UNIVERSITY OF CAPE COAST

HEALTH IMPLICATIONS OF GOLD MINING FOR MINE WORKERS IN OBUASI

BY

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DECLARATION

Candidate's declaration

I hereby declare that this dissertation is the result of my own original work and that no party has been presented for another degree in this University or elsewhere.

Candidate's Signature:..... Date:..07/06/09..

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Supervisor's declaration

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation laid by the University of Cape Coast

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ABSTRACT

The increased trend of health problems in the extractive industries including gold mining has been a major concern in recent times. Communities, workers, NGOs and government agencies have been looking at the best ways to reduce these unfortunate incidents to a minimum.

This study was conducted at the Obuasi Municipality of Ghana, to find out the health implications of gold mining in the areas of common water-related diseases and common-air related diseases of Anglogold Ashanti (AGA) operations on inhabitants' health. The study depended on primary data collected from the field through interview schedule method and questionnaire administration and secondary data from the Obuasi Municipal Health Directorate.

The study identified that pipe-borne water was the major source of drinking water for the majority of the people. Diarrhoea and typhoid; and respiratory tract infections were the main common water-related and air-related diseases respectively in the Obuasi Municipality. Malaria came first as the most prevalent disease in the municipality. With regard to the causes of the prevalent diseases, poor sanitation, polluted water, and dusty and smoky environment were mentioned.

Among the recommendations suggested is the need for AGA management to increase its education on the use of Personal Protective Equipments (PPE), to suppress dust, backfill mined-out pits on time, enforcement of exit and periodic medical examination, and establish an Environmental Protection Agency office (EPA) in the Obuasi Municipality.

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DEDICATION

In Memory of My Parents

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LIST OF ACRONYMS

AGA - AngloGold Ashanti

AEDA – Adansi East District Assembly

AIDS – Acquired Immune Deficiency Syndrome

AWDA – Adansi West District Assembly

AWDHS - Adansi West District Health Services

CO - Carbon Monoxide

CVA – Cerebrovascular Accident

DANIDA - Danish International Development Agency

DHO - Danish International Development Agency Health Office

EIA – Environment Impact Assessment

ERP – Economic Recovery Programme

EPA – Environmental Protection Agency

GDP – Gross Domestic Product

GGL – Golfields Ghana limited

GHS – Ghana Health Services

GMWU - Ghana Mine Workers Union

HCN – Hydro-Cyanide

HIV – Human Immunodeficiency Virus

ISSER – Institute of Statistical, Social and Economic Research

LDCs – Less Developed Countries

LI – Legislative Instrument

OMHD - Obuasi Municipal Health Directorate

MO - Mining Ombudsman

MOH - Ministry of Health

NGOs – Non-Governmental Organisations

ODH – Obuasi District Hospital

OPD – Out Patient Department

P_{M10} - Particulate matter (diameter less than micrometer)

PPE – Personal Protective Equipment

Ppm – Part per million

PTP – Pompora Treatment Plant

SAP – Structural Adjustment Programme

SO_2 – Sulphur Dioxide

TB - Tuberculosis

TGL – Teberebie Goldfields Limited

TUC – Trade Union Congress

URTI – Upper Respiratory Tract Infection

WACAM – Wassa Association of Communities Affected by Mining

WEF – Women Economic Forum

WHC - Worker Health Chartbook

WHO – World Health Organisation

WUC - Western University Campus

CHAPTER ONE

INTRODUCTION

Background to the study

Most developing countries that want to advance in development either economically or socially, have come to realise that they cannot do so without the expansion of resource extraction and consumption opportunities. Thus, they are confronted with some challenges. Some of them are: (1) how to improve on their health care delivery (2) how to manage the natural resources on the basis of sustainable development (3) how to manage the staggering external debts without necessarily over-exploiting and degrading available natural resources given the over-reliance by many developing countries on primary products among others.

The links between mining especially gold mining and its associated problems are yet to be clearly systemized and understood in many areas of the developing world. The World Health Organisation (WHO) defines Health as a state of complete physical, mental, and social well-being and not merely the absence of disease and illness (WHO, 2003a). The cost of health to society from environmentally related diseases comes from the loss of human-hours of work and resources (doctors, nurses, technicians, administrators and drugs). Thus, if the human-hours of work is lost greatly due to ill health then productivity will reduce and hence a country or society cannot develop at the pace it wants to. This is because human capacity needed for development is

affected by these environmental diseases. Thus, health problems of the majority of the population can affect the economic development of a country.

Almost all countries, especially the developing ones, are trying to ensure the health of their citizens as development and health move together. According to Tutu (1996), the annual recurrent and capital budgetary allocation for health, 25% of the recurrent expenditure was assumed to be due to health problems arising from environmental degradation. From the above, it presupposes a healthy people is very significant for national development and hence the government's effort to combat diseases.

Globally, the extraction and consumption of natural resources have led to the depletion of tropical forests, global warming, ozone depletion and its attendant health problems. However, the goal of sustainable development is to improve the living standard and the quality of people's lives for now and for the future generation. Africa can boast of substantial deposits of minerals including oil, gold, bauxite, diamond, manganese, and cobalt. As a result of this, most of its development activities have been concentrated to a large extent on the exploitation of these natural resources. However, in spite of the rich natural resources that Africa is blessed with, it is among the poorest continents. This is due to several factors including political instability, colonial exploitation, lack of economic independence, high level of illiteracy and poor health status.

The economic performance of African countries in 1950's and 60's was relatively good, however in the late 1970's and 1980's most of the countries' economies deteriorated showing negative growth rates (Collier and Gunning, 1999). The need to intensify economic growth, reduce poverty and

improve the quality of life in general for the average people led to the institution of the Structural Adjustment Programme (SAP) in Africa. Kendie (1995) citing Sawyerr (1998:1), claim that the crisis was thought to have arisen from failures in the economic system, the measures instituted and the instruments selected to achieve the objectives of the programme were largely economic. When a country is implementing SAP, it implies that the country is undertaking macro-economic reforms so as to remove or eliminate imbalances that militate against economic growth. As part of SAP conditionality, there was the export drive and since most African countries who were then implementing the SAP were blessed with minerals this meant more exploitation of such resources and hence its environmental implications and the attendant health problems.

Ghana, though endowed with mineral resources such as gold, bauxite, manganese and diamonds was among the first 37 developing countries to undertake significant policy changes, dubbed the "SAP", which was embarked upon in April 1983 due to the negative growth that she experienced during the late 1970's and early 1980's (Kendie, 1995). These economic changes of the early 1980's, which culminated in the Economic Recovery Programme (ERP) of 1983, marked the beginning of a new phase with an upsurge in mining activities. Since then, there has been an increase in mineral work in areas not traditionally associated with workable deposits often found in agricultural land, forest estates and sometimes in areas of natural beauty (Asamoah, 1998). The policy measures that were instituted specifically for the mining sector under the Ghana Mineral Code of 1986 triggered phenomenal growth in that sector. Ashanti Gold typifies that remarkable surge.

Under the ERP/SAP, there has been substantial investment in gold mining leading to an increase of 140% in 1990 over 1983 production (Tutu, 1996). Also, it has been documented that between 1987 and 1997 alone, the number of foreign controlled-exploration companies rose from 13 to 74 because of the relaxed mining laws in Ghana, Ghanaian-owned prospecting companies increased from 17 to 123 with gold production shooting up by 500%. The gold mining sector has since emerged as the country's largest foreign-exchange earner. Gold accounts for more than 40% of the country's total gross foreign-exchange earnings. However, this boom in the mineral extraction industry has recorded negative effects like violation of human rights, diseases, homelessness etc on the people living in the mining areas (Dramani, 2000). Further, records have it that 200 companies have been prospecting for gold since the last nine years (Ahadzie, 2000).

Mining activity in Ghana can be categorized into two: large scale mines, which are heavily capitalized and operated by companies employing hundreds and in some cases thousands of workers, and small scale mines with little or no capital equipment. Though gold mining has been playing and continues to play a central role in the socio-economic and political life of Ghanaians, its contribution to the Ghanaian economy has offset to a considerable extent the decline of cocoa production and for that matter agriculture which for a long time remained the number one foreign exchange earner. However, there are environmental problems associated with mining. Some of these are:

- Subsidence and surface disturbance including that of water courses.

- The health problems arising from certain highly toxic materials such as cyanide may be significant
- Dust emissions, especially if they include cyanide, arsenic and other pollutants, constitute health hazards.
- Noise pollution emanating from mining activities such as the use of heavy dump trucks, blasting, rock drillers and heavy machines can result in the loss of hearing, nervous disorders and circulatory troubles among others.

The huge gold deposits at Obuasi accounts for the reason why the Anglogold Ashanti (Obuasi), one of the largest producers of gold is sited there. The AGA was listed in the London Stock Exchange in 1897 then Ashanti Goldfields Corporation. It was also the first African company to be listed on the New York Stock Exchange. The company has been in existence since 1897 and has produced almost 600 tons (18 million ounces) of gold from ore averaging about 0.65 ounces per ton.

The Obuasi mine works on steeply dipping quartz veins over a strike length of 8km. and has a labour force of about 6800 as of now. This process of exploiting resources in the district and for that matter Obuasi to meet basic socio-economic needs has brought in its wake environmental problems like land degradation, air pollution, water pollution and its attendant health problems. For instance, in 1999, a tailing dam pipeline burst causing pollution of the River Nyam at Sansu near Obuasi where the AGA was then using as a waste dump as part of its surface mining operation (WACAM, 2003) . It is against this background that the researcher decided to research into whether or not gold mining is actually responsible for the health problems in Obuasi area.

Statement of problem

Gold mining has been playing a central role in the socio-economic and political life of the people of Ghana for more than 100 years. Rawlings (1997) stated that the gold mining sector has now emerged as the country's largest foreign-exchange earner, accounting for more than 40 percent of the country's total gross foreign-exchange earnings. However, Dramani (2000) stated that the boom of the extractive industry in Ghana especially gold mining has had adverse impact on the environment which has also accounted for a set of social problems including violation of human rights, diseases and homelessness. Again, some water-related diseases such as bilharzia and schistomiasis are prevalent in mining areas in Ghana.

Also, the buruli ulcer prevalent in the Amansie West District of Ashanti Region is believed to have resulted from the mining activities over there (Duker, 2005). Further, skin diseases, lung cancer and other respiratory diseases are believed to be quite prevalence in mining areas (Reddy, 2005).

There are numerous advantages that the local communities in Obuasi derive from the operations of AGA in the form of employment, health care, education and leisure facilities for employees and their dependants and the Obuasi Township as a whole. Furthermore, the construction of new housing schemes has opened up the Obuasi Township and led to increased local economic activities. This contributes to new employment opportunities for the young people, who hitherto could only become miners. However, because AGA is engaged in both surface and under ground mining, which employs chemicals, it is possible for mining effluents to leak into water bodies. This may pose health hazards to human beings in and around Obuasi.

The inhabitants, NGOs and other civil society organizations claim that the socio-economic life of the people has been deteriorating and hence their marginal social cost does not equate their marginal social benefit. For instance, sulphur dioxide produced during roasting and smelting, is believed to be a major contributor to most respiratory diseases in most towns as it can cause chronic asthma and bronchitis. It sometimes causes eye irritation (Boadi, 2002).

Again, the AGA hospital has it on records that the inhalation of noxious gases has resulted in the following diseases in Obuasi:

- Bronchitis-infection in the bronchiole of the lungs.
- Bronchitis-infection in the bronchi.
- Bronchopneumonia infection of the thoracic cavity.
- Asthma
- Rhinitis-Nasal cavity infection.
- Narcosis drowsiness, sleep by insensibility (Nyarko, 2002).

The inhabitants, the NGOs among others claim that these social costs must be borne by AGA. Others think that their life must be insured by the AGA since its operations have negative impact on their health. On the basis of all that is said above, the thrust of the study will be to find out the health implications of gold mining in the Obuasi Municipality.

Objectives of the study

The main objective of this study is to investigate the effects of mining on the health of the people in Obuasi. The specific objectives are to:

- Describe the main diseases of the population in the Obuasi area.
- Ascertain the extent to which these diseases are manifested in the mining area.
- Identify the effect of mining activities on water bodies in the operation area.
- Ascertain the extent to which AGA operations affect the health of inhabitants.
- Recommend to the management of AGA, the government and interested parties, preventive and protective policies to put in place.

Research questions

The following are the research questions that the study sought to find answers to:

- What are the main diseases of the population in the Obuasi Municipality?
- To what extent are diseases manifested in the mining area?
- What are the sources of drinking water for the population?
- What water-related diseases are common in the area?
- What are the causes of these common diseases?
- Has the operation of AGA any effect on the health of inhabitants?

Rationale of the study

The study is expected to benefit AGA management, the Obuasi Municipal Assembly, the Environmental Health and Sanitation Unit of the Assembly. First, management of AGA will find the study useful since it will enable them to understand the impact of gold mining especially surface mining operations on the health of the workers and the people in and around Obuasi so that they can factor it into future plans and operations of the company.

Furthermore, the study will help the District Assembly, the Environmental Health and Sanitation Unit of the assembly as well as the Environment Protection Agency (EPA) in their policy formulation and implementation. The extractive industry especially gold mining has experienced a very drastic boom and this has led to more demands on the environment, even to the extent that the Ghana Chamber of Commerce has put in place measures to allow forest reserves to be mined. This presupposes more degradation of the environment and its attendant health implications. But, for sustainable development to be achieved, it will require an understanding of the various linkages between the common diseases and gold mining. There is therefore the need to scientifically assess the relationship between gold mining and health implications for proper decision making.

Organisation of the study

The study has been divided into five chapters. Chapter One deals with the introduction which covers background, statement of the problem, objectives, research questions, rationale of the study and organisation of the

study. Chapter Two dwells on a review of the literature. Chapter Three involves the methodology used in the study. Chapter Four focuses on the results and discussions of the study. Chapter Five involves the summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter is devoted to the review of related literature on the study topic. The review covers the following:

- Mining and environmental problems
- Mining and health implications

Mining and environmental problems

Pollution of the air, land and water is widespread in the mining sector. Thus, mining operation, either surface mining or deep mining, has some major environmental and health effects. For instance, surface mining brings about the destruction and disruption of vegetation, natural drainage patterns and land use among others. Also, soil erosion resulting from cleared lands for mining and over burdened dumps have led to sedimentation and pollution of water courses. These polluted water courses pose health problems for those people who depend on them for drinking. There is also the possibility of acid mine drainage, not forgetting visibility problems among others as a result of dust pollution during operations. Further, there are water consumption effects in arid areas.

Deep mining basically is of two types, that is either long wall or pillar. This deep mining (either long wall or pillar) affect the environment as

production on surface soil heaps has potential erosion effects such as sedimentation and acidification of water courses. There is possibility of air pollution and tip instability as a result of spontaneous combustion of the soil heaps which can affect the air quality, hence leading to respiratory diseases. Also, mine drainage significantly alters the water quality of a large area by removing soluble minerals from aquifers and by acidifying surface water courses (Chadwick et al, 1987).

