Chapter II
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LITERATURE REVIEW

2.1 Introduction

Worldwide consumption of mined commodities has increased steadily in recent years, a trend that is expected to continue, as a result of strong demand in fast growing developing countries. Mining is an important economic activity which has the potential of contributing to the development of areas endowed with the resource. The process of taking out minerals from rocks buried under the earth’s surface is called mining. Minerals that lie at shallow depths are taken out by removing the surface layer; this is known as open-cast mining. Deep bores, called shafts, have to be made to reach mineral deposits that lie at great depths is called shaft mining. Open pit mining is the most destructive as it requires removing whole mountains and excavation of deep pits. Generally, open pits need to be very big sometimes more than 2.5 kilometers long. In order to dig these giant holes, huge amounts of earth need to be moved, forests cleared, drainage systems diverted, and large amounts of dust let loose. According to the Baguette Corporation, “Any open-pit mining operation, by the very nature of its method, would necessarily strip away the top soil and vegetation of the land” [1]. In this study the author highlights the impact of mining activity on the environment and the effects caused like degradation of land, removal of fertile soil and the clearance of forest resource.

Iron is the fourth most abundant rock-forming element and composes about 5% of the Earth's crust. According to Kuck (1992) world identified resources of iron ore to the end of 1991 are estimated to be over 8,00,000 million tonnes [2]. The work carried
out by Kuck gives the statistical estimation of the extraction of iron ore through out the globe as well as the production of iron and steel. Geological Survey of India states that India has one of the largest iron ore resources in the world and in India, like in most other countries belonging to the Gondwana Supercontinent, major economic deposits of Iron ore are found associated with volcano-sedimentary Banded Iron Formation (BIF) of Precambrian age [3, 4]. Prasad et al (1982) in their earlier studies quote that iron ore deposits of South India are the group of PreCambrian iron formations occurring as narrow, highly deformed and metamorphosed belts within Archaean granulite terrain [5]. The work done by Radhakrishna et al (1986) on Banded Iron Formation of India concludes that In India, the iron ore deposits are found as Banded Hematite Quartzite (BHQ) and Banded Magnetite Quartzite (BMQ) in parts of Jharkhand, Karnataka, Chattisgarh, Maharashtra, Orissa and Tamil Nadu states and These rocks are older than > 3, 000 m.y represented by oxide iron formations [6].

2.2 Distribution of Iron in India

According to the Detailed Information Dossier (Did) on Iron ores in India carried out by Geological Survey of India (2006) the major iron ore formation in India are as follows:

- ZONE I: Bonai Iron Ore Ranges in Jharkhand and Orissa and in the adjoining areas in Eastern India with important deposits of Hematite at: Chiria, Noamundi, Kiribur, Bolani, Meghahataburu, Thakurani, Gua, Banspani, Baraiburu, Daitari, Gandhamardan and Malangtoli.
• ZONE II: North-South trending liner belt in Central India in the states of Chhattishgarh, Madhya Pradesh and Maharashtra (Eastern part) with rich Hematite iron ore. Bailadila, Dali- Rajhara, Mahamaya, Aridongri , Rowghat, Surajgarh main deposits.

• ZONE III: Bellary-Hospet region of Karnataka State with Donimalai, Ramandurg, Kumarraswamy, NEB range, Ettinahatti, Belagal are the major deposits of Hematite.

• ZONE IV: Rich magnetite deposits of Bababudan-Kudremukh area of Karnataka with Kudremukh, Bababudan and Kodachadri are main deposits of Magnetite.

• ZONE V: Iron ores of Goa and Maharashtra (West) with North Goa, South Goa and Redi deposits are the major deposits of Hematite. In addition, magnetite rich Banded-Magnetite Quartzite (BMQ) deposits occur in parts of Andhra Pradesh near the East Coast and Tamil Nadu in South India [4].

