

Application of Environmental Management plan on Impact Assessment of Gas Plant Development Project (GPDP)

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Abstract

Gas plant development project has several environmental impact that were assessed through methodological investigative approaches that considered potential environmental, economic and social precondition evaluation that x-rayed their pre-existing condition prior to gas plant development project start point. Environmental management plan (EMP) was adopted to help us deliver mitigation measure for the impact of gas plant development project during impact assessment process. Structural responsibility for implementation of EMP for gas plant development project was developed as well Sustainability life circle Model for stages of EMP standard methods of operation for impact assessment of gas plant development project showing pre- construction stage to post-construction and operation stages of gas plant development project. Different Criteria for assessing environmental impact of gas plant development project were identified for different environmental and climatic components that were used for analysis of numerous risk associated with different impacts of gas plant development project in relation to distance of 2km from the project site to 8km and after that, mitigation concept for reducing Impact of gas plant development Project in Nigeria was developed to incorporate National Environmental standard regulatory enforcement agency (NESREA) that would oversee the enforcement of such concept which stakeholders have been advised to adopt for implementation.

Keywords: Gas plant, Development project, Environmental impact, Assessment project, Mitigation, Criteria.

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1: Introduction

Impact assessment of gas plant development project would involve a globally acceptable methodological investigation of gas plant development project towards potential environmental, economic and social implications, through evaluation of the existing environmental situations in order to assess all possible positive and negative impacts of such projects and to suggest ways to mitigate any perceived negation in such project as well as presenting alternatives, in case the environmental impact statement suggest none development of such project within the area or to pay compensation to host communities in case of possible environmental social and economic damages within proposed project development site. EIA been a compulsory investigation for all large projects, perceived to be of potential risk to the environmental social and economic sustainability of any proposed project site, becomes necessary for any gas development project since there are always possibilities for alteration of natural environment with its potential possible trigger of ecosystem dislodgment resulting to environmental hazards that affects both humans and other terrestrial habitats as well as all aquatic

habitats. Apart from environmental impacts of gas development projects during project development process, the aftermath of functionality and use of the developed gas project may result in horrible air pollution resulting from gas emissions especially in areas where gas emission laws and regulations are not strictly adhered to as well as areas with weak institutional frameworks to strictly monitor the overall environmental standards for achievement of environmental sustainability as required in the millennium development goals and sustainable development standard expectations. Areas without equipment that is used in strict monitoring of air quality are exposed to greater risk during the full take off of any gas project therefore, Environmental impact statement becomes very necessary in its role in specifying standard methods of globally acceptable standards of operation for such gas plant development project for sustainable development. Thus Environmental impact assessment becomes a matter of necessity for decision makers if development must be sustainable. EIA training resource manual {1} According to James et al {2}, gas companies globally have heavy environmental economic and socio-cultural impacts in both positive and negative ways in the society since the world is getting more industrialized by the day, with higher demand on gas for both domestic and industrial uses. Parfomak et al {3} in James et al {4} stated that gas plant developments globally always face government regulations due to the adverse effects of such development projects. These government regulation are necessary to checkmate gas plant projects so that they can operate within globally acceptable standard method of operation for reduction of gas plant project impact to the barest minimum for sustainable development. In a situation where these government regulations are not in place or possibly not enforced, it may result in neglecting the EIA due process by project developers with consequential negative Environmental impact of such project within the project development site. Irtwange et al {5} stated that during environmental impact assessment, the interaction between project activity and the environmental component gave credence to baseline study of the environmental components prior to take off of the project. This consideration should be accepted, to avoid causing nonredeemable environmental damages that may negate the principles of environmental sustainability as stipulated in the millennium development goals. According to Whiteman et al {6}, environmental Impact assessment (EIA) should be necessarily carried out as compulsory part of comprehensive design, planning and approval of all project development processes. EIA the case of this study should be considered as a proactive means of preventing the hazards associated with gas plant development project through understudying the already existing environmental conditions and components by suggesting possible technical inputs, alternatives, and compensation to host communities and mitigation measures to ensure environmental sustainability, Hussein et al {7}.

Conducting EIA on this proposed gas plant project requires sound environmental management plan (EMP) that will cover the entire proposed project environment in line with prevention of possible negative environmental, social, health and economic impact or possibly, device a mitigation plan that could proffer solution to any such impact as well as develop standard for compensation in case the project is allowed to be carried out if its general impact would be mild on the project environment, SPDC Nigeria LTD {8}.

The aim of this study is to apply a standard environmental management plan in conducting Impact assessment of gas development project to prevent environmental damages that could impact on the present and future generations for sustainable development and application of environmental justice.

The objectives of this Impact assessment would include:

- (1) Advising all stakeholders including host communities on the acceptability of this gas plant development project.
- (2) Recommendation of possible mitigation measures in case of foreseen negative impacts throughout the project life circle.
- (3) Carrying out surveys and scientific studies to ascertain the baseline environmental characteristics of the proposed project site.
- (4) Conducting research to identify the impact of gas project on air quality, water quality, human health, economy of the proposed gas plant project environment.

Benefits that will accrue from the gas plant development projects include:

- (a) Gas plant development project will be beneficial to both local, regional and national economic sustainable development since it will improve the power supply system across all economic sectors in the country.
- (b) It will improve the level of domestic gas distribution and quantity of gas supply to consumers.
- (c) It will improve the level of use of clean energy and reduce the rate of pollution that emanates from the use of coal, kerosene, fire wood and other sources of energy that are not clean energy sources.
- (d) It will reduce the level of unemployment by creating employment opportunities within the communities where the gas plant development project will be executed.

2: Materials and Methods

This study started with proper reconnaissance survey that was carried out to identify the environment properties that could be investigated through baseline study to ascertain the initial characteristics in order to verify the possibilities of negative impacts of the gas plant development project in the area.

The use of Environmental Management Plan (EMP) was adopted to help in the mitigation measures of the impact of gas plant development project to a most insignificant level as well as optimization of beneficial impacts of this gas development project. Furthermore, EMP will help in mapping out a management system that would handle issues that might be presented by developers and host communities for easy construction of gas plant development project as well as specifying formats that can be used to audit and monitor processes that are not coherent with stipulated environmental management standards expected to be put in place during this gas plant development project. The application of EMP in this gas plant construction project, will help in streamlining measures that will direct project developers on the best construction and operational pattern in all the gas plant development project stages that will be acceptable by all stakeholders because it reflects as part of standard for Integrated Environmental Management practice. EMP will also be used to identify best mitigation actions for all negative environmental impact of this gas plant development project. It will also enhance quick and satisfactory compliance of all safety standards recommended by EIA team.