It proved to be true that one area of pollution, which mostly affects both humans and plants, is air pollution. One of the worst examples of air pollution ever recorded was the London smog of 1952. 2 Science Probe (10) second edition about 4000 people died as a result of the smog pollution, most of them from respiratory diseases such as bronchitis and asthma (Younayelle, 2001)

Kwarteng (2003) revealed that mining firms also discharge water used in processing and refining minerals into rivers. In some cases spillage of poisonous substances like cyanide also find their way into water bodies. For instance in 1999, a tailing dam pipeline burst occurred at Bibiani and polluted Tano River. There was another cyanide spillage in October 2001 from the Goldfields Ghana Limited into River Asuman, which served as drinking water for the people of Abekoase and other villages in the Wassa West District of the Western region.

According to Kwame Peprah then Acting Minister of Mines and Energy in 1997 at the opening of a two-day national symposium with the theme "The mining industry and the environment" organized by UST/DRC Environment Research Group in the Chemistry Department, that the

government was aware of the public concern, especially in the local mining communities, about the environmental problems resulting from mining operations. The discussion of the symposium was mainly focused on identifying strategies for the development of the mining industry with practicable and sustainable solutions to environmental problems associated with the industry such as tropical forest destruction, land degradation, atmospheric pollution, health hazards, and pollution and sedimentation of inland water bodies (FOELINE, 1997).

In line with Dramani (2000), the growth of the extractive sector for the past two decades as a result of the boom in the mining industry has had adverse effect on the environment in Ghana as the nation has recorded a loss of four million hectares of her virgin forest at the same time.

Rawlings (1997) stated that though gold is the leading foreign exchange earner, yet the surface mining and the practice of illegal mining cause environmental problems. He also stated that illegal diamond mining practices cause irreparable environmental damage. Tutu (1999) claimed that there has been an issue of land degradation where residual deposits are abandoned in the vicinity of mines and such soil-heaps sometimes contain dangerous minerals that may be washed into rivers thus adding to pollution. The accumulation of these minerals may pose serious health hazards to the communities who depend on the rivers as a source of drinking water and other domestic and farming activities. He further stressed that small-scale gold prospecting has had particular undesirable impact on the landscape and on soil degradation. Chemicals used for the separation of gold can be hazardous to humans as well as wildlife.

Chemicals used for the separation of gold can be hazardous to humans as well as wildlife.

Blasting can also cause adverse effect on the environment such as the cracking of buildings and so on. For instance, last year, Newmont Ghana received, through its grievance system set up in the surrounding communities of its Ahafo Mine, complaints of cracks by 143 landlords in some dwellings outside the legally mandated 500m buffer zone as a result of its blasting activities in the mine (Baffoe, 2007). This blast can adversely affect the health of the people in the catchments areas such as loss of hearing, nervous disorders and circulatory troubles. This continuous noise pollution places everybody at risk - both workers and non-workers who were housed in and around mining sites.

Tutu (1996) estimated that the cost of environmental degradation resulting from natural resource exploitation and consumption in Ghana was 4% of GDP in 1988. Exploitation in the mining and forestry sectors respectively is not sustainable. Again, as stated in the Younayelle's (2001) that a report by the Institute of Statistical, Social and Economic Research (ISSER) of the University of Ghana revealed that the estimated cost of environmental degradation in Ghana was 417 billion cedis (US$128 million) representing 4% of GDP (TUC, 2000). In the mining industry, both the large scale and small-scale companies contribute to pollution and environmental degradation. Thus, the small-scale miners have no reclamation plans for the environment just like the investors. Their aim is only to search for gold, leaving the environment degraded. The result of this has been the deprivation of the inhabitants of the

mining areas of good drinking water, agricultural lands, quality air and in fact robbery of better livelihood.

It is stated in Amoako's (1986) works that as a result of the roasting operation in gold mining at Obuasi Gold Mine, huge volumes of poisonous smoke of arsenic oxide incessantly pour out of the giant 186ft chimney on to the surrounding countryside and render it brown and barren. These emissions may lead to skin diseases and visibility problems of the people in the Obuasi area.

People of Sansu who are predominantly farmers lost large tracts of agricultural lands in the process leading to loss of livelihood as a result of AGA using the area as a waste dump as part of its surface mining operation. Again the Saa River, which is their source of drinking water, has been polluted as a result of sediments from the waste dump being washed directly into the river during periods of heavy rains. Buildings in Sansu developed cracks from blasting when AGA was engaged in surface mining operations there (WACAM, 2003). The AGA -Obuasi, also caused the pollution of the river Nyam at Sansu (Kwarteng, 2003). The pollution of the air and water as a result of extraction and processing of minerals led to many diseases and sickness among the inhabitants at the catchments areas. Such diseases and sicknesses may include lung cancer, typhoid, skin rashes, visibility problems among others as a result of emissions of sulphur dioxide, hydrocarbons, carbon monoxides, mercury into the atmosphere and into the water bodies. The blast also produces noise pollution which may also go a long way to affect the ear leading to hearing impairment.

Ghana is believed to derive huge economic benefits from the operation of surface mining. Unfortunately, the impacts of surface mining are quite significant in comparison to other industries. Thus, every major gold rush meant death and devastation for the local people at the hands of fortune-seekers, pollution of water, air among others and its attendant health problems (Agyei, 2003).

To start with, at the pre-production stage which deals with clearing of land for construction of mine infrastructure can give rise to increased soil erosion which in turn can lead to increase in sediment loading in nearby water bodies. This will make the waters unsafe for drinking and its attendant water-borne diseases. Also, dust is generated from haul roads and other working areas which affect the inhabitants. Further, at the production stage waste dumps and ore stockpiles may cause dust emission; leaching and percolation process acting upon residuals contained in mine waste together with run-off from ore stockpiles and mill area can cause contamination of land and water bodies. Improper management of hazardous chemicals such as sodium cyanide and mercury can pose health and safety problems (Boateng, 1997).

Mining and health implications

Gold extraction is not the only stage in the mining process that creates hazardous exposures for workers (and communities as we will discuss later), but the other processes as well. There are a number of publications that link most environmental hazards in mining areas as well as occupational health risks to the operations of the mines (Ashwathanarayana, 2003). Hence, the

review of the various pollutions and their health implications on mine workers and inhabitants of mining areas.

Air pollution

Air pollution can be referred to as the transfer of harmful amount of natural and synthetic (artificial) materials into the atmosphere as a result of a direct or indirect consequence of human activities. Air pollution is caused by dust gas or droplets we stir up in doing what we do as human beings. Air pollution is a very complex problem because a pollutant can be of any member of chemical substances existing in solid, liquid (aerosol) or in gaseous forms (roughly 90% of the weight of all pollutants in the air is gas). To Kupchella and Hyland (1993), pollutants can be added to the air directly (primary pollutants, or they can be created in the air as secondary pollutants) from other pollutants under the influence of electromagnetic radiation from the sun.

Effects of air pollution

The extent of air pollution related problems range from relatively small areas, such as an industrial area impacted by one or more emission sources, to an urban area impacted by a number and variety of contaminants and multifaceted problems resulting from multiple contaminants coupled with atmospheric interactions on public, health, vegetation, minerals and/or visibility are used to describe the effect of air contaminants. The effect of pollutants vary considerably because of differences in their concentrations and their chemistry, some are by far more toxic than others, and some have far

greater impacts than others on materials and the ecosystems. Air pollution has diverse effects on human and other parts of the natural world.

The particulate matter, sulphur dioxide (SO_2) and carbon monoxide (CO) are the principal pollutants (Mate, 1998). Their major health effects of concern include effects of breathing, respiratory illness, breakdown of lung disease or cardiovascular disease. Furthermore, the health threat of carbon monoxide is greatest to those with cardiovascular disease because it reduces oxygen delivery to organs and tissues at elevated concentrations; carbon monoxide impairs visual perception, manual dexterity and mental ability. To Down and Stocks (1978), carbon monoxide (CO) and particulate matter can present very severe health hazards to mine employees at their work place. They further stressed that carbon monoxide (CO) which is a colourless and odourless gas is the most important gaseous pollutant which at a high concentration, causes death in humans by blocking the oxygen transport system of the blood.

In accordance with Kusi (1987), toxic oxides when reacted with moisture form nitrous and nitric acid. Relatively small quantities of these gases if inhaled can cause death either very quickly by combining with the moisture in the lungs and corroding the respiratory passages or several days after as a result of pulmonary edema (water in the lungs) or even weeks later as a result of infectious pneumonia.. Furthermore, long-term exposure to nitrogen dioxide concentration of 0.6 to 0.11 parts per million (ppm) increases the incidence of acute respiratory diseases, particularly bronchitis.

Sulphur dioxide produced during roasting and smelting, is believed to be a major contributor to most respiratory diseases in most mining towns as it

can cause chronic asthma and bronchitis. It sometimes causes eye irritation (Boadi, 2002).

In relation to Larrain (1993) all the mining regions throughout Chile, particularly those that produce copper, should have been declared saturated areas by the government, since their high levels of emissions have caused serious damage to the health of the population and the environmental costs in the mining sectors are very difficult to reverse. For example. one company, CODELCO, the state copper company alone, invested more than 900 million dollars to reverse the air and water pollution it is producing. Cleary et al (1994) maintained that gold mining activities in Brazil and other Amazonian countries, for example are currently giving rise to high exposure levels in gold traders who inhale mercury vapour when burning mercury-gold amalgam, and in local fish-eating communities which consume methyl contaminated fish.

The community studies Charpin, et al. (1988) and Pless -Mulloli, et al (2000) in coal mining regions were predominantly concerned with respiratory illness caused by air pollution from mining activities. In their study of the Gardanne coal-basin, Charpin et al (1988) evaluated the long-term effects of exposure to air pollutants in school children. The prevalence of pulmonary and ear, nose and throat symptoms was higher in the polluted communities, but a statistically significant difference was only observed for the symptom "wheezing in the chest"

Dust pollution

Dust may be defined as any broken piece of solid particles, which is capable of being airborne. As said by Clottey (2000), an important air

pollution impact produced during mining is dust. To him, dust is created at all stages of the mining process, including excavation, processing and transportation, and that dust clouds may be carried far from the mine site depending on the wind and other climatic conditions. Furthermore, the harmful effect of mine dust is that it may impact the health of residents who live near mining site as well as that of the employee.

Any dust if present in excess amount for a sufficient length of time can cause pathological damage to human beings and must be considered a fibrogenic or pulmonary dust. Factors other than composition that affect the harmfulness of a given dust are its particle size range, its freshness, and the susceptibility of the individual exposure (Anon, 1946).

Effects of dust pollution

Hartman (1982) classified mine dust 2 their harmful physiological effects or explosive properties into the following:

- Fibrogenic dusts: These are harmful to the respiratory system, they include silica (quart, chart), silicates(asbestos, talc, mica) metal fumes, beryllium ore, tin ore, iron ore, coal (anthracite, bituminous)
- Carcinogenic dusts e.g.: (radon daughters, asbestos and arsenic)
- Toxic dusts: These are very poisonous to body organs and tissues, these include ore of beryllium, arsenic, lead, uranium, thorium, mercury, manganese, silver (principally the oxides and carbonates)
- Radioactive dusts: These are very injurious because of the Alpha and Beta radiation e.g. ores of uranium, thorium and radium.

- Explosive dusts: These are very combustible when airborne and include: Metallic dusts (magnesium, aluminum, zinc, tin, and iron), coal (bituminous lignite), sulphide ores and organic dusts.

Mine dust is undesirable from three points of views: (Anon 1980)

- As a health hazard
- As a nuisance
- As a possible cause of explosion (e.g. In coal mines)

The dust produced by mining operations is a serious health hazard as it may cause pneumoconiosis. Pneumoconiosis refers to a large group of diseases of the respiratory organs caused by the inhalation of silica dusts and anthracosis (caused by the inhalation of coal dust.). Large particles of silica of the order of 7 microns and larger do not play an important part in causing silicosis. This is because during breathing, these particles are effectively filtered from the air by fine hairs in the nose and by sticking to the net surfaces in the throat and so on. However, they can lead to other diseases such as bronchitis. Large particles of dust can also cause irritation to the eyes, nose and throat (Clottey, 2000). This presupposes that the dust particles that are most dangerous to health are not visible.

Chadwick et al (1987) affirmed that health hazards in coal mining can be classified into four categories:

- Physical hazards e.g. dust, excessive heat, noise, heavy physical work, contorted postures
- Chemical hazards e.g. carbon dioxide, carbon monoxide, methane, nitrogen oxide gases
- Biological hazards e.g. hookworm, fungus

- Mental hazards e.g. shift work, constant danger

They further stressed that both surface and deep mining have the potential health effects such as silicosis, pneumoconiosis and respiratory problems arising from dust. There are also noise and vibration effects from machinery as well as blast effects. Moreover, effects of mine gases, poor working environment-high temperature, wet conditions, poor lighting, and hard physical work have effects on the mine workers. Again there are emissions of noxious gases, heat and dust during utilization through coking, direct combustion and coal conversion that have occupational health risks. It is estimated that annually 11 million people worldwide suffer from occupational related diseases (WHO, 1999).

Records have it that an estimated 40-50 percent of the world's active population are at risk through exposure to physical, chemical, biological, psychological or ergonomic hazards which may cause occupational injuries and/or disease. For instance, mineral dust causes irreversible diseases of the lungs including silicosis, which is one of the most progressive occupational lung diseases known for many years. The silicosis lung is prone to tuberculosis and lung cancer. However, the lung cancer is not curable but can be prevented.

Younayelle (2001) has documented that there was a medical surveillance at Tarkwa underground mine between 1973 and 1986 which revealed a significant incidence of silicosis. A subsequent survey conducted on the workforce susceptive to silicosis at Tarkwa underground mine came out with this statistics in Table 1.Table 1 depicts a decline in the incidence of

silicosis, by 1986 which was attributed to improved working practices, especially improved ventilation and dust suppression techniques.

Ashwathanarayana (2003) quoting Chadwick et al (1987) claimed that the most feared complication of silicosis is infection of the lungs with tuberculosis. The infection is hard to treat because of the fibrosis and scar tissues in which the regular antituberculostatics cannot penetrate. Thus, silicotuberculosis still causes 25 per cent of deaths. They also stress that bronchitis probably should, however, be regarded as a distinct occupational disease in mines. It comes as a result of inhalation of large particles from 0.005-0.015mm in diameter and becomes stuck in the upper airways, not reaching the lung tissue because of their size causing infection as a result of constant irritation of the airways, coughing and sputum production. Chronic bronchitis is very common in coal workers reaching a prevalence of 30 to 40 per cent in some instances.

A survey by the TUC - Ghana and the occupational health unit of the Ministry of Health revealed that in 1997 and 1998 there were very poor safety standards in the mines. Mine workers still suffer hazards relating to falling materials, handling, trucking noise, exposure to chemicals, dust gassing, excessive vibration, heat and fumes. The outcome of these hazards has been an upsurge in diseases like respiratory infection, waste pains, skin diseases, stress tuberculosis and other terminal diseases (TUC, 2000).

Table 1: Medical surveillance at Tarkwa underground mine between 1973 and 1986

Year	Number of Underground workers	Silicosis	Silicosis per 1000
1973	2323	19	8.2
1974	2252	13	5.8
1975	2179	6	2.8
1976	1996	14	7
1977	1779	11	6.2
1978	1603	4	2.5
1979	1733	5	2.9
1980	1523	4	2.6
1981	1320	5	3.8
1982	1551	12	7.7
1983	1362	5	3.7
1984	1463	3	2.1
1985	1480	4	2.7
1986	1374	5	3.6

Source: Ghana Employers Association, 2000.