2.3 Iron ore deposits of Karnataka

In the work done by Geological Survey of India on Geology and Mineral Resources of the States of India [7] they state that the iron ore deposits of Karnataka are classified into three groups

• Banded hematitic quartzite of Dharwarian age.

• Metamorphic deposit comprising magnetite-quartzite.

• Magmatic deposits which include titaniferous magnetites associated with basic and ultrabasic rock.
Among this the most important iron ore deposits of the states occur in Sandur hills of Bellary Hospet sector, Bellary District and Bababudan hills and Kudremukh-Gangmula range of Chickamagalur district. It is also reported that the other districts which contain smaller iron ore deposits are Chitradurga, Shimoga, Bijapur, North Kanara, South Kanara and Hassan. Minor occurrences are reported from Belgaum, Bidar, Dharwar, Mandya and Raichur districts. Titaniferous magnetite ores are reported from Bangalore, Hassan, North Kanara and Tumkur districts.

2.4 Iron Ore deposition in Chickmagalur District

According to work done by Karnataka and Goa Geological Survey of India [8] in Chickamagalur district major iron ore deposits are found in Bababudan Hills range and Kudremukh-Gangumala range. The larger deposits of iron ore are found in Jansurigudda, Kaldatti, Attigundi, Galikere, Siddaragalli, Rudragiri, Kemmanagundi, Lakkihalli and Marenahalli. The Detailed Information Dossier (Did) on Iron ores in India (2006) made the detail mapping in this area which shows the higher concentration of iron ore in Kemmanugundi, Kalhattigiri, Totlukhan Hebbegiri, Jensari, Attigundi Shankasolenala, Virupakshivan area [9]. It also states that Kuduremukh is the richest sector of iron ore deposition in this belt and BMQ occurs in association with metapelites and volcanics of Dharwar Supergroup. Ore bearing magnetite bands ranges in thickness from 120 m to 200 m and continue along strike for a long distance. Ores are mainly weathered hard massive type. The principal ore mineral is magnetite.

2.5 Impact of Mining

Mining industries perform various activities such as extraction of minerals, processing of minerals and transportation of these minerals to market place. Years of
unregulated mining and mineral processing activities like drilling, blasting, crushing and other associated activities have not come without high environmental costs. In comparison with other sectors, the potential social and environmental issues associated with mining and mineral processing operations are both significant and complex to manage. H. Jenkins, and N. Yakovleva (2006) states that the discovery, extraction and processing of mineral resources is widely regarded as one of the most environmentally and socially disruptive activities undertaken by business [52]. In the earlier work done by D. O'Connor, and D. Turnham (1991) quotes that mining is associated with low investment capacity and poor working conditions, which enforces use of traditional technologies and unskilled manpower, which ultimately negatively affects productivity and maintenance of equipment [17]. This results in consumption of more energy and generation of more waste, making it most polluting sector. The negative impact of mining on health, land, water, air, plants and animals, and other aspects of society can be reduced by careful planning and implementation of mining activities. It is essential to strike a balance between mineral developments on the one hand and the restoration of the environment on the other.

2.6 Impact of mining on social and economical condition

From the day a mining operation starts, it is immediately in a closure phase, counting down the clock until that inevitable day when the doors of the mine will close. Once mines close, the social impacts on employee households, communities and regions are mostly severe and long term, leaving thousands of people impoverished. Ghost towns develop in areas that were once heavily reliant on mining for economic sustainability. The majority of these people who were dependent on the mining operation for income are usually left stranded in an area that they cannot
escape from, due to a lack of resources and capacity to ensure their sustainable integration into other sectors of the economy. The more affluent and skilled individuals usually leave the area and are able to successfully migrate to other economic activities and become reabsorbed into the economic mainstream. However, this is mostly only a minority of people. There is also often a lack of proper planning in the placement and rehabilitation of mine infrastructure, land and waste dumps in considering the future social and economic impact on communities and development for the region. After closure, mine waste deposits and unproductive, disturbed land are often left behind; this precludes the productive use of economically valuable land for the socio-economic development of communities over the long term. Some of the impacts caused by mining on the society and the people residing to the proximity of mining areas are as follows:

