Chapter – 6 Additional Studies

6.1 GENERAL

An additional study including Risk Assessment (RA), Disaster Management Plan and Occupational, Health & Safety Management System has been carried out for the proposed expansion project to identify main hazards, to review the effectiveness of selected safety measures and to expand the safety measures in order to achieve a zero risk culture at the company. The study has been incorporated in the Environmental Impact Assessment (EIA) report to support the Environmental Management Plan. The study for the project has been further divided into the following sections:

- Risk assessment (Part - 01)
- Disaster Management Plan (Part - 02)
- Occupational Health and Safety Management System (Part - 03)

6.2 SCOPE OF THIS STUDY

The Qualitative Risk Assessment (QRA) study for proposed expansion has specifically been conducted considering the Terms of References (TORs) given by the State Expert Appraisal Committee for Environmental Clearance (EC).

The study has been carried out with a view to comply the following TORs:

- TOR No. 41: Disaster Preparedness and Emergency Management Plan including Risk Assessment and damage control needs to be addressed and included
- TOR No. 42: Details of occupational health programme.

Additional TOR for Synthetic Organic Chemical Industry

- TOR No. 10: Details of occupational health programme.
- TOR No. 11: A toxic management plan shall be prepared.
- TOR No. 13: What are onsite and offsite emergency plan during chemical disaster.

PART 01 – RISK ASSESSMENT

6.3 GENERAL

Atul Ltd. is an agrochemical, Pharma intermediates, dyes & dyes intermediates, polymers, resins and specialty chemicals unit located at Atul, Di. Valsad, Gujarat. Hence, it deals with various chemicals, some of which are hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of them. Fire, explosion, toxic release or combinations of them are the hazards associated with industrial plants using hazardous chemicals. Comprehensive, systematic and sophisticated methods of Safety Engineering, such as, Hazard Analysis and Quantitative Risk Assessment have been developed to improve upon the integrity, reliability and safety of the industrial plant.

6.4 OBJECTIVES OF RISK ASSESSMENT

Risk analysis involves an extensive hazard analysis. It involves the identification and assessment of risks to which the plant personnel, neighboring populations and the surrounding environment are exposed as a result of the hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies. It provides basis for what should be the type and capacity of its on-site and off-site emergency plan and the types of safety measures to be required for the same.

Objectives of risk assessment are:

- To identify hazard and risks resulting from the hazards
- To study and foresee the effects of such risks on the workers, public, property and the environment
- To find out necessary control measures to prevent or minimize risk
- To comply the legal requirement by various safety and environment laws of the country
- To get the necessary information for Emergency planning and evacuation

6.5 SCOPE OF THE STUDY

Atul Ltd. has proposed to enhance the production of Dyes, Chlor alkali products, Agrochemical, Resins and other chemicals. The process deals with various hazardous chemicals. Hence, a quantitative risk assessment (QRA) was undertaken to assess the risk impacts associated with the installation, and to establish a system for minimizing these risks. The QRA study in this report has specifically been conducted considering the Terms of References (TORs) given by Expert Appraisal Committee of MoEF&CC for Environment Clearance (EC) as mentioned below:

- TOR No. 41: Disaster Preparedness and Emergency Management Plan including Risk Assessment and damage control needs to be addressed and included
- TOR No. 42: Details of occupational health programme.

i. Details of existing Occupational & Safety Hazards. What are the exposure levels of above mentioned hazards and whether they are within Permissible Exposure Level (PEL). If these are not within PEL, what measures the company has adopted to keep them within PEL so that health of the workers can be preserved.

ii. Details of exposure specific health status evaluation of worker. If the workers' health is being evaluated by pre designed format, chest x rays, Audiometry, Spirometry, vision testing (Far & Near vision, colour vision and any other ocular defect) ECG, during pre placement and periodical examinations give the details of the same. Details regarding last month analyzed data of above mentioned parameters as per age, sex, duration of exposure and department wise.

iii. Annual report of health status of workers with special reference to Occupational Health and Safety.

iv. Action plan for the implementation of OHS standards as per OSHAS/USEPA.

v. Plan and fund allocation to ensure the occupational health & safety of all contract and casual workers.

Additional TOR for Synthetic Organic Chemical Industry

- TOR No. 10: Details of occupational health programme.

i. To which chemicals, workers are exposed directly or indirectly.

ii. Whether these chemicals are within Threshold Limit Values (TLV)/ Permissible Exposure Levels as per ACGIH recommendation.

iii. What measures company has taken to keep these chemicals within PEL/TLV.

iv. How the workers are evaluated concerning their exposure to chemicals during pre-placement and periodical medical monitoring.

v. Liver function tests (LFT) during pre-placement and periodical examination.

- TOR No. 11: A toxic management plan shall be prepared.
- TOR No. 13: What are onsite and offsite emergency plan during chemical disaster.

6.6 METHODOLOGY ADOPTED

Consequences of loss of containment can lead to hazardous situation in any industry handling potentially hazardous materials. Following factors govern the severity of consequence of the loss of containment:

- Intrinsic properties; flammability, instability and toxicity.
- Dispersive energy; pressure, temperature and state of matter.
- Quantity present
- Environmental factors; topography and weather.

Consequence analysis and calculations are effectively performed by computer software using models validated over a number of applications. Consequence modelling is carried out by PHAST of DNV Software.

PHAST contains data for a large number of chemicals and allows definition of mixtures of any of these chemicals in the required proportion. The calculations by PHAST involves following steps for each modelled failure case:

- Run discharge calculations based on physical conditions and leak size
- Model first stage of release (for each weather category)
- Dispersion modeling taking into account weather conditions
- In case of flammable gas release, calculate size of effect zone for fire and explosion

6.7 CONSEQUENCE ASSESSMENT

For each defined failure case for the Chemical Storage Facility, the consequence modelling is carried out to determine the potential effects of releases, the results of which are discussed in terms of hazard distances.

The corresponding consequences in terms of flammable and explosive effects are modelled and analysed by using PHAST software version 6.7. The flammable consequences that may potentially arise from failure of a storage vessel are:

- Jet fires;
- Flash fires;
- Toxic consequence;
- Fireball; and/or
- Explosions.

The hazard distances for each event depend on the leak size, operating conditions, weather conditions, the release location, the release conditions and the dispersion characteristics as calculated by the PHAST software. Each failure case is entered into PHAST software, where the corresponding consequences are calculated, based on built-in programmable event trees.

The dispersion of gas releases from different hole sizes are modelled using state-of-art methods. For flammable, toxic and explosive consequence, the effect zones for the various possible outcomes of such a release are determined for both early and delayed ignition presents the consequence hazard distances for the various tank failure case scenarios.

Consequence distances for the following weather conditions have been evaluated in the tables below,

D11: D stability (neutral) and 11 m/s wind speed.

B2: B stability (neutral) and 2 m/s wind speed.

F2: F stability (very stable) and 2 m/s wind speed.

The following descriptions are based on the different hazard types modelled, which are jet fires, flash fires, toxic consequence, vapor cloud explosions, pool fires.

6.7.1 Jet Fire

A jet fire may result from ignition of a high-pressure leakage of gas from process plants or storage tanks. Jet fires are characterized by a high momentum jet flame that is highly turbulent. The flame is lifted above the exit opening from which the gas is discharged generally at high pressure. This distance appears because the combustion process can only take place when the flow velocity is reduced sufficiently to allow stable combustion. Another feature of such fires is the high entrainment of air into the flame plume due to the highly turbulent flame.

The extent of the consequence of a Jet fire is represented by the thermal radiation envelope. Three levels of radiation are presented in this report, i.e.:

- 4 kW/m^2; this level is sufficient to cause personnel if unable to reach cover within 20 s; however blistering of the skin (second degree burn) is likely; 0: lethality,
- 12.5 kW/m^2; this level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
- 37.5 kW/m^2; this level of radiation is assumed to give 100% fatality.

Jet fires are a direct hazard to people and structures caught within the flame envelope or exposed to high thermal radiation levels. This scenario is considered for the whole storage facility in which material is handled at the significant pressures.

6.7.2 Flash Fire

A flash fire is the non-explosive combustion of a flammable vapour cloud resulting from a release of volatile material into the open air, which, after mixing with air, ignites. The flame initially propagates slowly, often 10 m/s or less, and in the Shell Maplin Sands experiments often was unable to overcome the wind speed to flash back to the source. However, where congestion or confinement exist, flame speeds can accelerate to hundreds of m/s and overpressure effects will result.