Although many questions remain, certain facts regarding fibrogenic damage by dusts has been established. In its least harmful effects, an airborne dust may cause pigmentation of the lungs and shortness of breath. In addition, exposure to excessive concentrations of all dusts increases the frequency of mild respiratory ailments (colds, influenza) and can worsen existing respiratory diseases including asthma and tuberculosis (Anon, 1976). It has been acknowledged that dust has much in common with gases in their modes

of occurrences, behaviour and control. Dust is either a nuisance or a health hazard that produces pneumoconiosis or any other physiological effects in a human being (Down and Stocks, 1978).

The resulting effects of the environmental impact of blasting are the associated health hazards such as respiratory-related diseases like cold and influenza, and the worsening of existing respiratory ailments like asthma, being the result of dust pollution in the short-run whilst in the long-run results generally to pneumoconiosis (Osei-Mensah, 2001). Mining and quarrying operations usually generate a lot of silica-rich dust which when inhaled in substantial amounts, can cause severe colds and sometimes silicosis. Tsidzi and Adofo (1993) claimed that plant defoliation problem caused by dust has been reported at most quarrying centres and at some mining towns like Prestea and Tarkwa. San (1996) investigated the environmental aspects of quarrying in Ghana and came out with effects of dust. To him, pathologically, dust particles less than 5μm are inhaled and settled on the lungs causing silicosis (silica dust).

To Amebgey (1998) potential health hazards from dust occur on three levels:

- First, the inhalation of sufficient quantities of dust, regardless of its chemical composition can cause a person to choke or cough. It accumulates in the lungs and the pores of the skin.
- Second, depending upon its chemical composition, the dust can cause allergic or sensitization reaction in the respiratory tract or on the skin.

- Finally, depending upon both its size and chemical composition, the dust can by physical irritation or chemical action, damage the vital internal tissues.

He further stressed that prolong exposure to the high silica content dust usually characteristics of the deposit, is likely to lead to lung diseases like silicosis and silico-Tuberculosis. Again, Amebgey (1998) citing unpublished work of Forson (1989) confirmed that an incidence of 10.1 to 18.7/1000/year as a result of quartz dust from the gold bearing rocks in the Tarkwaian deposits.

It has been disclosed that people living near an open cast coal mining sites are affected with acute and chronic respiratory health, that is particulate matter – diameter less than micrometer (PM_{10}) was higher in open cast areas, especially in children who live in open cast coal mine communities had significantly more respiratory consultations compared to children in the control communities (Pless- Mulloli et al, 2000). Munan, et al (1981), stated that several studies have it that communities living close to asbestos mine have health problems which are attributed to the mine activities.

Water pollution

Water pollution is the contamination of water by foreign matter such as industrial waste, runoff from fields treated with chemical fertilizers, and runoff from areas that have been mined. Such matter deteriorates the quality of the water and renders it unfit for its intended uses. Owusu-Ansah (2002), made it known that surface water pollution can be caused by any of the following:

- Leakage of process water pipes or ponds.

- Introduction of substances into surface water, which cause physical and chemical changes.
- Run-off from mine pits.
- Milling and leaching operations.
- Run-off from tailing and waste dumps.

Damage to water and water resources is the worst environmental consequence of gold mining. For instance, in Papua New Guinea at the Tolukuma Gold Mine, local communities complain that dumping of tens of thousands of tonnes of mine waste directly into their water systems by the mine owners has polluted their water sources and undermined their food security. (MO, 2003).

Again, the Rain mine in Nevada owned by Newmont has contaminated 2 miles of Dixie Creek with arsenic and mercury. And Newmont's Hollister mine also in Nevada has developed a probable permanent condition of acid mine drainage, releasing sulphuric acid into the water table (WHC, 2000). Mining activities are considered as one of the potential primary sources of water pollution. This is so, because of the use of some chemicals including arsenic, mercury, and cyanide. The mine tailing or spoils is the waste material resulting from the processing. The waste materials may include top soil, rock, and dirt. Inappropriate disposal and management of these waste materials could pollute river bodies. Exposed mine tailings have polluted most rivers. Research has shown that River Ankobra Basin has been contaminated with arsenic and mercury. These are responsible for the high turbidity levels of the river at Prestea in the Western Region. Agyei (2003) revealed that the adverse impact of mining activities on health of humans is indisputable, since mining

is one of the potential primary sources of water pollution. The health of millions of people is threatened by contaminated drinking water. The use of polluted water for drinking and bathing is a major common source of disease infection.

Effects of water pollution

The impact of mining is reported to have long effect on surface water. The extent of the pollution from the mill or mine effluents (mainly of chemical or organic compounds) depends upon the mineralogy of the ore, climate, and topograghy, method of processing, water disposal practices and the nature of receiving water courses (Owusu-Ansah, 2002).

Mercury bearing waste from a chemical plant which discharged into inshore waters contaminated the fishes. A local fish-eating Minamata Bay community in Japan was affected by Minamata disease (A degenerative neurological disorder caused by poisoning with a mercury compound found in seafood obtained from waters contaminated with mercury-containing industrial waste). This neurological disorder is associated with excessive amount of mercury (D'Itri and D'Itri, 1977).

Mining pollutants in water can affect human as well as the other organisms. However, a human being is able to perceive the effects both in terms of nuisance and health hazards. The damage to human health though rare in many occasions, has impacted negatively on human development. For instance, Tsuchiya (1978), as cited in the Thornoton (1995), confirmed that Itai-Itari disease, which causes skeletal deformations and kidney damage was recognized during and after the World War II, and was due to effluent

containing cadmium from lead-zinc mine contaminating the irrigation water used to water paddy rice fields causing excessive pollution of the alluvial soils used for paddy rice in the Jintsu valley and exposure of the local rice-dependant community. Mining remains one of the most difficult, dirty and hazardous occupations – causing more fatalities than other occupations even in the United States or in Europe (Stephens and Ahern, 2001).

Yeboah (2001) stressed that water pollutions are major contributors to the cases of diarrhoea, schistosomiasis, cholera and typhoid especially in Africa. Reports have it that current environmental debate has paid too little attention to the problems of sanitation and clear water. The lack of access to clean water and sanitation have effect on health in that they are the major contributors to about 900million cases of diarrhoea, 200million cases of schistosomiasis (bilharzia), cholera and typhoid in developing countries. Water pollution and water scarcity has had an increasingly negative effect on fisheries, rural households and municipal cost of providing safe water. (Anon, 1992). It has been established that for the daily reported illnesses in Ghana for 1987 and 1988, environmentally related illnesses formed 72% and 70% respectively. Malaria was the commonest making 43% of all cases followed by diarrhoea, upper respiratory infection, skin diseases and intestinal worms (Tutu, 1996).

In keeping with Carruthers and Smith (1979), there was an evidence of cadmium toxicity in a population living in a zinc-mining area in Shipham, Somerset. Investigation into mercury contamination around Lake Victoria with a sample of 150 gold miners, 103 fishermen and their families, and 19 volunteered residents of Mwanza City revealed a high mercury level of

48.3ppm (near to 50ppm, a critical level of Minamata disease) and over. The highest value of 953ppm mercury level was found in the head hair of the six gold miners who were observed and four of the fishermen and their families also had highest value of 416ppm. Further, four of the volunteered residents of Mwanza City also showed a highest value of 474ppm (Harada et al, 1999).

In accordance with Bentil (1998) hospital information received showed that quite a number of workers reported eye and ear infection problems. Furthermore, malaria, bilharzia, and diarrhoea were among the health care issues in the Nsuta area. Malaria prevalence may be due to the problem of increased sediment such as siltation and tailing settling pond, ideal breeding site for malaria-carrying mosquitoes. As said by Amegbey (1998), gang of workers in rivers are likely to contaminate the water with pathogens of water-borne diseases such as bilharzia. He further stressed that patches of water bodies left at work sites may also serve as breeding ground for the malaria parasites.

Chemical pollution

Cyanide is the chemical-of-choice used by mining companies to extract gold from crushed ore. Very low-grade ore, with minimal residues of gold, is crushed and piled on the ground and then sprayed with a cyanide solution. Cyanide is common in gold mill waste water at a concentration between (0.01- 0.03) mg/litre. It is lethal to both man and aquatic life at a very low concentration. Free cyanide is evermore toxic than total cyanide. (Owusu-Ansah, 2002).

Effects of chemical pollution

WHC (2000), long-established that no Mine has ever avoided leaking cyanide-laced water and waste into the ecosystem In Kyrgyzstan, a major cyanide spill in 1998 resulted in 4 deaths and the evacuations of thousands of people living downstream of a Canadian-owned gold mine. At the Summitville mine in Colorado taxpayers have already paid out $100 million in a few years for the EPA to simply contain—not clean up—contaminated local rivers. Meanwhile, a spill of billions of gallons of cyanide laced-waste from the Omai mine in Guyana caused the death of thousands of fish and scores of other animals downstream (WHC, 2000)

It has been identified that the alkali cyanide and Hydrogen Cyanide (HCN) acids are extraordinarily poisonous when ingested into the body or have prolonged contact with the skin. The HCN acid inhibits the O_2 from the arterial blood, and this will finally result in death by suffocation. Again, Hydrogen Cyanide acid from cyanide solution can be adsorbed through injured skin and cause symptoms of poisoning. Some initial symptoms include headache, dizziness vomiting and shortness of breath, which can lead to death if not treated in time (Asante, 2000).

In 1989, there was a cyanide spillage at Obenemase Mine, near Konongo, which contaminated a tributary of the Owerri River. In 1996, quantities of cyanide solution were released into Angonaben stream, a tributary of River Bonsa by the Teberebie Goldfields causing loss to aquatic life. In October 2001, there were two cyanide spillages occurring in the concessions of Goldfields Ghana Limited (GGL) at Abekoase and that of Satellite Goldfields at Kyekyewere, near Tarkwa in the Wassa West and

Mpohor Wassa East districts of the Western Region. Again, May, 2003, another spillage occurred within the premises of GGL (Kwarteng, 2003).

Many breakdown compounds are toxic to aquatic organisms and may persist in the environment for a long time since some form of these compounds can be accumulated in plants and fish tissues. People can be exposed to cyanide through breathings, water, food, or touching soil, or air as a result of both natural processes and industrial activities. People exposed to cyanide may have rapid breathing, restlessness, dizziness, weakness, headache, nausea and vomiting, rapid heart rate, convulsion, low blood pressure, loss of consciousness, lung injury and respiratory failure leading to death (Kwarteng, 2003).

As stated in the work of Stephens and Ahern (2001) since 1999 the Collegium Ramazzini has called for a ban on all mining and use of asbestos, supported by international journals of occupational and environmental health (1999a; 1999b.) Currently, health outcomes related to "occupational land "community" or environmental exposures to asbestos form one of the most significant insurance claims in the world, and have been responsible for the collapse of a major British insurance group, and the loss of an international law suit at the World Trade Organization.

The effect of arsenic poisoning on human beings is through ingestion. Thus, it can be acute or chronic. The symptoms are abdominal pains and vomiting, appearing usually within an hour of ingestion. But with the chronic arsenic poisoning, it consist of loss of weight, gastro-intestinal disturbances in the form of loss of appetite, pigmentation and falling out of hair. Once more, inhalation of arsenic containing dust is much less frequent and the symptoms

of that are coughs, pain in the chest especially on inspiration. Additionally, chronic symptoms observed in workers exposed to arsenic and its compounds are related chiefly to skin mucous membrane, nervous system and in few cases disorders of the circulation system and the liver as well as skin cancer.

Noise pollution

Noise is the unwanted sound which produces an unpleasant or irritating auditory sensation. Sound can be described as a propagating disturbance through a physical medium. From the perspective of noise pollution, sound is induced by a vibrating source and travels through air in the form of sound waves. Walker (1992) claimed that the design of excavation and processing operations must take into account the health and safety of operations within the working environment hazards of the operations and the impact upon the external environment often termed nuisance.

Effects of noise pollution

Noise can impact negatively on humans in several ways. Health ramification such as hearing loss, permanent and temporary threshold shifts (hearing loss attributable to noise only), ear pain, and tinnitus (ringing in the ears) are typically associated with occupational and not environmental/ community noise. However, interference with speech, annoyance, sleep disturbance, psychophysiological effects, and mental health effects may be associated with environmental/community noise. Furthermore, noise has been postulated to act as a general stressor and may lead to changes in blood pressure, heart rate, and vasoconstriction and the likes. For instance,

community studies focusing on noise as a risk factor for cardiovascular disease have shown a tendency for increased blood pressure for persons living near airports or on streets with higher levels of noise as compared with controls (Williams and Langley, 2001).

Gombillah (1993) confirmed that exposure to high noise levels can result in temporary or permanent hearing disability. Again, it has been recognized that exposure to high noise levels can result in temporary or permanent impairment of hearing ability (Down and Stock, 1978). In line with San (1996), ten workers who were part of his respondents on the work "Some Environmental Aspect of Quarry in Ghana" complained of restless, sleepless and interruption during night after work. Again, some crushers also complained of the inability to hear normal speeches apart from shouts which may be due to some damage to the tympanic membrane, implying hearing impairment as a result of noise at the work place. Furthermore, headache was found to be common among the workers due to long hours of stay in the noisy environments.

The Ghana Mine Workers Union manual on health and safety states that mechanization of surface mines has led to increasingly high noise and vibration (GMWU, 1997). Thus the use of heavy dump trucks, rock drillers and heavy machines can result in the loss of hearing, nervous disorders and circulatory troubles. This continuous pollution places everybody at risk; both workers and non-workers who are housed in and around the mining site. However, miners who are exposed directly have the greatest risk.

HIV/AIDS

There are indirect health and related social impacts on communities. Miners often leave their families for a prolonged duration to work. Commercial sex workers are attracted to mining areas to service the miners' desire for sexual services when they are away from their families. HIV/AIDS is a major problem in mining areas. Although it is not as prevalent when compared to diseases such as malaria, its higher rate of prevalence in many mining areas when compared to non-mining areas is a cause for concern (Reddy, 2005). In 2002, for instance, AngloGold mines in South Africa estimated a 30% prevalence of HIV among its miners (WEF, 2003).

The mining sector has therefore been affected by the world-wide HIV/AIDS epidemic, and this is apparent in the South African mines. For instance, Campbell (2000) asserted that migrant labour plays a significant role in the mining sector of South Africa, and these migrants are believed to play an important role in the transmission of HIV/AIDS. However, reports have it that the effort of mining industry to deal with it through the establishment of HIV- prevention programmes has had little impact. Meanwhile, Corbett, et al. (2000) investigated the combined effects of HIV infection and silicosis a mycobacterium disease in a South African gold mine, and concluded that the risks of silicosis and HIV infection combine in a multiplicative manner.