2.1: Structure for implementation of EMP for gas plant development project

EMP for this gas development project will consider the use of three different experts to carry out all its operations and construction in order to deliver best quality project that will be economically viable and environmentally and socially sustainable through EIA with strict and timely implementation of all recommendations in the environmental impact statement EIS.

Figure 1 below displays the structure for implementation of EMP for this gas plant development project.

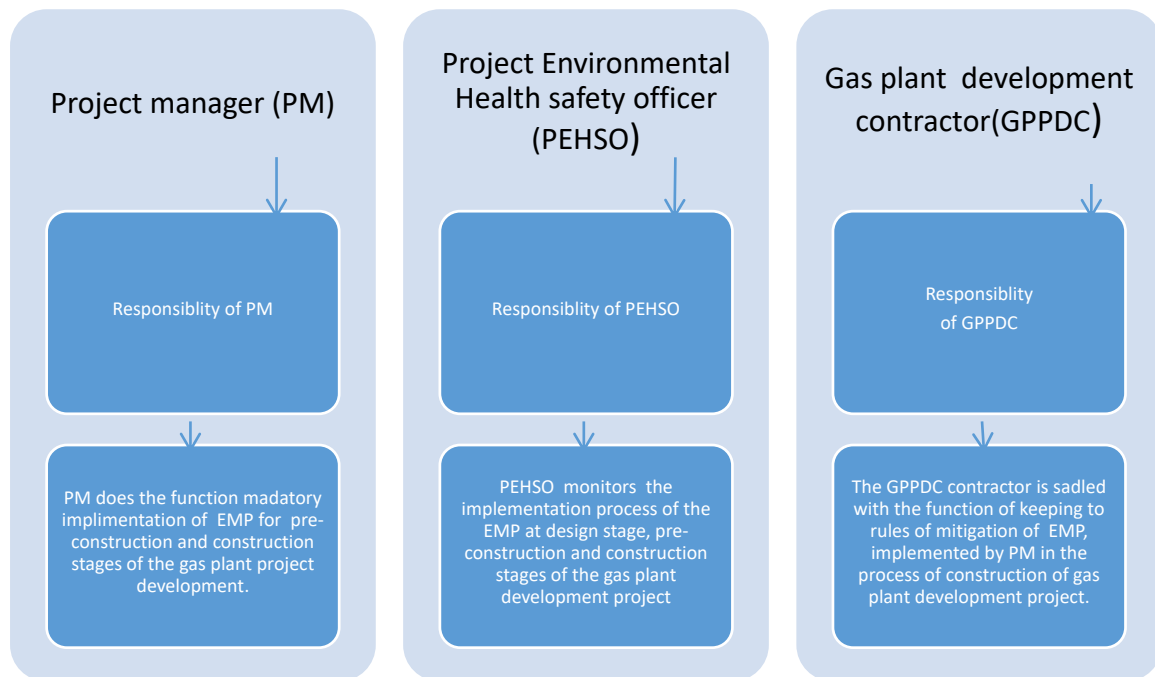


Figure 1: Structural responsibility for implementation of EMP for gas plant development project.

2.2: Sustainability life circle Model for stages of EMP standard methods of operation

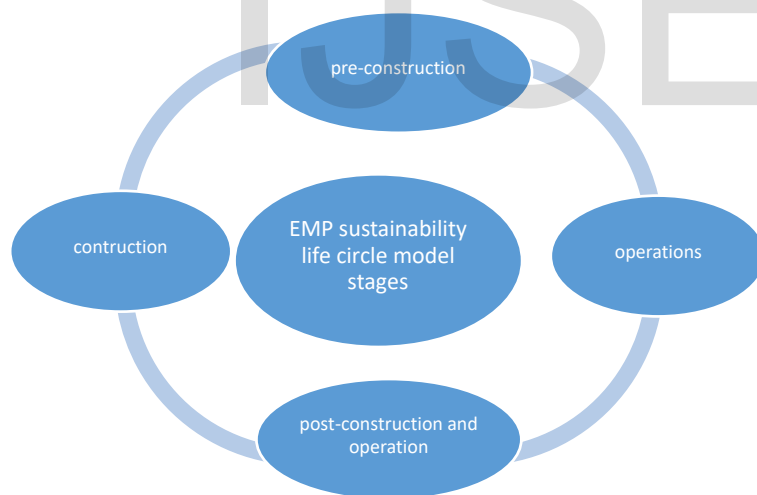


Figure 2: Pre- construction stage to post-construction and operation stages of gas plant development project

2.3: EMP standard methods of operation for Pre- construction stage of gas plant development project

According to Kurrents technologies Ltd {9}, Gas plant development project pre-construction stage requirements are stated below as:

- (1) The use of liaison officer to bridge the gap between contractor handling the gas plant development Projects and host community to make sure that both parties are properly given steady information concerning the activities that would be involved in the construction stage at every required period.

- (2) Information should be given to the host community regarding the gas development project start date and the different phases of the project construction.
- (3) Contractor handling the gas plant development project is mandated to keep to all contract agreements as well as conditions stated on the Environmental Management Plan.
- (4) Gas plant development project contractor should consider the climate of the construction site during construction planning stage to avert possible disruption of heavy rains and other non-friendly climatic conditions that set back the project time line.
- (5) Existing roads should be taken note of to keep good record of both bad and good roads that may need rehabilitation either before the commencement of the project to avert damage to construction equipment or risk of loss of construction materials during construction phase or keep records of good roads that may need repairs after the construction as degraded during the construction process.
- (6) Proper official Gas plant development project site records must be kept for all negative feedbacks and all possible actions must be taken to resolve all such negative reports.
- (7) Project initiator must appoint nominate a HSE Officer who must work in collaboration with the Contractor HSE officer that would be appointed by the gas plant development project contractor for a successful implementation of environmental management plan and also resolve every possible project community related issues,
- (8) Quarterly environmental audit as well as environmental inspections should be carried out during the process of gas plant development project and as soon as the project construction is completed.
- (9) The gas plant development Project HSE Officer must always supervise the project construction process so as to enforce implementation of standard quality construction guidelines.
- (10) During construction of this gas plant development project, the Project HSE Officer, project manager and EPC contractor must establish a communication link to help in resolving all recorded issues indicated by the project stake holders during the project construction life circle.