The cloud burns as a flash fire and the major hazard to people and to equipment (especially control cabling) is for those within the burning envelope (including those who might be above on elevated structures). Flame duration and intensity for most flammable clouds are insufficient to cause a significant thermal radiation hazard outside the flame envelope. The literature provides little information on the effects of thermal radiation from flash fires, probably because thermal radiation hazards from burning vapour clouds are considered less significant than possible blast effects. Furthermore, flash combustion of a vapour cloud normally lasts no more than a few tens of seconds. Propane experiments (Maplin) gave average flame speeds of up to about 12 m/s. higher transient flame speeds, up to 28 m/s were observed in one instance. Pool Fire Formation of pools is also likely, particularly for materials that have high boiling points. Flash calculations were conducted to consider the vaporization of light components in the streams, especially for high pressure or high temperature process conditions. Flashed vapor and light component releases will behave as jets, with jet fire and vapor cloud impacts modelled in the same way as for gas releases, as set out in the previous sections.

The extent of the consequence of a flash fire is represented by the flash fire envelope. i.e. the maximum dispersion distance of the flammable cloud at LFL concentration.

6.7.3 Vapor Cloud Explosion (VCE)

Due to the large volume of flammable materials and highly flammable material with higher proportion of the more volatile components, there is significant potential for Vapour Cloud Explosion Events (VCE) in case any ignition source is not available immediately.

Maximum flammable fuel volume for prediction of explosion overpressure effects estimated to be considerable based on inventory, isolation time, time for vaporization and probability of VCE scenario.

6.7.4 Toxic Consequences

In the event of a release of toxic material not being ignited, the concentration of material in the cloud is progressively reduced by dilution with air until the concentration is well below any toxic effects. Such releases do not directly affect the plant, but cloud affect people enveloped by the cloud. Distances to 3% fatality level, or the IDLH concentration and the exposure limit have been calculated using the dispersion models. Table No. 6.1 below summarises the toxic consequence results.

Consequence results tables below summarises representative failure cases together with their various consequence results.

Table No. 6.1 – Consequence Results at Atul

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
1.	Caustic Chlorine Plant	Caustic Chlorine Plant (ST3 & ST5)	Small	0.314 kg/s & 300 s	Toxicity	IDLH (10 ppm)	196.53	204.71	1345.30
			Medium	7.858 kg/s & 300 s	Toxicity	IDLH (10 ppm)	792.68	720.40	4996.31
			Large	125.7 kg/s & 238.6 s	Toxicity	IDLH (10 ppm)	2654.64	2252.39	18207.50
			Rupture	282.9 kg/s & 106 s	Toxicity	IDLH (10 ppm)	2816.40	2382.01	18556.80

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
		Chlorine Tonner	Small	0.056 kg/s & 300 s	Toxicity	IDLH (10 ppm)	97.76	100.97	641.06
			Medium	1.41 kg/s & 300 s	Toxicity	IDLH (10 ppm)	498.85	491.54	3168.01
			Rupture	5.82 kg/s & 154.7 s	Toxicity	IDLH (10 ppm)	905.44	864.48	5547.69
2.	Sulphuric Acid Plant	CSA ST6/7/10	Small	0.235 kg/s & 300 s	Toxicity	IDLH (50 ppm)	4.32	11.97	17.19
			Medium	5.88 kg/s & 300 s	Toxicity	IDLH (50 ppm)	24.24	39.35	111.12
			Large	94.22 kg/s & 300 s	Toxicity	IDLH (50 ppm)	95.87	87.28	386.22
			Rupture	212 kg/s & 259.4 s	Toxicity	IDLH (50 ppm)	119.61	94.18	403.98
		CSA ST-102	Small	0.218 kg/s & 300 s	Toxicity	IDLH (50 ppm)	0.93	0.21	0.88
			Medium	5.45 kg/s & 300 s	Toxicity	IDLH (50 ppm)	2.21	9.36	62.71
			Large	87.23 kg/s & 300 s	Toxicity	IDLH (50 ppm)	7.73	41.76	215.93
			Rupture	196.3 kg/s & 300 s	Toxicity	IDLH (50 ppm)	9.03	37.86	237.88
		Liq. SO3(ST-12/106)	Small	0.211 kg/s & 300 s	Toxicity	IDLH (100 ppm)	37.35	32.68	116.58
			Medium	5.274 kg/s & 300 s	Toxicity	IDLH (100 ppm)	65.71	102.78	445.71
			Large	84.39 kg/s & 189.6 s	Toxicity	IDLH (100 ppm)	287.21	295.55	1117.14
			Rupture	189.9 kg/s & 84.27 s	Toxicity	IDLH (100 ppm)	349.54	343.59	1124.13
		25% Oleum ST1	Small	0.42 kg/s & 300 s	Toxicity	IDLH (100 ppm)	20.19	25.31	91.75
			Medium	10.56 kg/s & 300 s	Toxicity	IDLH (100 ppm)	89.94	80.51	290.29
			Large	169 kg/s & 300 s	Toxicity	IDLH (100 ppm)	231.26	236.03	811.92
			Rupture	280.2 kg/s & 210.4 s	Toxicity	IDLH (100 ppm)	300.72	300.98	1080.80
		25% Oleum ST2	Small	0.446 kg/s & 300 s	Toxicity	IDLH (100 ppm)	21.18	26.47	95.58
			Medium	11.16 kg/s & 300 s	Toxicity	IDLH (100 ppm)	91.87	83.31	300.58
			Large	178.5 kg/s & 300 s	Toxicity	IDLH (10 0ppm)	234.79	241.94	835.40
			Rupture	401.6 kg/s & 300 s	Toxicity	IDLH (100 ppm)	320.39	341.35	1252.56
		25% Oleum ST9	Small	0.42 kg/s & 300 s	Toxicity	IDLH (100 ppm)	15.54	30.92	99.03
			Medium	10.56 kg/s & 300 s	Toxicity	IDLH (100 ppm)	100.98	97.28	339.88
			Large	169 kg/s & 163.2 s	Toxicity	IDLH (100 ppm)	303.93	210.74	681.43
			Rupture	380.2 kg/s	Toxicity	IDLH (100	338.59	206.43	646.86

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
				& 72.52 s		ppm)			
		65% Oleum ST101& 103	Small	0.502 kg/s & 300 s	Toxicity	IDLH (100 ppm)	30.18	43.49	174.48
			Medium	12.57 kg/s & 300 s	Toxicity	IDLH (100 ppm)	165.20	147.05	559.12
			Large	201.2 kg/s & 300 s	Toxicity	IDLH (100 ppm)	519.81	420.68	1523.10
			Rupture	452.6 kg/s & 169.8 s	Toxicity	IDLH (100 ppm)	641.60	506.35	1795.05
3.	Phosgene	Chlorine Tonner	Small	0.056 kg/s & 120 s	Toxicity	IDLH (10 ppm)	84.21	86.84	522.03
			Medium	1.41 kg/s & 120 s	Toxicity	IDLH (10 ppm)	417.89	411.95	2477.81
			Rupture	5.82 kg/s & 120 s	Toxicity	IDLH (10 ppm)	856.86	822.09	5155.86
		Phosgene Storage tank-18-1/18-2	Small	0.1539 kg/s & 1800 s	Toxicity	IDLH (2 ppm)	374.48	408.51	3244.90
			Medium	3.849 kg/s & 264 s	Toxicity	IDLH (2 ppm)	641.89	601.48	5485.70
			Large	61.58 kg/s & 16.5 s	Toxicity	IDLH (2 ppm)	728.63	694.14	6096.69
			Rupture	138.6 kg/s & 7.33 s	Toxicity	IDLH (2 ppm)	728.63	698.43	6187.58
		Phosgene Service tank-19-1/19-2/ 19-3	Small	0.141 kg/s & 1800 s	Toxicity	IDLH (2 ppm)	357.25	387.63	3097.62
			Medium	3.526 kg/s & 288.2 s	Toxicity	IDLH (2 ppm)	633.35	594.28	5408.01
			Large	56.41 kg/s & 18.01 s	Toxicity	IDLH (2 ppm)	741.54	656.32	5830.80
			Rupture	126.9 kg/s & 8s	Toxicity	IDLH(2ppm)	742.67	679.61	6191.72
		Phosgene reactor	Small	0.001261 kg/s & 60 s	Toxicity	IDLH (2 ppm)	NH	NH	22.98
			Medium	0.03152 kg/s & 60 s	Toxicity	IDLH (2 ppm)	NH	16.99	103.25
			Rupture	0.292 kg/s & 6.83 s	Toxicity	IDLH (2 ppm)	NH	22.81	162.45
		Phosgene cylinder	Small	0.00814 kg/s & 120 s	Toxicity	IDLH (2 ppm)	28.21	29.03	147.29
			Medium	0.2036 kg/s & 120 s	Toxicity	IDLH (2 ppm)	126.93	127.51	452.17
			Rupture	1.892 kg/s & 16.92 s	Toxicity	IDLH (2 ppm)	146.62	151.03	697.20
			Small	0.0006816 kg/s & 180s	Flash Fire	125000 ppm	0.30	0.29	0.30
					Toxicity	IDLH (1200 ppm)	NH	NH	NH
			Medium	0.01704 kg/s & 180 s	Flash Fire	125000 ppm	1.03	1.18	1.26
					Toxicity	IDLH (1200 ppm)	NH	NH	NH
			Large	0.2726 kg/s & 164.9 s	Flash Fire	125000 ppm	3.17	3.84	4.28
					Toxicity	IDLH (1200 ppm)	NH	NH	NH

