in the form of a checklist to make physical observations and confirm whether certain structural measures, EPA guidelines and employee's safety measures were put in place used this.

3.6 Validity and Reliability of Instruments

The Content Validity Index (CVI) of the questionnaire and interview items was computed and found to be 0.83 and 0.8 respectively, this was reasonable enough, and therefore these tools of data collection were considered valid. The instruments were considered reliable since the Cronbach Alpha Coefficient was found to be 0.66, which was above the minimum standard of 0.5.

3.7 Data Collection Procedure

In this study, colleagues and supervisor through an assessment of the questionnaire and interview questions to ensure that the instruments cover all aspects of the study under investigation established validity of instruments. The questions rated not relevant were omitted from the questionnaire and those rated vague and ambiguous were rephrased. After establishing, the validity of the instruments, familiarization visits and a pre-test was carried out using four respondents whose responses were subjected to a Cronbach Alpha Coefficient reliability test. Time taken to completed questionnaire administration and interview was two weeks.

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3.8 Data Presentation and Analysis

Data was presented using tabulation, graphical methods and analysis of frequencies. The quantitative data was analyzed by descriptive means. In the other hand, qualitative data analysis and presentation, involved a narrative analysis of the data to enrich the study with real and vivid information as given by respondents. The data collected through questionnaires was edited, coded and entered into the computer. The data fed into the computer was then analyzed using the Statistical Programme for Social Sciences (SPSS) version 21.0 and spreadsheet (Excel of Microsoft Office 2013).

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CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Overview

This chapter deals with the analysis and discussion of the results of this research. It identifies the major road construction activities that can lead to potentially serious environmental impacts and the challenges the Environmental Protection Agency faces in the enforcement of the mitigation measures stated in the Environmental Impact Statement on road construction projects. The results also identify and describe the best management practices mostly used in the effective management of control or prevent environmental negative environmental impacts on road construction sites in Ghana.

The results and discussion are presented in the form of Texts, Figures and Tables, and organized as follows; Response rate, Demographic profile of Respondents, Sources of environmental negative impacts on construction activities, methods and best practices of managing environmental negative impacts and then a summary of knowledge of various issues pertaining to road construction.

4.1 Response Rate

Twenty (20) questionnaire were administered, out of which seventeen (17) were completed and returned. The response rate is (85%) percent, which is good for a construction research.

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4.2 Demographic Profile of Respondents

This section presents background information or demographic profile of the 17 respondents in the road construction profession (public institutions) and managers (personnel of road construction firms) who hold various positions in their respective organizations with various academic qualifications and quite a lot of years of experience in managing road construction projects.

4.2.1 Gender of Construction Professionals in Kintampo Municipality, 2016

The Table 4.1 shows the dominance of males (88.2%) in the construction industry compared to females.

Table 4.1: Gender of Construction Professionals, Kintampo Municipal, 2016

Variable	Frequency	Percentage (%)
Male	15	88.2
Female	2	11.8
Total	**17**	**100.0**

Field Survey, 2016

4.2.2 Age of Construction Professionals in Kintampo Municipality, 2016

With respect to the age of the construction professionals, about three-fourth were relatively young. The ages between 30 – 40 years were seen to be working aged group managing the construction firms. The rest was 23.6% between the age 41-60 years. This year group is seen as becoming weaker and therefore cannot do too much of hard work. The summary information shows in the Table 4. 2.

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Table 4 2: **Age of Construction Professionals, Kintampo Municipal, 2016**

Variable	Frequency	Percentage (%)
30 years and below	5	29.4
31 years – 40 years	8	47.1
41years – 50 years	2	11.8
51 years – 60 years	2	11.8
Total	**17**	**100.0**

Field Survey, 2016

4.2.3 Company/Place of Work of Respondents

The majority of respondents representing 23.5% were from SAECO construction company Ltd., while 17% were from J. Adom constructions. Two people representing 11.8% each from government institutions involved in construction activities in the Kintampo Municipality.

Table 4 3: **Company/Place of Work of Construction Professionals in Kintampo Municipality, 2016.**

Variable	Frequency	Percentage (%)
Municipal Assembly	2	11.8
Urban Road	2	11.8
Highway Authority	2	11.8
Department of Feeder roads	2	11.8
SAECO const. company Ltd.	4	23.5
Cieman const. company Ltd.	2	11.8
J. Adom construction Ltd.	3	17.6
Total	**17**	**100.0**

Field Survey, 2016

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4.2.4 Position of Construction Professionals in Kintampo Municipality, 2016

The information on the positions that individual respondents held in their respective workplaces are shown in Table 4.4. Majority of respondents were Engineers. Over 76% (11/17) of the respondents were either Engineers or Assistant Engineers., The remaining 23.6 %(6/17) held other positions as Site supervisor, Quantity surveyor, the Municipal Urban officers among others.

Table 4 4: Position of construction professionals in Kintampo Municipality, 2016

Variable	Frequency	Percentage (%)
Engineer	5	29.4
Assistant Engineer	3	17.6
Project engineer	3	17.6
Architect	2	11.8
Site supervisor	1	5.9
Quantity surveyor M. EPA	1	5.9
Officer	1	5.9
NSP	1	5.9
Total	**17**	**100.0**

Field Survey, 2016

4.2.5 Educational Background

Respondents had various forms of academic qualifications; HND, a bachelor's degree Master's degree, among others. Most of the respondents had a bachelor's degree, representing 41.2%. A significant number; 23.5% had a Construction Technician academic qualification. There were a few individuals representing 11.8% each, who were holding second degree (masters), HND and Advanced certificate respectively. See Table 4.5 for detailed.