2.4: Proposed EMP standard methods of operation for Construction stage of gas plant development project

According to Kurrents technologies Ltd {10} certain functions are designated for the different participants in gas plant development project construction and operations stages. This responsibilities allow the contractor's health safety officer to ensure that environmental management plan will be implemented in the process of construction of the project which will be supervised by the project health safety officer while records will be kept between a week and two. The project health safety officer will also carry out this weekly inspection through a method of evaluation of records from inspectors of the gas plant development project site while the client will be accountable for environmental management within the project site. This site will be monitored throughout the period of project construction and operations to ascertain compliance with the recommended standard from the EIA operational licence.

2.5: Proposed EMP standard methods for operation stage of gas plant development project.

During the operation stage of gas plant development project, it is expected that project health officers will monitor the operations of gas plant development project to ascertain that all required safety measures are implemented during the operations stage for the safety of staff and residential population at close range within the project site, would not be victims of health hazards from non-implementation of environmental safety standards required for such operations to take place within any environment. The entire life circle of the project operational stage would be would be monitored

to also ensure compliance of EIA standard required for the gas plant operations in the on EIA operational licence.

2.6: EMP standard methods of operation for post-construction and operational stages of gas plant development project

Implementation of **EMP** for post-construction and operational stages of gas plant development project is a very necessary stage that should never be over emphasised since it is an avenue to put sustainability into consideration in gas development project. This stage considers the collaboration of all stakeholders that include the contractors, health safety officers from contractors, project manager's health safety officer, clients, project host communities and consumers. This collaboration would involve the government regulatory agency that issues EIA licence who will spare head an investigation to confirm that all environmental regulations where kept to its fullest by all stakeholders in the gas plant project. This is to make sure that issues like indiscriminate gas discharge wold not come up thereafter and cause the environmental regulatory agency to stop the company's operations as result of operating below standard methods of operations.

2.7: Criteria for assessing the environmental impact of gas plant development project

There are some essential criteria that must be given special consideration in other to carry out EIA on gas plant development project and they are as follows:

- (a) Impact of gas plant development project on air quality.
- (b) Possibility of presence of Odour emanating from gas plant development project.
- (c) Noise pollution from gas plant development project.
- (d) Possible soil pollution from gas plant development project.
- (e) Water pollution emanating from the same project.
- (f) Impact of gas plant development project on safety of the staff and residents around the gas station.

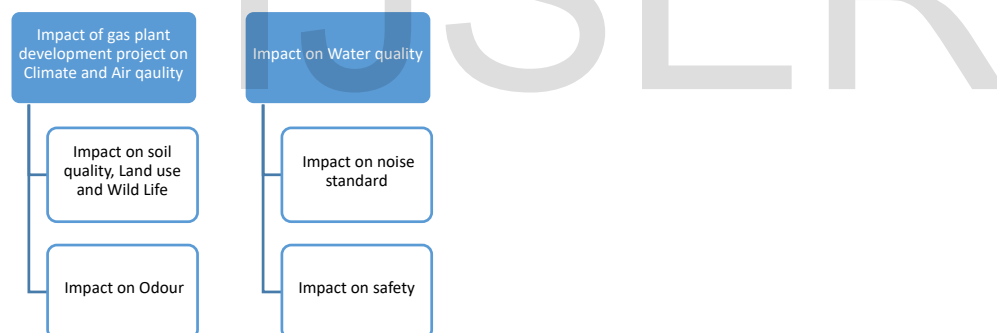


Figure 3: Criteria for assessing the environmental impact of gas plant development project

2.8: Impact of gas plant development project on Climate

The Impact of gas plant development project on climate cannot be compared to impacts from emissions from coal or crude oil manufacturing plants. According to NETL {11}, The emission rate of Natural gas falls within fifty to sixty percent reduced (CO₂) during combustion within a nascent, highly functional natural gas power plant in comparison with emissions with a new coal power plant. Fuel Economy.gov.{12} also stated that natural gas emission is about 15 to 20 percent less heat-trapping gases in comparison with gasoline during present day vehicular combustion in emissions from tailpipe. Myhre et al {13} stated that air pollution may arise from Methane gas emission, during exploitation and transportation and transportation of natural gas from wells and pipelines as a resultant effect of leakages from methane gas, that is about 34 times stronger than CO₂ in heat trapping over a 100-year period and 86 times stronger over 20 years. Methane gas being a primary component of natural gas has a high capacity to induce high level ozone layer depletion and greenhouse effect inciting global warming with its associated induced climatic variations capable of altering the normal climatic circle with several negative impact on human environment.

Tollefson {14} after evaluation and field measurement of Methane gas, described it as a fugitive with emission range of one to nine percent of entire lifecycle emission.

Despite all arguments in favour of gas as clean source of energy from different stakeholders in the energy sector, the process of exploitation, manufacturing and transportation of gases cannot be separated from causing high level negative impact of air quality.

A current research from Cathless {15} discovered that methane losses should be placed under 3.2 percent for natural gas power plants for it to possess lower life cycle emissions than emissions from coal plant development project over time frame of about 20 years or below. Reduction of leakages from Methane gas could be viewed as a very good green gas plant development and management concept but may meet some implementation hindrances arising from possibilities of policy support framework development approval by governments. Thus, Alvarez et al {16} stated that possibilities of delivering marginal benefits from combustion of natural gas in vehicular engines could be efficiently achieved when methane losses are placed below 1 percent and 1.6 percent in comparison with diesel fuel and gasoline engines, Recent technologies could be employed to do this reduction of leaking methane gas, but the expected difficulties may arise from expected new policies, financial cost and overall cost of such investments.

2.9: Impact of Gas development project on Air quality

There is no doubt that gas development projects may have some environmental benefits in terms of reduction in air pollution in comparison with coal and crude oil as stated earlier on but there are still some air quality alteration arising from gas emissions that could cause some forms of morbidity and increase mortality rate to humans especially those resident at close ranges to gas wells and gas plant project sites although, Alvarez et al {17} stated that gas burns in a cleaner manner than other fossil fuels and the combustion of natural gas produces negligible quantity of sulphur, mercury, and particulates burning natural gas also produces nitrogen oxides which are precursors to smog, though at reduced volumes than gasoline and diesel used in vehicle engines.