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
			Rupture	0.6135 kg/s & 73.29 s	Flash Fire	125000 ppm	4.37	5.38	6.05
					Toxicity	IDLH (1200 ppm)	NH	NH	NH
		Phosgene line transfer to PHIN/NBD	Small	0.007104 kg/s & 300 s	Toxicity	IDLH (2 ppm)	NH	NH	102.88
			Medium	0.1776 kg/s & 28.15 s	Toxicity	IDLH (2 ppm)	NH	34.59	136.32
			Large	2.841 kg/s & 1.76 s	Toxicity	IDLH (2 ppm)	NH	86.83	154.55
			Rupture	6.393 kg/s & 0.7821 s	Toxicity	IDLH (2 ppm)	NH	92.02	162.50
		Ammonia Cylinder	Small	0.03349 kg/s & 120 s	Flash Fire	160000 ppm	2.08	1.70	2.51
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	2.40	3.03	3.03
					Toxicity	IDLH (300 ppm)	21.79	32.16	95.16
			Medium	0.8373 kg/s & 47.77 s	Flash Fire	160000 ppm	9.92	7.93	10.24
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	8.65	11.02	11.01
					Toxicity	IDLH (300 ppm)	84.11	126.11	298.03
			Large	13.4 kg/s & 2.99 s	Flash Fire	160000 ppm	36.46	31.55	26.82
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	29.24	37.29	37.28
					Toxicity	IDLH (300 ppm)	179.53	286.25	44.27
			Rupture	30.14 kg/s & 1.33 s	Flash Fire	160000 ppm	53.52	39.24	37.18
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	42.00	53.38	53.37
					Toxicity	IDLH (300 ppm)	235.49	96.96	51.24
		Ammonia Chilling tank	Small	0.5448 kg/s & 300 s	Flash Fire	160000 ppm	3.44	4.89	5.24
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	7.76	9.66	9.66
					Toxicity	IDLH (300 ppm)	113.67	115.09	283.81
			Medium	13.62 kg/s & 14.68 s	Flash Fire	160000 ppm	33.87	28.14	28.07
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	32.74	41.41	41.39
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	30.05	24.62	22.03
					Toxicity	IDLH (300 ppm)	238.89	272.82	405.14
			Large	217.9 kg/s & 0.92 s	Flash Fire	160000 ppm	95.29	75.74	80.08
					Jet Fire	37.5 kW/m^2	75.79	NR	NR
						4 kW/m^2	113.24	140.18	140.12
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	42.90	38.30	33.72

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
					Toxicity	IDLH (300 ppm)	345.59	592.07	741.72
			Rupture	490.4kg/s & 0.41s	Flash Fire	160000 ppm	133.99	104.39	109.76
					Jet Fire	37.5 kW/m^2	109.41	NR	NR
						4 kW/m^2	162.37	200.12	200.02
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	45.95	41.67	37.21
					Toxicity	IDLH (300 ppm)	458.57	762.19	968.11
		MDC Chilling Tank	Small	0.264 kg/s & 1800 s	Flash Fire	159000 ppm	0.88	1.47	1.66
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	4.75	4.13	4.24
			Medium	6.59 kg/s & 151.2 s	Flash Fire	159000 ppm	2.13	1.92	2.01
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	5.87	5.52	4.89
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	13.20	9.54	9.56
			Large	105.6 kg/s & 9.47 s	Flash Fire	159000 ppm	2.35	2.00	2.44
					Jet Fire	37.5 kW/m^2	10.28	NR	NR
						4 kW/m^2	17.65	10.71	8.37
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	13.09	9.73	9.74
			Rupture	237.6 kg/s & 4.21 s	Flash Fire	159000 ppm	2.35	2.10	2.44
					Jet Fire	37.5 kW/m^2	12.60	NR	NR
						4 kW/m^2	20.87	11.75	9.47
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	13.12	9.77	9.80
4.	SHED C	Anhydrous Ammonia Storage (C-03/03/30)	Small	0.5492 kg/s & 600 s	Flash Fire	160000 ppm	9.18	9.86	7.03
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	6.63	8.39	8.39
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	5.59	5.29	5.34
					Toxicity	IDLH (300 ppm)	98.09	102.01	442.98
			Medium	13.73 kg/s & 600 s	Flash Fire	160000 ppm	28.43	26.61	15.19
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	26.73	33.92	33.91
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	20.30	19.38	19.36
					Toxicity	IDLH (300 ppm)	352.57	263.83	1182.21
			Large	219.7 kg/s & 45.52 s	Flash Fire	160000 ppm	79.76	46.48	43.22
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	92.47	114.74	114.70
					Pool Fire	37.5 kW/m^2	NR	NR	NR

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
						4 kW/m^2	33.44	32.39	32.44
					Toxicity	IDLH (300 ppm)	687.32	278.32	1879.53
			Rupture	494.3 kg/s & 20.23 s	Flash Fire	160000 ppm	105.99	61.38	59.27
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	132.67	163.91	163.84
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	33.74	32.64	32.67
					Toxicity	IDLH (300 ppm)	804.30	372.24	1956.15
5.	Epoxy	T-601	Small	0.14 kg/s & 1200 s	Flash Fire	38000 ppm	0.93	1.08	1.21
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	0.51	1.14	1.14
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	10.39	8.84	8.86
					Toxicity	IDLH (7ppm)	69.23	66.31	462.61
			Medium	3.56 kg/s & 1200 s	Flash Fire	38000 ppm	1.51	2.22	2.59
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	2.65	2.93	2.46
					Pool Fire	37.5 kW/m^2	9.06	9.08	9.10
						4 kW/m^2	38.52	35.89	35.98
					Toxicity	IDLH (7 ppm)	314.55	296.78	2135.92
			Large	56.96 kg/s & 1200 s	Flash Fire	38000 ppm	1.74	2.75	3.90
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	7.08	4.32	3.69
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	483.14	491.45	3395.35
			Rupture	128.2 kg/s & 829.8 s	Flash Fire	38000 ppm	1.94	3.02	4.37
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	7.63	4.91	4.31
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	492.51	464.64	3493.11
		T-601-A	Small	0.14 kg/s & 1200 s	Flash Fire	38000 ppm	1.00	1.17	1.22
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	0.59	1.19	1.19
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	10.87	9.32	9.34
					Toxicity	IDLH (7 ppm)	72.97	69.81	486.05
			Medium	3.56 kg/s & 1200 s	Flash Fire	38000 ppm	1.59	2.34	2.80
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	2.95	3.05	2.59
					Pool Fire	37.5 kW/m^2	9.53	9.56	9.59
						4 kW/m^2	40.44	37.75	37.84

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
					Toxicity	IDLH (7 ppm)	332.30	313.53	2251.19
			Large	56.96 kg/s & 1200 s	Flash Fire	38000 ppm	1.79	2.85	4.04
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	7.07	4.47	3.92
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	484.65	493.45	3433.08
			Rupture	128.2 kg/s & 825.5 s	Flash Fire	38000 ppm	2.06	3.17	4.57
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	7.64	5.11	4.58
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	494.26	466.81	3528.91
		T-608	Small	0.14 kg/s & 1200 s	Flash Fire	38000 ppm	0.92	0.79	1.23
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	0.23	0.19	0.18
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	9.89	8.34	8.35
					Toxicity	IDLH (7 ppm)	63.87	62.21	427.83
			Medium	3.56kg/s & 1200s	Flash Fire	38000 ppm	1.38	1.99	2.21
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	1.58	1.98	1.73
					Pool Fire	37.5 kW/m^2	8.57	8.57	8.59
						4 kW/m^2	36.54	33.94	34.01
					Toxicity	IDLH (7 ppm)	283.42	272.61	1939.12
			Large	56.96 kg/s & 596.9 s	Flash Fire	38000 ppm	1.50	2.12	2.66
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	4.76	2.82	2.36
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	434.09	376.93	2646.70
			Rupture	128.2 kg/s & 265.3 s	Flash Fire	38000 ppm	1.49	2.18	2.67
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	5.07	3.19	2.72
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	402.02	386.87	2741.92
		T-609	Small	0.14 kg/s & 1200 s	Flash Fire	38000 ppm	0.93	1.07	1.22
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	7.80	6.42	6.41
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	10.48	8.92	8.94
					Toxicity	IDLH (7 ppm)	67.89	65.99	464.80
			Medium	3.56 kg/s &	Flash Fire	38000 ppm	1.51	1.99	2.39

