ASSESSMENT AND ANALYSIS OF ENVIRONMENTAL IMPACTS IN LIMESTONE MINE – A CASE STUDY

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Abstract- *Environmental impacts of the mineral extraction have been a public concern. Presently, there is widespread global interest in the area of mining and its sustainability that focused on the need to shift mining industry to a more sustainable framework. The aim of this study was to systematically assess all possible environmental and climate change related impacts of the limestone mining operations. For the purpose the study was carried in form of case study, field observations and laboratory investigations. In the light of above, the current project work mainly focuses on the monitoring of environmental impacts by using high volume dust sampler (Envirotech APM 460 NL and Envirotech APM 550), sound level meter (Lutrun Model: 4010), analysis technology of waste water quality, land degradation & loss of vegetation and improvement in human health and safety. In this study measurement, investigations, status of environmental impacts, forecast and subsequent mitigation measures were taken care of for air pollution, noise pollution, water pollution, soil & land degradation and loss of vegetation. On the basis of the field work & observations taken and laboratory investigations carried out, the status of Air pollution, Noise pollution, Water pollution and Land degradation are assessed and quantified. Finally mitigating measures are suggested.*

Key words: Environmental impacts, Limestone mine, Mitigative measures.

1. INTRODUCTION

Mining has considerable effect on the air and water, loss of biodiversity, soil pollution and land degradation. Health and well being of the people living in and around the mining complexes get affected due to the pollutants in the air and water, noise and vibrations. Environmental Impact Assessment (EIA) is defined as a systematic identification & evaluation of the potential impacts of the proposed projects, plans, programs or legislative actions related to the physical-chemical, biological, cultural and socio-economic components of the total environment. It is the evaluation of various impacts and the resultant natural and induced changes, as simply and precisely possible, for optimizing the development to vis-à-vis the environment. The above study has been undertaken

with the objectives *viz.* identify and assess the impacts of mining operation on the environment, various controlling measures used to minimize environmental impact in mine, analyses various environmental impact and controlling measures, identify appropriate measures for human health and safety.

2. MATERIALS AND METHODS

2.1 Study Area

The study area selected for the field experiments is Lakshmi Cement Limestone mine, Sirohi, Rajasthan. The mining area falls under the survey of India, Topo Sheet No. 45H/2 between latitude 24 40' - 24°42' N, and longitude 73°00' - 73°01' E, near Banas village, Taluka Pindwara, District Sirohi, Rajasthan, India. The location map of this mine is shown in figure.1
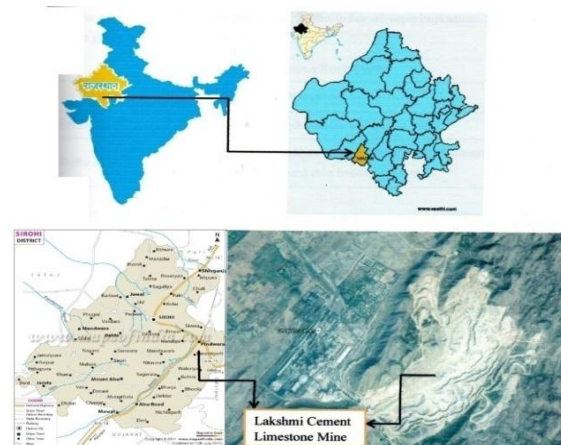

Fig.1: Location map of m/s Lakshmi Cement Limestone mine

2.2 AIR QUALITY MONITORING

The following air pollution parameters were monitored during the sampling periods.

2.2.1 Respirable particulate matter

The sampling of ambient air was performed with Respirable Dust Sampler (Model No-APM 460 NL) with gaseous attachment for PM_{10}, SO_2, and NO_2. The instrument draws the air by the use of high flow rate

blowers at the nominal flow rate of 1.1 to 1.5 cubs per min. On passing the sampled air from cyclone the non-respirable and coarser particles are stacked and collected in the bottle. The size varies from 100 to 10 microns. On the other hand fine dust whose diameter is less than 10 microns is collected on the filter paper. The air after passing through cyclone and filter paper is further passed through impingers filled with suitable absorption liquids (depending upon the kind of gas to be monitored). The chemical analysis of these solutions then reveals the gaseous content of air.

Fig.2: Envirotech APM 460 NL

2.2.2 Suspended particulate matter

Sampling for SPM was also performed with the sampler used for RPM sampling. The coarser particles (NRPM) collected in the cyclone separator are transferred quantitatively on a Petri dish and evaluated gravimetrically. The sum of masses of coarser (NRPM) and respirable particles (RPM) gives the mass of SPM collected during the sampling. The SPM concentrations are computed from the total mass of SPM and total volume of air sampled.

2.2.3 Fine particulate matter

The sampling was performed with Fine Particulate Sampler (Envirotech; Model No APM 550) and $PM_{2.5}$ was collected by the use of this instrument. In this type of sampler, the system is designed that particulate matter of less than 2.5 micron is separated from coarse heavy particles and fine particles are collected on a membrane

filter. The duration of sampling is 24 hours and air flow rate is maintained at 1 m^3/hr. or 16.7 LPM.

Fig.3: Envirotech APM 550 NL

2.2.4 Sulphur dioxide

The sampling of SO_2 was performed with a Gaseous Attachment (model APM 411 TE, make Envirotech) along with Respirable Dust Sampler for drawing the air samples through the impingers. Air is drawn at a measured and controlled rate of 400 to 500 ml/min through a solution of sodium tetra chloro mercurate. After completion of the sampling, the used absorbing reagent is treated with dilute solutions of sulphonic acid, formaldehyde and pararosaniline hydrochloride. The absorbance of the intensely coloured pararosaniline methyl sulphonic acid is measured and the amount of SO_2 in the sample is computed from graphs prepared with standard solutions. The ambient SO_2 concentrations were computed from the amount of SO_2 collected and the volume of air sampled.

2.2.5 Oxides of nitrogen

The sampling of NO_2 was performed with a Gaseous Attachment (model APM 411 TE, make Envirotech) along with Respirable Dust Sampler for drawing the air samples through the impingers. Air is drawn at a measured and controlled rate of about 200 ml/minute through an orifice-tipped impinger containing solutions of sodium hydroxide and sodium arsenite. After completion of the sampling, an aliquot of the used

absorbing solution was treated with solutions of H_2O_2, sulphanilamide and NEDA. The nitrite ion present in the impinger was calculated from the absorbance of the resulting solution and from the graphs prepared with standard solutions. The ambient NO_2 concentrations were computed from the total nitrite ion present in the impingers, overall efficiency of the impinger and the procedure, and the volume of air sampled.

2.3 NOISE QUALITY MONITORING

The noise level monitoring was done by sound level meter (Lutrun Model: 4010) as shown in figure.4. Noise levels were measured at site and villages located within 10 km radius in and around the project site. Noise level were recorded at 10 locations of core zone and 06 locations of buffer zone and summarized as noise level during day time (Ld) and during night time (Ln). During the time of measurements, the sound level meter is held at arm's length at the ear height for those exposed to the noise. The sound level meter is calibrated before and after each use. The readings were taken according to the SLOW or FAST response. The response rate is the time period over which the instrument averages the sound level before displaying it on the readout. Workplace noise level measurements are taken on SLOW response.