There is also a high prevalence of HIV/AIDS in the Obuasi Municipality. Between the 1998 and 2001, the new cases of HIV/AIDS reported a rise from 301 to 356. However, it fell to 173 as at June 2002 due to the publicity campaigns on the disease. Again, 3 out of 15 cases of relapse TB cases randomly tested in 2002 were all HIV positive in the district

(OMHD, 2003).This supports Corbett, et al (2000) investigation of the combined effects of HIV infection and silicosis on mycobactarial disease in gold mine. Thus, TB remains as much a silica-related occupational disease in the HIV-positive as in HIV-negative miners. Hence, increasing impact of HIV over time may indicate TB transmission with rapid disease development in HIV-infected miners. This may buttress why HIV and TB cases are common in Obuasi.

Cases of schistosomiasis, tuberculosis (TB) and malaria are reported from communities around polluted streams and rivers in the Adansi West District. In the year 2000, TB cases increased from 70 to123 in the district. (AWDA, 2003).

Conceptual framework

Most people of the world and for that matter Ghana, individuals, NGO's and civil society organizations are of the opinion that mining operations especially with the advent of the open-cast method have affected the villages and towns in their catchment areas in terms of air pollution, land degradation and water contamination and its attendant health problems such as skin diseases, respiratory diseases, hearing impairment among others. For instance, inorganic and organic sources taken in the village of Dumasi, Western Ghana, showed a diffused mercury contamination of all the environmental media in the entire village. The study on human health revealed that the entire community of Dumasi, whether directly or indirectly involved in mining or not, was over-exposed to mercury (Stephens and Ahern, 2001).

However, members of the mining industry think otherwise, especially with regard to health implications since to them gold mining has been playing and continue to play a central role in the socio-economic and political life of Ghanaians and for that matter people of Obuasi and that diseases existed long before AGA started operation. Thus, it provides employment for a large number of people. Further, its products provide a source of raw material for some of our industries and also serve as a source of foreign exchange for many industrial and developing countries like Ghana.

Few attempts have been made to link common diseases in mining areas to the activities of mining within a framework capable of explaining the connections in a particular mining area. The relationship between gold mining and health are complex, however, the framework adopted will attempt to integrate the findings of gold mining and its attendant health implications. The relationship is conceptualised using Thor et al (1978) Cause and Effect Network depicted in The United Nations University (1987). The frame work recognizes the effects of various mining activities such as excavation, exploration, blasting, transportation, processing and waste disposal and their impacts on health of individuals.

The starting point in understanding the Health Impact Network is that the activity of mining may have direct or indirect impact on health. This is evidently the case, Pless-Mulloli et al (2000) investigated the effects of pollution on a community living adjacent to a copper smelter, and showed an excess of deaths by lung cancer, chronic respiratory diseases, and diseases of the digestive system among men. This excess remained even after adjustment

for occupational exposure. Among women, deaths by endocrine and metabolic diseases and chronic respiratory diseases were also in excess.

The excess of lung cancer mortality in Ontario gold miners is associated with exposure to high dust concentrations before 1946, with exposure to arsenic before 1946, and with exposure to radon decay products. In terms of this review, the most disturbing feature of this study is its evidence of the complex and long term impacts of multiple exposures of miners on their health, and the fact that the impact of past exposures may be felt long into the future of a miner's life. The prevalence of pulmonary and ear, nose and throat symptoms was higher in the polluted communities, but a statistically significant difference was only observed for the symptom "wheezing in the chest" (Stephens and Ahern, 2001)

Figure 2 shows the first step in the mining activity models such as excavation, exploration, blasting, transportation, processing and waste disposal. The second step addresses the various likely pollution models that the activities emit in terms of air, water, noise and chemical. At the end of the chart is the ill health model which shows various ailments resulting from the various mining activities. This chart is used to obtain a general impression of likely impacts from mining activity. There are many works on health implication of mining; however, for the purpose of this study the work of Thor et al (1978) is adopted. This is because this work addresses the health implications of gold mining in a mining area. Though this work does not address all the health hazards of gold mining, it helps to set the frame.

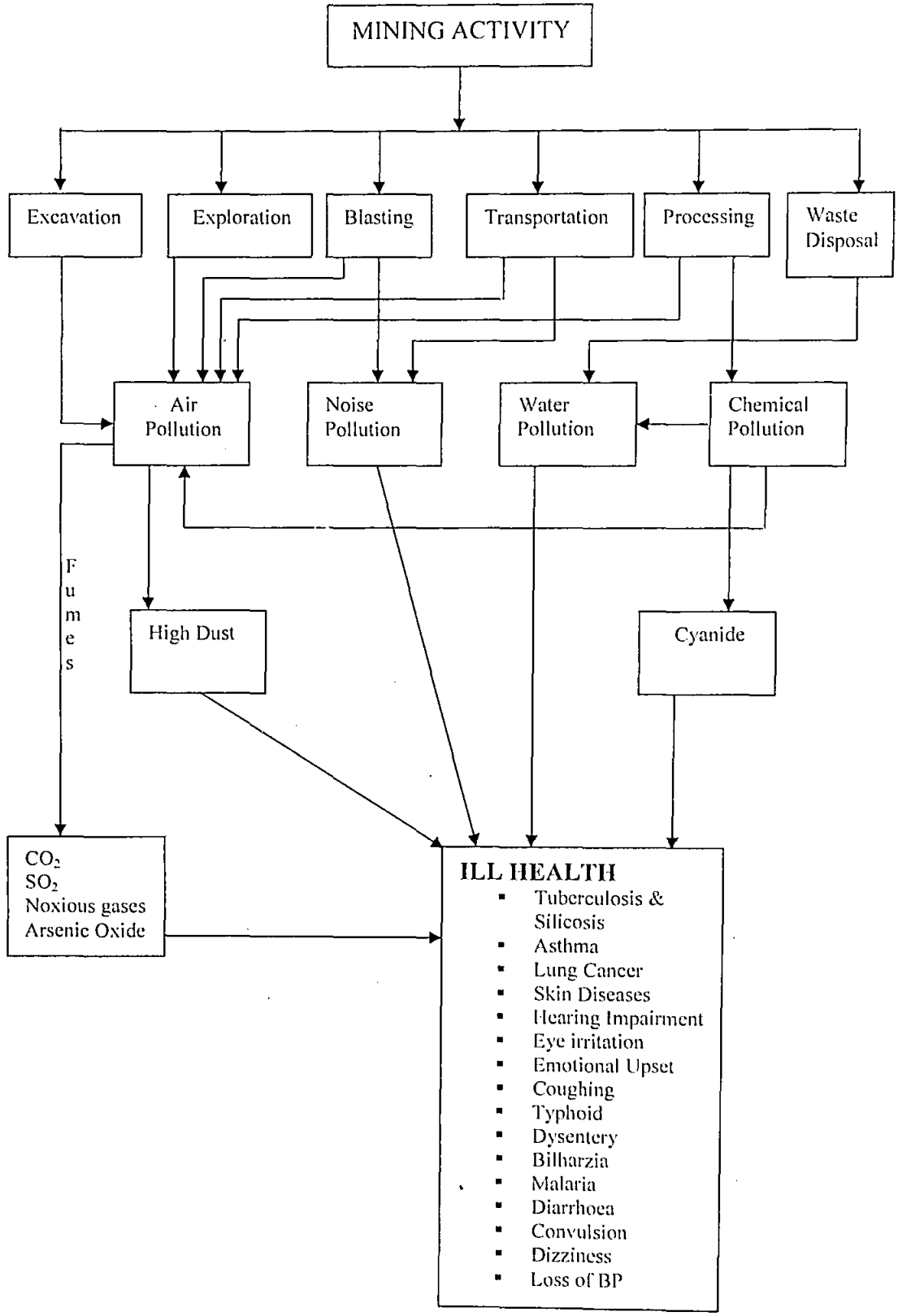


Figure 1: Health impact network

Source: Adapted from Thor et al (1978) cited in United Nations University (1987)

CHAPTER THREE

METHODOLOGY

Introduction

This chapter covers the study area, sampling technique sample size, methods of data collection, administration of instruments and methods of data analysis. The Obuasi Municipal area was purposively chosen for the study because of the presence of the Anglogold Ashanti mine.

Study area

Obuasi Municipality which is the case study for the research is about 64km south-west of Kumasi, which is the capital of the Ashanti Region. Obuasi is not only the biggest and most important town; it is also the capital of the Obuasi Municipality. Obuasi is a major mining centre in Ghana and for that matter Africa. Thus, Ghana which is one of the largest producers of gold in the world has its major supply from Anglogold Ashanti (AGA), that is one of the largest producers of gold in the world and the African legacy of the world's most precious metal has its major supply from the Obuasi mine (Ayensu, 1997).

The Obuasi area has a population of 115,564 (2000 Population Census), which was 48.5% of the entire population of the then Adansi West District Assembly (AWDA). The Obuasi area has one of the highest growth rates in Ghana. Ghana's approximate population of 20 million grows at about 2% per year compared to the Adansi West district's growth rate of 3.1%. In Obuasi and its immediate surroundings the population grows at a rate of 4%

(AWDHS, 2001). Gold mining may be the main reason for this high population growth rate. More and more people migrate to work in the mining industry since Obuasi is primarily a mining town. A large section of the economy of Obuasi is based on the revenue generated from gold mining.

With regard to the relief and drainage, generally, the then Adansi West District which had Obuasi as its capital had an undulating terrain with more than half the total area rising up to 500meters above sea level. Rocks in the district are mostly of Tarkwaian (Pre-Cambrian) and Upper Birimian formation in a North East (NE) - South West (SW) trending belt. They are noted for their rich mineral bearing potentials. Areas around the contacts of the Birimian and Tarkwaian zones known as reefs are noted for gold deposits.

In terms of climate and vegetation, the area under study experiences semi-equatorial climate conditions with a double maximum rainfall regime. The mean annual rainfall ranges between 125cm and 1275cm (50"- 70") with major rains occurring between April and July whilst minor rains occur between September and October. The vegetation is predominantly semi-deciduous forest. The forest consists of large species of hard-wood, which are harvested as timber for logging and lumbering. The Anglogold Ashanti has maintained large tracts of teak plantations known as green belt covering 12.10km^2 within its concession areas. There is a small reserved area of 0.44 km^2 in Obuasi known as Obuasi Catchments, which is almost deforested as a result of surface mining.

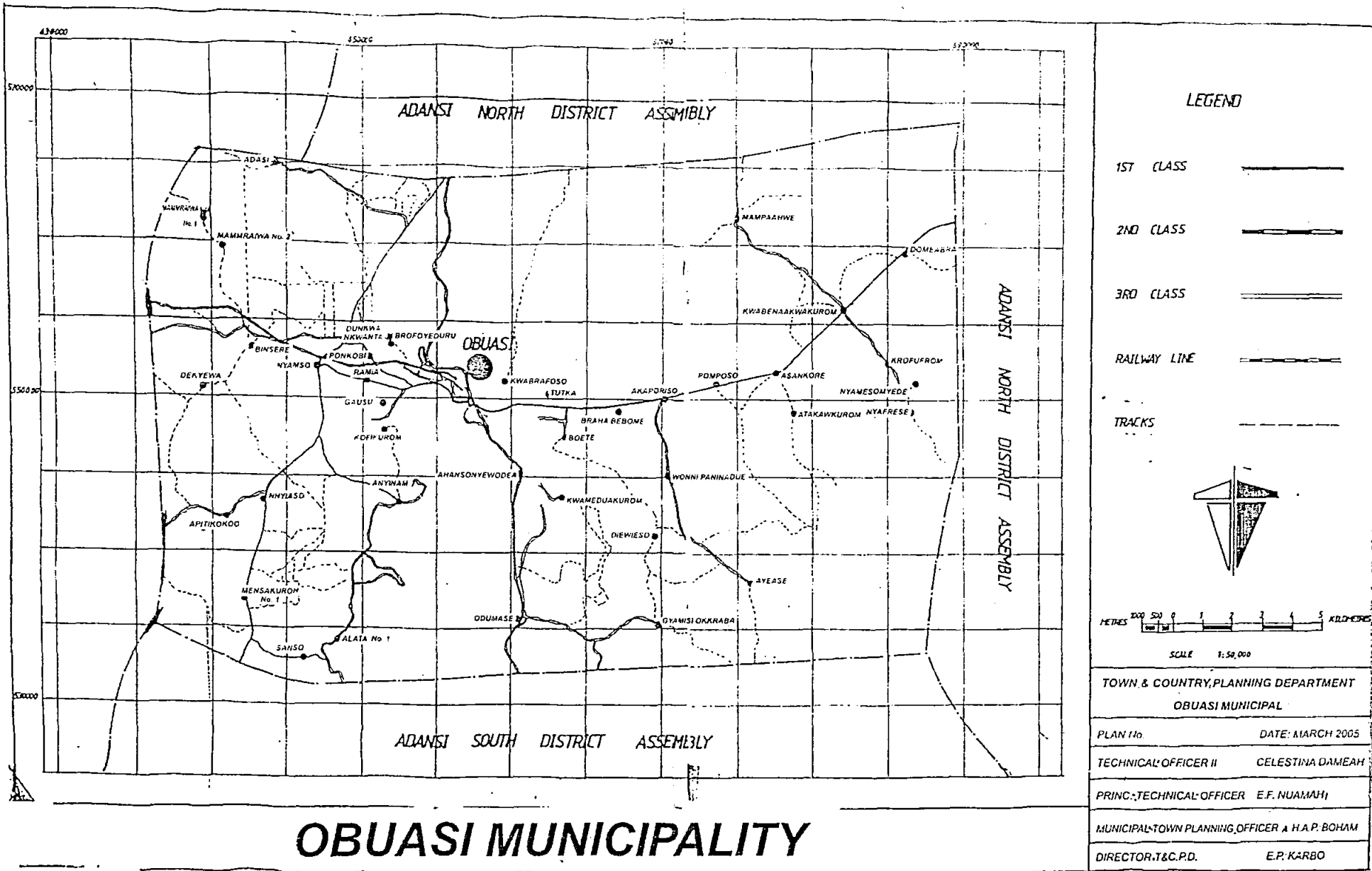
Furthermore, Anglogold Ashanti operates and manages its own water system for its industrial and domestic needs. Apart from that from the Ghana Water Company, District Water and Sanitation Team (DWST), Non-

Governmental Organisations especially Water and Sanitation Health Team (WASHT) are among the providers of sources of drinking water in the municipality. Boreholes are the commonest sources of drinking water for the majority of the people in the Obuasi Municipality. But due to unreliability of the sources of drinking water in the Obuasi area especially during dry seasons, most people in the communities particularly where rivers and streams are common depend on them as their main sources of water supply.

The area is not left out in environmental problems like land degradation, air and water pollution and its attendant diseases. The Environmental Health and Sanitation Unit of the Assembly is charged with environmental and waste management in the municipality, but due to inadequate logistics like transport and personnel among others, the Unit is unable to undertake effective monitoring of sanitary sites.

In the case of health and health facilities, most of these communities where rivers and streams are main sources of drinking water are exposed to water-related diseases such as bilharzia and schistomoiasis. Apart from these water-related diseases, malaria, tuberculosis, skin diseases and HIV/AIDS are the common diseases in the district. However, the Obuasi area is blessed with both public and private hospitals and clinics.

The Obuasi Municipal is chosen because it is where Anglogold Ashanti (AGA) is located. AGA contributes very high in terms of gold extraction and even as the leading producer of gold in the country. The selected area is the Obuasi Municipal area.