Sr. No.	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 2m/s	F 2m/s
				1200 s	Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	1.81	2.05	1.79
					Pool Fire	37.5 kW/m^2	9.15	9.16	9.18
						4 kW/m^2	38.90	36.23	36.29
					Toxicity	IDLH (7 ppm)	309.71	292.48	2073.14
			Large	56.96 kg/s & 1036 s	Flash Fire	38000 ppm	1.57	2.21	2.69
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	4.73	2.92	2.49
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH (7 ppm)	390.79	356.33	2564.68
			Rupture	128.2 kg/s & 460.3 s	Flash Fire	38000 ppm	1.57	2.27	2.96
					Jet Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	5.06	3.32	2.91
					Pool Fire	37.5 kW/m^2	12.14	11.70	11.70
						4 kW/m^2	52.29	48.84	48.79
					Toxicity	IDLH(7ppm)	384.04	363.58	2572.62
6.	FDH	Methanol Tank (380 KL)	Small	0.124 kg/s & 600 s	Flash Fire	73000 ppm	1.11	2.41	3.15
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	5.66	4.88	4.90
					Toxicity	IDLH (6000 ppm)	1.35	5.04	16.93
			Medium	3.09 kg/s & 600 s	Flash Fire	73000 ppm	2.58	5.08	5.27
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	19.69	18.97	19.08
					Toxicity	IDLH (6000 ppm)	4.89	7.77	20.21
		Methanol Tank (90 KL)	Small	0.124 kg/s & 600 s	Flash Fire	73000 ppm	1.21	2.41	3.15
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	5.66	4.88	4.90
					Toxicity	IDLH (6000 ppm)	0.14	1.18	16.17
			Medium	3.09 kg/s & 600 s	Flash Fire	73000 ppm	2.58	5.08	5.27
					Pool Fire	37.5 kW/m^2	NR	NR	NR
						4 kW/m^2	19.69	18.97	19.08
					Toxicity	IDLH (6000 ppm)	0.14	1.92	19.08
			Tank On Fire		Pool Fire	37.5 kW/m^2	31.91	35.23	178.59

The figures below represent the consequence distance due to toxic release. Due to practical difficulties in order to capture the distances, the consequence distances between 200 m and 2000 m are only represented. The consequence contours are shown in the best possible manner for easy reference and understanding.