Fig.4: Sound level meter (Lutrun Model: 4010)

The ambient noise levels are measured in the A - weighted SPL, abbreviated dB (A). This scale resembles the audible response of human ear. Sounds of frequencies from 800 to 3000 HZ are covered by the A - weighted scale. The sound pressure level, L_1 in dB is measured at r_1 meters, and then the sound pressure level, L_2 in dB at r_2 meters is given by:

$$L_2 = L_1 - 20 \log_{10} (r_2/r_1)$$

The sound levels are measured in terms of pressure, then, sound pressure level is given by:

$$L_P = 20 \log_{10} (P/P_0) \text{ dB (A)}$$

The Lp is measured against a standard reference pressure is given by:

$$P_0 = 2 \times 10^{-5} \text{ N/m}^2 \text{ (equivalent to zero decibels)}$$

2.4 WATER QUALITY MONITORING

Following methods are used for measurement of waste water pollutants which are shown in below table.1

Table.1 Methodology of waste water measurement

Pollutants	Method of Measurement
Suspended Solids, mg/l	Gravimetric
Biochemical Oxygen Demand	Difference of DO after 3 days
Chemical Oxygen Demand, mg/l	Titrimetric Method
Ph	Electrometric Method
Oil & Grease, mg/l	Gravimetric
Temperature ºC	Thermometer

2.5 SOIL QUALITY ANALYSIS

For the analysis of the impacts due to mining activities on the soil in the vicinity, the standard procedure was followed. For this purpose the data from the mines area were collected in form of soil samples. After the collection of soil samples from suitably selected sites, subsequent analysis was carried out in the laboratory in form of standard physical and chemical tests conducted on soil. The details of locations are summarized in below table.2

Table. 2 : Proposed sites of soil sampling

S. N.	Name of site	Location from working	Distance from Working
1	Working area	-	-
2	Crusher area	West	Adjacent
3	River Banas	NW	$\sim$ 3.6 Km
4	Village Gariya	NE	$\sim$ 8.3 Km
5	Village SwaroopGanj	SW	$\sim$ 8.6 Km
6	Dhanari Village	West	$\sim$ 7.8 Km
7	Goliya Village	NNW	$\sim$ 8.2 Km
8	Kambai Village	South	$\sim$ 7.2 Km

3. FIELD WORK AND LABORATORY INVESTIGATIONS

3.1 Sampling and analysis of air quality parameters

3.1.1 Sampling and analysis of SPM - High volume method

In this method the mass of the materials filtered out from the sample of air was measured. For the purpose a standard high volume sampler was used was used. A flow-metering device was attached, after that the reading of float was taken and it was on sealed by the adjusted mechanism. The motor was shut off and the filter was removed and the orifice calibration unit was attached in its place. After operating the high volume sampler the constant rate of air flows was measured. The readings were taken by using the differential manometer from the orifice calibration unit and the readings of the flow meter for each flow-rate were recorded. The pressure and temperature of the ambient atmosphere was measured and differential manometer readings were converted into m^3/min that is q. The volume of air sampled was computed by:

$$V = q \times t$$

Where,

Q is flow rate in cum per min and

T is duration of sample in minutes

The suspended particulate matter in ambient air was calculated as:

$$SPM \ (\mu g/ \ m^3) = \frac{[(W_f - W_i) + (WC_s - WC_e)] \times 10^6}{V}$$

Where,

W_f = Final weight of filter paper in gram

W_i = Initial weight of filter paper in gram

WC_s = Weight of cup plus sample in gram

WC_e = Weight of empty cup in gram

10^6 = Conversion of gram to milligram

V=Volume of air sampled m^3

Sampled air quality data of core zone and buffer zone was collected from the field work and collected data was analyzed in environment laboratory. The Baseline data for the study area was obtained and mentioned in the suitable column in table.3 and table.4 is shown below. The readings on the selected site are also summarized for comparison in core zone and buffer zones in tabular form in same tables:

Table.3: Analysis of suspended particulate matter (SPM) at core zone

No	Site	Observation Date	Flow rate (m³/min)	Filter Paper Weight		Weight of SPM (gm)	SPM (µg/m³)	Tem (°C)	Humidity (%)
				Initial (gm)	Final (gm)				
1	Mine office	18.5.18	1.132	2.7698	2.8890	0.1192	462.37	39.7	34.1
2	View point of crusher area	18.5.18	1.132	2.4584	2.5830	0.1246	262.58	38.6	36.3
3	Screen machine area	18.5.18	1.132	2.1442	2.2710	0.1268	347.2	36.6	35.1
4	Mines Blasting Area	18.5.18	1.132	2.4681	2.5935	0.1254	399.02	37.5	37.1
5	Drilling Point	19.5.18	1.132	2.9995	3.1520	0.1525	372.73	37.9	37.1
6	Belt no. 12 reject area	19.5.18	1.132	2.6547	2.7955	0.1408	465.280	40.1	35.2
7	Mine area 435 meter.	19.5.18	1.132	2.6551	2.7948	0.1397	371.92	39.5	36.5
8	Mine area 453 meter.	19.5.18	1.132	2.4787	2.6093	0.1306	317.85	40.5	35.5
9	Dump at waste	19.5.18	1.132	2.6958	2.8385	0.1427	361.32	39.9	31.3
10	Near crusher	20.5.18	1.132	2.1212	2.2653	0.1441	335.23	37.9	34.5

Table.4: Analysis of suspended particulate matter (SPM) at buffer zone

S.N.	Site	Observation Date	Flow rate (m³/min)	Filter Paper Weight		Weight of SPM (gm)	SPM (µg/m³)	Tem (°C)	Humidity (%)
				Initial (gm)	Final (gm)				
1	Adarsh	20/05/18	1.132	2.4584	2.5660	0.1076	77.72	38.6	36.3
2	Rohida	21/05/18	1.132	2.1442	2.2520	0.1078	71.26	36.2	35.3
3	Puravato Ki Phali	21/05/18	1.132	2.6358	2.7385	0.1027	69.32	38.4	36.2
4	Silwa	21/05/18	1.132	2.9995	3.1070	0.1075	74.59	37.8	37.1
5	Rampura	21/05/18	1.132	2.6547	2.7715	0.1168	69.02	40.1	35.1
6	Basantgarh	20/05/18	1.132	2.7698	2.8785	0.1087	77.71	39.1	34.1

3.1.2 Sampling and analysis of CO - Non-dispersive infrared absorption method

This method is based on the principle of the utilization of absorption of infra red energy with respect to the presence of CO in the medium. Thus the instrument based on this provides the prevailing concentration of Carbon mono Oxide in the sample. For the purpose a spectrometer was used for the measurement of CO absorption. The signals for the spectrum are amplified, displayed and having recording facilities. Gas filters were used for correlation and for comparative analysis of IR absorption of sample and standard gas column. During the time of sampling the sampling line or probe was

utilized and extended at 1 meter from the site. The instrument was placed with all the prescribed precautions in the manual with the proper atmospheric control with constant temperature. The temperature and pressure of the atmosphere samples were recorded.

After the completion of sampling, recording and field procedure the concentration of CO (in mg/m³) was estimated by following:

$$C_{CO} = CO_i \times K \times W / T$$

Where,

CO_i = Reading from the instrument (ppm).