California Environmental Protection Agency Air Resources Board, {18} indicated that analyses from DOE shows that every 10,000 homes in United states of America is powered with natural gas instead of coal which leads to reduction in annual emissions to 1,900 tons of nitrogen oxide, 3,900 tons of SO₂, and 5,200 tons of particulates. Although, reductions in these emissions brings about public health benefits, since these pollutants are associated with health related issues like asthma, bronchitis, lung cancer, and heart disease as may be diagnosed in numerous American population. California Environmental Protection Agency Air Resources Board, {19} also stated that irrespective of the benefits unconventional gas development projects can cause negative effects on local and regional air quality. Experience has shown that in some areas where gas drilling occurs have noted increases in concentrations of hazardous air pollutants that includes two of the six criteria pollutants like particulate matter and ozone plus its precursors that are regulated by the Environmental Protection Agency due to their hazardous effects on health and environment.

According to Environmental Protection Agency (EPA), {20} exposure to high level of these air pollutants from gas emissions, can cause hazardous health outcomes, like respiratory symptoms, cardiovascular disease, and cancer. McKenzie et al. {21}, stated that in a recent study people residing within less than half a mile from unconventional gas well project locations stood a higher risk of health adverse impact from gas development process air pollution than those resident far away from gas well locations.

2.10: Impact of Gas Development Project on Water Quality

The impact of gas development project on water quality is not a negligible area of emphasis in environmental sustainability because the entire lifecycle process of gas production produces chemical substances either as waste or leakages from products and by-products that would eventually be transported to surface water during and after rainfall or transported to groundwater, through solute transport.

Unconventionally, gas development projects has the possibilities of becoming a health hazard especially to host communities by contaminating portable water sources for human use with hazardous chemicals used in the drilling of wellbore, hydraulically fracturing the well, processing, separating and refining the gas either as natural gas or separated from crude oil. These process allow for waste water disposal that may eventually find its way into drinking water sources and end up contaminating them. Colborn et al {22}.

Airgas {23} stated that radioactive materials like methane that occur naturally as well as other underground gases have leaked into drinking water supply sources in most cases as a result of wrong well casing development from. Although methane may not be associated with severe health impact but sufficient volumes may raise concerns about inflammation. Unconventional gas development project may make use of much volume of water that could affect the availability of water within host communities and surrounding environments, Report and multimedia/explainer {24}.

Groundwater contamination has been recorded in several areas close to gas development project. These groundwater sources have been contaminated with fracking fluids and gases like methane and volatile organic compounds. These gas contamination may have occurred due to poor quality gas well development that may cause well failure and allow gas leakages into groundwater. Gas stray may also contaminate groundwater as a result of natural or anthropogenic fractures during gas manufacturing processes. PADEP {25}.

Surface water bodies used as water sources are also exposed to contaminations from gas development projects through leakages from chemical components used as additives during gas manufacturing processes as well as fluid leakages from waste water storage tanks, treatment tanks and disposal tanks. NMOCD {26}.

2.11: Impact of Gas plant development Project on Soil quality and Wildlife.

Gas plant development project has severe impact on soil and wildlife within host communities. Chemical additives in used during gas manufacturing projects are in some cases injected into the soil through leakages and fracking processes which in turn may cause soil quality reduction and reduce the level of biodegradation thereby impacting negatively on the soil through soil contamination. This would as well affect agricultural production quality and quantity thereby reducing food availability and supply with its resultant economic degradation. Wildlife within gas development project locations and host communities are displaced as a result of noise from the project development process and many of the animals suffer high mortality and morbidity due to the impact of gas emission and leakages which may contaminate plants that serve as food to such wildlife.

According to Haswell et al {27} carried out studies that involved discussions with communities and experts with research concentration in USA and Australia. The studies showed severe health concerns in six major areas which include improper toxic waste management issues, air pollutions, competition on land and water, mental health and risk on psychological wellbeing, methane emission and lack of proper regulatory process implementation. Results from these studies suggested interference in foetus development and negative birth outcomes like asthma conditions in humans and livestock.

2.12: Impact of gas plant development Project on Noise standard.

The stipulated noise standard for workers in Nigeria as established by Federal Environmental protection Agency specifies that noise level for Nigerian workers should not exceed 90 Decibels Db (A) within 8 hours interval but studies carried out on different Noise levels within industrial areas in Nigeria have proven that the standard is exceeded and regulatory agencies have not always enforced compliance within such Environments. This noise level of 90 Decibels was dictated to be as high as masking speech and communication. Noise measurements were taken within 108 locations and results displayed that about 92 of the measurements were either high or very high while some workers within the plant areas complained about hearing impediments while high number of them shout while they speak to people. Nwali et al {28}

Gas plant development project has a lot of heavy duty equipment and Machines that are capable of generating high level noise above the FEPA stipulated standard and at such could affect both workers and host communities negatively with ear related morbidity cases.

2.13: Impact of gas plant development project on Odor

Some gases that are associated with gas plant development projects could have some offensive odor capable of choking people when inhaled. A very good example is Hydrogen sulphide, known for its bad egg odor, this gas can be smelt down to less than 0.1ppm. High concentrations (>60ppm) cannot be smelt due to paralysis of the olfactory glands, thus its exposure can lead to instant paralysis. H_2S is slightly heavier than air that is why, fixed detectors are usually mounted 1 to 1.5 meters from the ground, or near potential sources of leaks. The second gas with bad smell is Methyl Mercaptan which is an additive to natural gas (methane) for easy dictation of leak. Methane as natural gas in its native state is colorless and odorless but smells bad with Mercaptan additives due to sulphur content that has a concentrated odor almost equivalent to rotten cabbage or bad eggs. The next gas is Sulphur Dioxide which is colourless but has characteristic choking smell. It is formed when burning sulphur, and materials containing sulphur such as crude oil which is also found in the process of gas separation from crude oil deposits.

2.14: Impact of gas plant development project on Safety

The impact of gas plant development project on health and safety of residents of host community and expected numerous population of workers of the company should be taken seriously considering the possible health hazards associated with the development of such projects and its associated mortality and morbidity implications. The health and safety of workers and host community resident within this gas plant development project should be an issue that should be given a very serious consideration because of exposure to heavy machines and dangerous chemicals that and expected gas emissions which may lead to harmful effects at such, safety precautions are expected to be taken to reduce the risk of such exposure and its resultant mortality and increase in level of morbidity in the area. According to Allison et al {29}, between 2007 2016, the mortality rate arising from exploitation of oil and gas in the United States of America exceeded one thousand.