Figure No. 6.1 – Small leak of 25% oleum from the 25% oleum ST1

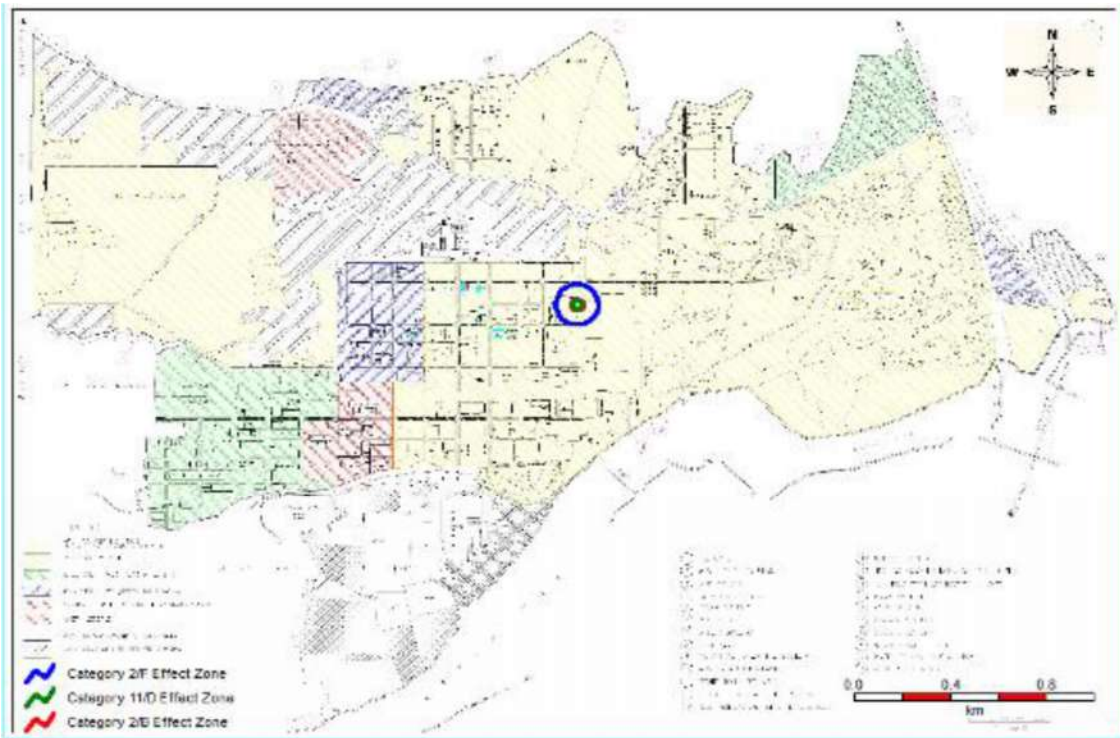


Figure No. 6.2 – Medium leak of 25% oleum from the 25% oleum ST1

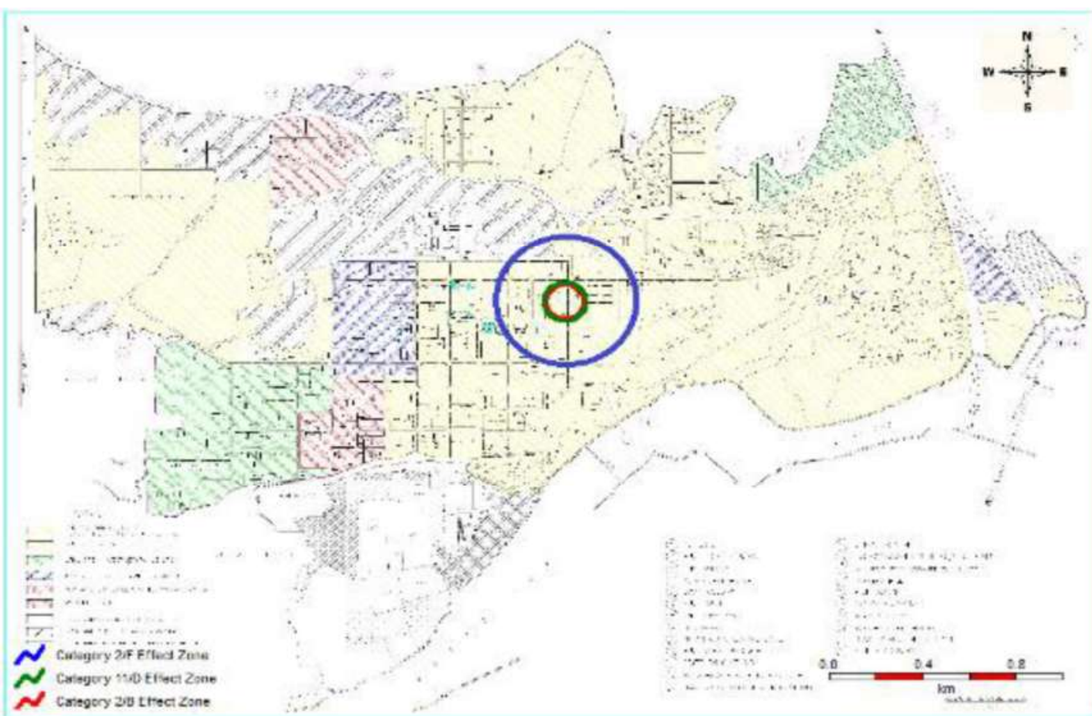


Figure No. 6.3 – Large leak of 25% oleum from the 25% oleum ST1

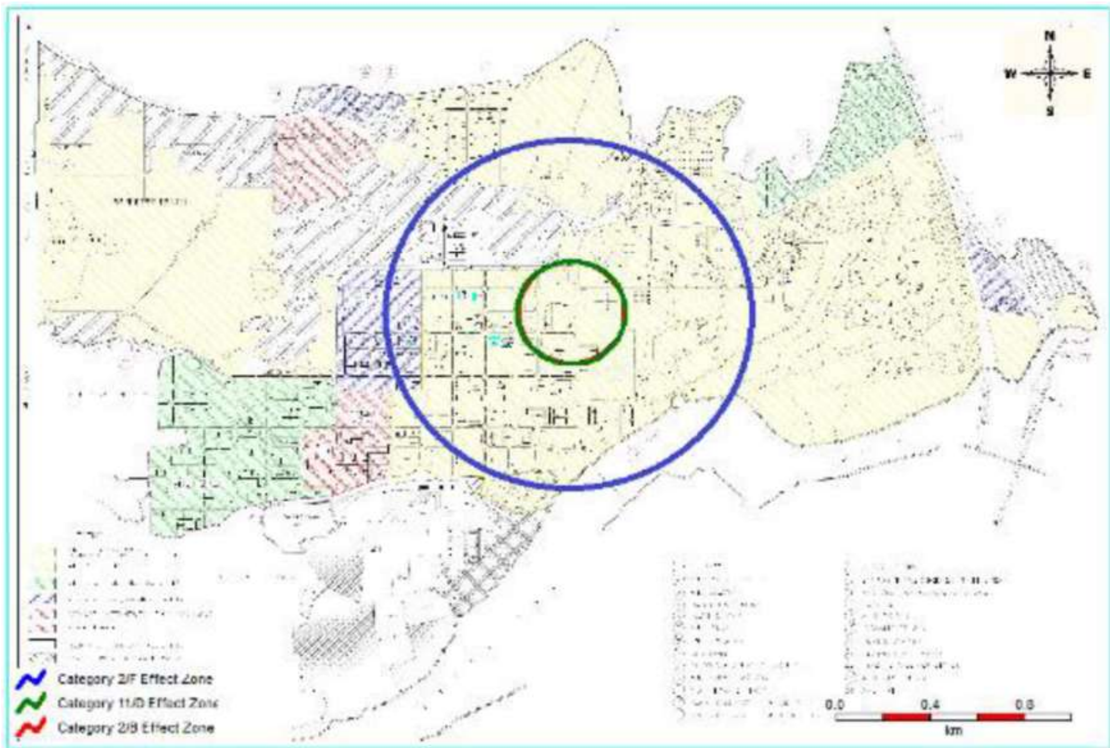


Figure No. 6.4 – Rupture of 25% oleum from the 25% oleum ST1

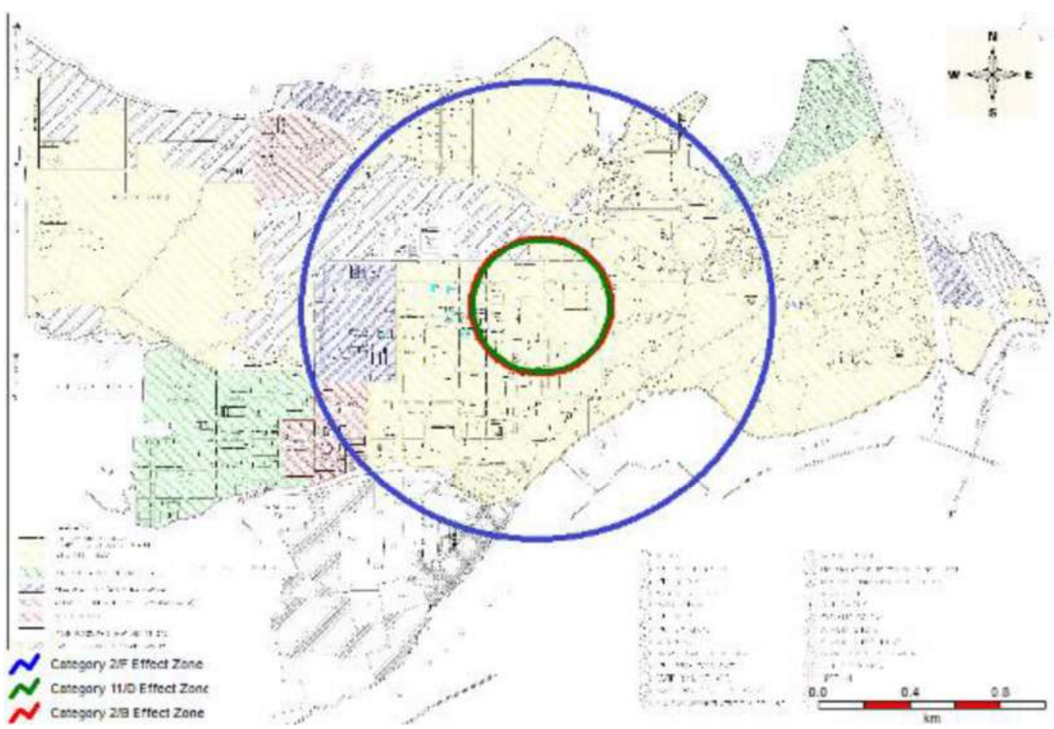