2.6.1 Mining Cycle

One of the characteristics of mining is its rotational nature. For mine employees, since work-sites are often located away from home, two weeks on two weeks off schedules are common and day shifts last twelve hours. Miners cycle between periods of complete immersion in work and total lack of it. However, unlike other extractive industries such as forestry, mining is not seasonally constrained by weather conditions, so work is more-or-less constant throughout the year. Both mine workers and the surrounding community are subject to “the mining cycle.” According to G. Gibson, J. Klinck [7] “The mining cycle is characterized by the activities of exploration, construction, operation (mineral extraction and refinement), mine closure, and reclamation”. For miners, this can mean periods of unemployment are common between jobs.
2.6.2 Mobilization of Miners

Mining is often characterized by transience, indicated by employee turnover. Centre for Social Responsibility in Mining, (2003) defined as “any employee movement that creates a vacancy on site”. In an Australian study of fly-in fly-out (FIFO) operations carried out by Centre for Social Responsibility in Mining the turnover rates for mining were highest among all professions, reaching up to 33% at some sites. The turnover rate for Nanisivik mine was calculated by Hobart (1979) [9] to be 106% for northern males, and 63% for southern male staff. Centre for Social Responsibility in Mining (2003) states that the mobility of miners or turnover has the effect of lowering production and employee morale, and increasing training costs and the risks associated with inexperience. Other aspects of mobility include geographical and temporal transience. According to Rhodes, (2001) as workers near the closure stage of the mining cycle, they are forced to move to new mines still in operation. In doing so, mine workers commonly bring their families, thus establishing “mining communities,” which themselves are consequently temporary. With their specialized skills, miners have become global nomads, with some families moving more than 21 times in 19 years.

2.6.3 Occupation Structure

Occupational structure in an area or a state depends on the availability of natural resources and influences the livelihood pattern of the society or community. The definition of occupation structure includes duties also performed by workers in another occupation, cross-references to the occupation provided in an area or state. In the work carried out by Driver (1962) [55] and more Tsukahara (2007) [56], they identified the effects of family background characteristics on the subsequent
occupational choices of children, A new look at gender effects in participation and occupation choice by Soopramanien and Johnes (2001)[57] reports the estimation of the effects of gender on labor market participation decisions and occupational choices among individuals in the United States, Parental education and young people's educational and labor market outcomes: A comparison across Europe by Iannelli (2002)[58] reports the study of differences in the extent to which social origin effects young people's educational and occupational outcomes in European Union countries, and Constant and Zimmermann (2003)[59] in Occupational choice across generations (2003), analyze the contrast in the occupational choices of native and non-native Germans. Further, Amin (2004)[60] estimates the impact of government affirmative action policies in Malaysia on the employment patterns of married women for three ethnic groups (the Malays, Chinese, and Indians) and finds that the policies have significantly different effects across the three groups.

2.6.4 Mining and Health

The World Health Organization (2005) defines health as “a state of complete physical, mental and social well being of an individual, and not merely the absence of disease and infirmity” [33]. An alteration in the living cells of the body which jeopardizes survival in the environment results in diseases. Health problems arise from a variety of man’s activities including industrialization, farming, mining, migration and others. According to Stephens and Ahern (2001)[34], mining remains one of the most perilous occupations in the world, both in terms of short term injuries and fatalities, but also due to long term impacts such as cancers and respiratory conditions such as silicosis, asbestosis and pneumoconiosis. Studies of mining and health by type of mine process are divided into deep and open cast mines. Deep mines
produce severe harms for employees in terms of their risks of high blood pressure; heat exhaustion; myocardial infarction and nervous system disorders. Studies of surface mining focus on coal, granite and rock mining and health risks related to dust breathing. In all levels of mining health risks occur with dust exposure (Stephens and Ahern, 2001) [34]. Respiratory impacts are the most studied and problematic of health impacts for mine workers. Injuries have declined in importance but continue to be an important safety issue in mines. Long-term effects include cancers, mental health impacts and some proof of impacts on genetic integrity of workers. The heated discussion on the impact of the mining and minerals sector on both worker and community health is polarized. On the one hand the industry tends to underscore the supposed benefits of the sector, whilst on the other, community groups and NGOs suggest that the sector is injurious to health and sustainable development (Stephens and Ahern, 2001)[34].