K = Multiplying Constant (as prescribed with Instrument)

W = Molecular weight (g/mol)

T = Temperature (K)

Table.5: Analysis of carbon monoxide (CO) at core zone

No	Location	Date	Tem. (K)	CO (µg/ m³)
1	Mine Office	18/05/18	313.15	240
2	Crusher Area View Point	18/05/18	310.05	380
3	Screen Machine Area	18/05/18	311.05	280
4	Mines Blasting Area	18/05/18	311.75	310
5	Drilling Point	19/05/18	312.00	290
6	Belt No 12 Reject Area	19/05/2018	314.15	280
7	Mine Area 435 Meter	19/05/2018	313.05	410
8	Mine Area 453 Meter	19/05/2018	314.05	290
9	Waste Dump	19/05/2018	314.15	210
10	Near Crusher Area	20/05/2018	312.00	430

Table.6: Analysis of carbon monoxide (CO) at buffer zone

No	Location	Date	Tem.(K)	CO (µg/ m³)
1	Adarsh	20/05/2018	313.05	250
2	Rohida	21/05/2018	313.25	270
3	Puravato Ki Phali	21/05/2018	311.35	190
4	Silwa	21/05/2018	311.25	240
5	Rampura	21/05/2018	309.15	250
6	Basantgarh	20/05/2018	312.15	240

3.1.3 Sampling and analysis of NO₂ - Jacob & Hochheiser Method

The measurement of Nitrogen dioxide (NO₂) in the field is based on the colorometry. In this process the NO2

concentration are estimated by the absorbance of the highly coloredazo-dye at 540 nm. For the purpose the sample is titrated with by reaction of nitrite ion with phosphoric acid, sulphanilamide, and NEDA.

Concentration of NO_2 was calculated as per the following formula:

$$CNO_2 \quad = \quad \frac{A_s - A_b \times CF \times V_s}{V_a \times V_t \times 0.82}$$

Where,

CNO_2 = Concentration of NO_2 in microgram / m³

A_s = Absorbance of Sample

A_b = Absorbance of Blank

CF = Factor of Calibration

V_a = Volume of air sampled in m³

V_s = Volume of sample in ml

V_t = Volume of aliquot taken for analysis ml

0.82 = Sampling efficiency.

The study data for the study area was obtained and mentioned in the suitable column in table.7 and table.8 is shown below. The readings on the selected site are also summarized for comparison in core zone and buffer zones in tabular form in same tables:

Table.7: Analysis of nitrogen dioxide (NO₂) at core zone

No	Site	Observation Date	Flow Rate (lpm)	Abs. Sample	Abs. Blank	Absorbance Final	NO₂ (µg/m³)	Tem (°C)	Humidity (%)
1	Mine office	18/05/2018	0.2	0.043	0.012	0.031	20.76	38.5	35.6
2	View point of crusher area	18/05/2018	0.2	0.045	0.012	0.033	20.56	41.6	38.2
3	Screen machine area	18/05/2018	0.2	0.046	0.012	0.034	18.3	42.4	36.1
4	Mines Blasting Area	18/05/2018	0.2	0.047	0.012	0.035	16.71	39.4	38.1
5	Drilling Point	19/05/2018	0.2	0.047	0.012	0.035	14.69	37.9	36.5
6	Belt no. 12 reject area	19/05/2018	0.2	0.046	0.012	0.034	17.63	38.5	37.3
7	Mine area 435 meter.	19/05/2018	0.2	0.046	0.012	0.034	18.58	40.1	35.2
8	Mine area 453 meter.	19/05/2018	0.2	0.045	0.012	0.033	17.76	40.5	35.5
9	Dump at waste	19/05/2018	0.2	0.050	0.012	0.038	17.61	39.9	38.5
10	Near crusher	20/05/2018	0.2	0.047	0.012	0.035	17.49	37.9	36.5

Table.8: Analysis of nitrogen dioxide (NO$_2$) at buffer zone

No	Site	Observation Date	Flow Rate (lpm)	Absorbance Value		Absorbance Final	NO$_2$ (µg/m³)	Tem (°C)	Humidity (%)
				Abs. Sample	Abs. Blank				
1	Adarsh	20/05/2018	0.2	0.043	0.012	0.031	17.12	39.2	35.5
2	Rohida	21/05/2018	0.2	0.038	0.012	0.026	17.13	38.3	33.1
3	Puravato Ki Phali	21/05/2018	0.2	0.040	0.012	0.028	14.23	35.5	38.2
4	Silwa	21/05/2018	0.2	0.037	0.012	0.025	11.94	37.3	36.5
5	Rampura	21/05/2018	0.2	0.047	0.012	0.035	15.75	41.5	34.7
6	Basantgarh	20/05/2018	0.2	0.042	0.012	0.030	17.54	39.7	34.1

3.1.4 Sampling and analysis of PM$_{2.5}$ – Gravimetric method

The Envirotech APM 550 is fitted with an electric motor to establish the flow rate of approx 16 litres per min. The cyclone is used for this purpose, which is instrumental in creating flow of air. This is coupled with impactor segregate the particulate matter below the diameter of 2.5 microns. This segregation is achieved at the especially manufactured, suitably placed, pre-weighed PTFE filter. The air flow impinges the particulate matter onto the filter for a suitable duration (1 hour, 8 hours, 16 hours, 24 hours). During the sampling a constant flow rate is maintained. Then the filter is taken out and stored properly. Subsequently the filter along with the impinged particulate matter of below 2.5 microns is once again weighed in the precision balance in the laboratory. This differential weighing gives mass of particulate matter impinged in the said duration.

In the result of these, the concentration of PM$_{2.5}$ can be computed in terms of fraction of mass computed per unit volume of air flow. This is generally designated in µg/m³.

The following formula was used for the determine concentration of PM$_{2.5}$:

$$CPM_{2.5} = \frac{(W_f - W_i) \times 10^6}{(V_f - v_i)}$$

Where;

W$_f$ = Final weight of filter paper, gm

W$_i$ = Initial weight of filter paper, in gram

V$_f$ = Final volume in m³

V$_i$ = Initial volume in m³

10^6 = Conversion of gram to milligram

The Baseline data for the study area was obtained and mentioned in the suitable column in table.9 and table.10 is shown below. The readings on the selected site are also summarized for comparison in core zone and buffer zones in tabular form in same tables:

Table.9: Analysis of particulate matter (PM$_{2.5}$) at core zone

No	Site	Observation Date	Flow Rate PM$_{2.5}$ (lpm)	Filter Paper Weight		Weight of PM$_{2.5}$ (gm)	PM$_{2.5}$ (µg/m³)	Tem (°C)	Humidity (%)
				Initial (gm)	Final (gm)				
1	Mine office	18/05/2018	16.7	0.14441	0.14515	0.00074	35.98	41.5	35.5
2	View point of crusher area	18/05/2018	16.7	0.14695	0.14770	0.00075	34.75	39.6	37.1
3	Screen machine area	18/05/2018	16.7	0.14660	0.14725	0.00065	45.67	38.9	34.4
4	Mines Blasting Area	18/05/2018	16.7	0.14896	0.14523	0.00059	8.56	40.1	38.2
5	Drilling Point	19/05/2018	16.7	0.14879	0.14953	0.00074	42.65	37.9	37.4
6	Belt no. 12 reject area	19/05/2018	16.7	0.14698	0.14762	0.00064	34.25	40.1	35.1
7	Mine area 435 meter.	19/05/2018	16.7	0.14321	0.14386	0.00065	38.18	39.5	36.5
8	Mine area 453 meter.	19/05/2018	16.7	0.14658	0.14724	0.00066	43.95	40.5	35.5
9	Dump at waste	19/05/2018	16.7	0.14789	0.14859	0.00070	27.05	39.9	31.3
10	Near crusher	20/05/2018	16.7	0.14441	0.14510	0.00069	44.48	37.9	34.3