Figure No. 6.5 – Small leak 25% oleum from the 25% oleum ST9

Figure No. 6.6 – Medium leak of 25% oleum from the 25% oleum ST9

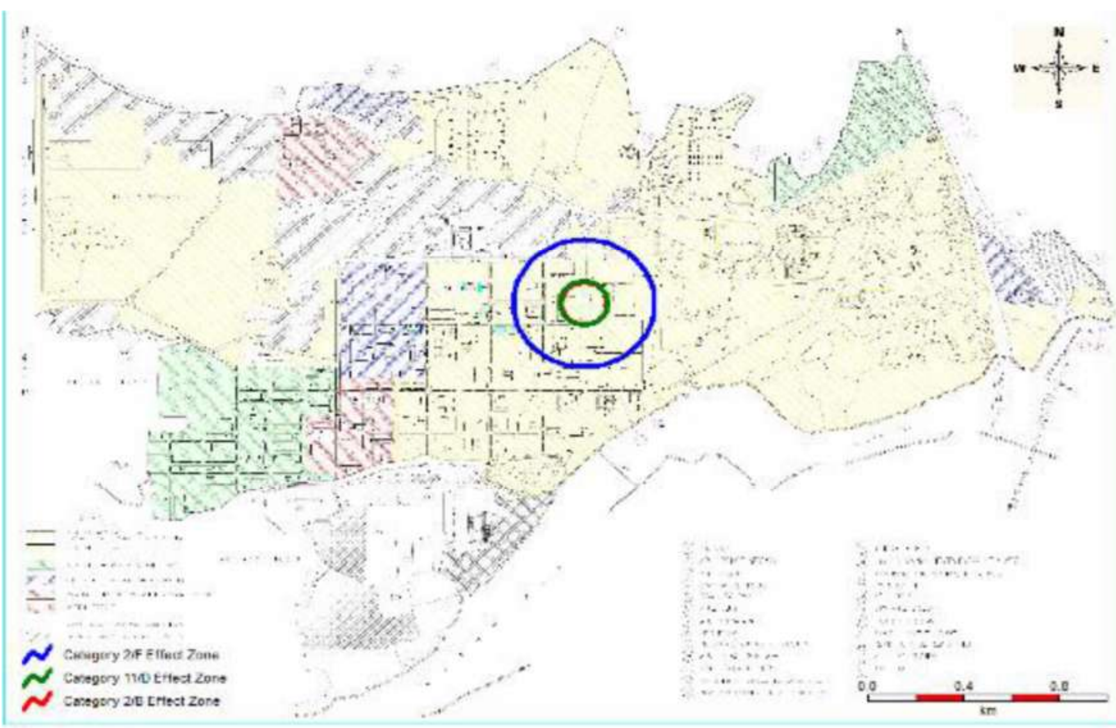


Figure No. 6.7 – Large leak of 25% oleum from the 25% oleum ST9

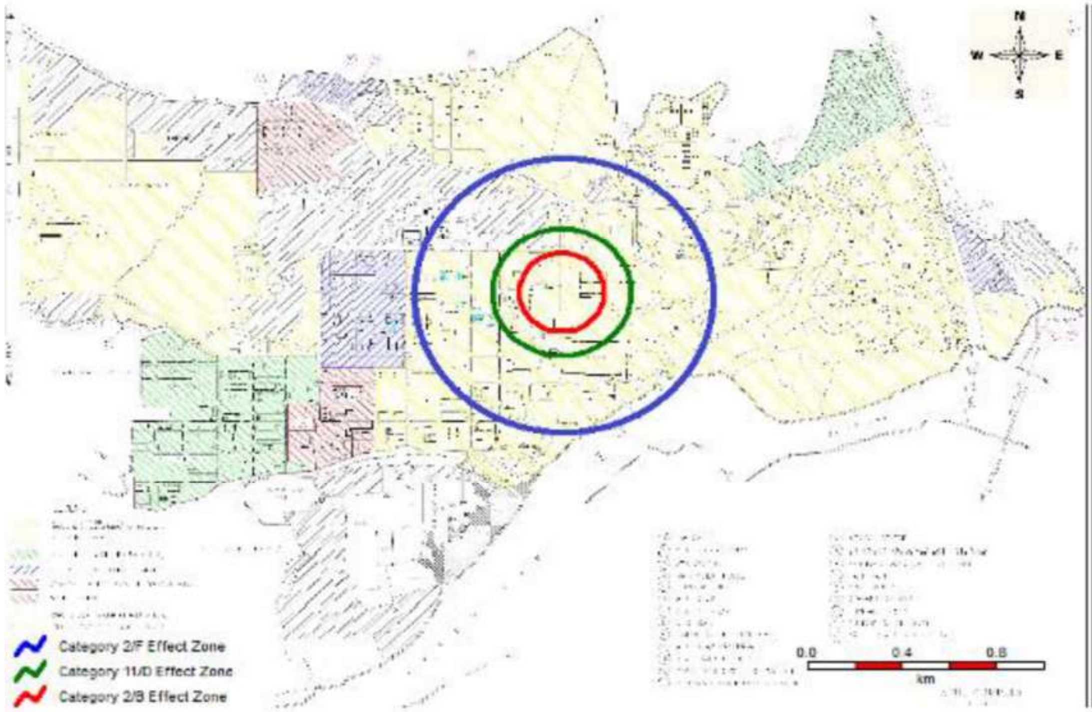


Figure No. 6.8 – Rupture of 25% oleum from the 25% oleum ST9

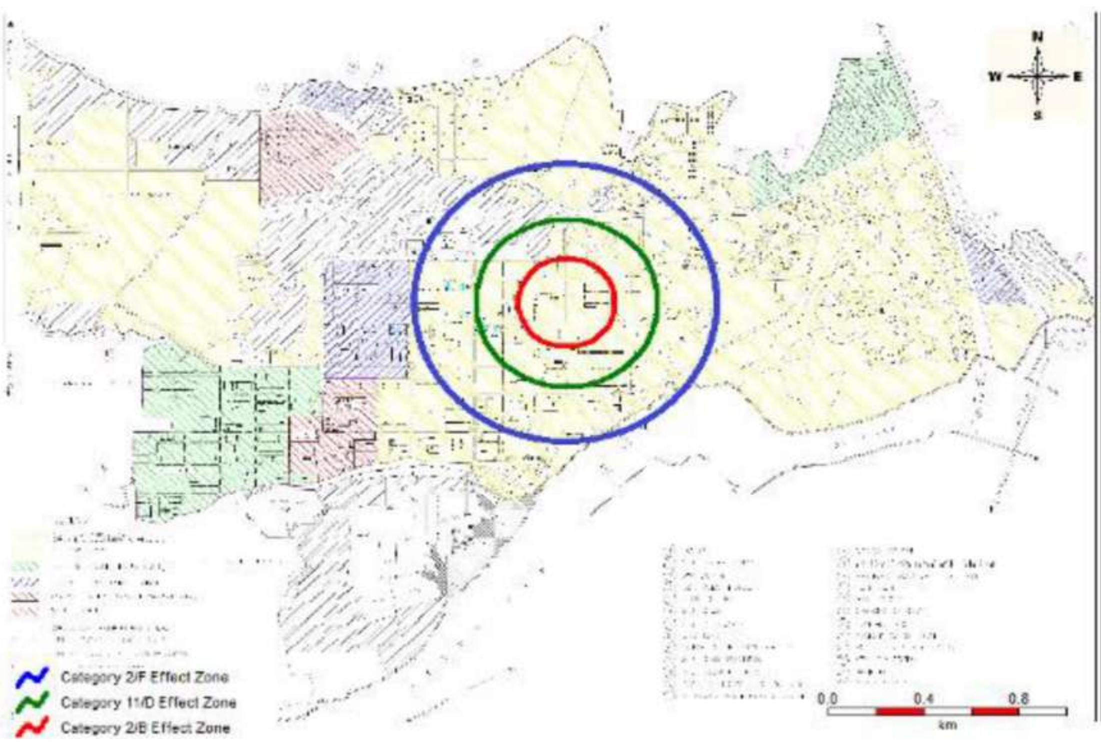


Figure No. 6.9 – Small leak 25% oleum from the 25% oleum ST2

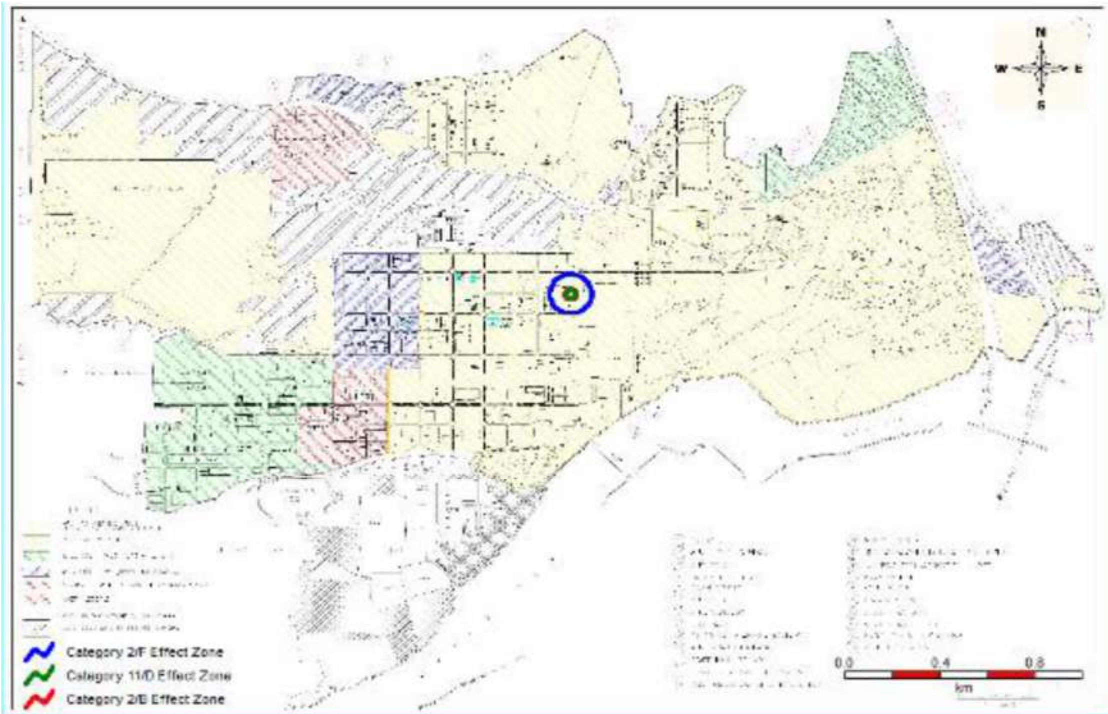