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Table 4 5: Educational Background of Respondents

Qualification	Frequency	Percent	Valid Percent	Cumulative Percent
Advance Certificate	2	11.8	11.8	11.8
HND	2	11.8	11.8	23.5
CTC	4	23.5	23.5	47.1
Degree	7	41.2	41.2	88.2
Masters	2	11.8	11.8	100.0
Total	**17**	**100.0**	**100.0**	

Field Survey, 2016

4.2.6 Working Experience of Respondents, 2016

Figure 4.5 shows that, almost half of the respondents; 41.2% have worked for at least six years and 58.8% had work experience of 5years or below. The figure revealed that high profile of experience of construction personnel were ideal to handle managerial level so far as road construction is concerned.

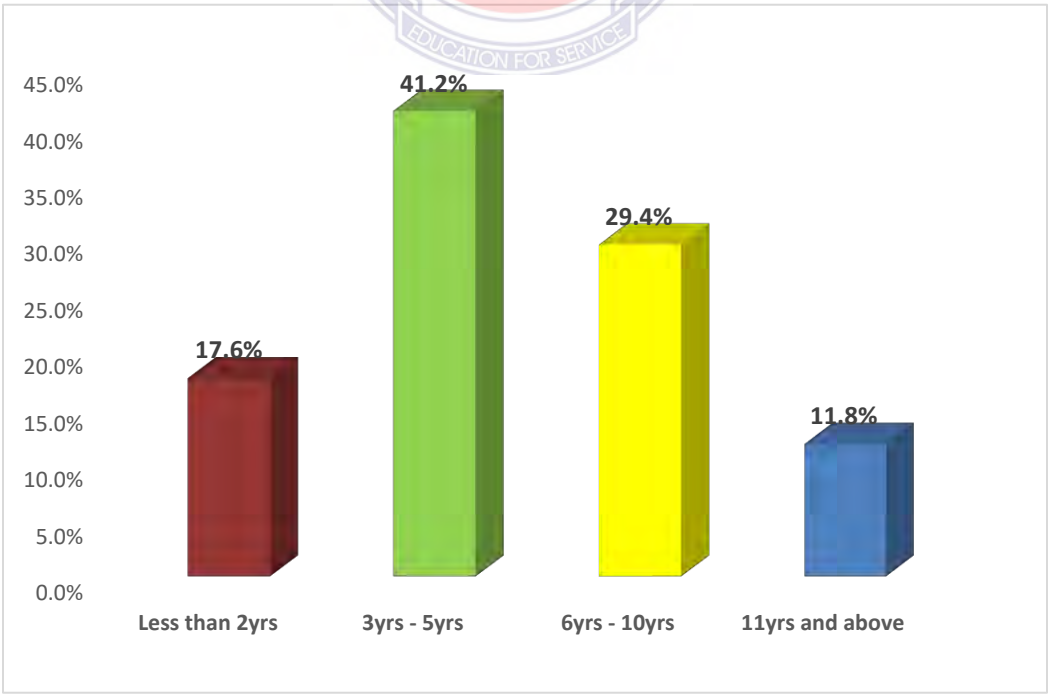

Figure 4.1: Working Experience of Respondents, 2016

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4.3 Major Road Construction Activities and its Related Environmental Impacts

The section presented data collected on levels of environmental impacts from various sources such as air pollution (dust & harmful gases), noise, etc. during specified road construction activities in Kintampo Municipal. Respondents were asked to rank their responses on a Likert scale of 1-5 where 1 - very low and 5 - Very high as an indication of how seriously the specified road activities affect environment during the given road construction activity. The responses have been presented using the mean.

4.3.1 Effects of Road Clearing, Reshaping and Excavation on the Environment

From table 4.6, the results indicated that, the noise and ground movement was ranked first as a negative effect of road clearing, reshaping and excavation on the environment. Noise in the environment is a nuisance to peace of mind and concentration. Especially when these activities are being carried out near schools, it interrupts the activity of teaching and learning. While teachers have to virtually scream before students can hear them, the students have to strain their ears to maximize their hearing capacity which in the long run has the tendency to affect their health. Also, if the activity is carried out around a hospital where patients need a very quiet environment to rest and recover faster, their sleep are interrupted by noise from the activity of earth movement. This view is further buttressed by Teixeira's view that, noise generated at road construction sites may affect the right to silence, comfort and health of residents and the visiting population and may thereby affect normal activities of nearby schools, hospitals and other services (Teixeira, 2005). Erosion ranked second and may be explained by the fact that, when roads are cleared or reshaped, the top soil are left loose and can by carried away by rain water or heavy winds.

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Erosion creates gullies, which serve as threats to buildings, they create pot holes that may cause accidents, posing risk to the life of both humans and animals, filth from eroded soils may be carried into water bodies that humans drink from, and may pose a health threat as indicated by Goodland and Irwin, the top soil carried away by erosion may become airborne and create dust problem or be carried by water into natural waterways and pollute them (Goodland & Irwin, 1975). However, dust, solid and liquid waste, ground movement, etc. have negative effects on the environment as indicated by (Osei, 2014).