Further, the mining sector has been affected by the world-wide epidemic of HIV/AIDS, and this is apparent in the studies of South African mines. Several studies (Jochelson, Mothibeli et al. 1991; Campbell 1997; Williams and Campbell, 1998; Campbell and Williams, 1999; Campbell 2000; Corbett, Churchyard et al. 2000) have focused on the condition of the gold mines of South Africa. Migrant labor plays a vital role in the mining sector of South Africa, and these migrants are believed to play an important role in the transmission of HIV/AIDS [35-39]. In terms of how the mining industry has dealt with this problem one study (Williams and Campbell, 1998; Campbell and Williams, 1999) reports that “many mines made substantial efforts to establish HIV-prevention programmes relatively early on in the epidemic, these appear to have had little impact”. Meanwhile, Corbett, Churchyard et al. (2000) investigated the combined effects of HIV infection and silicosis on mycobacterial
disease in a South African gold mine, and concluded that the danger of silicosis and HIV infection combine in a multiplicative manner. This indicates that tuberculosis (TB) remains as much a silica-related occupational disease in HIV-positive as in HIV-negative miners, and HIV-positive silicotics have by far higher TB prevalence rates than those reported from other HIV-positive Africans. The increasing impact of HIV over time may indicate epidemic TB transmission with swift disease development in HIV-infected miners.

There were relatively few studies of policy initiatives by Stephens and Ahern (2001). According to them, health and safety improvements in mines have been developed over a long period of negotiation and struggle. Laws have come after union and management activities. Governments have supported organized labor in the improvements [34].

2.6.5 Mental stress

Mental stress and anxiety are also created by the nature of the work itself. Due to the high risks involved in the operation of heavy machinery, mine workers require intense concentration over long shifts, while often doing menial or repetitive tasks. Such stress can lead to burnout, leaving workers physically and mentally exhausted by the time their rotation is up [10] (North Slave Metis Association, 2002). Mental anxiety and exhaustion may also pose a physical threat to miner health and safety.

Goretskii et al. [11] (1995) found that 50% of operators in their study showed a decrease in concentration by the end of their shift, and 70% suffered from compromised psycho-physiologic parameters. Such mental stress may make workers more prone to occupational accidents, or even off-site ones. Reports of road fatalities during long commutes may also be attributable to mental exhaustion and loss of
concentration [12] (Kuyek and Coumans, 2003). Another mental health risk linked to mining is depression. Depressive disorders in mining may be triggered by a combination of factors including roster schedules, the repetitive nature and high concentration demands of the work, the after effects of job-related physical disabilities, or the closure of the mine and job loss. While, due to high wages, miners typically enjoy lower levels of under-employment during mine operation compared to other resource extraction industries [13] (Slack and Jensen, 2004), they face a more serious threat of post mine lay-off. In [14] Avery et al.’s (1998) study of mining and mental health, following a national pit closure, 52% of unemployed former miners faced psychological disorders. After the Elliot Lake mine closure, health centres began receiving an increased case-load of patients suffering from depression [15] (Robinson and Wilkinson, 1998). Depression is especially dangerous because of its well established link to suicide, though as a group, miners do not suffer significantly higher rates of suicide [16] (Ames, 1985).