OBUASI MUNICIPALITY

Figure2: Map of Obuasi Municipality

Source: Town and Country Planning, Obuasi Municipality

Sampling technique and sample size

The sampling population is the AGA workers and management, medical Staff in the Obuasi area and head of Environmental Health Office There were about thirty (30) departments in AGA, but now it has been regrouped under eight (8) major divisions. These eight (8) divisions are Human Resource, Finance, Mining, Mineral Resources, Work Place Environment, Engineering, Production Services and Processing. For representativeness, each division was treated as a stratum. A sample of 2% of the total labour force of AGA was selected. Within each of the divisions a simple random-sampling approach was used in drawing the respondents from the various divisions through the use of the staff number as a sampling frame and questionnaire administered to them. The stratified sampling was used because of representativeness. In addition, medical staff in the municipality as well as the head of the Environmental Health Office was interviewed. The researcher also relied on the Obuasi Municipal hospitals and clinics health record on common diseases and their causes in the study area.

Methods of data collection

The main secondary source of data for the study is the Obuasi Municipal Health Directorate. These data were supplemented with data from the hospitals and clinics health records of the Obuasi Municipal as well as other relevant sources. For the primary sources, the technique that was used was interview guide for the medical staff (including AGA's hospital), management of AGA and head of Environmental Health Office, and questionnaire for the rest of the respondents.

Also, observation was used as part of data collection. The questionnaire was designed to cater for AGA-workers within the Obuasi Municipal. The AGA worker's questionnaires consisted of four sections and covered the socio-demographic background of respondents, sources of their drinking water, common diseases and their causes. The interview for the medical staff related to the health records of their patients as to the common diseases often reported at the hospital. The AGA management and Environmental Health Officer interview guide consisted of four sections and covered the socio-demographic background of respondents, sources of their drinking water, common diseases and their causes.

Administration of instruments

First, the whole exercise was thoroughly and particularly, the researcher assured the entire respondents of confidentiality of the information given as part of the ethical issues that was reviewed before the questionnaires and the interviews were administered. The exercise was carried out between August and December, 2004. The researcher administered the instrument alone. Again, there was no pre-test of the instrument.

Methods of data analysis

Each group of respondents was considered one after the other during the analysis of the data. For example, all the AGA workers were considered as one group, medical staff as another group etc. Frequency tables and charts were constructed for each of the group where applicable and the results converted into percentages for easy analysis.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

This chapter is devoted to the analysis and discussion of data collected from respondents. It covers:

- Analysis of background data
- The health implications of gold mining
- Main diseases

Analysis of background data

Five (5) groups of respondents were involved in the study. They were 12 medical officers from various hospitals and clinics in Obuasi Municipality: one from AGA, one from government and ten from private hospitals; one official from Municipal Environmental Office and two managers were interviewed from the Work Place and Environment Division. However, out of the 120 respondents from AGA workers to whom questionnaires were administered 92 responded representing about 76.7%.

Sex and age

Out of 92 AGA workers respondents, only six were females representing 6.5%. Out of the 13 medical officers interviewed, only two were

females. The Municipal Environmental Officer interviewed was a male. The age distribution of the AGA workers respondents is presented in Figure 3.

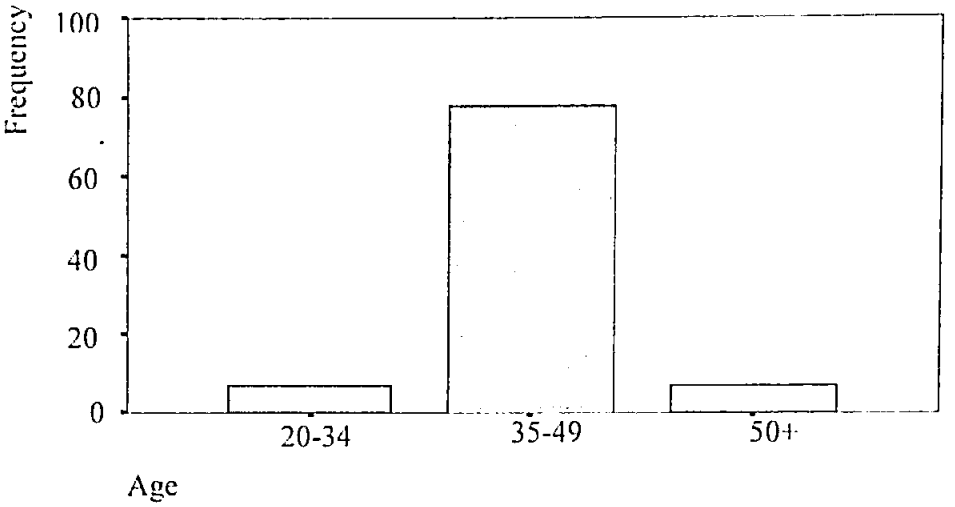


Figure 3: Age distribution of AGA workers

Source: Field data, 2004.

The figure indicates that 78 of AGA workers respondents fell within the ages of 35 and 49, while 7 each fell within 20 and 34, and 50+. This seems to imply that most of the AGA workers were middle aged men and women.

Place of residence

With regard to place of residence, 83 of the 92 respondents stayed in Obuasi, whereas 2 each stayed at Anyinam and Pompora respectively.

Distribution of levels and length of service of AGA workers

This section explored the various levels held by the workers as well as the length of time that the workers had been with the company. With regard to level, Senior Staff had the highest percentage followed by Junior Staff and Management as shown in Table 2. In the case of length of service, out of the

total respondents 11-20 years and 31-40 years were the highest and lowest respectively as shown in Figure 4.

Table 2: Position at mine

Position	Frequency	Percent
Junior	34	37.0
Senior	55	60.0
Management	3	3.0
Total	92	100.0

Source: Field data. 2004.

From Table 2. 60.0% of the 92 AGA worker- respondents at the mine fell within the senior staff. while only 3(3.0%) fell within the management level. These 92 respondents were the core sample population for the study.

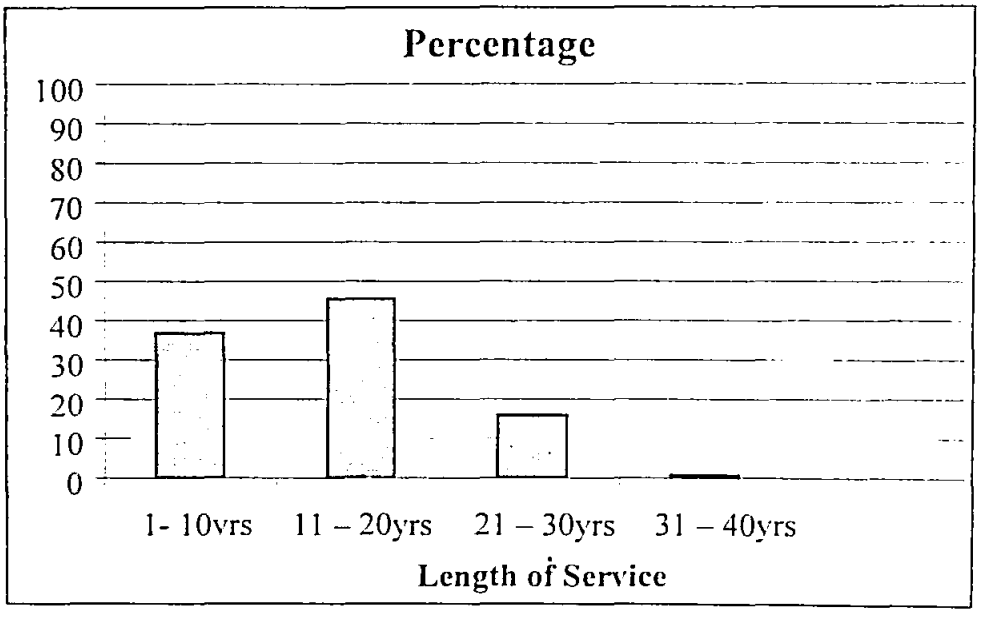


Figure 4: Length of service of AGA workers

Source: Field data. 2004

Figure 4 reveals 45.7% of the 92 AGA workers respondents have served between 11 – 20 years, whereas 1.1% fell within 31-40 year of service. However, 1-10 and 21-30 have 37.0% and 16.3% respectively.

The health implications of gold mining

The data presented in this section relates to the major issues of the study. Those were sources of water, common water-related diseases in the area, common air-related diseases in the area, causes of the diseases, and the relationship that exists between gold mining and the related diseases in the area.

Sources of water

This part of the study explored the sources of water and the providers of those waters. In this study hand-dug wells, boreholes and pipe-borne water were classified as the sources of water with AGA, NGOs, GWCL and Others (i.e. District Water and Sanitation Team-DWST and individuals) as the providers of such water illustrated in Table 3.

Sources of water and providers

Table 3 shows that about 89.0 % of AGA workers respondents have their source of drinking water from pipe- borne water, whereas hand-dug well was the least source of drinking water representing 4.0%. With regard to the providers, 98.8% of the 82 AGA worker respondents who have pipe-borne water as their source of drinking water have AGA as their provider, whereas the remaining 1.2% who depend on pipe-borne water have 'Others'(i.e. DWST and individuals) as the provider of water.

In the case of borehole, 50% of the 6 respondents have GWCL as provider, with only 16.7% having AGA as the provider. But the remaining respondents have NGOs as providers. Furthermore, 75% of the total hand-dug well users have 'Others' as providers, whereas the remaining 25% have AGA as the provider. This seems to suggest that AGA in terms of provision of water plays a major role in all the three sources of drinking water especially pipe-borne water for her workers. This may also suggest that AGA is committed to its social responsibility to the communities.

Table 3: Source of drinking water and water provider(s)

Source of drinking water	Water provider (s)					
	AGA	NGOs	GWCL	Others	Total	Percent
Hand-dug well	1	0	0	3	4	4.0
Borehole	1	2	3	0	6	7.0
Pipe-borne water	81	0	0	1	82	89.0
Total	83	2	3	4	92	100.0

Source: Field data, 2004

Water pollution

This section surveyed the evidence of perceived pollution in the various sources of drinking water. In the study the responses were classified as 'yes' and 'no' as shown in Table 4.

Table 4 shows that 28(34.1%) out of the 82 respondents who get their source of drinking water from pipe-borne responded in the affirmative to whether there is any evidence of pollution, whereas the remaining 54(65.9%) responded in the negative. But all the 6 respondents who have borehole as

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Pipe-borne water	81	0	0	1	82	89.0
Total	83	2	3	4	92	100.0

Source: Field data, 2004

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Table 4 shows that 28(34.1%) out of the 82 respondents who get their source of drinking water from pipe-borne responded in the affirmative to whether there is any evidence of pollution, whereas the remaining 54(65.9%) responded in the negative. But all the 6 respondents who have borehole as

their source of drinking water responded in the negative. However, for the 4 respondents who utilised hand-dug well, 2(50%) each responded yes and no respectively to evidence of pollution.

Table 4: Perception of water pollution evidence

Source of drinking water	Water pollution evidence		Total
	Yes	No	
Hand-dug well	2	2	4
Borehole	0	6	6
Pipe-borne water	28	54	82
Total	30	62	92

Source: Field data, 2004

From Table 4, it is clear that 30 out of the 92 responded yes to evidence of pollution. Out of the 30, 28 were users of pipe-borne water and 2 were users of hand-dug well. This seems to suggest that pipe-borne water is perceived as a safe source of drinking water as 54(65.9%) using it answered in the negative as to whether there is any evidence of pollution. Also, all the 6 respondents for borehole answered in the negative, this suggests that it is also perceived to be safe for drinking.

However, when the Municipal Environmental Officer was asked whether there was any evidence of sources of water being polluted, he answered yes and mentioned AGA operations as the number one cause of pollution. He also mentioned that the waters were not meant for drinking for they have contributed to many bilharzia cases in the municipality as unsuspecting children swim in those waters. The officer's assertion supports Agyei (2003) that the adverse impact of mining activities on health of humans

is indisputable, since mining is one of the potential primary sources of water pollution. Also, the extent of water pollution evidence may be attributed to water disposal practices and the nature of receiving water courses (Owusu-Ansah, 2002). From the forgoing, it is perceived that the 54, 6 and 2 respondents from pipe-borne water, hand-dug well and borehole respectively who responded no to pollution evidence might have said so due to their perception.

Perception of pollution

This area of the study sought to find out the nature of perceived pollutants in the sources of drinking water. It was realized that particle suspension, colouring and odour are the major pollutants as indicated by the respondents in Figure 5.

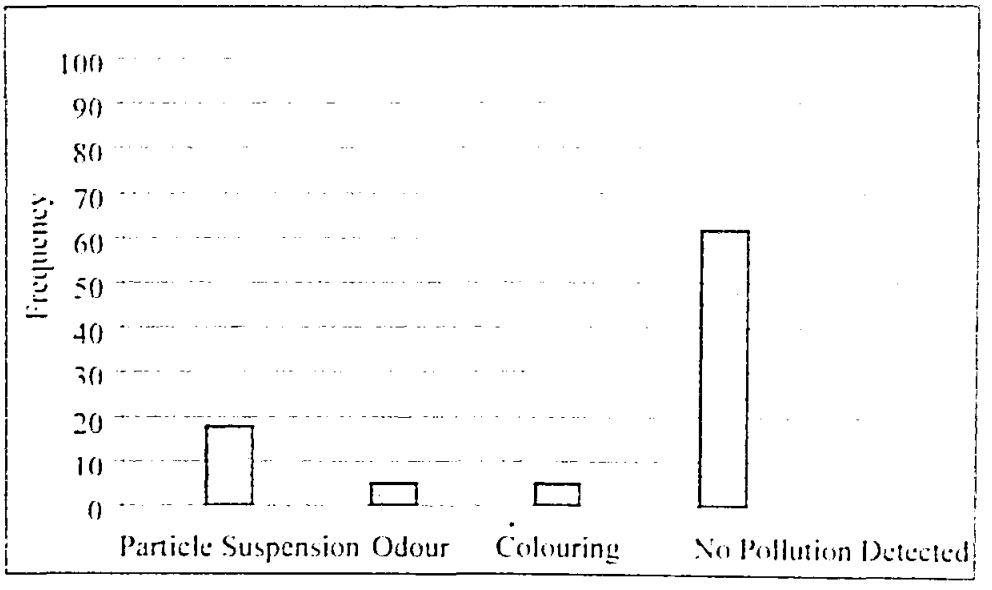

Figure 5: Nature of perceived water pollution

Source: Field data, 2004

About 64.3% of the 28 respondents who affirmed evidence of pollution (i.e. both pipe-borne and hand-dug well) mentioned particle suspension in water, the remaining 35.7%, 17.8% each of the respondents mentioned odour and brownish colour respectively as the nature of perceived pollution.

However, 'No pollution detected' has the highest bar representing 67.8% of the total respondents. This indicates that 67.8% of people who depended on pipe-borne water as means of drinking water do not perceive pollution in their source of water. As documented by WHC (2000) that damage to water and water resources is the worst environmental consequence of gold mining. For instance, from California's Sierra Nevada in the 1850s to the lands of the Pemon in Venezuela today, rivers have been ruined by people panning for gold, using high pressure hoses to spray down river banks and sift through the sediment for gold.