4 6: Effects of Road Clearing, Reshaping and Excavation on the Environment

Environmental Impacts	Mean	Standard deviation	Rank
Noise and Ground Movement	4.47	.516	1st
Erosion	4.53	.743	2nd
Air Pollution (Dust & Harmful Gases	4.20	.775	3rd
Accidents and Incidents	3.40	.737	4th
Solid and Liquid Waste	2.53	.516	5th

Field Survey, 2016

4.3.2 Effects of Activities of Earth-Moving Equipment

The noise and ground movement was ranked first among factors considered as bad effects the activities of the earth-moving equipment. This issue might have been considered so because, movement of the ground shakes the normal ground layers, and affects the original structure of the soil profile. This can have dire consequences on all other bodies that depend on the normal soil layers for survival such as flora and other living organisms in the soil, among others. As noted by Forman & Deblinger, and

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Jodion et al., the physical compaction changes the local soil structure and water holding capacity. Nearby grading, change the hydrology of the roadside environment, resulting in channelization of streams and the draining or creation of wetlands, which can create or destroy habitat for various plants (Forman & Deblinger, 2000; Jodoin, et al., 2008)**.** Air pollution was second in position and follow by erosion. This view is further reinforced by Hansen & Barnett; Oreskes's view that, National science academies throughout the world agree that there is strong evidence that significant global warming is occurring and that it is attributable to human activities (Hansen & Barnett, 2005). A study that analyzed more than 900 scientific articles concluded that there is a consensus among scientists that humans are contributing to global warming (Oreskes, 2004).

Table 4 7: Effects of Activities of earth-moving Equipment on the Environment

Environmental Impacts	Mean	Standard deviation	Rank
Noise and Ground Movement	3.47	.516	1st
Air Pollution (Dust & Harmful Gases	3.20	.676	2nd
Erosion	2.73	1.280	3rd
Accidents and Incidents	2.40	.986	4th
Solid and Liquid Waste	1.93	.961	5th

Field Survey, 2016

4.3.3 Effects of Waste Disposal on the Environment

Creation of solid and liquid wastes was ranked first as effects to waste disposal on the environment. Air pollution was second on the list. The rest of the rankings are shown in table 4.8. This may be explained by the fact that, waste disposal during construction activities create silts. Silts may have effects on the air we breathe, because they are likely

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to increase the presence of particulate matter in the atmosphere hence, leading to elevated risks of respiratory infections. They may also be carried into water bodies thereby polluting water for drinking this is in line with the claim by Teixeira that, road construction generates both liquid and solid waste that may have adverse effect on the land and the water bodies (Teixeira, 2005). Children who go to play around these silts may suffer the risk of infections such as diarrhea. Disposed wastes, usually have very bad stench and interrupts the air we breathe.

Table 4 8: Effects of Waste disposal on the Environment

Environmental Impacts	Mean	Standard deviation	Rank
Creation of Solid and Liquid Wastes	4.27	.799	1st
Air Pollution (Dust & Harmful Gases	3.07	1.387	2nd
Noise and Ground Movement	2.80	1.207	3rd
Erosion	2.27	.799	4th
Accidents and Incidents	2.27	.799	4th

Field Survey, 2016

4.3.4 Effects of Interference in Road Traffic on the Environment

The accidents and incidents had an extremely high response for interference in road traffic on the environment and therefore, ranked first. Air pollution being the next in terms of potentially serious. The road users sometimes either forgetfulness or over-confidence drive reckless to overlook road signs when construction is go on and cause accident. Again, equipment operators deposited mountain materials on roadsides that reducing clear visibility of road users and at the end accident occurs. It is reported by Mohammed-Shafi, (1989), internationally agreed that visibility of less than 1000 metres

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due to dust as a result of road activities as a dust storm day. Osei (2014) opines that, it is necessary to manage dust evolved on road construction sites that put the lives of both the road operators and the environment in danger. Road traffic create pot holes that may cause accidents, posing risk to the life of both humans and animals as specified by (Goodland & Irwin , 1975)

Table 4 9: Effects of Interference in road traffic on the Environment, 2016

Environmental Impacts	Mean	Standard deviation	Rank
Accidents and Incidents	4.80	.414	1st
Air Pollution (Dust & Harmful Gases	4.27	.458	2nd
Solid and Liquid Waste	3.47	.743	3rd
Noise and Ground Movement	3.53	1.187	4th
Erosion	2.60	.986	5th

Field Survey, 2016

4.3.5 Effects of Bridges Construction and others on the Environment

From the Table 4.10, erosion, accidents and incidents raked first and second. Erosion creates gullies, serve as threats to buildings, they create pot holes that may cause accidents, posing risk to the life of both humans and animals, filth from eroded soils may be carried into water bodies that humans drink from, and may pose a health. The result was in line with Goodland and Irwin, (1975) that stated, the top soil carried away by erosion may become airborne and create dust problem or be carried by water into natural waterways and pollute them.