2.7 Environmental Impact

The adverse environmental impact of mining activities on the environment is well documented (Heath et al., 1993; Veiga and Beinhoff, 1997; Warhurst 1999; Warhusrt, 1994). Particular attention has been directed towards the impacts of large scale and smallscale gold mining activities on environmental contamination [40-43]. According to Yelpaala (2004) the mining activity results in pronounced land degradation and chemical contamination from the gold extraction process cause a double burden on the environment, with harmful health implications on mining communities and people residing in close proximity to such activities [44]. Camara, Filhote et al. (1997), Malm, (1998), Harada et al. (1999), Tirado et al. (2000), van Straaten (2000a), Rojas,
Drake et al. (2001) have reported that the informal nature of gold-mining in the South Africa and Latin America concentrates on mercury exposure and intoxication incurred in the extraction and processing stage of mining [45-50].

2.7.1 Degradation of Land and Vegetation

According to Akabzaa and Darimani (2001), extensive areas of land and vegetation in Tarkwa have been cleared to make way for surface mining activities. Currently, open pit mining concessions have taken over 70% of the total land area of Tarkwa. It is estimated that at the close of mining a company would have utilized 40-60% of its total concession space for activities such as siting of mines, heap leach facilities, tailings dump and open pits, mine camps, roads, and resettlement for displaced communities (Akabzaa and Darimani, 2001). This has momentous adverse impact on the land and vegetation, the main sources of livelihood of the people. Agricultural lands are not only generally degraded, but the loss of land for agricultural production has also led to a shortening of the fallow period from 10-15 years to 2-3 years. The deforestation that has emanated from surface mining has long-term effects even when the soil is replaced and trees are planted after mine decommissioning. The new species that might be introduced have the potential to influence the composition of the topsoil and then determine soil fertility and fallow period for certain crops. In addition to erosion when surface vegetation is depleted, there is deterioration in the viability of the land for agricultural activities and loss of habitat for birds and other animals. This has degenerated into destruction of the luxuriant plant life, biodiversity, cultural sites and water bodies (Akabzaa and Darimani, 2001).
2.7.2 Waste Management

By nature, mining involves the production of large quantities of waste, in some cases contributing significantly to a nation’s total waste output. Matthews et al., (2000) reports that “a large proportion of the materials flows inputs and outputs in the United States can be attributed to fossil fuels, coal, and metal mining”[17]. The amount of waste produced depends on the type of mineral extracted, as well as the size of the mine. The work done by Da Rosa (1997) and Sampat (2003) says that the iron mining is less wasteful, with approximately 60 percent of the ore extracted processed as waste. Disposing of such large quantities of waste poses tremendous challenges for the mining industry and may significantly impact the environment. The impacts are often more pronounced for open-pit mines than for underground mines, which tend to produce less waste.

2.7.3 Sedimentation

Erosion from waste rock piles or runoff after heavy rainfall in mining area often increases the sediment load of nearby water bodies. According to Johnson (1997) mining may modify stream morphology by disrupting a channel, diverting stream flows, and changing the slope or bank stability of a stream channel. These disturbances can significantly change the characteristics of stream sediments, reducing water quality [18]. Ripley (1996) reports that higher sediment concentrations increase the turbidity of natural waters, reducing the light available to aquatic plants for photosynthesis [21]. In addition, Johnson (1997a) reports that the increased sediment loads can smother benthic organisms in streams and oceans, eliminating important food sources for predators and decreasing available habitat for fish to migrate and spawn [19]. Manson (1997) states that the higher sediment loads
can also decrease the depth of streams, resulting in greater risk of flooding during times of high stream flow [20].

2.7.4 Impact of Mining on Ecology

According to G. Singh mining results in degrading land and existing ecosystems are replaced by undesirable wastes. The mineral extraction process drastically alters the physical and biological nature of a mined area. Strip-mining, commonly practiced to recover coal reserves, destroys vegetation, causes extensive soil damage and destruction and alters microbial communities. In the process of removing desired mineral material, the original vegetation is inevitably destroyed and soil is lost or buried by waste [54].