Mortality rate was about six times higher than the average rate for all workers in the U.S. 21.6 versus 3.5 per 100,000 workers. These deaths were traced to transportation of oil and gas facilities and products making up 42% of all fatalities, workers contact with objects/equipment recorded about (25%), fires/ explosions (14%), exposure to harmful substances/environments (9%), and falls (8%) but between 2003 and 2013, fatality rate decreased by 36% though this period experienced growth in the industry workforce, this may suggest a possible improvement in safety efforts with positive results.

Inhalation of silica is a major hazard associated with oil and gas operations Silica dust clouds from delivery trucks loading into sand movers at a hydraulic fracturing site constitute high level chemical hazard for oil and gas workers and serious safety precautions should be taken by workers in such department. Breitenstein {30}. These gas workers are also expected to be exposed to hydrocarbon gases and vapour for instance, the hydrogen sulphide gas which is very dangerous to human health when inhaled with resultant instant death when higher concentration is inhaled.

3: Results and discussion

This research result would be based on criteria for assessing the environmental impact assessment of gas plant development project in this research.

3.1: Risk associated with different impacts of gas plant development project

The following are the meaning of abbreviations that will be used for risk identification: Very high impact (VHI), High impact (HI), Moderate impact (MI), Low impact (LI) and Very low impact (VLI) while km represents distance in kilometres.

Table 1: Risk identification for environmental and safety criteria

SN	Environmental criteria	Environmental Impact of gas project	Proposed Project site - 2KM	4km beyond project site	6km beyond project site	8-10km beyond project site
1	Climate	Climate change	VHI	HI	MI	LI
2	Air	Air pollution	VHI	HI	MI	LI
3	Water	Water Pollution	VHI	HI	MI	LI
4	Soil	Soil pollution	VHI	HI	MI	LI
5	Noise	Noise pollution	VHI	HI	MI	LI
6	Safety	Hazardous Impact	VHI	HI	MI	LI

This study will make use of percentage values to represent levels of projected impact of gas plant development project on different environmental criteria link to the different impact of gas emission and contamination within resident/host communities and beyond to a distance of between 2k to 10km.

- (1) Climate criteria = Temperature (Cerebral Spinal Meningitis, Heat rashes)
- (b) Rainfall (Cholera and bloody stooling, typhoid fever and hepatitis).
- (2) Air pollution= Human health Impact (Asthma, bronchitis, Eye irritation/Itching and Lungs cancer).
- (3) Water pollution= Human health Impact (skin Rashes and stomach disorder and cancer).
- (4) Soil pollution= Impact on soil nutrient and food production. (Cassava, Yam, Pumpkin)
- (5) Noise pollution= Human health Impact (Hearing distortion and total hearing loss, Very loud speeches).
- (6) Safety= Mortality and morbidity from accident and chemical exposure.

Table 2: Impact of Exposure to gas production on Environmental criteria in host community and 8-10km beyond

SN	Environmental criteria	Environmental Impact of gas project	2km Proposed project site- Owaza (VHI)	4km beyond project site Obehie (HI)	6km beyond project site Umuokwo MI	8-10km beyond project site Umunteke (LI)
1	Climate	Climate change	2	4	6	8
2	Air	Air pollution	2	4	6	8
3	Water	Water Pollution	2	4	6	8
4	Soil	Soil pollution	2	4	6	
5	Noise	Noise pollution	2	4	6	8
6	Safety	Accident and Death	2	4	6	8

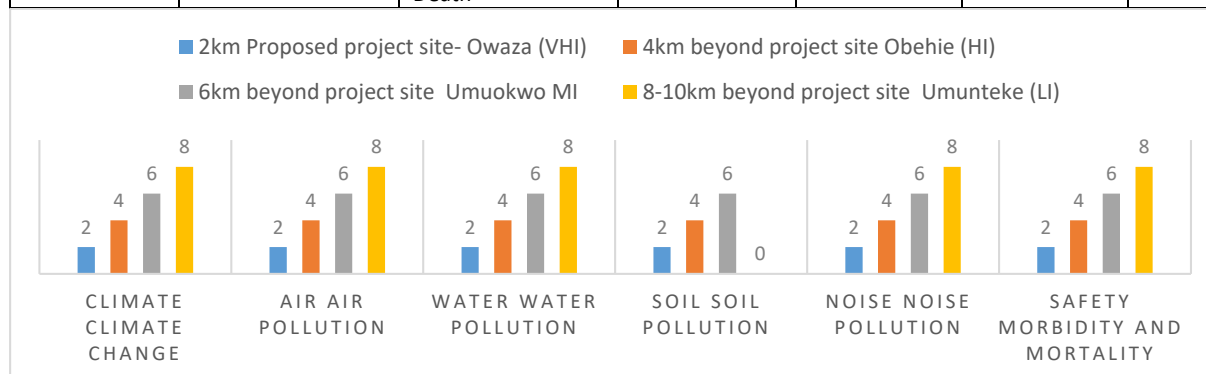


Figure 4: Impact of Exposure to gas production on Environmental criteria in host community and 8-10km beyond

Table 3: Impact of Induced high temperature on human health

High Temperature Impact	Impact on Hunan within 2km	Impact on Human within 4km	Impact on Human within 6km	Impact on Human within 8km
Cerebral Spinal Meningitis	13	9	5	2
Heat rashes	195	102	75	37
Skin Cancer	12	7	3	1