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Table 4 10: Effects of Bridges Construction and others on the Environment

Environmental Impacts	Mean	Standard deviation	Rank
Erosion	3.53	1.246	1st
Accidents and Incidents	2.80	1.146	2nd
Air Pollution (Dust & Harmful Gases	2.40	1.058	3rd
Noise and Ground Movement	2.27	.884	4th
Solid and Liquid Waste	1.93	.961	5th

Field Survey, 2016

4.4 Challenges faced by the EPA in Ghana

The respondents through questionnaire items gave their opinions about the challenges regarding implementation of mitigation measures as summarized in Table 4.11. Poor supervisions, failure to enforce EPA measures and cost of implementation of all mitigation measures were ranked first, second and third respectively. The study found that EPA not only fail to optimize socially responsible supervision processes, but they do not seem to tackle their environmental footprint either.

Table 4 11: Challenges faced by the EPA in Ghana

Challenges	Mean	Standard deviation	Rank
Poor supervision during construction increases road accident	4.80	.414	1st
Failure to enforce EPA mitigation measures and interference in road traffic can cause accident.	4.67	.488	2nd
Implementing all mitigation measures is very expensive	4.47	.516	3rd
EPA officials are located only in the regional levels	4.40	.507	4th
The measures do not address the anticipated negative impacts	4.13	.640	5th
Inadequate means to achieve the objectives and lack of project continuity.	3.47	.516	6th
Implementation of EPA mitigation measures has many challenges	3.27	1.580	7th

Field Survey, 2016

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4.5 Recommendations for Effective Implementation of Mitigation

Figure 4.2 shows that, majority of the respondents recommend sensitization and awareness of public and relevant institutions about the importance of implementing mitigation measures should be prioritized. Followed by recruitment of environmental officers for various institutions and construction companies as a way of ensuring that mitigation measures are properly implemented through regular monitoring and follow up programs. The least recommended action was law enforcement.

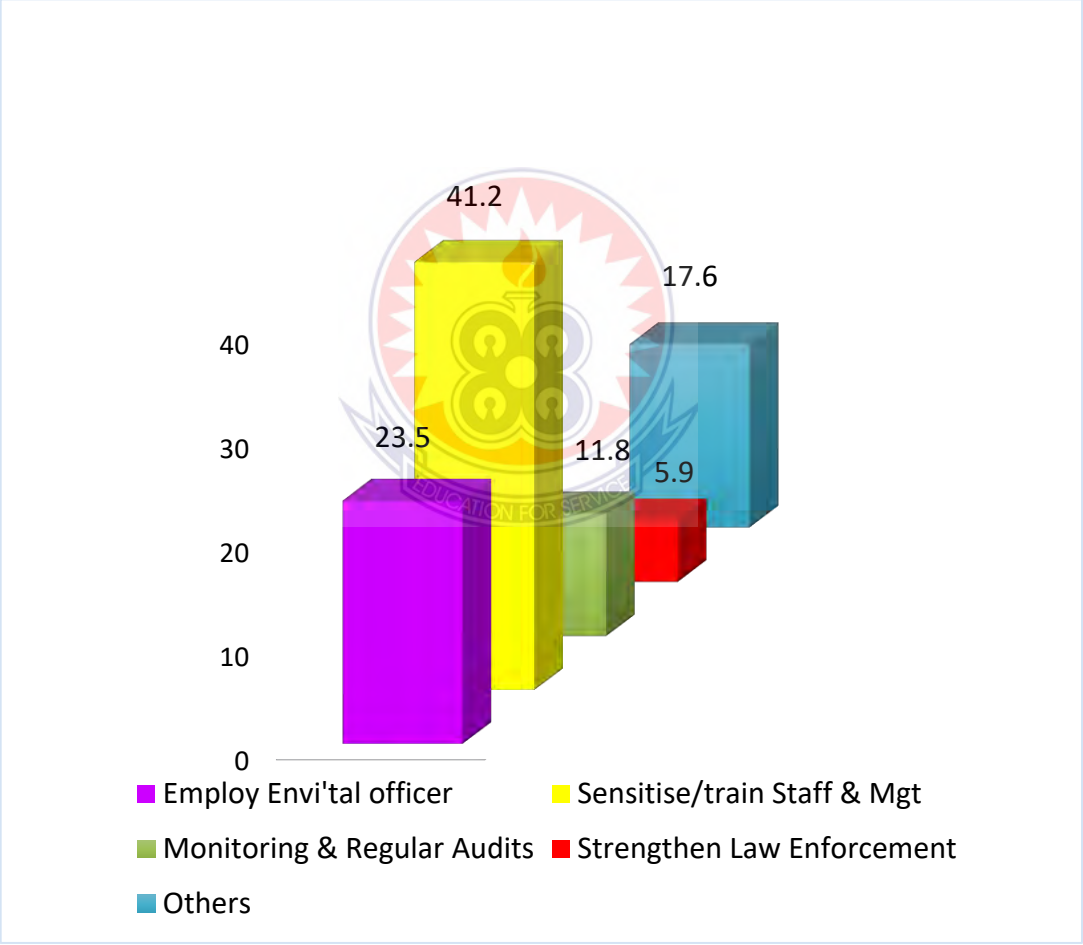

Figure 4.2: Recommendations for effective mitigation

Field Survey, 2016

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4.6 Prevention of Environmental Impacts on Road Construction Sites

The research also investigated the best management practices mostly used in the effective management of negative environmental impacts during road construction. The specific management practices that were examined and ranked included management of Erosion, Air pollution (dust & harmful gases), Noise & Ground movement (vibration) and Solid and liquid waste and Accidents and Incidents.