Table.10: Analysis of particulate matter (PM$_{2.5}$) at buffer zone

No	Site	Observation Date	Flow Rate PM$_{2.5}$ (lpm)	Filter Paper Weight		Weight of PM$_{2.5}$ (gm)	PM$_{2.5}$ (µg/m³)	Tem (°C)	Humidity (%)
				Initial (gm)	Final (gm)				
1	Adarsh	20/05/2018	1.175	2.4588	2.5660	0.1072	77.72	40.5	36.9
2	Rohida	21/05/2018	1.175	2.1440	2.2525	0.1085	71.26	39.1	34.5
3	Puravato Ki Phali	21/05/2018	1.175	2.6355	2.7390	0.1035	69.32	36.6	33.1
4	Silwa	21/05/2018	1.175	2.9990	3.1065	0.1075	74.59	38.1	33.5
5	Rampura	21/05/2018	1.175	2.6545	2.7720	0.1175	69.02	37.5	34.1
6	Basantgarh	20/05/2018	1.175	2.7698	2.8784	0.1086	77.71	39.1	34.1

3.1.5 Sampling and analysis of PM$_{10}$ – Gravimetric method

The Envirotech APM 460 NL is fitted with an electric motor to establish the flow rate of approxe. 16 litres per min. The cyclone is used for this purpose, which is instrumental in creating flow of air. This is coupled with impactor segregate the particulate matter below the diameter of 10 microns. This segregation is achieved at the especially manufactured, suitably placed, pre-weighed PTFE filter. The air flow impinges the

particulate matter onto the filter for a suitable duration (1 hour, 8 hours, 16 hours, and 24 hours). During the sampling a constant flow rate is maintained. Then the filter is taken out and stored properly. Subsequently the filter along with the impinged particulate matter of below 10 microns is once again weighed in the precision balance in the laboratory. This differential weighing gives mass of particulate matter impinged in the said duration. In the result of these, the concentration of PM_{10} can be computed in terms of fraction of mass computed per unit volume of air flow. This is generally designated in $\mu g/m^3$.

The following formula was used for the determine concentration of PM_{10}:

$$CPM_{10} = \frac{(W_f - W_i)}{V} \times 10^6$$

Where;

CPM_{10} =Concentration of PM_{10} in milligram / m^3

W_f =Final weight of filter paper, gm

W_i =Initial weight of filter paper, in gram

3.1.6 Sampling and analysis of SO_2 – West & Gaeke method

This method uses the Potassium Tetra chloromercurate (TCM) is used as impinger. It is based on the principle of absorption of sulphur dioxide from air into the TCM solution. The absorption takes place in the results of a complex reaction. As the SO_2 is absorbed the concentration is estimated by change in colour after reaction. The instrument is calibrated with the known concentration of SO_2. It produces the color product of Pararosaniline methyl sulphonic acid after following reactions:

$$2\ NaCl + [HgCl_2] ======= 2\ Na^+ + [HgCl_2]^-$$

$$\&$$

$$SO_2 + [HgCl_4]^- + H_2O = [HgCl_2SO_3]^- + 2H^+ + 2\ Cl^-$$
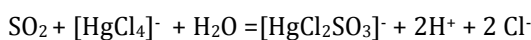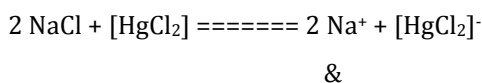
The concentration of SO_2 (in µg per cum) of ambient air passed in the sampler during the designated duration can be computed as:

$$SO_2 = \frac{(Ps - P_o)\ x\ 10^3\ x\ K}{U}$$

Where;

P_s –Value for absorbance of air

P_o –Standard absorbance of reagent

K–Instrument constant (in µg/absorbance)

U–Sampled Air Volume (in litres)

The study data for the study area was obtained and mentioned in the suitable column in table.11 and

table.12 is shown below. The readings on the selected site are also summarized for comparison in core zone and buffer zones in tabular form in same tables:

Table.11: Analysis of sulphur dioxide (SO_2) at core zone

No	Site	Observation Date	Flow Rate (lpm)	Absorbance Value		Absorbance Final	SO_2 (µg/m³)	Tem (°C)	Humidity (%)
				Abs. Sample	Abs. Blank				
1	Mine office	18/05/2018	0.2	0.040	0.025	0.015	7.86	36.0	33.5
2	View point of crusher area	18/05/2018	0.2	0.041	0.020	0.021	7.27	39.1	36.2
3	Screen machine area	18/05/2018	0.2	0.046	0.030	0.016	7.09	38.4	34.8
4	Mines Blasting Area	18/05/2018	0.2	0.045	0.023	0.022	6.81	40.1	37.1
5	Drilling Point	19/05/2018	0.2	0.048	0.023	0.025	7.52	37.9	37.1
6	Belt no. 12 reject area	19/05/2018	0.2	0.045	0.023	0.022	7.58	40.1	35.2
7	Mine area 435 meter.	19/05/2018	0.2	0.044	0.023	0.021	6.58	39.5	36.5
8	Mine area 453 meter.	19/05/2018	0.2	0.045	0.023	0.022	7.64	40.5	35.5
9	Dump at waste	19/05/2018	0.2	0.048	0.023	0.025	7.18	39.9	36.5
10	Near crusher	20/05/2018	0.2	0.044	0.023	0.021	9.03	37.9	34.3

Table.12: Analysis of sulphur dioxide (SO_2) at buffer zone

No	Site	Observation Date	Flow Rate (lpm)	Absorbance Value		Absorbance Final	SO_2 (µg/m³)	Tem (°C)	Humidity (%)
				Abs. Sample	Abs. Blank				
1	Adarsh	20/05/2018	0.2	0.040	0.025	0.015	7.07	40.4	37.3
2	Rohida	21/05/2018	0.2	0.045	0.020	0.025	5.09	39.5	35.5
3	Puravato Ki Phali	21/05/2018	0.2	0.041	0.029	0.012	6.56	41.1	37.9
4	Silwa	21/05/2018	0.2	0.043	0.030	0.013	6.17	38.2	35.4
5	Rampura	21/05/2018	0.2	0.049	0.028	0.021	7.93	37.9	34.8
6	Basantgarh	20/05/2018	0.2	0.047	0.023	0.024	5.43	39.7	36.5

3.2 NOISE LEVEL MEASUREMENT

Noise level recorded during the study period are given in table.13 and table.14

Table.13: Sampled noise quality data of core zone

No	Location	Location Number	Noise Level [Leq in dB(A)]			
			Measured Value		Permissible Limit	
			Day	Night	Day	Night
1.	Mines Office	N1	68.5	61.7	75	65

2.	View point of crusher area	N2	71.2	62.3	75	65
3.	Screen machine area	N3	70.3	58.6	75	65
4.	Drilling Site	N4	73.5	60.2	75	65
5.	Mine Blasting Area	N5	73.4	61.4	75	65
6.	Belt No:12 Reject Area	N6	66.5	56.4	75	65
7.	Mine Area 435 Meter	N7	63.7	56.9	75	65
8.	Mine Area 453 Meter	N8	68.4	60.5	75	65
9.	Waste Dump	N9	62.8	56.3	75	65
10.	Near Crusher	N10	73.5	62.3	75	65

Table.14: Sampled noise quality data of buffer zone

| No | Location | Location Number | Noise Level [Leq in dB(A)] | | | |
| | | | Measured value | | Permissible limit | |
			Day	Night	Day	Night
1.	Adarsh	N1	52.3	40.6	55	45
2.	Rohida	N2	53.2	41.3	55	45
3.	PuravatokiPhali	N3	52.5	38.6	55	45
4.	Silwa	N4	51.2	40.5	55	45
5.	Rampura	N5	50.6	38.4	55	45
6.	Basantgarh	N6	41.7	38.6	55	45

3.3 WATER QUALITY ANALYSIS

Study was carried out for wastewater quality of mine workshop. Water samples were collected from pre-defined locations which shown in table.15 and every parameters of waste water were analysis in laboratory.