The respondents gave the following as some of the causes of water pollution. These causes include presence of dust in water, surface run-offs from open pits mining activities into rivers, cyanide pollution, pollution from Mine Senet near the stream as it floods and iron presence in water among other things. From the foregoing, it was revealed that the responses from the respondents see eye to eye with the literature above.

Main diseases

About 91.7% of all the 12 medical officers interviewed (including the AGA medical officer) mentioned malaria, diarrhoea, typhoid and respiratory tract infection (i.e. pneumonia, tuberculosis, silicosis etc) as the common diseases reported at their Out Patient Department (OPD). Secondary data from

the Obuasi Municipality showed the top ten OPD causes of attendance, top ten causes of admission and top ten causes of institutional deaths.

From Table 5, malaria recorded the highest among the top ten OPD causes of attendance rating from 30.3%, 40.5% and 58.0% for the years 2001, 2002 and 2003 respectively. The percentage of malaria OPD attendance increased from year to year. Diarrhoea which is rated second to malaria in 2003 started from 7th position and then to 4th in 2001 and 2002 respectively, followed by upper respiratory tract infection (URTI) with 12.7%.

Table 5: Top ten out-patient department causes of attendance – Obuasi Municipal Hospital

2001			2002			2003		
Diseases	No.	(%)	Diseases	No.	(%)	Diseases	No.	(%)
Malaria	107,742	30.3	Malaria	95,265	40.5	Malaria	133,982	58.0
URTI	45,311	12.7	Rheumatism	19,009	8.1	Diarrhoea	12,918	5.6
Rheumatism	30,162	8.5	URTI	13,,375	5.6	Cough/Colds	11,582	5.1
Pre. Rel.Com	10,875	3.0	Diarrhoea	7,049	3.0	Anaemia	5,994	2.6
Accidents	7,656	2.1	Anaemia	6,102	2.5	Rheumatism	5,807	2.3
Ear Infection	5,941	1.6	Int. Worms	4,484	1.9	Hypertension	5,289	2.2
Diarrhoea	5,671	1.5	Skin Disease	4,270	1.8	Int. Worms	4,513	2.0
Anaemia	4,549	1.2	Hypertension	3,776	1.6	Acute Eye	3,778	1.6
Skin Disease	4,467	1.2	Accidents	3,963	1.6	Accidents	3,771	1.6
Acute Eye	4,393	1.2	Pneumonia	1,517	0.6	Acute Ear	3,564	1.5
Total OPD Attendance	354,657	100	Total OPD Attendance	234,619	100	Total OPD Attendance	223,802	100

Source: Obuasi Municipal Health Directorate, 2003.

However. Anaemia. Skin Diseases and Acute Eye recorded the least among the top ten with 1.2% each. This information confirmed the OPD cases mentioned by the medical officers interviewed especially with regards to malaria, diarrhoea and typhoid cases.

Moreover, Table 6 shows additional secondary sources of data which deals with the summary of monthly morbidity returns – (district by district) for the period of ten years (i.e. 1992-2002) which revealed that incidence of malaria is more prevalent in Adansi West District (with Obuasi as its former district capital) than its sister district Adansi East where there is no mining activities. For instance, Table 7 reveals that in 1992 malaria incidence was 2,986 and 48,244 for AEDA and AWDA respectively. After six years (i.e. 1988 - 1994) of surface mining operation, the AWDA recorded its least incidence of malaria (19,988), while AEDA recorded only 2,497. Further, in 1996 the AWDA recorded the highest malaria cases of 81,457 where as AEDA recorded 2,806 malaria incidences around the same period. This supports (Reddy, 2005) that disease prevalence varies with geographic location. It has been established by previous work that prevalence of certain diseases such as HIV/AIDS, malaria and skin diseases may be higher in mining areas than in non-mining areas. This is due to the change in environment that mining related activities have on a location.

Table 6: Summary of monthly morbidity returns – (district by district) between 1992 and 2002.

Year	Incidence of malaria	
	Adansi East District Assembly (AEDA)	Adansi West District Assembly (AWDA)
1992	2,986	48,244
1992/93	3,272	50,561
1993/94	2,497	19,988
1995	2,555	31,872
1996	2,806	81,457
1997	4,633	77,176
1998	7,017	73,219
1999	10,053	35,318
2000	11,134	40,018
2001	12,549	44,840
2002	12,969	62,685

Source: Ghana Health Services, Ashanti. - 1992 to 2002.

From the foregoing, it is concluded that incidence of malaria was increasing in both districts but the extent of increase in AWDA to that of AEDA shows a higher prevalence of malaria incidence at mining area than a non-mining area. Abandoned open pits arising from operations of AGA was mentioned as one of the major factors contributing to breeding of malaria carrying mosquitoes in the Obuasi area. This support Akabzaa and Darimani (2001), that malaria may have a higher prevalence in mining areas, particularly areas with surface level mines due to the numerous pits that are

dug for mining activities. When these fill up with water they act as perfect breeding grounds for mosquitoes. A survey in 1994 of Tarkwa mineworkers in Ghana showed that 75% of them carried the malaria parasite.

Table 7: Relationship between AGA gold output and incidence of malaria in Obuasi area between 1992 and 2002

Year	Surface mining output(ounces)	Total gold output(ounces)	Incidence of malaria
1991/92	301,063	654,298	48,244
1992/93	401,765	770,410	50,561
1993/94	508,112	822,954	19,988
1995	574,382	932,323	31,872
1996	481,495	860,384	81,457
1997	387,502	858,000	77,176
1998	381,772	885,342	73,219
1999	253,099	743,111	35,318
2000	147,062	640,988	40,018
2001	42,999	528,451	44,840
2002	65665	537,219	62,685

Source: Ghana Health Services, Ashanti. - 1992 to 2002.

Again, Table 7 reveals that apart from 1993/94 where the incidence of malaria was the least though there was an increase in gold output; the rest seems to show a positive relationship between a previous year total gold output and current year malaria cases. For instance, 1995 was the year that the gold output was the highest and surface mining component being the highest among them, the following year (1996) recorded the highest malaria case of

81,457. Furthermore, Table 7 reveals a positive relationship between a previous year's surface mining output and current year incidence of malaria with the exception of 1993/94. For instance, after seven years of surface mining operation (i.e. 1995), AGA recorded the highest output from surface mining (574,382 ounces of gold) and the following (1996), the highest incidence of malaria was recorded in the district.

From the foregoing, it shows that at the peak of surface mining activity in Obuasi area, incidence of malaria was very high. But getting to the later years where gold output especially surface mining was going down, the incidence of malaria went down as well. About 88 percent of the AGA worker- respondents mentioned malaria as one of the common diseases among them.

Most (91.7%) of the medical officers mentioned poor drainage system and poor sanitation as the main causes of malaria. Thus, these areas serve as breeding ground for mosquitoes. Twenty-five percent of the total medical officers interviewed outside AGA hospital mentioned that the abandoned pit of AGA contributes to the breeding of mosquitoes and hence malaria. Furthermore, the only medical officer interviewed at the AGA's Hospital added his voice to the open pits of the company as one of the sources of mosquitoes' breeding ground and for that matter the prevalence of malaria in the Obuasi Municipality.

With regard to the top ten causes of admission, Table 8 has anaemia as number one, followed by hernia, pneumonia, malaria, meningitis, and typhoid sequentially in 2001. However, in 2002, malaria was ranked the number one, with typhoid maintaining its position. Further, diarrhoea which was not among

them came in ranking at the fourth position. Again, malaria maintained its lead in 2003, with pneumonia and diarrhoea following respectively. Table 8 seems to support the information gathered from the AGA workers' respondents as many mentioned malaria as one of the common diseases which affect them.

Table 8: Top ten causes of admission – Obuasi Municipal Hospital

2001			2002			2003		
Diseases	No.	(%)	Diseases	No.	(%)	Diseases	No.	(%)
Anaemia	104	5.5	Malaria	214	8.7	Malaria	193	7.8
Hernia	71	3.7	Anaemia	189	7.7	Anaemia	110	4.5
Pneumonia	64	3.4	Pneumonia	124	5.0	CVA	47	1.9
Malaria	43	2.3	Hernia	44	1.8	Pneumonia	44	1.7
Meningitis	35	1.8	Diarrhoea	43	1.5	Typhoid	34	1.4
Typhoid	29	1.5	Typhoid	36	1.4	Diabetes	33	1.3
Hepatitis	24	1.3	Pre. Rel.	36	1.4	Malnutrition	29	1.2
CVA	17	0.9	Hepatitis	28	1.4	Meningitis	28	1.1
Hypertension	16	0.8	Meningitis	20	1.0	Hypertension	22	0.1
Accidents	10	0.5	Gynae Dis.	20	1.0	R. Failure	20	0.2
Others	1481	78.3	Others	1698	69.2	Others	1893	77.2
Total OPD Attendance	1894	100	Total OPD Attendance	2452	100	Total Admission	2,453	100

Source: Obuasi Municipal Health Directorate, 2003.

In the case of institutional death, the top ten causes have pneumonia as number one with malaria and typhoid being ranked number five and seven respectively in 2001. But malaria and typhoid moved to the third and fourth position respectively, and then followed by pneumonia in the fifth position in

2002. Furthermore, in 2003 malaria moved to the number one position, but typhoid fell back to the fifth and pneumonia moved upwards to fourth position. This confirms the medical officers' acceptance of malaria as one of the common diseases generally reported at their OPDs.

Table 9: Top ten causes of institutional death – Obuasi Municipal Hospital

2001			2002			2003		
Diseases	No.	(%)	Diseases	No.	(%)	Diseases	No.	(%)
B. Pneumonia	10	0.5	Anaemia	18	1.0	Malaria	13	0.5
Anaemia	8	0.4	Meningitis	11	0.4	Anaemia	13	0.5
Meningitis	8	0.4	Malaria	7	0.3	CVA	8	0.3
CVA	6	0.3	Typhoid	7	0.3	Pneumonia	7	0.3
Malaria	4	0.2	Pneumonia	6	0.2	Typhoid Perf.	4	0.2
Hepatitis	2	0.1	Diarrhoea	5	0.2	Diabetes	4	0.2
Typhoid	2	0.1	AIDS	5	0.1	Malnutrition	4	0.2
Septicaemia	1	0.05	Septicaemia	3	0.1	Meningitis	3	0.1
-	0	0	CVA	2	0.1	Hypertension	2	0.1
-	0	0	Accidents	2	0.1	R. Failure	2	0.1
Others	1853	97.95	Others	2,386	97.2	Others	2,393	97.5
Total Admission.	1894	100	Total Admission	2452	100	Total Admission.	2,453	100

Source: Obuasi Municipal Health Directorate, 2003.

Common water-related diseases

This section looks at consequences of drinking polluted water, common water-related diseases and causes of those diseases as shown in Tables 10, 11 and 12.

Table 10 depicts the cross-tabulation between perceived nature of pollution against consequences of drinking the polluted water. About 89%, 80% and 60% of the total respondents who mentioned particle suspension, odour and brownish colour respectively as nature of pollution stated diarrhoea and typhoid as the consequences of drinking the polluted water, whereas 5.5%, 20% and 20% respectively mentioned diarrhoea and skin rashes. But 5.5% and 20% of the respondents mentioned particle suspension and brownish colour declared 'no disease' and cholera, typhoid and diarrhoea respectively.

Table 10: Consequences of drinking polluted water

Perceived nature of pollution	Consequences of drinking polluted water				Total
	Diarrhoea & typhoid	Cholera, typhoid & diarrhoea	Diarrhoea & skin rashes	No disease	
Particle suspension	17	0	1	1	19
Smells	5	0	1	0	6
Colouring	3	1	1	0	5
No pollution detected	0	0	0	62	62
Total	25	1	3	63	92

Source: Field data, 2004.

This seems to suggest that diarrhoea and typhoid are rampant among the workers who responded yes to evidence of pollution as those pollutants lead in all the nature of pollution mentioned. Furthermore, 91.7% of the 12 medical officers interviewed outside AGA hospital mentioned diarrhoea and typhoid as the common water-related diseases reported at their OPD with bilharzia infections occurring occasionally representing 8.3%. This seems to corroborate the AGA workers response of diarrhoea and typhoid as one of the major consequences of drinking the polluted water.

Moreover, the AGA medical officer who was interviewed confirmed typhoid and diarrhoea as the common water-borne diseases generally reported at its OPD. In addition, the Municipal Environmental Officer mentioned cholera, intestinal infections such as typhoid, diarrhoea, dysentery; and Tuberculosis as common diseases/sicknesses/illnesses. This seems to buttress the Ghana Health Services' (GHS) top ten OPD causes of attendance league table and the medical officers' response to the question posed to them as common diseases and diseases generally reported at their various OPDs.

From the analysis above, it supports Bentil (1998)'s work, which shows that malaria, bilharzia, and diarrhoea were among the health care issues in the Nsuta area. Malaria prevalence may be due to the problem of increased sediment such as siltation and tailing settling pond as ideal breeding sites for malaria-carrying mosquitoes.

Causes of the common water-related diseases

With regard to the causes of those water-related diseases, the majority of AGA workers respondents mentioned the polluted water that they use as the

main cause. Again, the District Environmental Health Officer was quick to add that the effluents discharged by AGA into local water courses is one of the causes of the common water-related diseases as it pollutes the waters.

Regarding the causes, the medical officers mentioned poor sanitation. For instance, in Table 12, 72.7% of the medical officers mentioned poor sanitation as the main cause of the water-borne diseases. It has been proved that water pollutants are major contributors to the cases of diarrhoea, schistosomiasis, cholera and typhoid especially in Africa (Yeboah, 2001). The study revealed that pollution of the waters in Obuasi is partly due to activities of AGA and the poor sanitation in the Municipality, these support the work of Yeboah (2001).

Table 11: Causes of the common diseases/sicknesses as seen by medical doctors

Causes of diseases	Frequency	Percent
Poor sanitation	8	72.7
Dusty and smoky environment	2	18.2
Selling of improper prepared food and water	1	9.1
Total	11	100

Source: Field data, 2004.

Common air-related diseases

Eighty-seven point five percent of the medical officers responded that respiratory tract infections such as pneumonia, Tuberculosis and silicosis are the common air-related diseases generally reported at their OPD, whereas catarrh forms 12.5%. Younayelle (2001) claimed that medical surveillance at

Tarkwa underground mine between 1973 and 1986 revealed a significant incidence of silicosis. TUC (2000) revealed that mine workers still suffer hazards. The outcome of these hazards has been an upsurge in diseases like respiratory infection, waste pains, skin diseases, stress, tuberculosis and other terminal diseases. The two works support the prevalence of these diseases mentioned above in mining areas as they agree with the medical officer's response.