4.6.1 Prevention of Erosion on Road Construction Sites

The minimization of vegetation clearing ranked as very good observed management practice for controlling erosion during road construction. EPA, (1996) that road construction activities should be properly coordinated, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining not stabilised.

Table 4 12: Useful Management of Erosion on road construction Sites, 2016

Useful management practices	Mean	Standard deviation	Rank
Minimize clearing of vegetation and the removal/cutting of soil	4.07	1.335	1st
Sandbags or erosion control measures shall be installed to prevent silt runoff to public roadways from sites	2.53	1.126	2nd
Vegetative ground cover shall be planted in disturbed areas	1.60	.826	3rd

Field Survey, 2016

4.6.2 Measures Used to Control Air Pollution on Road Construction Sites

Respondents shared their opinion on how air pollution in the form of dust in the environment during construction can be minimized. Watering unpaved part of the road was seen as one of the most important ways of minimizing air pollution, thus, the best

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management practice for controlling dust generation on road construction site with water was also in line with literature review observed by Osei (2014) ranked as researcher case air pollution. All the next important practice is to check for proper functioning of all equipment which must also be serviced by certified mechanic.

Table 4 13: Useful Management of Air pollution on road construction Sites, 2016

Useful management practices	Mean	Standard deviation	Rank
All exposed surfaces shall be watered two times per day	4.67	.488	1st
All equipment shall be checked and serviced by a certified mechanic	4.53	.516	2nd
Fitting appropriate emission control and frequent maintenance of equipment	3.80	1.781	3rd
All haul trucks transporting soil, sand, or other loose material off-site shall be covered	3.67	.488	4th
Post a publicly visible sign with the telephone numbers to contact regarding dust complaints	2.53	.915	5th
Deep ripping smooth surfaces and left rough and cloddy	2.47	.516	6th

Field Survey, 2016

4.6.3 Management of Noise and Ground Movement on Road Sites

Installation of silencers on machines and mufflers on earth moving equipment was ranked fourth. This mean that noise and Ground Movement, which was observed as the highest form of environmental impacts according to this research was poorly managed, as compared to other forms of impacts. According to Martin, (1980) there are no strong laws controlling the noise from road construction sites and recommends that there is a need to control this environmental impacts in the environment. The EPA Act 490, (1994) of Ghana thereby recommends that environmental impact assessment should be provided on how to control noise and vibration involved in road construction.

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Table 4 14: Management of Noise and Ground Movement on road sites

Useful management practices	Mean	Standard deviation	Rank
Servicing equipment frequently	4.07	.704	1st
Limit times of operation of machines	2.13	1.407	2nd
Application of new technologies	2.00	.926	3rd
Installation of silencers on machines and mufflers on earth moving equipment	1.60	1.056	4th

Field Survey, 2016

4.6.4 Management of Solid and Liquid Waste on road sites

On how to manage solid and liquid wastes, using improved technology as best method was ranked first. Excavation of hidden materials and disposal of them properly, came second in rank and the least ranked was of all contaminated material uncovered on a construction site should be excavated and disposed of in an environmentally responsible manner (EPA, 1996, Chen et al., 2000).

Table 4 15: Management of Solid and Liquid Waste on road sites

Useful management practices	Mean	Standard deviation	Rank
Using improved technology	3.53	.516	1st
All contaminated material uncovered on a construction site should be excavated	3.33	.816	2nd
Re-use of waste water on site	3.20	1.373	3rd
Recycling of waste for usage	3.00	1.309	4th

Field Survey, 2016

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4.6.5 Management of Accidents and Incidents on Road Sites

With regards to effective management of accidents and incidents, respondents opined that, setting speed limits for all vehicles on unpaved roads at 15 mph was the way to go. Provision of signage at all access points also came high at the second position. The display of adequate warning signs and lights for open excavations was ranked lowest at the 6th position as shown in Table 4.16.

Table 4 16: Management of Accidents and incidents on road sites, 2016

Useful management practices	Mean	Standard deviation	Rank
All vehicle speeds on unpaved roads shall be limited to 15 mph	4.60	.507	1st
Clear signage shall be provided at all access points	4.60	.507	2nd
Workers provided with protective wear at all time	4.40	.507	3rd
Gantry scaffolding should be erected intermittently at construction	4.27	.594	4th
overpass	4.27	.704	5th
Bypass and stoppage point introduce to control the traffic	2.93	1.033	6th
Display of adequate warning signs and lights for open excavations			

Field Survey, 2016

The role of EPA in preventing negative effects of road construction

Sami-structured questions where used to interview the EPA officers on the role of the EPA in the prevention of the negative effects of road construction activities. The participants ranked the need for Environmental permit granted to the developer or contractor was first. The need for environmental audits and the employment of EPA officers ranked 4th and 5th respectively. (Table 4.14).

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Table 4 17: The Role of EPA in Preventing Negative Effects of Road construction, 2016

Useful management practices	Mean	Standard deviation	Rank
Environmental permit is granted to the developer or contractor	4.20	.775	1st
Environmental monitoring plan	4.00	.535	2nd
EPA regularly carries out environmental inspections at our road site and community members are involved	2.80	.941	3rd
The management at our company normally carries out environmental audits	2.80	.676	4th
An environmental officer has been employed	2.07	1.033	5th

Field Survey, 2016

4.7 Challenges and Recommendations from the Interview

From the interview made with the EPA on the challenges it faces in the enforcement of the mitigation measures stated in the Environmental Impact Statement or the Preliminary Environmental Report on road construction projects the following findings were identified:

Firstly, the biggest challenge to the implementation of EPA mitigation measures are the high financial costs involved coupled with inadequate resources to enforce the implementation process. There is a resource limitation for monitoring of road construction operations.