Table.15: Sampled waste water quality data of mines workshop

No	Location	Parameters		Observed value
1.	Mines Workshop waste water inlet	1.	TSS (mg/l)	150
		2.	BOD (mg/l)	230
		3.	COD (mg/l)	783.36
		4.	Ph	7.22
		5.	Oil & Grease (mg/l)	1003
2.	Mines Workshop waste water outlet	1.	TSS (mg/l)	67
		2.	BOD (mg/l)	28
		3.	COD (mg/l)	176.26
		4.	pH	7.58
		5.	Oil & Grease COD (mg/l)	8

3.3.1 Measurement of suspended solids in waste water

A well-mixed sample was filtered through a weighed standard glass-fiber filter and the residue retained on the filter was dried to a constant weight at 103 to 105°C. The filter weight was increased and which represent the total suspended solids. Total suspended solids were obtained by the difference between total dissolved solids and total solids. The standard deviation required is 5.2 mg/L (coefficient of variation33%) at 15 mg/L, 24 mg/L (10%) at 242 mg/L, and 13 mg/L (0.76%) at 1707 mg/L in study by two analysts of four sets of each 10 determinations.

Total suspended solids, mg/L$= \frac{(A-B) X\ 1000}{\text{sample volume mL}}$

Where:

A = weight of filter + dried residue, mg.

B = weight of filter, mg

3.3.2 Measurement of biochemical oxygen demand (BOD)

The method consists of filling with diluted and seeded sample, to overflowing, an airtight bottle of specified size was used and incubating oxygen was required for the BOD measurement.

BOD was calculated as per the following formula:

BOD_3, mg/L$= \frac{(D1-D2)-(S)Vs}{P}$

Where:

D_1 = DO (Dissolved Oxygen) of diluted sample immediately after preparation, mg/L,

D_2 = DO (Dissolved Oxygen) of diluted sample after 5 d incubation at 20°C, mg/L,

S = Oxygen uptake of seed

V_s = Volume of seed in the respective test bottle, ml

P = decimal volumetric fraction of sample used;

1/P = dilution factor.

3.3.3 Measurement of chemical oxygen demand (COD)

A sample was refluxed in strongly acid solution with potassium dichromate ($K_2Cr_2O_7$). After digestion, the remaining unreduced$K_2Cr_2O_7$ is titrated with ferrous ammonium sulphate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidizable matter is calculated in terms of oxygen equivalent. Results are enhanced by reacting a maximum quantity of dichromate and provided that some residual dichromate remains.

COD was calculated as per the below formula:

COD as mg O_2/L$= \frac{(A-B)\ X\ M\ X\ 8000}{\text{mL sample}}$

Where:

A = ml FAS used for blank,

B = ml FAS used for sample,

M = Molarity of FAS, and

8000 = Mill equivalent weight of oxygen x1000 ml/L.

3.3.4 Measurement of pH

Electrometric pH measurement was done by to using a standard hydrogen electrode and a reference electrode. The hydrogen electrode consists of a platinum electrode

across which hydrogen gas was bubbled at a pressure of 101 kPa. Because of difficulty in its use and the potential for poisoning the hydrogen electrode, the glass electrode was used. The electromotive force (emf) produced in the glass electrode system varies linearly with pH. Measurements of pH are affected by temperature in two ways: mechanical effects that are caused by changes in the properties of the electrodes and chemical effects caused by equilibrium changes.

3.3.5 Measurement of oil & grease

Dissolved or emulsified oil and grease were extracted from water by intimate contact with an extracting solvent. Oil and grease were minimized by acids and solvent vapor displacement.

Total gain in weight, A, of tared flask, less calculated residue from solvent blank, B, is the amount of oil and grease in the sample and was calculated as below formula:

$$\text{Oil and grease , mg/l} = \frac{(A-B) \times 1000}{\text{mL sample}}$$

Where:

A = Total weight tared flask

B = Residue from solvent blank

3.3.6 Measurement of temperature

Temperature is measured by mercury-filled Celsius thermometer. Temperature readings are used in the calculation of various forms of alkinity, in studies of saturation and stability with respect to calcium carbonates, in the laboratory operation.

3.4 ANALYSIS OF SOIL QUALITY

After the collection of soil samples from pre decided locations of the site of mine, laboratory testing procedures were proposed for the testing of collected soil samples. The physico-chemical analysis of soil samples are presented in Table.16

Table.16: Soil quality in the study area

No	Parameter	Unit	Mine Site	Plant Site	Banas RS	Goliya	Dhanari	Kambai	Swarop Ganj	Garia
1	Ph	-	7.80	8.02	7.81	7.48	8.09	7.28	7.38	7.63
2	Conductivity	ms/cm	0.21	0.29	0.31	0.21	0.20	0.28	0.19	0.26
3	Soil Texture	-	Silty Clay	Silty Clay	Silty Clay	Sandy Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay
4	Color	-	Brownish yellow	Brownish yellow	Black-ish Brown	Blacki-sh Brown	Blackish Brown	Blackish Brown	Reddish Brown	Black-ish Brown
5	Water holding Capacity	%	32.10	34.10	41.58	39.10	37.03	41.45	36.10	38.10
6	Bulk Density	g/cc	1.38	1.36	1.32	1.36	1.31	1.32	1.35	1.30
7	Chloride	mg/kg	339.37	286.81	352.99	305.46	285.43	327.91	297.37	264.00
8	Ca	mg/kg	746.48	605.96	408.57	271.90	467.33	526.81	369.94	346.41
9	Sodium	mg/kg	92.79	233.54	188.27	255.73	131.57	189.30	81.39	107.30
10	Potassium	kg/h	331.0	272.37	446.00	153.48	384.23	380.69	263.94	389.48
11	Organic Matter	%	0.70	0.80	0.86	0.76	0.70	0.77	0.64	0.73
12	Mg	mg/kg	46.40	82.49	180.45	108.27	62.49	86.23	25.78	41.25
13	Nitrogen-N	kg/h	285.43	264.21	291.71	271.88	267.83	285.60	276.49	270.50
14	P	kg/h	36.32	44.93	48.64	49.10	46.10	38.10	43.29	52.10
15	Zn	mg/kg	13.22	33.26	18.36	34.12	50.23	31.44	35.58	41.93
16	Mn	mg/kg	216.73	343.74	272.38	323.52	349.02	403.10	286.33	251.12
17	Cr	mg/kg	23.64	21.07	26.97	16.32	28.18	38.36	42.09	20.82
18	Pb	mg/kg	15.83	16.00	11.17	21.55	21.47	19.45	13.06	33.08
19	Cd	mg/kg	3.47	3.29	4.19	4.30	2.30	2.96	1.16	1.20
20	Cu	mg/kg	14.57	24.09	25.27	28.23	16.39	15.49	20.43	17.51
21	Org.Carbon	%	0.41	0.46	0.50	0.44	0.41	0.45	0.37	0.42