2.7.5 Biodiversity and Habitat

Fearnside (1989) estimated that the Carajás project in the Brazilian Amazon would result in the deforestation of 72,000 hectares of forest per year over the 250 year life of the project to provide charcoal for pig-iron smelters [22]. The most obvious impact to biodiversity from mining is the removal of vegetation, which in turn alters the availability of food and shelter for wildlife. At a broader scale, mining may impact biodiversity by changing species composition and structure. Kelly (1998) in his work on Mining and the Freshwater Environment reports that acid drainage and high metal concentrations in rivers generally result in an impoverished aquatic environment. Some species of algae and invertebrates are more tolerant of high metals and acid exposure and may, in fact, thrive in less competitive environments [23]. Ripley (1996) states that the exotic species (e.g., weedy plants and insect pests) may thrive while native species decline. Similarly MacCallum (1989) in his work done on the Seasonal and spatial distribution of bighorn sheep at an open pit coal mine in the Alberta
foot hills reports that some wildlife species benefit from the modified habitat provided by mines, such as bighorn sheep that use coal mine walls as shelter [24].

2.7.6 Land Use

In addition to waste management issues, mines also pose environmental and social challenges due to potential disruptions to ecosystems and local communities. According to Ashton et al (2002) in his work on Impact of Mining and Mineral Processing Operations reports that mining requires access to land and natural resources, such as water, which may compete with other land uses [25]. Ledec (1990) states that the larger-scale impacts from mining occur from indirect effects, such as road building and subsequent colonization. An area of approximately 400-2,400 hectares has been colonized in the Amazon Basin for every kilometer of oil pipeline built [26]. According to Soliman (1998), “Collapse of surficial materials into underground voids is the most dramatic kind of subsidence. Buildings and other engineered structures may be damaged or destroyed, and land may be removed from productive use by such ground failure” [31].

Steve Blodgett,(2002) reports that the Surface land uses may be affected by mining subsidence include crop production and grazing; areas which serve as aquifers and areas of recharge for underground waters; and areas with surface waters that support aquatic life or supply water for public use. Mining subsidence also affects the use of lands by wildlife or for human recreation. Additional consideration is required where lands are intended to support threatened or endangered wildlife species or in wilderness areas that are intended to retain certain undisturbed or natural characteristics [30]. Subsidence impacts agricultural lands in ways that include formation of surface fissures, change in ground slope, changes to surface drainage,
disruption of ground water hydrology, deterioration of surface and ground water quality, and occurrence of subsidence areas (SME, 1986) [32].

Environmental Science for Social Change (1999) reports the Philippines, upland ecosystems are under pressure as a result of the migration of small-scale farmers. Mining could threaten these sensitive ecosystems by stimulating additional migration [27].

Recent concerns regarding the potential conflicts between mining and other land uses has prompted some communities to pass non-binding referendums banning mineral development. For example, the work carried out by Oxfam (2002) reports the Peruvian community of Tambogrande voted to reject mining in their community due to concerns regarding the projected displacement of half of its residents and fears regarding the potential impacts of mining on the community’s traditional livelihood [28]. According to a study commissioned by the mining industry, displacement may result in serious social problems, including marginalization, food insecurity, and loss of access to common resources and public services, and social breakdown MMSD (2002).

2.7.7 Ground Water/Surface Water

The primary concerns for ground water and surface water at mine sites are chemical and physical contamination associated with mine operation. Exposed ore, overburden piles, waste rock and ore piles, tailings impoundments, and other disturbed areas can contribute sediment and increase the total solids load to surface water bodies. Other potential sources of surface and ground water contamination include fuel spills, flotation reagents, cleaning solutions, and other chemicals used or stored at the site. For iron recovered from sulfide-bearing ores, acid generation due to
the oxidation of sulfides (e.g., pyrite and pyrrhotite) in the ore body, host rock, and waste material may be of concern. Trace elements and minerals often associated with iron deposits includes aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, nickel, selenium, silver, sulfur, titanium, and zinc (U.S. DOI, Geological Survey 1973). Lowering of pH increases the solubility of these constituents, and may make them available for transport in both surface water and ground water. However, acid drainage from iron ore mines is known to occur only at the Dunka Mine in Minnesota and at abandoned underground mines.