Again, there is the problem of institutional gab between road construction stake holders, because EPA deals directly with the client of undertakings and not the contractors. The EPA does not have adequate number of qualified personnel, funds and equipment to monitor road construction activities.

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Adding to these, breaks in road construction projects due to financial constraints from the Government makes it difficult to enforce mitigation measures. This is because the contractor would not be on the site to be charged with the duty of mitigating the pollution associated with the cleared road area surface, which is left untarred due to the financial constraints on the side of the client.

Again, it becomes difficult to enforce mitigation measures stated in environmental impact statement when road construction projects are funded by international bodies with a time frame on the spending of funds. This released fund goes back to the international body to another country if funds are not used within the scheduled time. This makes it difficult to enforce mitigation measures as it could delay the project finish time and hence sometimes these types of road projects could start before permit is even granted.

In light of the challenges encountered in implementing mitigation measures, the EPA through the interview made several recommendations as a way forward for the effective implementation of mitigation measures. The views of the engineers were somehow similar to those of the EPA officials who recommended that;

- Incorporate integrated Management Systems into environmental management practices to reduce the costs of implementation.
- All reports submitted by developers should have Environmental Monitoring Plan duly check by EPA before the contract sum paid.
- The EPA should also be equipped enough to check the day-to-day activities of road contractors in connection with environmental maintenance.

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- It was identified that most of the essential equipment to assist the personnel in checking the levels of pollution on road construction sites are few and only the Headquarters of the EPA has them.
- Road construction firms should employ Environmental officers for internal monitoring. Management of road construction firms should carry out regular internal audits.
- Municipal EPA should be friendly to management while carrying out their audits to avoid conflicts. They should strengthen enforcement of mitigation measures, because the developers just intentionally neglect some mitigation measures.
- All workers should be involved in the implementation of mitigation measures and not leaving the task only to the management. Workers should be sensitized to increase awareness. Community members should be consulted.

4.8 Field Observation

The data collected through questionnaires was supplemented with the findings of the interviews and observation checklists. There were no differences in the levels of implementation of the mitigation measures by the various road construction firms. It was revealed during this study that some mitigation measures have been implemented especially those with little financial implications on their projects and those that have direct harm to the employees and their projects, while some have not been implemented at all. Upon the researcher's interaction with workers and people in communities during observation visit, it's revealed that, in respect with interference in road traffic, during construction, quite number of accident occurs frequently and about 35 to 40 death were recorded since 2010.

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The respondents level of education suggest that Kintampo Municipal has a brighter future for construction industry. Even though, one of the EPA official was a National Service Personnel, the researcher concludes, that the quality control managers were directly responsible for quality assurance in the industry including compliance to environmental standards, and were thus the right people to provide the required information for this study.

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CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This study sought to identify the severity of environmental impacts during road construction projects, which affect the people in the communities along the roadside, and road users in Ghana. The Environmental Protection Agency mitigation challenges and the useful management actions that can be planned to prevent environmental impacts on road construction sites in Ghana. The chapter presents a summary of the findings, the recommendations made to address the findings and finally the conclusions drawn from the analysis of this research.

5.1 Summary of the Findings

The following are the summary of findings:

- The study revealed that all the five issues the researcher considered as environmental impacts, which negatively affects the environment during road construction activities were true/
- Nonetheless the most protruding issues were noise and ground movement, accidents and incidents and air pollution respectively displayed in the Tables 4.3 - 4.7.
- This research established the fact that interference of road traffic was a cause of accident on environment during activities of road construction which most researchers do not consider.

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- It was also disclosed orally; during observation visit that the number of death recorded between 2010 to date stand at 35 – 40 as the result of road accident in Kintampo Municipal. Because of the important of road construction activities, several studies have been conducted to evaluate its impacts on environment (Osei, 2014; Ametepey et al., 2013). However, one obvious impact they did not include in their studies was accident cause by road construction operations. This was the researcher driving force to gather this work and the responses gathered agreed.
- While EPA is preferable to manage and prevent the generation of impacts rather than to reduce or control their effects, it was noted that, most of the recommended mitigation measures did not focus on how to prevent adverse impacts on the environment from occurring. The mitigation measures rather focused on reducing the impacts. It could therefore have been better for the EPA practitioners to put more emphasis on prevention of impacts. This view is supported by Mitchell's (1997) mitigation hierarchy, which suggests that, mitigation should be based on the principle that it is preferable to prevent the generation of an impact rather than counteract its effects.
- Ahmad and Sammy (1987) argue that, too many alternatives are unmanageable and too large to handle effectively. Large numbers of unmanageable alternatives can be reduced by defining the problem in terms of a series of choices. This will reduce the cost and time of the EPA process while ensuring that all alternatives are considered.
- The study revealed that, the EPA does not have adequate number of qualified personnel, funds and equipment to monitor road construction activities. It was

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identified that most of the essential equipment to assist the personnel in checking the levels of pollution on road construction sites are few and only the Headquarters of the EPA has them.