4. RESULTS AND DISCUSSIONS
4.1 Air quality analysis of core zone
4.1.1 Concentration of suspended particulate matter
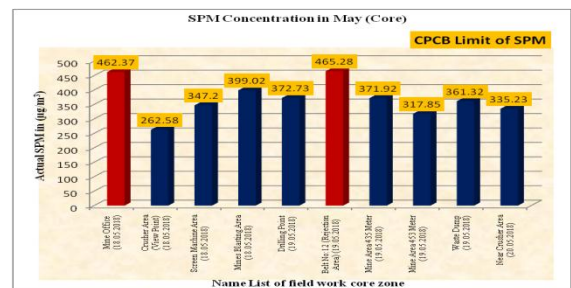

Fig.5: Concentration of SPM in month of May-2018 at core zone

According to the fig.5 it is clearly visible that the concentration of SPM is high at mine working zone, basically in the belt no.12 (Rejection area) and at mine office as compared to the other areas. Highest concentration is found at the belt no.12 (Rejection area) (465.28 µg/m³) and lowest concentration is found at the crusher area (View point) (262.58 µg/m³).
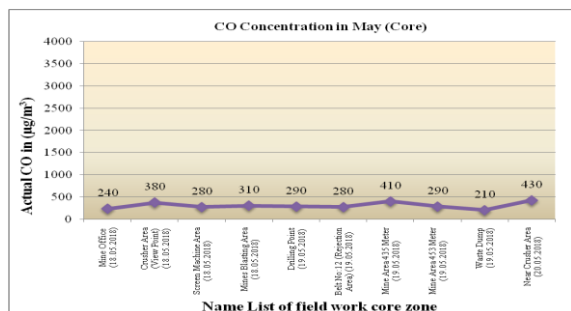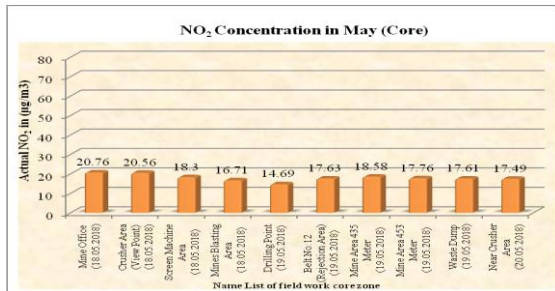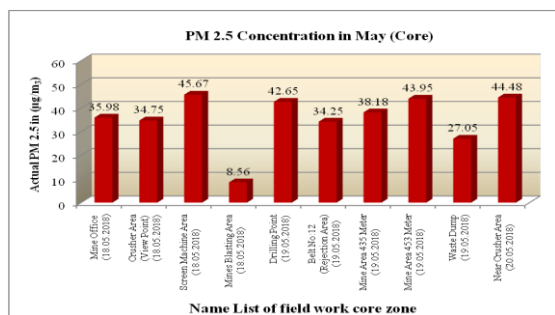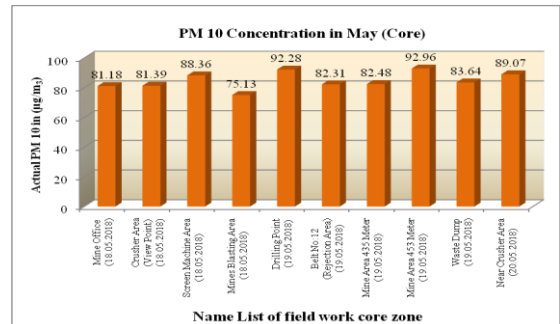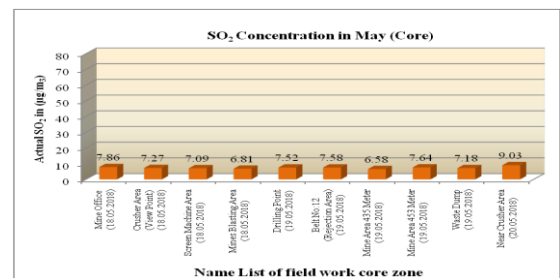
4.1.2 Concentration of CO

Fig. 6: Concentration of CO in month of May-2018 at core zone

According to the fig.6 it is clearly visible that the concentration of CO is high at mine working zone

basically near at the crusher area and at mine area 435 meter as compared to the other areas. Highest concentration is found at mine area 435 meter (430 $\mu g/m^3$) and lowest concentration is found at mine waste dump (210 $\mu g/m^3$).

4.1.3 Concentration of NO_2

Fig.7: Concentration of NO_2 in month of May-2018 at core zone

According to the fig.7 it is clearly visible that the concentration of NO_2 is high at mine working zone basically at mine office, crusher area (view point) and mine area 435 meter as compared to the other areas. Highest concentration is found at mine office (20.76 $\mu g/m^3$) and lowest concentration is found at drilling point (14.69 $\mu g/m^3$).

4.1.4 Concentration of $PM_{2.5}$

Fig.8: Concentration of $PM_{2.5}$ in month of May-2018 at core zone

According to the fig.8 it is clearly visible that the concentration of $PM_{2.5}$ is high at mine working zone basically in the screen machine area and near at the crusher area as compared to the other areas. Highest concentration is found at the screen machine area (45.67$\mu g/m^3$) and lowest concentration is found at the mine blasting area (8.56$\mu g/m^3$).

4.1.5 Concentration of PM_{10}

Fig.9: Concentration of PM_{10} in month of May-2018 at core zone

According to the fig.9 it is clearly visible that the concentration of PM_{10} is high at mine working zone basically at the mine area 453 meter, drilling point and nearby the crusher areas as compared to the other areas. Highest concentration is found at the mine area 453 meter (92.96$\mu g/m^3$) and lowest concentration is found at the mine blasting area (75.13$\mu g/m^3$).

4.1.6 Concentration of SO_2

Fig.10: Concentration of SO_2 in month of May-2018 at core zone

According to the fig.10 it is clearly visible that the concentration of SO_2 is high at mine working zone basically at nearby crusher area, mine office and mine area 453 meter as compared to the other areas. Highest concentration is found at near the crusher area (9.03$\mu g/m^3$) and lowest concentration is found at the mine area 435 meter (6.81$\mu g/m^3$).