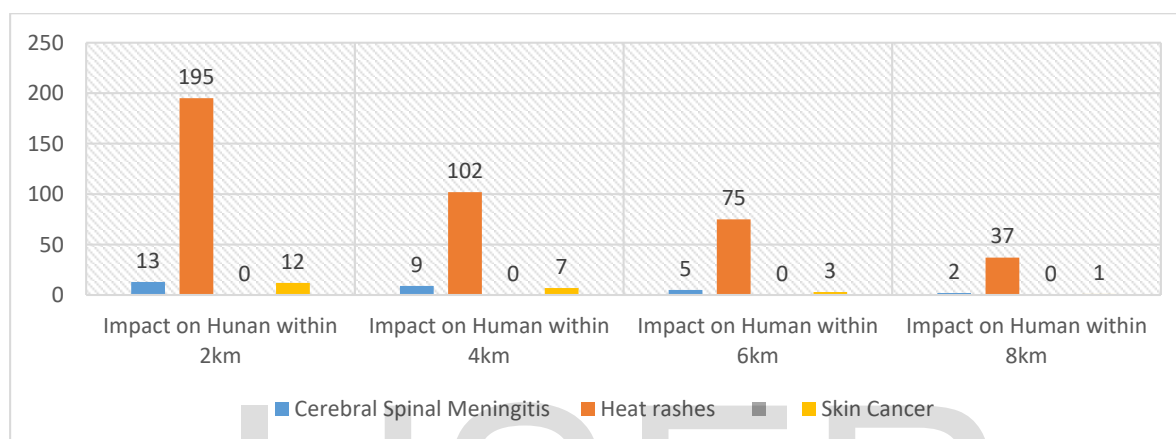


Figure 5: Impact of high temperature on Human health

Table 4: Impact of Induced High Rainfall on Human health

High Rainfall Impact	Impact on Hunan within 2km	Impact on Human within 4km	Impact on Human within 6km	Impact on Human within 8km
Cholera	2324	1757	946	357
Bloody stooling	1996	934	679	241
Typhoid fever	2767	2431	1789	702
Hepatitis	1654	1233	987	453

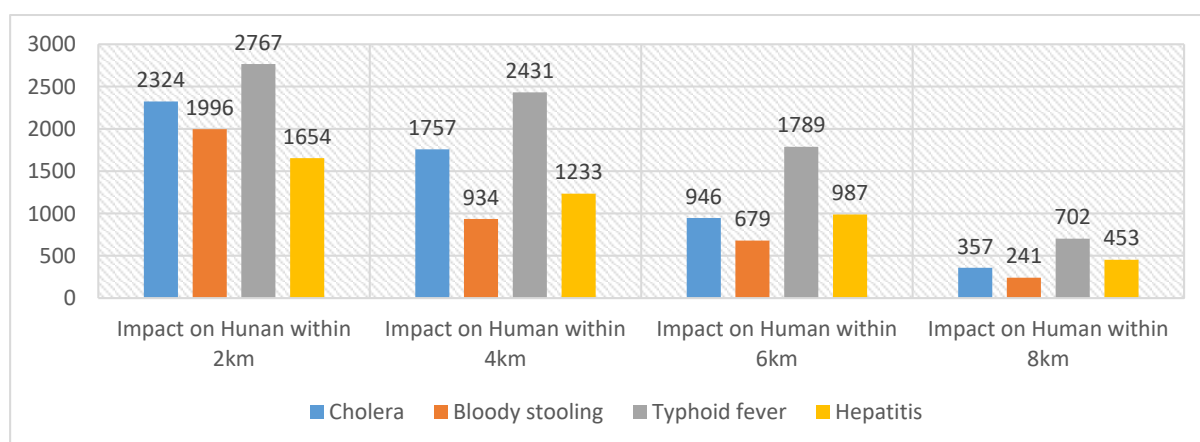


Figure 6: Impact of rainfall on Human health

Table 5: Impact of induced Air Pollution on Human Health

Air Pollution	Impact on Human within 2km	Impact on Human within 4km	Impact on Human within 6km	Impact on Human within 8km
Asthma	2877	2265	1889	987
Bronchitis	2389	2123	1700	1023
Lungs Cancer	573	378	143	97
Eye irritation/Itching	3245	2567	2113	1923

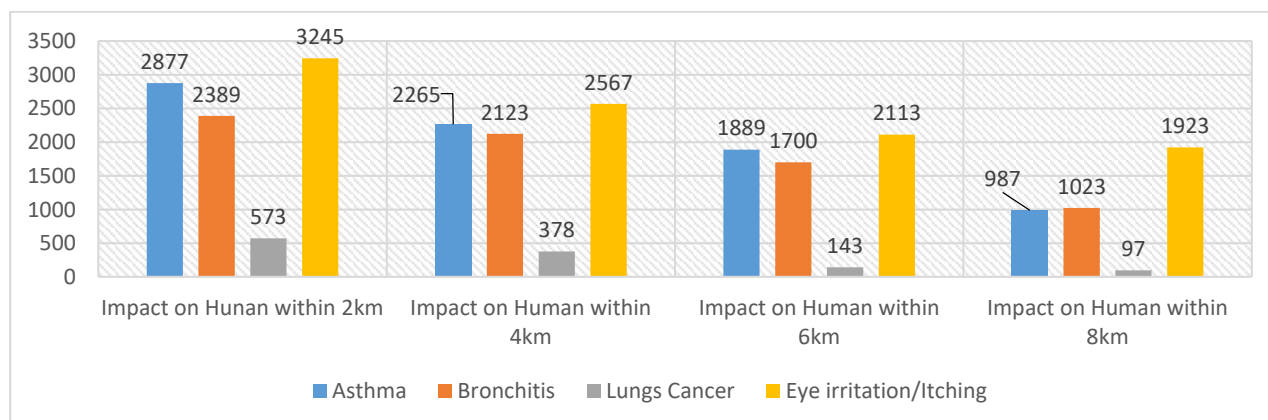


Figure 7: Impact of air pollution on Human health

Table6: Impact of induced Water Pollution on Human health

Water Pollution	Impact on Human within 2km	Impact on Human within 4km	Impact on Human within 6km	Impact on Human within 8km
Skin Rashes	3211	2145	1809	1600
Stomach Disorder	2354	1456	1109	921
Blue Baby Syndrome	78	53	35	14