Figure No. 6.10 – Medium leak of 25% oleum from the 25% oleum ST2

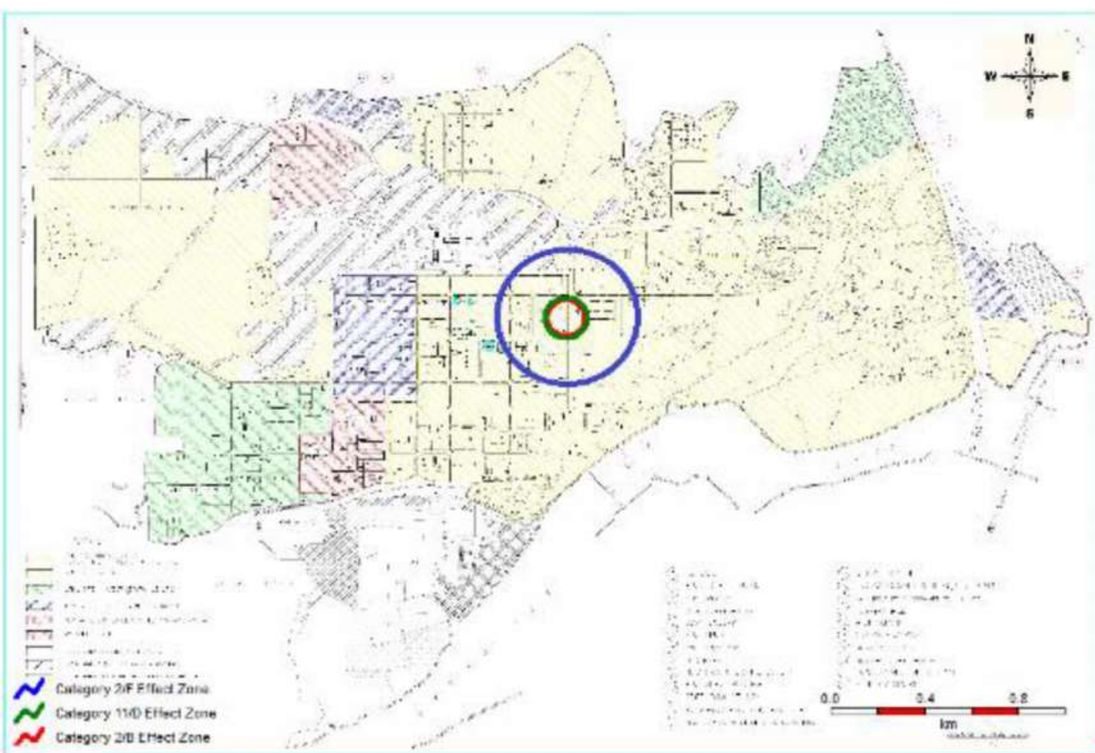


Figure No. 6.11 – Large leak 25% oleum from the 25% oleum ST2

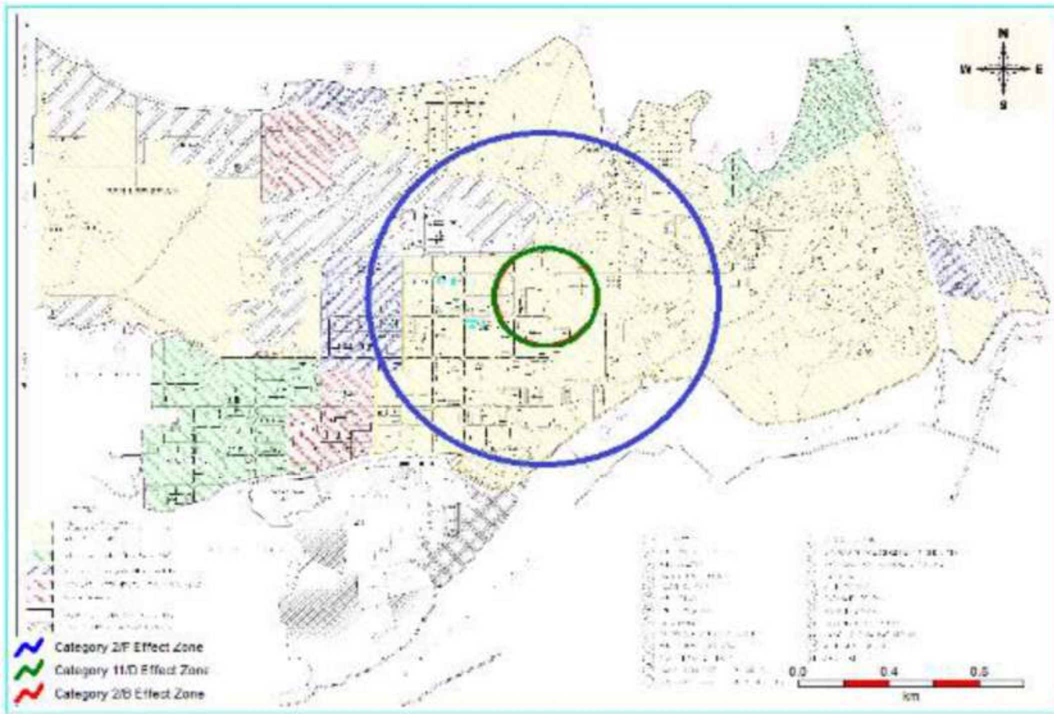


Figure No. 6.12 – Rupture of 25% oleum from the 25% oleum ST2

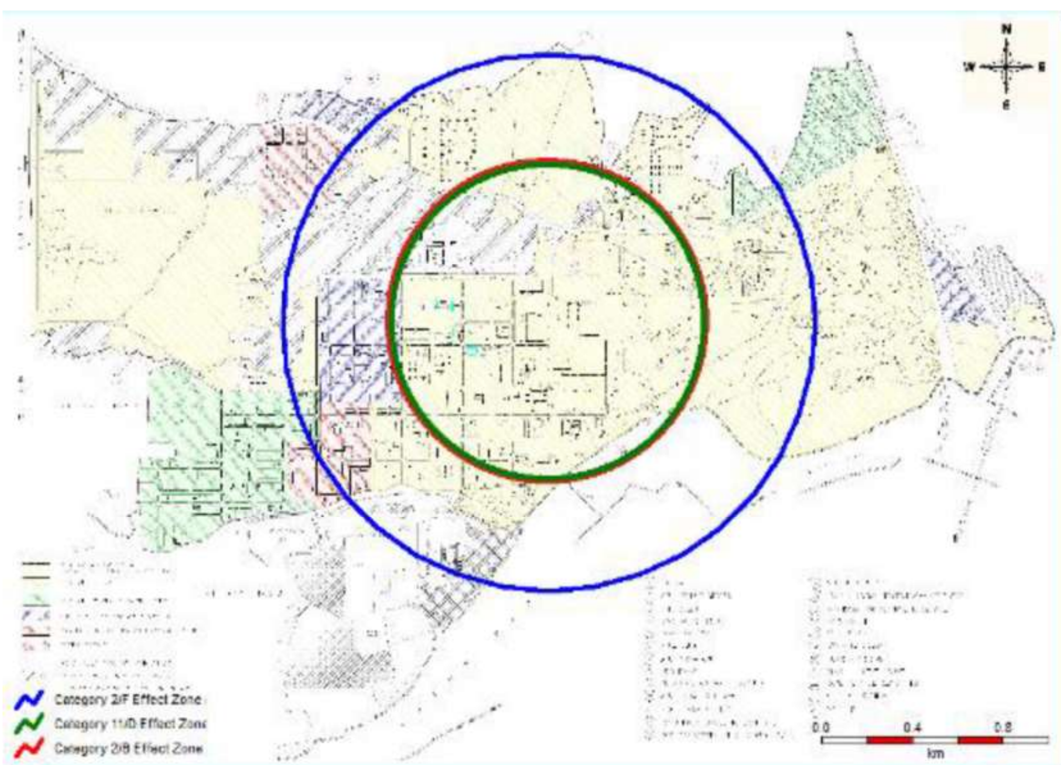


Figure No. 6.13 – Small leak of 65% oleum from the 65% oleum

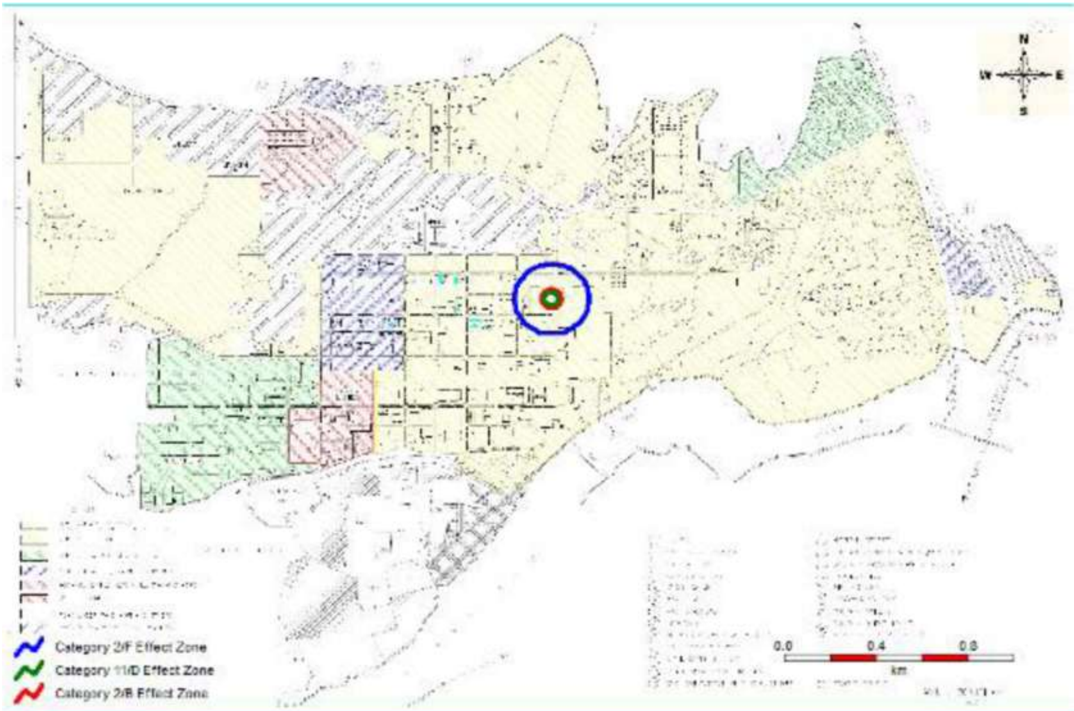