4.2 AIR QUALITY ANALYSIS OF BUFFER ZONE
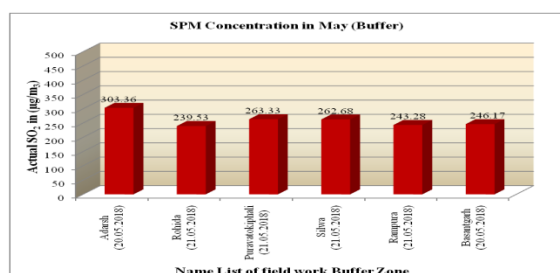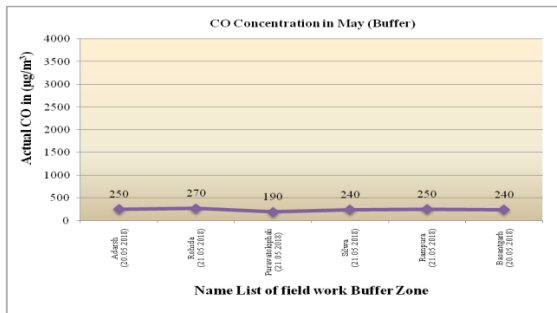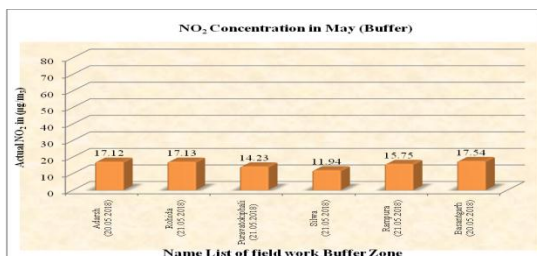
4.2.1 Concentration of SPM

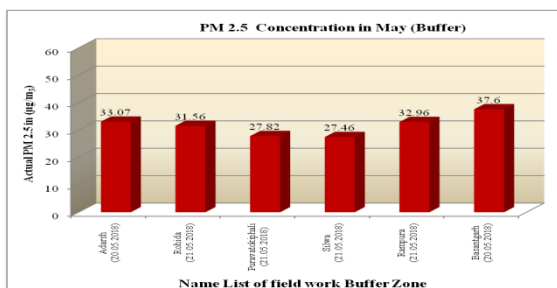**Fig.11:** Concentration of SPM in month of May-2018 at buffer zone

According to the fig.11 it is clearly visible that the concentration of SPM is high at Adarsh and Puravato ki phali villages because these both villages are nearby the working zone of mines. Highest concentration is found at Adarsh village (303.36μg/m³) and lowest concentration is found at Rohida village (239.53μg/m³).
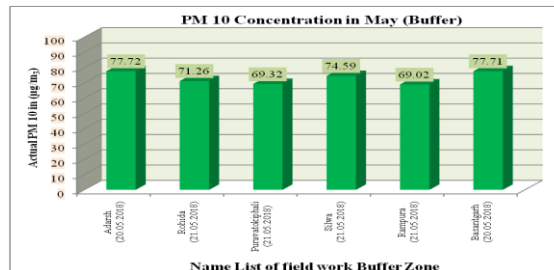
4.2.2 Concentration of CO

Fig. 12 Concentration of CO in month of May-2018 at buffer zone

According to the fig.12 it is clearly visible that the concentration of CO is high at Rohida and Adarsh villages because these both villages are nearby the working zone of mines. Highest concentration is found at Rohida village (270μg/m³) and lowest concentration is found at Puravato ki phali village (190μg/m³).
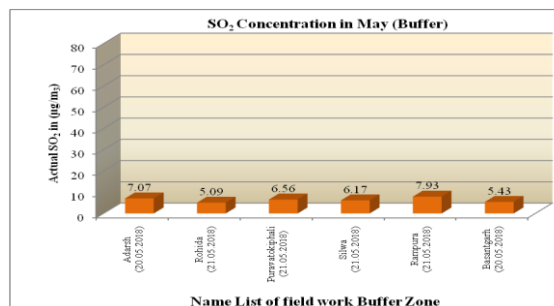
4.2.3 Concentration of NO₂

Fig.13: Concentration of NO_2 in month of May-2018 at buffer zone

According to the fig.13 it is clearly visible that the concentration of NO_2 is high at Basantgarh and Rohida villages because these both villages are nearby the working zone of mines. Highest concentration is found in Basantgarh village (17.54μg/m³) and lowest concentration is found at Silwa village (11.94μg/m³).

4.2.4 Concentration of PM₂.₅

Fig.14: Concentration of $PM_{2.5}$ in month of May-2018 at buffer zone

According to the fig.14 it is clearly visible that the concentration of $PM_{2.5}$ is high at Basantgarh and Adarsh villages because these both villages are very nearby the working zone of mines. Highest concentration is found in Basantgarh village (37.6μg/m³) and lowest concentration is found in Silwa village (27.46μg/m³).

4.2.5 Concentration of PM₁₀

Fig.15: Concentration of PM_{10} in month of May-2018 at buffer zone

According to the fig.15 it is clearly shown that the concentration of PM_{10} is high at Adarsh and Basantgarh villages because these both villages are very nearby the working zone of mines. Highest concentration is found at Adarsh village (77.72μg/m³) and lowest concentration is found at Rampura village (69.02μg/m³).

4.2.6 Concentration of SO₂

Fig.16: Concentration of SO_2 in month of May-2018 at buffer zone

According to the fig.16 it is clearly visible that the concentration of SO_2 is high at Rampura and Adarsh villages because these both villages are very nearby the working zone of mines. Highest concentration is found at Rampura village (7.93μg/m³) and lowest concentration is found in Rohida village (5.09μg/m³).

the observed values of core zone was high as compared to the buffer zone, so it is clearly visible that the concentration of SPM, CO, NO_2, $PM_{2.5}$, PM_{10} and SO_2 was high in the core zone because of continuous operations of mining like as drilling, blasting, loading, unloading, transportation, crushing etc. The concentration of SPM, CO, NO_2, $PM_{2.5}$, PM_{10} and SO_2 was minimum in the buffer zone as compared to the core zone because the buffer zone was not much affected to the mining operations. All

observed values of core zone and buffer zone are found within the prescribed limits of CPCB.

4.3 Noise quality analysis of core zone
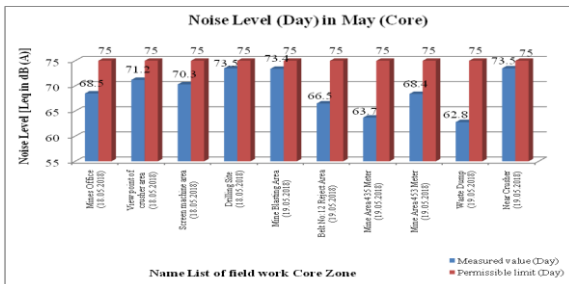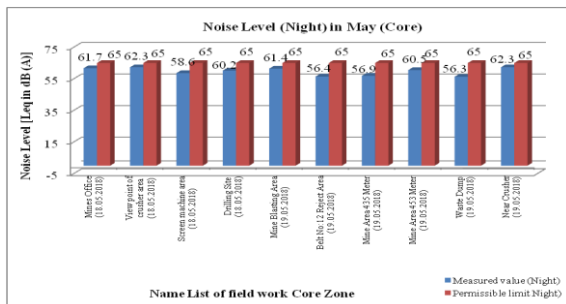
4.3.1 Noise level (Day)

Fig.17: Noise Level (Day) in month of May-2018 at core zone

According to the fig.17 it is clearly visible that the level of noise is high at mine working zone basically at drilling site, near crusher area and mine blasting area. Highest level of noise is found at drilling site (73.5 dB (A)) and near crusher area (73.5 dB (A)). Lowest level of noise is found at mine waste dump (62.8 dB (A)).

4.3.2 Noise Level (Night)

Fig.18: Noise Level (Night) in month of May-2018 at core zone

According to the fig.18 it is clearly visible that the level of noise is high at mine working zone basically at view point of crusher area and near crusher area. Highest level of noise is found at view point of crusher area (62.3dB (A)) and near crusher area (62.3dB (A)). Lowest level is found at mine waste dump (56.3dB (A)).