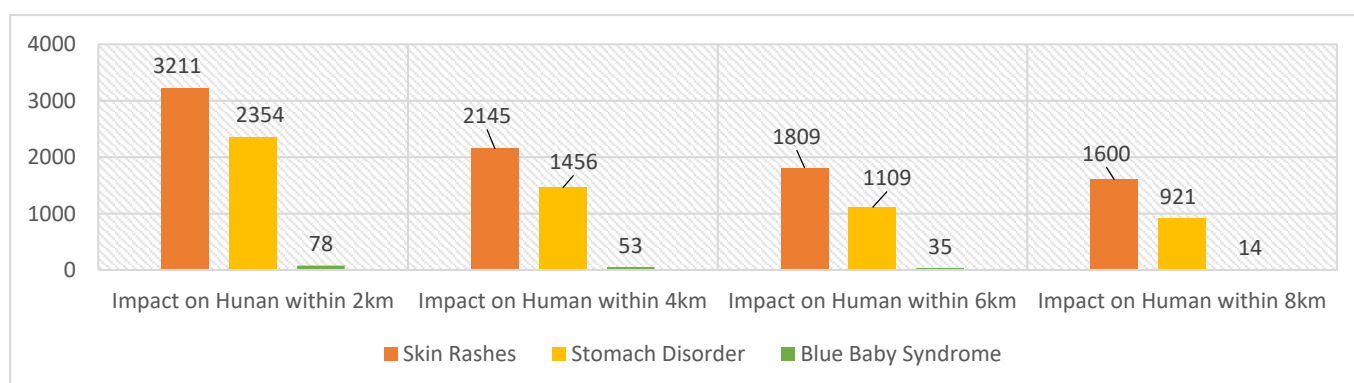


Figure 8: Impact of water pollution on Human health

Table 7: Impact of Noise Pollution on human health

Noise Pollution	Impact on Human within 2km	Impact on Human within 4km	Impact on Human within 6km	Impact on Human within 8km
Hearing difficulty	123	57	23	16
Total hearing loss	42	17	12	9
Very loud speeches	971	145	87	43

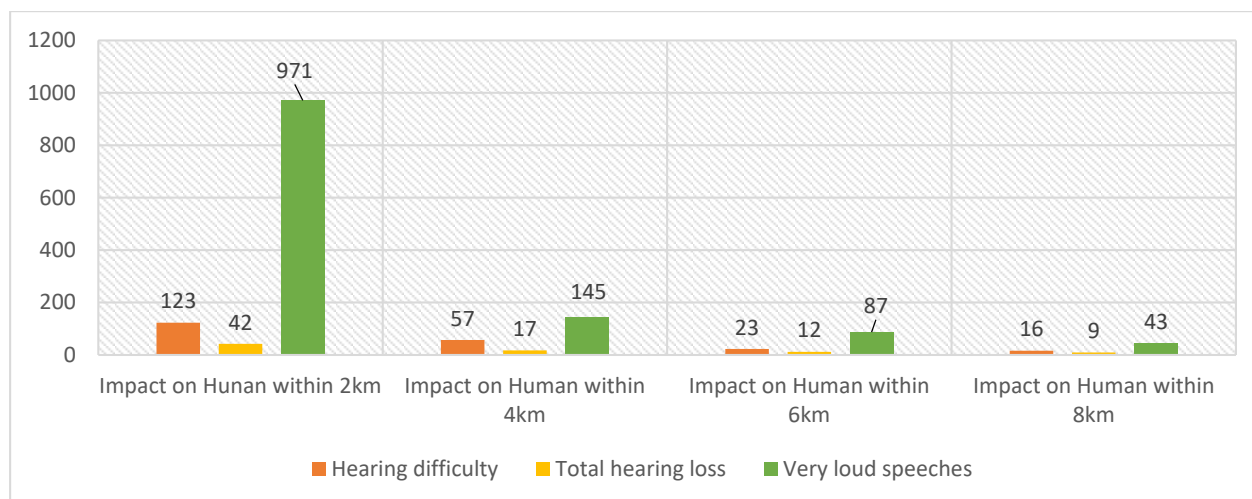


Figure 9: Impact of Noise pollution on Human health

Table 8: Impact of Gas production project on Human safety (Number per annum)

Risk on Safety	Impact on Hunan within 2km	Impact on Human within 4km	Impact on Human within 6km	Impact on Human within 8km
Accident	252	125	98	54
Death	179	145	122	79

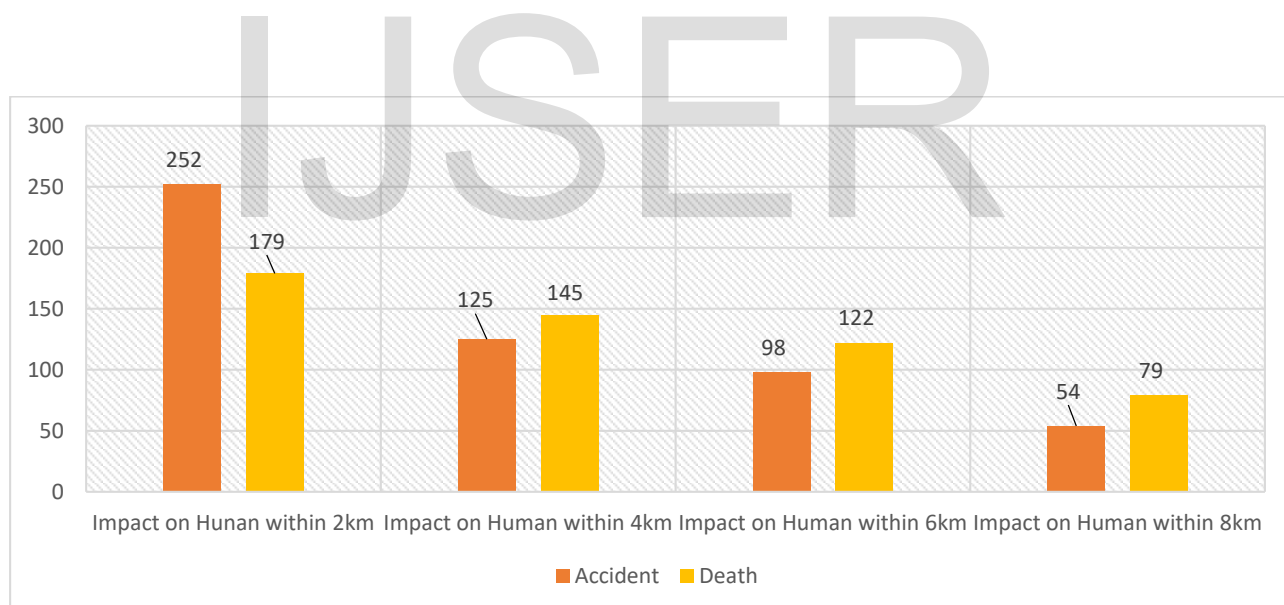


Figure 10: Impact of gas project on human safety

Table 9: Impact of Gas production project on soil Microorganisms

Soil Pollution	Impact on soil within 2km (on plots of land)	Impact on soil within 4km (on plots of land)	Impact on soil within 6km (on plots of land)	Impact on soil within 8km (on plots of land)
Death of soil Bacteria	19	14	11	9
Death of soil Algae	17	11	9	7
Death of soil Fungi	15	13	11	8