Causes of air-related diseases

In Table 12, dusty and smoky environment which forms 25% of the total causes of common diseases is believed to be the major causes of the respiratory tract infection. This seems to support responses of AGA workers that dusty and smoky environment are causes of many of their diseases especially the common ones. For instance, Table 13 shows that 54.3% out of the total AGA worker respondents' in response to causes of common occupational diseases mentioned dusty and smoky environment. This agrees with Osei-Mensah (2001), that the resulting effects of the environmental impact of blasting are the associated health hazards such as respiratory-related diseases like cold and influenza, and the worsening of existing respiratory ailments like asthma, being the result of dust pollution in the short-run whilst in the long-run results generally to pneumoconiosis. Further, San (1996) investigated the environmental aspects of quarrying in Ghana and came out with effects of dust. To him, pathologically, dust particles less than 5μm are inhaled and settled on the lungs causing silicosis (silica dust). According to Anon (1976), exposure to excessive concentrations of all dusts increases the

frequency of mild respiratory ailments (colds, influenza) and can worsen existing respiratory diseases including asthma and tuberculosis

Table 12: Causes of commonest occupational diseases

Causes of occupational diseases	Frequency	Percent
Use of computer without screen filter for long hours	4	4.3
Chemical pollution from processing plant	7	7.6
Dusty and smoky environment	50	54.3
Heaviness of lamp battery attached to the waist	5	5.4
Non- compliance of safety measures	7	7.6
Not applicable	19	20.7
Total	92	100.0

Source: Field data 2004

From the above analysis, it suggests that though there are other causes of common occupational diseases, dusty and smoky environment is the highest with 54.3%. However, "Not applicable" was second from the rating with 20.7%. This seems to suggest that the respondents (Not applicable) may be perceived to be ignorant of the causes of common occupational diseases and this calls for further studies into that. Apart from the dusty and smoky environment, chemical pollution and non-compliance of safety measures follow with 7.6 % each as shown in Table 12.

Figure 6 depicts that 65.5% of the total AGA workers' respondents answered in the affirmative in response to whether they use chemicals in their activities, while the remaining 34.5% responded negative (no). This shows that majority (65.5%) of the workers make use of chemicals in their respective activities

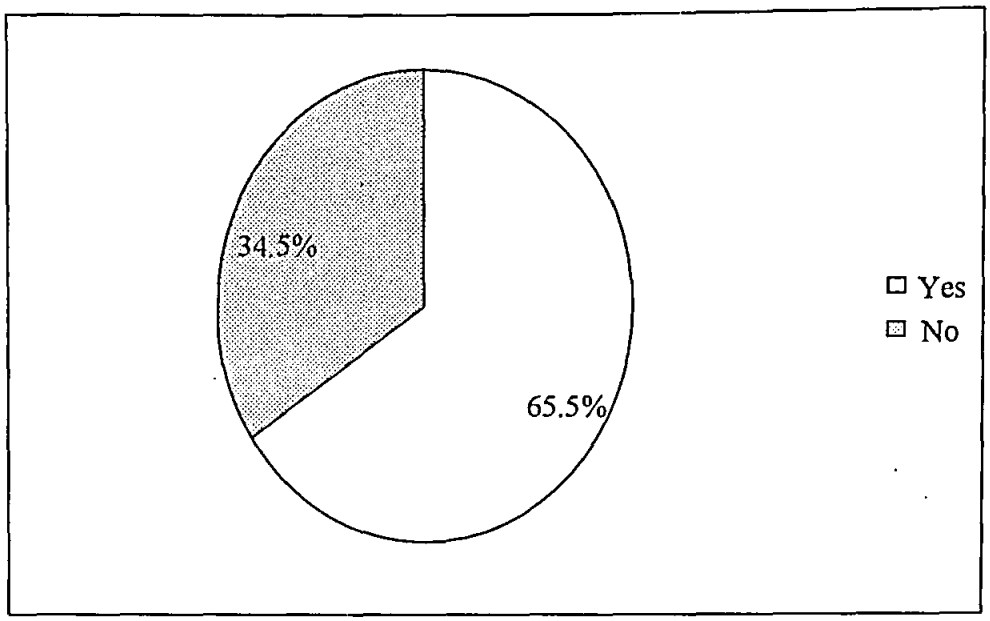

Figure 6: AGA workers respondents' response to chemical usage

Source: Field data, 2004

Chemicals use against part of body/ies mostly affected.

Table 13 reveals the cross-tabulation between chemicals in use and part of the body(ies) mostly affected, 56.5% out of the total respondents who used chemicals such as sodium cyanide, hydrochloric acid, ammonia nitrate among others mentioned 'no effect' from the chemicals on any part of their body, whereas the remaining 43.5% mentioned various parts of the body such as eyes, head, chest, liver and lungs, skin among others being affected, with the skin infection being the highest forming about 30%. However, lungs and liver had the least with 5%.

Owusu-Ansah (2002) and Asante (2000) have stated that cyanide is common in gold mill waste water at a concentration between ((0.01- 0.03) mg/litre and that it is lethal to both man and aquatic life at a very low concentration. Thus, cyanide especially alkali and hydro-cyanide acids are

extraordinarily poisonous when ingested into the body or have prolonged contact with the skin. Some initial symptoms include headache, dizziness vomiting and shortness of breath, which can lead to death if not treated in time. Again, Boadi (2002) confirmed that sulphur dioxide produced during roasting and smelting, is believed to be a major contributor to most respiratory diseases in most mining towns as it can cause chronic asthma and bronchitis. It sometimes causes eye irritation.

Table 13: Part of the body (ies) mostly affected

	Some of the chemicals in use				
Body(ies) part mostly affected	Sodium cyanide sulphuric acid, hydrochloride acid etc.	Blasting explosives	Thinners, spray maker	No chemicals used	Total
Eyes	4	1	1	0	6
Skin	5	0	0	1	6
Stomach	2	0	0	0	2
Chest	2	2	1	0	5
Head	4	0	0	1	5
Lungs & liver	1	3	0	1	5
Muscles strains	2	0	2	1	5
No Effect	26	3	18	11	58
Total	46	9	22	15	92

Source: Field data, 2004

In the case of blasting explosives, 33.3% of the AGA workers' respondents using blasting explosives mentioned lungs and liver as the most affected body part, whereas 33.3% responded 'no effect'. Also, eyes (11.1%) recorded the least affected part of the body. Furthermore, thinner and spray marker, though ranked third chemical usage had only 9.1% users mentioned muscle strains as the infection, while 4.5% each mentioned eyes and chest respectively as part of the body affected. However, the remaining 81.8% of AGA workers respondents using thinner and spray marker answered that they have no effect from the chemicals.

From the foregoing, the 58 AGA workers respondents who responded no effect to the chemical usage might have said so due to ignorance since the diseases they reported commonly were dizziness, weakness; headache, nausea and vomiting. To Owusu-Ansah (2002) and Asante (2000), these are as a result of coming into contact with the chemicals used. On the question as to the causes of the common diseases/illnesses/sicknesses, the Municipal Environmental Officer mentioned crude method of waste disposal, flies and mosquitoes.

Effects of AGA operation on the health of the inhabitants

The study revealed that the activities of AGA do have some negative impact on the inhabitants in the area of health. In a cross-tabulation of AGA activities against common diseases and nature, Table 14 indicates that the activities of AGA do have effects on inhabitants. Eighty-two of the medical officers interviewed affirmed that and mentioned the effects as air pollution, chemical pollution and overcrowding and their attendant health consequences.

This seems to agree with the responses of AGA workers assertion that the company's operations do have effect on their health. For instance, 51.1% of the total AGA workers respondents responded yes to the assertion that the AGA's operations pollution does have effect on their health. Again, 80.9% out of the 47 mentioned inhalation of dust and smoke, with ear problem and poor ventilation being the least with each representing 2.4%.

Table 14: Medical officers' views about AGA activities contribution to common diseases

Nature	AGA activities contribute to common diseases		
	Yes	No	Total
Air pollution	5	0	5
Chemical pollution	3	0	3
Overcrowding	1	0	1
None	0	2	2
Total	9	2	11

Source: Field data, 2004

The Municipal Environmental Health Officer responded yes to the question whether AGA operations contribute to the prevalent diseases/illnesses/sicknesses and mentioned uncovered open pits which collect water and breed mosquitoes; effluents discharged into local water courses pollute them; dusty environment emanating from vehicles and blasting; and chemical suspension in the environs especially at Kokoteasua.

From Table 15 which is a cross-tabulation of how the operation's pollution affects health and how, 51.1% of the 92 respondents answered yes to the fact that the operation's pollution has effect on their health. 80.9% out of

the 47 who responded yes mentioned inhalation of dust as how they are affected by the operation's pollution. This supports Nyarko (2002) that residents, near the PTP complain of skin colour change when they are exposed to the gaseous emission from the Plant.

Table 15: Operation's pollution on your health

Nature of effects	Operation's pollution on your health		Total
	Yes	No	
Inhalation of dust and smoke	38	0	38
Chemical pollution	3	0	3
Poor ventilation	1	0	1
Eye problem	2	0	2
Ear problem	1	0	1
Coughing periodically	2	0	2
Not applicable	0	45	45
Total	47	45	92

Source: Field data, 2004.

Again, an enquiry from AGA hospital revealed that the hospital has recorded the following diseases of patients as they inhale the noxious gases:

- Bronchitis- infections in the bronchiole of the lungs.
- Bronchitis- infections in the bronchi.
- Bronchopneumonia infections of the thoracic cavity.
- Asthma
- Rhinitis-Nasal cavity infection.
- Narcosis drowsiness, sleep by insensibility.

Community studies in coal mining regions were predominantly concerned with respiratory illness caused by air pollution from mining activities (Charpin, et al. 1988; Pless Mulloli, et al 2000). Further, Boadi (2002) revealed that sulphur dioxide produced during roasting and smelting, is believed to be a major contributor to most respiratory diseases in most mining towns as it can cause chronic asthma and bronchitis. It sometimes causes eye irritation.

Fifty-one point one percent responding yes to AGA's operations pollution on their health is a confirmation to the works of Nyarko (2002) and Boadi (2002) with regard to health effects from mining operations on workers and inhabitants in the catchment areas. However, about 48.9% of the respondents mentioned "Not Applicable", this goes contrary to the literatures above.

Protective measures against company's pollutions

On a question as to protective measures put in place by the company against chemical pollution Table 16 illustrates that. Table 16 shows that about 89.1% of the 92 respondents of AGA workers mentioned the various measures in place with personal protective equipment (PPE) leading with 42.4% respondents, followed by education with 15.2% respondents and recycling of decant water being the last with 1.1%.

One manager from the workplace and environment division who was interviewed answered that Arsenic trioxide and Sulphur dioxide (SO_2) which used to be the main chemical pollution from concentrate roasting of ore containing areno-pynite is now a thing of the past since June 2000. This is so,

because currently processing is done through the use of biological oxidation which end products are environmentally friendly since Arsenic Trioxide is converted to more stable ferric arsenic whereas SO_2 comes out as sulphuric which is neutralized with lime. In the case of air pollution, the manager responded by saying that air-borne dust is controlled by mobile pressurized water browsers to suppress dust on haul roads and as well as reclamation programme for mined-out areas.

Table 16: Protective measures against chemicals

Protective measures	Frequency	Percent
Personal protective equipment	39	42.4
Construction of tailing dams	11	12.0
Testing and monitoring	12	13.0
Education	14	15.2
Recycling of decant water	1	1.1
Keeping EPA standards	5	5.4
Nothing	4	4.3
Unanswered	6	6.5
Total	92	100.0

Source: Field data, 2003

With regard to land management, the Environmental division has a reclamation programme for reclaiming mined-out areas. Thus, most of the mined-out pits are backfilled with mine wastes and covered with top-soil and then regenerated using exotic and indigenous tree species. Liquid effluent, on the other hand, are disposed into local water courses only after treatment in a holding pond using calcium hypochlorite. Furthermore, the use of PPE such as

ear plugs/ear muffs are some of the measures put in place within the company for controlling noise pollution emanating from heavy moving equipments, and blasting among others.

However, when the Municipal Environmental Health Officer was asked as to how his outfit was doing in supervising the forms of pollution of AGA operations, he responded by saying that they played advisory role through the company's Workplace and Environment Division but it was Environmental Protection Agency (EPA) which has the power to supervise the AGA operations pollution. The EPA is currently doing that from the Kumasi office since the Obuasi Municipality does not have an office for that agency. With regard to measures the office has put in place against those forms of pollution, he responded in the negative that it was not applicable to the office.

HIV/AIDS

HIV/AIDS was also mentioned as one of the common diseases in Obuasi Municipality. Two (25%) out of the eight (8) medical officers interviewed outside AGA hospital confirmed that. In addition, the medical officer interviewed at the AGA hospital established the fact of HIV/AID prevalence among his patients. This confirmed the prevalence of HIV/AIDS in Obuasi Municipality apart from the common water-related diseases. (MOH/DHO, 2003). Again, AIDS was rated number seven (7th) among the top ten causes of institutional death in 2002 as indicated in Table 8 (OMHD, 2003).

As to the causes of HIV/AIDS prevalence in Obuasi, the medical officers explain that in Obuasi, gold mining attracts labour from the

surrounding areas. And those workers who leave their families for an extended period of time are often involved in sexual activities with multiple partners exacerbating the problem of sexually transmitted diseases such as HIV/AIDS.

Apart, many of the migrant workers who get a regular monthly income are to be connected with workers for their sexual needs. This confirms Campbell (2000) that migrant labour plays a considerable role in the mining sector and these migrants are believed to contribute to the transmission of HIV/AIDS. For instance, in Obuasi, reported cases of AIDS has in recent, implying that if immediate steps are not taken in time, sooner or later AGA will have a reduced work force (Sampong, 1998). This agrees with Campbell (2000) and Corbett, et al (2000) on the prevalence of HIV/AIDS in mining towns and even that there is a combined effect of HIV infection and illness.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presents a summary of the findings of the research, draws conclusions and finally offers recommendations. The project sought to meet certain objectives. They were to: describe the main diseases of the population in the Obuasi area, ascertain the extent to which these diseases are manifested in the mining area, identify the effect of mining activities on water bodies in the operation area, ascertain the extent to which AGA operations affect the health of inhabitants, and to make recommendations to the management of AGA, the government and interested parties.

Summary

With regard to sources of water, the majority (89.1%) of the AGA workers respondents depend on pipe-borne water as the main sources of drinking water. Pipe- borne water and Boreholes were perceived to be safe sources of drinking water. Malaria was one of the most prevalent diseases in the Obuasi Municipality. Diarrhoea and typhoid were water-related diseases found to be most prevalent in the Obuasi Municipality. In view of common air-related diseases, respiratory tract infections such as pneumonia, tuberculosis and silicosis are the most reported cases at the various OPDs.

Considering causes of common water-related and air-related diseases, polluted water as well as poor sanitation; and dusty and smoky environment were mentioned respectively. AGA operations were really believed to have effects on the inhabitants in the area of air and chemical pollution, and abandoned open pits which collected water and served as breeding ground for malaria-carrying mosquitoes.

Conclusions

The study revealed that mining activities have health implications for mine workers as well as inhabitants of the Obuasi Municipality. The perception of the mine workers is that both pipe-borne water and boreholes are safe sources of drinking water in the Obuasi Municpality.

The study further revealed that diarrhoea and typhoid are the most common water-related diseases in the Municipality. Medical officers within the Municipality admitted that these are the diseases generally reported at their various OPDs (including AGA medical officer). Also, bilharzia and cholera were occasionally reported.

With regard to causes, the study revealed that the use of polluted water, poor sanitation and poor drainage system are some of the causes of common water-related diseases in the Municipality. The source of pollution is found to include the effluents from AGA operations which are discharged into local water course.