4.4 Noise quality analysis of buffer zone
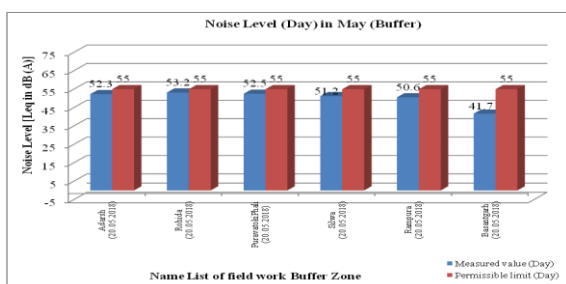
4.4.1 Noise Level (Day)

Fig.19: Noise Level (Day) in month of May-2018 at buffer zone

According to the above fig.19 it is clearly visible that the level of noise is high basically at villages of Rohida and Puravato ki phali because of these both villages are very nearby to the working zone of mines. Highest level of noise is found at Rohida (53.2dB (A)) and lowest level of noise is found at Basantgarh (41.7dB (A)).
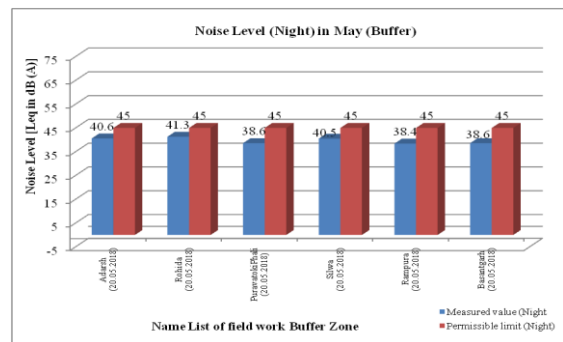
4.4.2 Noise Level (Night)

Fig.20: Noise Level (Night) in month of May-2018 at buffer zone

According to the above fig.20 it is clearly visible that the level of noise is high basically at villages of Rohida and Adarsh because of these both villages are very nearby to the working zone of mines. Highest level of noise is found at Rohida (41.3dB (A)) and lowest level of noise is found at Rampura (38.4dB (A)).

A measured value of core was high as compared to the buffer zone. So it's clearly visible that the noise level was high in the core zone due to continuous mining operations. Highest level of noise was found at drilling site due to drilling machines are continued to worked in a day time. Lowest level of noise was found at drilling site and mine blasting area because of drilling and blasting operation was not performed during the time of night. Highest level of noise was found at Rohida village due to mostly populated area and train traffic in a day time. Thus, after studying the results summarized above it can be concluded that this study area is not generating any noise above limit prescribed by government of India in the regulations and circulars.

4.5 WATER QUALITY ANALYSIS

The values of outlet waste water are more/less unchanged as compared to corresponding inlet water. According to the analysis, any kind of toxic element was not used during mining activities.

4.6 SOIL QUALITY ANALYSIS

The pH values and other parameters show that the soil in the region is generally alkaline. It was also found that there is not much effect due to mining activities on the

soil of the vicinity in the study area and it is still suitable for the agriculture.

5. CONCLUSIONS

In light of these faces and environmental pollution assessment, in the present study a case study of a limestone opencast mine was taken up and relevant observations were recorded and subsequently analyzed according to norms laid down by MoEF (Ministry of Environment and Forest) and CPCB (Central Pollution Control Board), GOI. For the purpose of assessment of environment pollution as a result of limestone mining activities, in this study mainly Air pollution, Noise pollution, Water pollution soil pollution were considered for analyzing impacts in pre mining and post mining scenario.

Accordingly the impacts of each parameter were considered in core and buffer zone. This study inferred that the main sources of Air pollution are excavation, transportation and machine operations. The study finds all the major related experiment results within the permissible limit. This study also suggested plantation of tree along the haul roads, settlements and unused areas as key mitigation measures for controlling air pollution. Also the water sprinkling on the sites of major air polluting sites are suggested.

According to the analysis, the values of outlet waste water are more/less unchanged as compared to corresponding inlet water and there is any kind of toxic element was not used in carried out mining activities. There will be no impact on water environment due to mining and there will be no waste water generation from the proposed mining activity.

This study inferred that the noise levels are not above the prescribed limits and that too are concentrated in the operation region. Also it was found that there is no effect on the nearby settlement area be As per the study, the mine is already in working condition and the mining activity are confined to the mineralized zone only and proper pollution measures are already in place, thus the proposed expansion in limestone production capacity. The mining activities are being done as also proposed to be done in a systematic manner by maintaining the road infrastructure and vehicle transport which will be protective measure for preserving the topography and drainage in the area. No human settlement should be permitted in the lease mining or nearby area. No mining will be carried out during the rainy season to minimize impact on aquatic life. The socio-economic status of the people will be improved. The local people have been provided with either direct employments or indirect employment such as business, contract works and

development work like roads, etc. and other welfare amenities such as medical facilities, conveyance, free education, drinking water supply etc. Except dust generation, there is no source which can show a probability for health related issues. Regular water sprinkling with sprinkle mounted tankers and dust masks to the workers will be very useful. All workers must be subjected to medical examination as per Mines Rule 1955 both at time of appointment and at least once in a year. Insurance of all employees as per the rules must also be provided.

6. REFERENCES

1. Carlos V M, Pompeo M L M, Lobo F L, 2011, "Impact of coal mining on water quality of three artificial lakes in Morozini River Basin", Acta Limnol.Bras, Vol. 23, pp: 271-281.

2. Ghosh, M.K and Majee, S.R.2001. Air pollution due to opencast coal mining and its control in Indian context. Journal of scientific and industrial research**60**: 786-797.

3. Kittipongvises, S. 2017.Assessment of environmental impacts of limestone quarrying operations in Thailand. Project report submitted to environmental research institute, Chulalongkorn University, **20**: 67–83.

4. Kumar, S.G and Reddy, N.A. 2016. Application of remote sensing to assess environmental impact of limestone mining in the Ariyalur district of Tamilnadu, India. Journal of Geomatics**10** (2): 158-163.

5. Lamare, E.R. and Singh, O.P. 2014. Degradation in water quality due to limestone mining in east jaintia hills, Meghalaya, India. Research journal of environment sciences**3** (5):13-20.

6. Lilic, N., Cvjetic, A., Knezevic, D., Milisavljevic, V. 2018, Dust and Noise Environmental Impact Assessment and Control in Serbian Mining Practice. Journal of MDPI, Vol.8, pp: 1-15.

7. Mankar, P., Mandal, B., Chatterjee, D. 2019. Monitoring and Assessment of Airborne Respirable Limestone Dust and Free Silica Content in an Indian Mine. Journal of Health & Pollution, Vol.9, pp: 1-10.

8. Mishra, P.C., Sahu, H.B, and Patel, R.K. 2004. Environmental pollution status as a result of limestone and dolomite mining. Pollution research**23**: 427-432.

9. Mishra, U.K., Tripathi, Mishra, A.K, Mishra, S.K, and Dwivedi, R. 2013. Assessment of physico-chemical parameters of limestone mines water near J.P. cement plant rewa district M.P. India. International journal of engineering science invention**2**:58-68.

10. Mondal, S., Bandayopadhyay, J., Chakravatry, D. 2014. Scientific investigation of the environmental impact of mines Using geospatial techniques over a small part of keonjhar district of Orissa. International journal of scientific and research, **4**: 1-8.