- In the other hand, majority of the respondents of road construction industries recommend that sensitization of staff and managers about the importance of implementing EPA mitigation measures should be prioritized.

5.2 Conclusion

Identification of Environmental Impacts on Road Construction: Regarding the identified major road construction activities and its related environmental impacts, it is concluded that the recommended EPA mitigation measures only focused on the contractor's employees and other working team (their health and safety) and neglected the entire public where the development taken place. The people in the communities are left to combat with these environmental impacts. Cole (2000) stated that the environmental impacts of the construction process should embrace resource uses, ecological loadings and human health issues supported these views.

The Challenges of the EPA: The cruelty of environmental impacts associated with road construction projects identified in this research such as accident, noise and ground movement and air pollution can assist road project managers and contractors to identify the most critical environmental impacts during road construction operations. The biggest challenge to the implementation of EPA mitigation measures are the high financial costs involved coupled with inadequate resources to enforce the implementation process. This

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is the reason why majority of the mitigation measures have not been implemented by developers of road construction industries.

The Effective Management of Environmental Impacts on Road Construction Sites: A number of strategies were clearly laid out in the EPA reports for the developers of road construction firms to use in implementing mitigation measures. These strategies included the use of Environmental Management Plans (EMP), carrying out internal audits, having internal monitoring programs, regular environmental awareness and recruiting environmental officers to assist in EPA follow up. The study established that, developers and managers of road construction firms had no deliberate policies for applying these strategies to prevent adverse environmental impacts from occurring.

The researcher thereby recommends that road construction project managers increase the frequency of employing best management practices to control these impacts with special attention to these critical environmental issues during road construction operations. This is believed to go a long way of help safeguard the environment in the communities.

5.3 Recommendations

The following Recommendations are made to address the findings of the study:

- Mitigation measures should focus on all the phases of the project life cycle that is, project design, construction and the operation phase. The mitigation measures also need to be detailed enough to avoid negative environmental impacts and they should be specifically designed for different projects.

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- It recommends that, the implementing mitigation measures of EPA need to be made known to the road developers right from the project proposal so that they are aware that the costs of mitigation implementation are part of the costs for project implementation. This means that, EPA practitioners should endeavor to include in the EPA reports a section on economic analysis that highlights the costs, benefits and cost-effectiveness of the identified mitigation measures. This will enable proponents of road construction projects to make their budget estimates for project implementation with mitigation measures in their mind.
- Established on the analysis of this research, it was identified that the noises and ground movement (vibration) were most critical environmental impacts with less mitigation measures.
- The Municipal Assembly and EPA should see to it all projects awarded to contractors were include the cost of mitigation EPA measures to reduce road accidents during road construction. The Municipal Assembly should make sure that contractors adhere to effective EPA mitigation measures through education to communities and road users.

5.4 Areas for Further Research

Future research could focus on effectiveness of the recommended mitigation measures could be another area for further research. It is therefore, not known whether development projects in Ghana are subject to EPA/EIA right from the project design stage.

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APPENDIX I

UNVERSITY OF EDUCATION, WINNEBA COLLEGE OF TECHNOLGY EDUCATION – KUMASI (DEPARTMENT OF WOOD AND CONSTRUCTION EDUCATION)

QUESTIONNAIRE FOR ROAD CONSTRUCTION PROFESSIONALS (ENGINEERS), AND MANAGERS (CONTRACTORS)

Dear Respondent,

The researcher is a student of the University of Education, Winneba - Kumasi, targeting a dissertation on the topic: Impact of road construction on environment in Ghana - Kintampo Municipal. This questionnaire is arranged into four sections aimed at achieving adequate information base on the research questions. The information you will provide will assist me in achieving the goals for this research and hence I guarantee you that the information you will provide will be kept confidential.

Section 2- 3, with your experience kindly assign numbers on a scale of 1-5 (with **5** as the highest and **1** as the lowest)

Section 1 Personal Data

1. Gender: ----------
2. Age: ……
3. Name of company: ----------
4. Position: ----------
5. Qualification: ----------
6. Level of experience (years):----------

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Section 2: What are the major road construction activities that can lead to potentially serious environmental impacts?

Environmental Impacts	7. Air Pollution	8. Solid & liquid waste	9. Erosion	10. Noise & Ground movement	11. Accidents and Incidents
Activity					
(a) Road Clearing, Reshaping & Excavation					
(b) Grading, Filling & Compaction					
(c) Waste disposal					
(d) Interference in road traffic					
(e) Bridges, culverts and others					
Others(please specify)					
(f)					

Section 3: What are the challenges the Environmental Protection Agency faces in the implementation of the mitigation measures by road developers in Ghana.

Please Tick (√) the option that best suits your opinion (with **5** as the highest and **1** as the lowest) **Challenges of EPA Mitigation Measures**	1	2	3	4	5
1. Implementing all the mitigation measures is very expensive.					
2. There is lack of a person with necessary expertise to deal with environmental issues at our organization.					
3. Inadequately developed means to achieve the mitigation objectives and lack of project continuity.					
4. EPA officials center only in the regional levels.					
5. Implementation of EPA mitigation measures has many challenges such as lack of guidance on how to conduct follow-up studies, legislation deficiencies, expertise and quantifying impacts, demands on financial, and staff resources.					
6. Failure to applied EPA mitigations measures and interference in road traffic can cause accident.					
7. Poor supervisions of road construction by road managers (engineers and EPA) has been increase road accident during road constructions.					