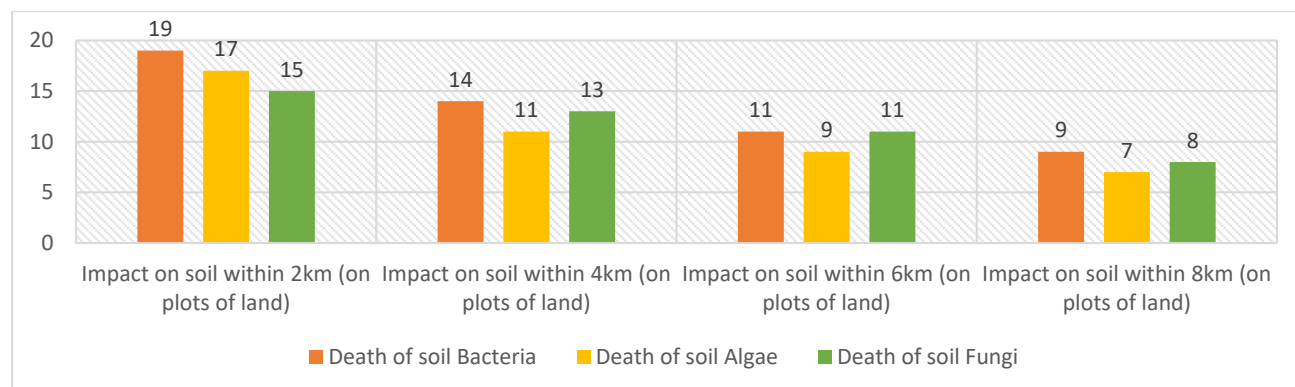


Figure 11: Impact of gas project on soil microorganism

Table 10: Impact of Gas production Project on Agricultural Production (Baskets per plot of land)

Impact on Agriculture	Impact on Agriculture within 2km	Impact on Agriculture within 4km	Impact on Agriculture within 6km	Impact on Agriculture within 8km
Yam	15	29	42	67
Cassava	17	31	56	71
Potato	14	27	43	69

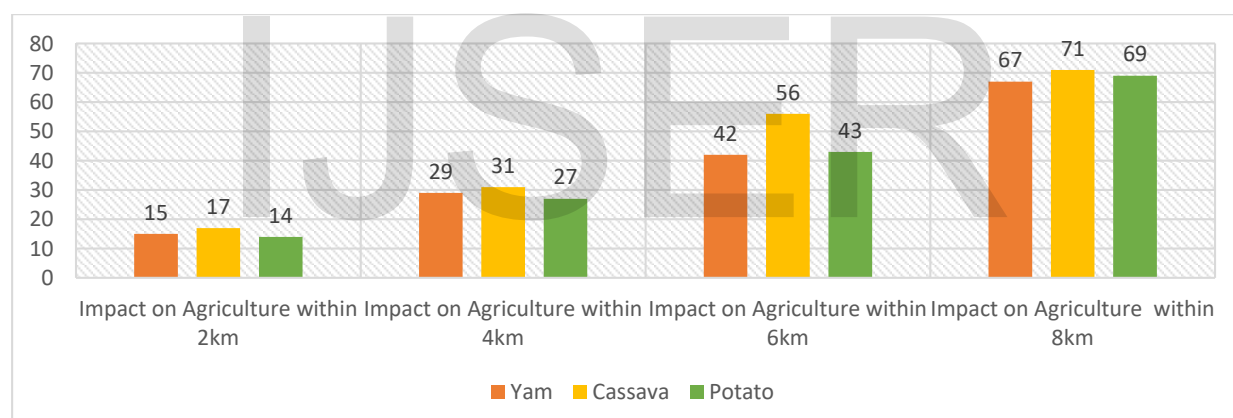


Figure 12: Impact of gas project on agricultural production

3.2: Development of mitigation concept for reducing Impact of gas plant Development Project in Nigeria.

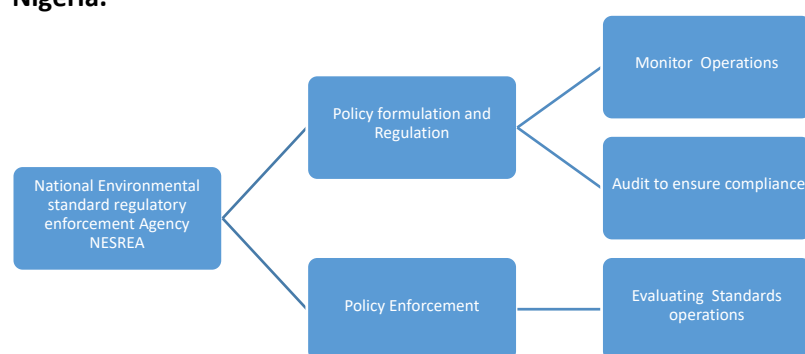


Figure 13: Developing mitigation process for Impact assessment in Nigeria

The above concept of mitigation involves the Main Environmental regulatory and Enforcement Agency in Nigeria Known as National Environmental standard regulatory enforcement agency (NESREA) established by the Federal government of Nigeria to replace the Federal Environmental protection Agency. The involvement of NESREA in this first stage of mitigation process goes as far as establishment of policies for Environmental protection for sustainable development as well as Environmental policy regulation while the second stage involves enforcement of Environmental laws and policy for maintenance standard Environmental quality. The third stage is the monitoring of Environmental operations within the different environmental operational systems to ascertain that the fourth stage which is auditing to ensure standard compliance is efficiently achieved. The fifth stage is evaluation of operational standard in comparison with the established standard of environmental quality in Nigeria.

4: Conclusion

Stakeholders including host communities are advised to accept the proposed gas plant development project due to the economic benefit consideration that would involve creation of Job opportunities for numerous jobless youths in the community. Furthermore, consideration should also be given to the power generation benefits that would accrue from development of the gas plant, as well as provision of access to clean energy in cooking gas at a reduced price to discourage the use of other forms of energy for cooking that are not environmental friendly especially the use of firewood for cooking would be totally discouraged thereby discouraging deforestation that exposes the soil to erosion that may end up becoming sources of damage to roads and other forms of infrastructure that would take a whole lot of funds to fix thus creating negative pressure to the economy of the state.

These possible mitigation measures are inevitable in case of foreseen negative impacts throughout the project life cycle, through surveys and scientific studies to ascertain the baseline environmental characteristics of the proposed project site and conducting research to identify the impact of gas project on air quality, water quality, human health and economic situation of the proposed gas plant project environment.

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