In the case of air-related diseases, the study reveals that respiratory tract infections such as pneumonia, tuberculosis, and silicosis are found to be common in the Obuasi Municipality. This was so because they were

established to be generally reported cases at the various OPDs. For example among the eight (8) key divisions in AGA, the Mining Division workers were at risk due to the nature of their work as they form the majority of this respiratory tract infection cases normally reported at the AGA hospital as revealed by the medical officer interviewed.

Dusty and smoky environment was ascertained to be the foremost cause of those respiratory tract infections mentioned above. This was due to poor ventilation underground, blasting and fumes from heavy moving equipment underground and AGA vehicles conveying haulage.

Moreover, the study revealed that AGA operations did affect the health of the inhabitants. For instance, it was ascertained that skin rashes used to be widespread before June 2000 as result of Arsenic Trioxide and Sulphur Dioxide (SO_2) which used to be the main chemical pollution from concentrate roasting of ore containing areno-pynite at PTP. However, it is now history with the introduction of environmentally friendly biological oxidation which converts Arsenic Trioxide and SO_2 to more stable ferric arsenic and sulphate which is neutralized with lime.

Again, malaria was found to be the most common of all the common diseases generally reported at the various OPDs, to the extent that nearly all AGA respondents reported that it is the common occupational disease in their respective division. Furthermore, the secondary sources also confirmed that in 2003 malaria was established as number one top ten OPD causes of attendance, causes of admission and causes of institutional death in the Obuasi Municipal (OMHD, 2003).

The study revealed that the abandoned mined-out pits of AGA are amongst the main breeding sites for malaria carrying agent. Summary of monthly morbidity returns- (District by District) for the period 1992 to 2002 confirmed the increasing number of malaria cases year by year in both AWDA and AEDA. However, the incidence of malaria in AWDA far outweighed that of AEDA. Between 1992 and 1996, the incidences of malaria ranged from 2,986 to 2,806 and 48,244 to 81,457 in AWDA and AEDA respectively. Again, there is a direct relationship between AGA total gold output in a particular year and incidence of malaria in the preceding year. For instance 932,323 ounces of gold output (the highest contribution between 1992/93 to 2002) in 1995, led to the highest incidence of malaria (81,457) in 1996.

In addition, the study revealed that HIV/AIDS is rife in the Obuasi area. This was witnessed as the number seven among the top ten causes of institutional death in 2002, Obuasi area (OMHD, 2003). To conclude, the study revealed that gold mining activities do have health implications for mine workers in the Obuasi Municipality especially among the AGA workers particularly with air-related and chemical-related diseases. However, they are not the only cause of the common diseases in the entire Obuasi Municipality as poor sanitation, crude method of waste disposal by the Assembly to mention but a few also contribute to the common diseases in the Municipality.

Recommendations

On the basis of this study, it is recommended that the following measures be considered and implemented:

- The AGA's management should see to the proper treatment of the pipe-borne water it provides to reduce the high incidence of diarrhoea and typhoid.
- The mined-out pits should be backfilled on time to avoid the pits being used as breeding grounds for mosquitoes.
- The AGA should use dust suppression measures with all seriousness so as to reduce the dust pollution.
- The AGA management should increase its education on the use of Personal Protective Equipments (PPE) such as nose masks, ear plugs/muffs and the rest at the work place. Again, management should encourage and enforce its usage to prevent avoidable diseases.
- The exit medical examination should be enforced as well as periodic medical examination the staff especially the miners and those who use chemicals in their activities.
- Environmental Protective Agency (EPA) office should be established at Obuasi Municipality to supervise the AGA operations pollution to complement the advisory role being played by the Municipal Environmental Health Office.

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APPENDIX A

UNIVERSITY OF CAPE COAST

FACULTY OF SOCIAL SCIENCES

INSTITUTE FOR DEVELOPMENT STUDIES

HEALTH IMPLICATION OF GOLD MINING FOR MINE WORKERS IN OBUASI

INTERVIEW GUIDE FOR AGA MANAGEMENT

The interview guide is intended for a research into the Health implication of gold mining for mine workers in Obuasi

The question below is part of a project being conducted in connection with the above-stated topic at the Centre for Development Studies, UCC. I shall be most grateful if you answer them to the best of your ability. This is a purely academic exercise and any information provided will be treated confidential. Moreover, your anonymity is guaranteed. Thank you.

Please, mark [X]. [√].

SECTION A: BIO- DATA

1. Sex Male [ ] Female [ ]

2. Town.....

3. Position at Mine (a) Junior [ ] (b) Senior [ ] (c) Management [ ]

4. How long have you been with the company? .....

5. Since when have you been with this department? .....

SECTION B: SOURCES OF WATER

1. What is/are source(s) of drinking water?

Hand-dug well [ ] Borehole [ ] Rivers [ ] Streams [ ]

2. Who is/are the provider(s) of your water supply?

AGA [ ] NGOs [ ] GWC [ ] Others [ ]

3. What shows that your sources of water have been polluted?

.....

4. Since when did you notice that? .....

SECTION C: MINING RELATED DISEASES

1. Which of these do your workers go through?

Pre-employment Medical Examination [ ]

Periodic Medical Examination [ ]

Special Medical Examination [ ] Exit Medical Examination [ ]

2. Do your outfit use chemicals in their activities?

Yes [ ] No [ ] If yes, What are some of the chemicals?

.....

3. What protective measures has your company put in place against chemical pollution? .....

4. How are diseases reported in the organisation? .....

5 Mention the commonest occupational illness/sickness/disease amongst your workers.

.....

6. Who takes care of occupational diseases?

Management [ ] Personal [ ]

7. Do victims receive workman's compensation?

Yes [ ] No [ ] If yes, What is the package?

.....

8. Generally, what is your view on occupational diseases at the work place?

.....

9. Do you receive complain of illnesses/sicknesses/diseases from the people in the catchment's areas? If yes, how are they addresses? .....

10. What mechanism has management put in place to prevent such diseases at work place? .....

SECCTION D: CAUSES OF THE DISEASES

1. What are the major or main waste generated by the company?

.....

2. How does the company manage the following pollution?:

(i) Air .....

(ii) Water.....

(iii) Land.....

3. How does your outfit dispose off its waste? .....

4. How is the liquid waste disposed off? .....

5. What do you think are the causes of that commonest occupational illness/sickness/disease? .....

6. What occupational health services are available in the company?

Clinic [ ] Hospital [ ] Others(specify) [ ]

7. What do you suggest will help the management in the management of waste and its attendant effects?.....

APPENDIX B

UNIVERSITY OF CAPE COAST

FACULTY OF SOCIAL SCIENCES

CENTRE FOR DEVELOPMENT STUDIES

HEALTH IMPLICATION OF GOLD MINING FOR MINE WORKERS IN OBUASI

QUESTIONNAIRE FOR AGA WORKERS

The questionnaire is intended for a research into the Health implication of gold mining for mine workers in Obuasi

The question below is part of a project being conducted in connection with the above-stated topic at the Centre for Development Studies, UCC. I shall be most grateful if you answer them to the best of your ability. This is a purely academic exercise and every information provided will be treated confidential. Moreover, your anonymity is guaranteed. Thank you.

Please, mark [X], [√],

SECTION A: BIO- DATA

1. Sex Male [ ] Female [ ]

2. Age 20 – 25 [ ]

26 – 29 [ ]

30 -35 [ ]

36 -39 [ ]

40 – 44 [ ]

45 – 49 [ ]

50 – 54 [ ]

55^{+} [ ]

3. Town.....

4. Position at Mine (a) Junior [ ] (b) Senior [ ] (c) Management [ ]

5. How long have you been with the company?.....

SECTION B: SOURCES OF WATER

1. What is/are source(s) of drinking water?

Hand-dug well [ ] Borehole [ ] Rivers [ ] Streams [ ]

2. Who is/are the provider(s) of your water supply?

AGA [ ] NGOs [ ] GWC [ ] Others [ ]

3. What shows that your sources of water have been polluted?

.....

4. Since when did you notice that? .....

5. What do you think are the causes of that pollution? .....

6. What are the consequences of drinking that water?

.....

SECTION C: MINING RELATED DISEASES

1. Do your outfit use chemicals in their activities?

Yes [ ] No [ ] If yes, What are some of the chemicals?

.....

2. What protective measures has your company put in place against chemical pollution? .....

3. Do you have any effect from the chemicals?

Yes [ ] No [ ] If yes, Which part of the body (ies) is/are mostly affected? .....

4. Which of these do you go through?

Pre-employment Medical Examination [ ]

Periodic Medical Examination [ ]

Special Medical Examination [ ] Exit Medical Examination [ ]

5. What type of mining related diseases have you ever experienced as a worker? .....

6. How are diseases reported? .....

7. Who takes care of occupational diseases?

Management [ ] Personal [ ]

8. Mention the commonest occupational illness/sickness/disease amongst your department's workers. .....

9. Do victims receive workman's compensation?

Yes [ ] No [ ] If yes, What is the package?

.....

10. Generally, what is your view on occupational diseases at the work place?

.....

SECCTION D: CAUSES OF THE DISEASES

1. What do you think are the causes of those commonest occupational illness/ sickness/disease mentioned above?

.....

2. Do the operation's pollutions have effect on your health? How?

.....

3. What occupational health services are available in the company?

Clinic [ ] Hospital [ ] Others(specify) [ ]

APPENDIX C

UNIVERSITY OF CAPE COAST

FACULTY OF SOCIAL SCIENCES

CENTRE FOR DEVELOPMENT STUDIES

HEALTH IMPLICATION OF GOLD MINING FOR MINE WORKERS IN OBUASI

INTERVIEW GUIDE FOR AGA MEDICAL STAFF

The interview guide is intended for a research into the Health implication of gold mining for mine workers in Obuasi

The question below is part of a project being conducted in connection with the above-stated topic at the Centre for Development Studies, UCC. I shall be most grateful if you answer them to the best of your ability. This is a purely academic exercise and any information provided will be treated confidential. Moreover, your anonymity is guaranteed. Thank you.

Please, mark [X], [√],

SECTION A: BIO- DATA

1. Sex Male [ ] Female [ ]

2. Town .....

3. Position at Hospital (a) Nurse [ ] (b) Medical Officer [ ]

(c) Administrator [ ]

4. How long have you been with the hospital?

.....

SECTION B: MINING RELATED DISEASES

1. Do the workers of AGA go through the following?

Pre-employment Medical Examination [ ]

Periodic Medical Examination [ ]

Special Medical Examination [ ]

Exit Medical Examination [ ]

2. Mention the commonest occupational illness/sickness/disease amongst the AGA workers. .....

3. Which part of the body (ies) is/are mostly affected?

.....

4. What do you think are the causes of that commonest occupational illness/ sickness/disease?

.....

5. Which of them are mining related diseases?

.....

6. Do you have patients from the catchment's areas with similar diseases/illnesses/sicknesses as AGA worker?

Yes [ ] No [ ]

If yes, how are they addressed? .....

SECTION C: CAUSES OF THE DISEASES

1. What diseases/illness/sicknesses are generally reported at the hospital?

.....

2. Which of these mentioned above are occupational illness/sickness/disease?

.....

3. Which group of people is in the majority of cases reported?

AGA workers [ ] Small scale miners [ ] others [ ]

If others, specify .....

4. Which level of AGA workers form the highest in terms proportion of your OPD patients?

Junior [ ] Senior [ ] Management [ ] Others [ ]

If others, specify.....

5. Which division's workers in AGA form the majority of your patients?

Human Resource [ ] Finance [ ] Processing [ ]

Production Services [ ] Mineral Resource [ ] Engineering [ ]

Mining [ ] Work Place Environment [ ]

6. What do you think account for their being in majority?

.....

.....

APPENDIX D

UNIVERSITY OF CAPE COAST

FACULTY OF SOCIAL SCIENCES

CENTRE FOR DEVELOPMENT STUDIES

HEALTH IMPLICATION OF GOLD MINING FOR MINE WORKERS IN OBUASI

INTERVIEW GUIDE FOR MEDICAL STAFF

The interview guide is intended for a research into the Health implication of gold mining for mine workers in Obuasi

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Please, mark [X], [√].

SECTION A: BIO- DATA

1. Sex Male [ ] Female [ ]

2. Town .....

3. Position at Hospital (a) Nurse [ ] (b) Medical Officer [ ]

(c) Administrator [ ]

4. How long have you been with the hospital? .....

SECTION B: MINING RELATED DISEASES

1. What diseases/illnesses/sicknesses are generally reported at the hospital?

.....

2. Which part of the body (ies) is/are mostly affected?

.....

3. What do you think are the causes of those common illnesses/sicknesses/ diseases?

.....

4. What are some of the common water-related diseases that are often reported at your hospital? .....

5. What are some of the common air-related diseases that are often reported at your hospital? .....

6 Do the activities of AGA contribute to the common illnesses/sicknesses/ diseases reported at your hospital? Yes [ ] No [ ]

If yes, how?.....

7. Do you have AGA workers visiting your OPD? Yes [ ] No [ ]

If yes, what kind of diseases do you commonly find with them?

.....

8. Are they mining related diseases? Why?

.....

9. Do you have patients from the catchment's areas with similar diseases/ illnesses/sicknesses as AGA workers visiting your OPD?

Yes [ ] No [ ]

If yes, what are some of those diseases?

.....

APPENDIX E

UNIVERSITY OF CAPE COAST

FACULTY OF SOCIAL SCIENCES

CENTRE FOR DEVELOPMENT STUDIES

HEALTH IMPLICATION OF GOLD MINING FOR MINE WORKERS IN OBUASI

INTERVIEW GUIDE FOR DISTRICT ENVIRONMENTAL HEALTH

The interview guide is intended for a research into the Health implication of gold mining for mine workers in Obuasi

The question below is part of a project being conducted in connection with the above-stated topic at the Centre for Development Studies, UCC. I shall be most grateful if you answer them to the best of your ability. This is a purely academic exercise and any information provided will be treated confidential. Moreover, your anonymity is guaranteed. Thank you.

Please, mark [X], [√],

SECTION A: BIO- DATA

1. Sex Male [ ] Female [ ]

3. Town.....

4. Position (a) Junior [ ] (b) Management [ ] (c) Senior [ ]

5. How long have you been at your present station?.....

SECTION B: SOURCES OF WATER

1. (a) Is there any evidence that the sources of water have been polluted?

Yes [ ] No [ ]

(b) If yes, what do you think are the causes of the pollution?

.....

.....

2. How does your outfit manage the following waste?:

Liquid Waste.....

Solid Waste.....

SECTION C: MINING RELATED DISEASES

1. What are some of the common diseases/illnesses/sicknesses that are prevalent in this Obuasi area?

.....

2. What do you think are the causes of these diseases?

.....

3. What are some of the problems that your outfit been having with the activities of mining in this area

.....

4. Is AGA one of the contributing factors of those prevalent diseases/illnesses/ sicknesses?

If yes, how?.....

5. How is your outfit supervising the following forms of pollution of AGA?

Water.....

Land.....

Air.....

Noise.....

Chemical.....

6. What protective measures has your outfit put in place against those forms of pollution? .....

7. What do you suggest will help the management in the management of waste and its attendant effects?.....