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8. Suggest what should be done to ensure that EPA mitigation measures are effectively implemented.

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Section 4: What are some useful management actions that can be planned to prevent environmental impacts on road construction sites in Ghana?

The respondents were asked to rank using the Likert scale as follows: 1 – poor, 2 – average, 3 – credit, 4 – very good and 5 – excellent. Please Tick (√) the option that best suits your opinion (with **5** as the excellent and **1** as the poor)

Management Practices on the various impacts	1	2	3	4	5
9. Sandbags or other erosion control measures shall be installed to prevent silt runoff to public roadways from site with a slope greater than 1 percent					
10. Vegetative ground cover (e.g., fast-germinating native grass seed) shall be planted in disturbed areas as soon as possible and watered appropriately until vegetation is established					
11. Minimize clearing of vegetation and the removal/cutting of soil					

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Air Pollution (Dust & Harmful Gases)	1	2	3	4	5
12. All haul trucks transporting soil, sand, or other loose material off-site shall be covered.					
13. All exposed surfaces and unpaved access roads shall be watered two times per day					
14. Deep ripping smooth surfaces and left rough and cloddy					
15. Post a publicly visible sign with the telephone numbers and person to contact at the lead agency regarding dust complaints.					
16. Fitting appropriate emission control and frequent maintenance of equipment.					
17. Waste control measures include obtaining construction materials, paints, lubricants and other liquids in reusable packaging or containers.					
18. All equipment shall be checked and serviced by a certified mechanic and determined to be running in proper condition prior to operation					

Noise and Ground Movement (Vibrations)	1	2	3	4	5
19. Limit times of operation of machines					
20. Installation of silencers on machines and appropriate mufflers on earth moving equipment					
21. Servicing equipment frequently					
22. Application of new technologies					

Solid and Liquid Waste	1	2	3	4	5
23. Using improved technology					
24. Contaminated water from sediment dams should be used for dust suppression and irrigating adjacent vegetated land. (Reuse of waste on site)					
25. Waste concrete from demolition activities should be sent to a concrete recycler instead of landfill					
26. All contaminated material uncovered on a construction site should be excavated and disposed of in an environmentally responsible manner					

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Accidents and Incidents	1	2	3	4	5
27. Clear signage shall be provided for construction workers and road users at all access points					
28. All vehicle speeds on unpaved roads shall be limited to 15 mph					
29. Open excavations should be adequately displayed warning signs and lights					
30. Gantry scaffolding should be erected intermittently when construction overpass					
31. Workers have been provided with protective wear at all time.					
32. Bypass and stoppage point introduce to control the traffic					

Implementation of EPA Mitigation Measures	1	2	3	4	5
33. Environmental permit is granted to the developer or contractor					
34. There is an environmental monitoring plan at our road construction site to ensure that the environment is not negatively affected.					
35. An environmental officer has been employed at our firm to follow up the implementation of EPA mitigation measures.					
36. The management at our company normally carries out environmental audits/inspections					
37. EPA regularly carries out environmental audits/inspections at our road site and community members are involved					

THANK YOU

END.

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APPENDIX II

INTERVIEW GUIDE FOR EPA OFFICIALS

This interaction seeks your critical assessment of the implementation of mitigation measures identified during the EPA/EIA process, with reference to road projects in Kintampo –North Municipal. Please note that this study is not an investigation into any activities of your job. The study is purely academic and any responses obtained will be treated with confidentiality. Kindly respond truthfully. Thank you.

Section A: Background information

1. Gender: ----------
2. Age: ……
3. Name of company: ----------
4. Position: ----------
5. Qualification: ----------
6. Level of experience (years):----------

Section B: Challenges and Recommendations of EPA

7. What are your major roles regarding implementation of EPA or EIA mitigation measures?

   ……

   ……

   ……

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8. What major strategies do you use to ensure that the mitigation measures are implemented?

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……

9. How do you deal with developers and road managers (engineers) who do not comply with the requirement for impact management?

……

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……

10. What are some of the challenges faced in ensuring that EPA/EIA mitigation measures are implemented?

……

……

11. Suggest what should be done to ensure that EPA/EIA mitigation measures are effectively implemented.

……

……

……

12. As EPA Officer, name some of the roads and firms regularly carries out environmental audits/inspections on their site from 2010 to date in Kintampo – North Municipal.

……

……

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APPENDIX III

OBSERVATION CHECKLIST FOR THE RESEARCHER

Section A: Background Information

Name of project: ……

1. Nature of activity……

2. Location…….

3. Type of Road (Highway or Feeder) ……

Section B: EPA Guidelines

No	Items to be observed	EPA Report	Implementation Schedule
4	Predicted adverse environmental impacts		
5	Recommended Measures impacts		
6	Action taken to achieve the objectives of the recommended mitigation measures		

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1. Mitigation Plan (Mitigation strategies used)

   a) ……

   b) ……

   c)……

2. Monitoring plan for adverse environmental impacts

   a Accidents and Incidents

   b Erosion Measures

   c Harmful gases treatment

   d Noise control

   e Solid waste treatment plant

   f Solid waste disposal site

   g Dusts treatment and control

   h Others

      i. …….

      ii. ……..

THANK YOU

END.