Surface and underground mines may need to be dewatered to allow extraction of ore. This can be accomplished in one of two ways: pumping from ground water wells to lower the water table, or pumping directly from the mine workings. After a mine is abandoned, pumping is usually stopped, allowing the pit or underground workings to fill with water. Over time, this may lead to uncontrolled releases of mine water. Mine water from iron mines generally has a pH of seven or higher and presents no known problems. However, mine water at the Dunka Mine site in Minnesota is acidic and contaminated with metals as well as dissolved and suspended solids. Pollution from mining activities is particularly difficult to deal with because it lasts for a very long time. Thirteenth century coal workings near Dalkeith in Scotland still discharge acidic, iron rich waters into the River Esk reported by Younger and Adams (1999). Discharges from abandoned mines can vary from seasonal trickles to substantial flows, and are not always polluted. For example, the Meerbrook Sough was built in 1772 to drain lead mines in the Derbyshire Peak District. It now discharges 60 million litres of clean water a day (Shepley, 2007) and is the largest public groundwater supply source in the Midlands.
2.7.8 Soil

Environmental impacts to soils as a result of mining activities are most commonly associated with erosion and contamination. Erosion may be caused by land disturbances and removal of vegetation related to mining activities. Under these conditions, precipitation events, such as snowmelt, may lead to erosion of soils. Contamination of soils may result from water discharge, runoff, seepage from tailings impoundments, pits and mine workings, as well as from the overburden, waste rock, and ore piles directly to soils. In addition, deposition of windblown particulates from piles and dry tailings impoundments may also be a source of soil contamination. Other sources of soils contamination include spills of fuels, flotation reagents, cleaning solutions, as well as other chemicals used or stored at the site. According to Kundu N.K and Ghose M.K (1998) in the process of open cast mining the area is to be completely stripped off, vegetation to remove the over burden covering the coal seam. Sendjein V.A (1983) reports that several changes occurs in the physical, chemical and microbiological properties of soils as a result of storage, some caused by the actual construction of store rather than during course of storage.

2.7.9 Air

The various mining and related construction activities mobilize tremendous quantities of dust particles. Mineral processing, and most specifically, smelting operations release massive quantities of potentially toxic airborne particles and gases. These constituents include the various sulfur, carbon, and nitrogen species commonly detected in air monitoring. In addition, they may include toxic concentrations of numerous metals such as arsenic, nickel, lead, cobalt, mercury, etc. These components
may result in the following impacts, especially if the operations are located near cities or towns.

The primary sources of air contamination at mine sites are fugitive dust from dry surfaces of dry tailings impoundments, as well as overburden, waste rock, and ore piles. Blasting generally produces relatively large particles that settle rapidly and have little effect on ambient air quality. In addition, fugitive dust from milling is limited because 99 percent of iron ore milling is wet. Often, tailings impoundments are not completely covered by pooled water; thus, dry tailings may be available for windblown transport. Deposition of windblown tailings provides exposure routes for contamination of ground water, surface water, and soil. The amphibole silicate mineral cummington-grunerite is present in some iron ore deposits. Although this silicate is not naturally found in a fibrous state, milling activities may lead to fibrous cleavage fragments that resemble asbestos. The study examined several iron mine production areas, including blasting, drilling, extraction, ore transportation, milling, and concentrating. The American Iron Ore Association sponsored studies of health impacts on taconite miners and millers beginning in 1979. The most recent study, "An Updated Analysis of Mortality in a Cohort of Minnesota Taconite Miners and Millers," concluded that considering the minimum potential latency period of 30 years, there was "no evidence to support any association between low level exposures to non-asbestiform amphibole particles or quartz with either lung cancer, nonmalignant respiratory disease or any other specific cause" (Cooper, et al. 1991).
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