Figure No. 6.14 – Medium leak of 65% oleum from the 65% oleum

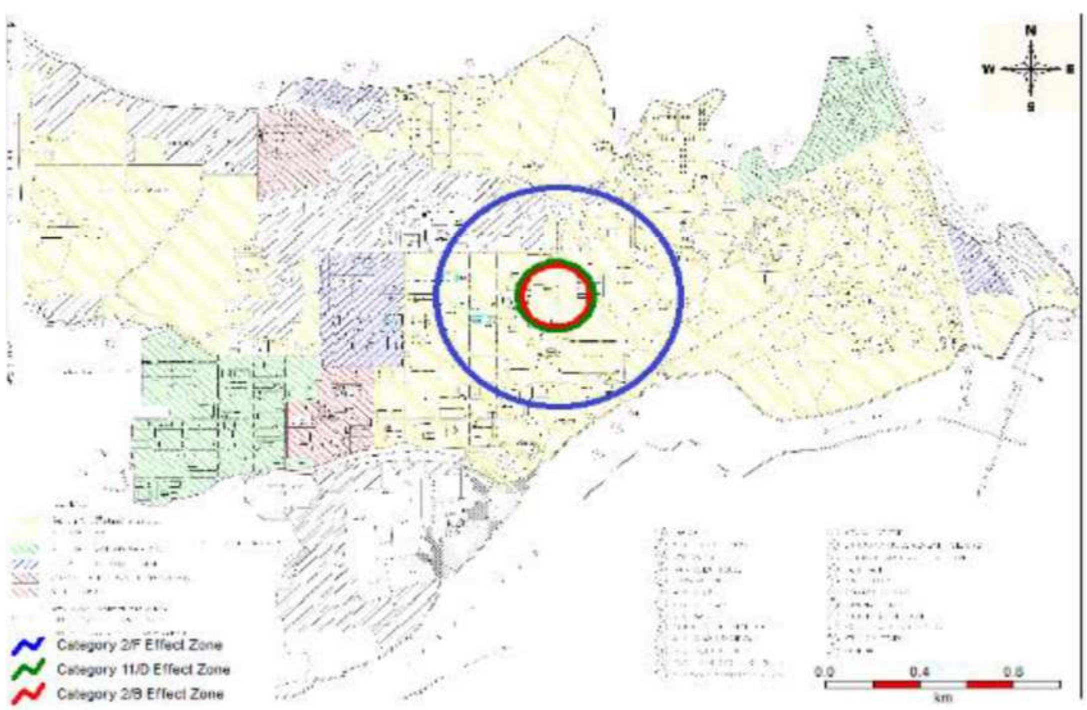


Figure No. 6.15 – Large leak 65% oleum from the 65% oleum

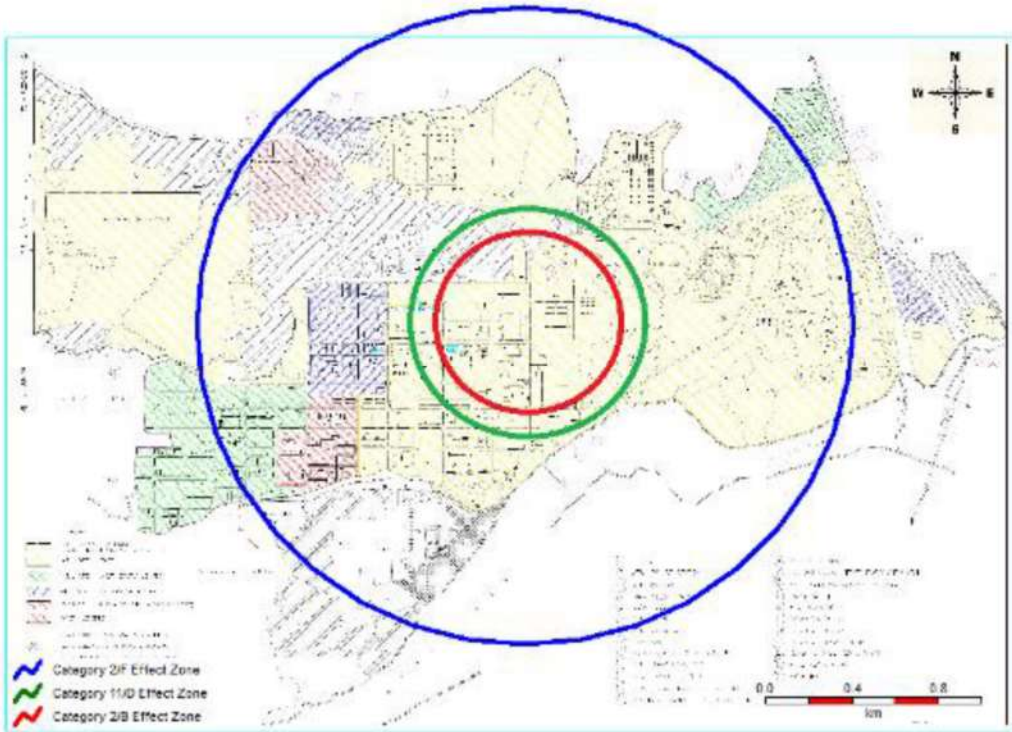


Figure No. 6.16 – Rupture of 65% oleum from the 65% oleum

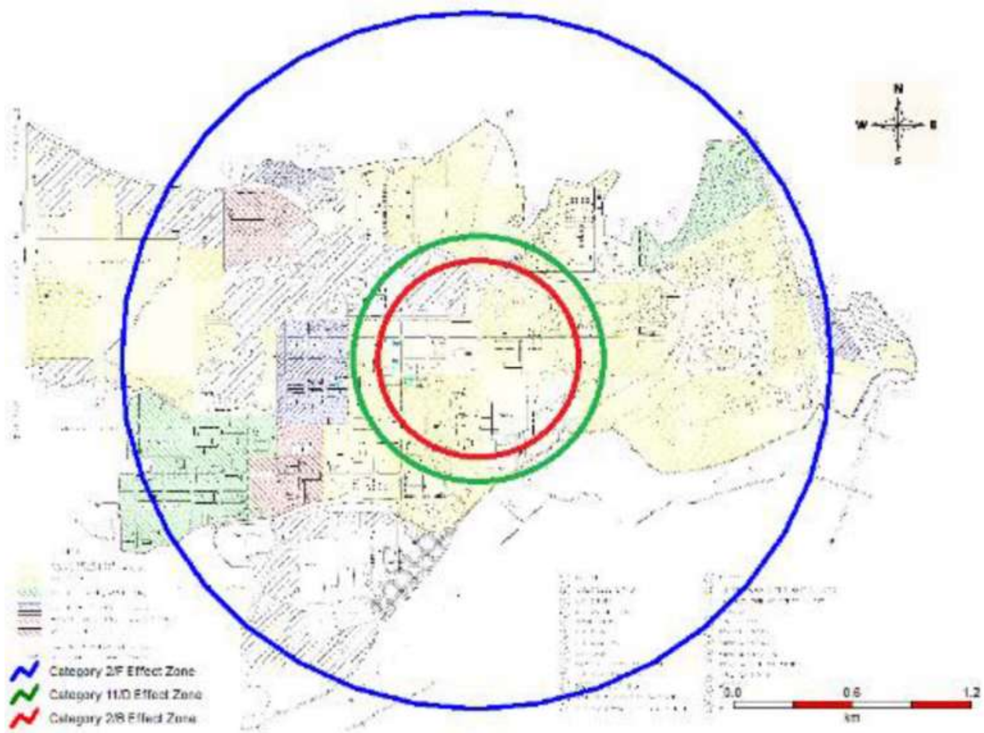


Figure No. 6.17 – Small leak of ammonia from the Shed C

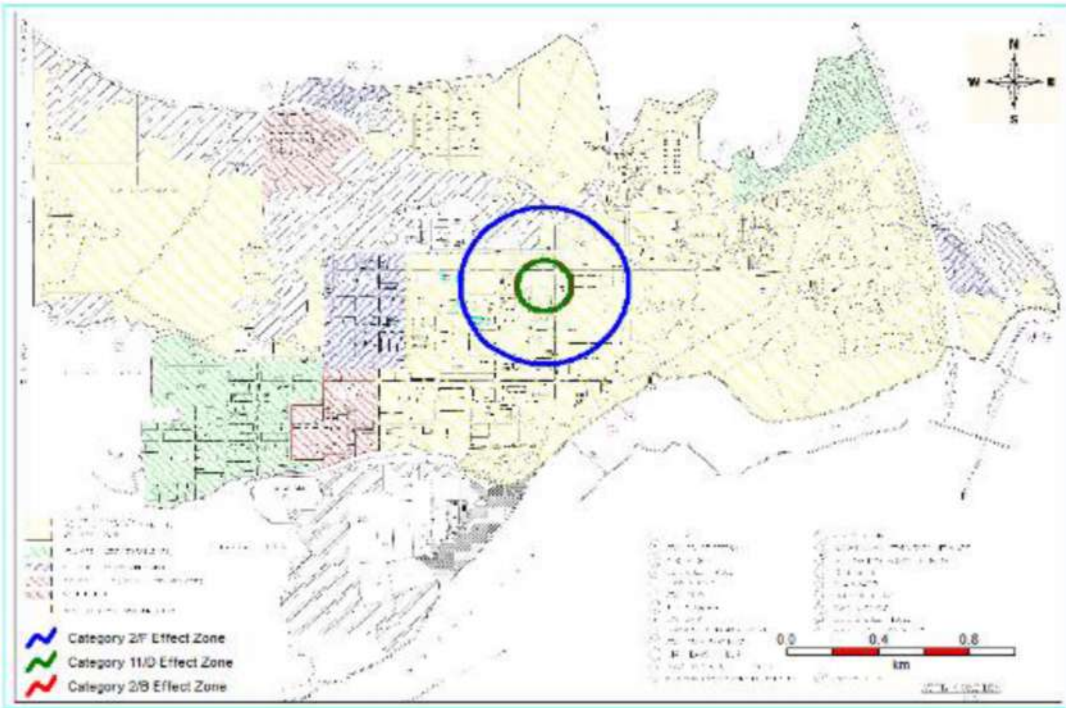


Figure No. 6.18 – Medium leak of ammonia from the Shed C

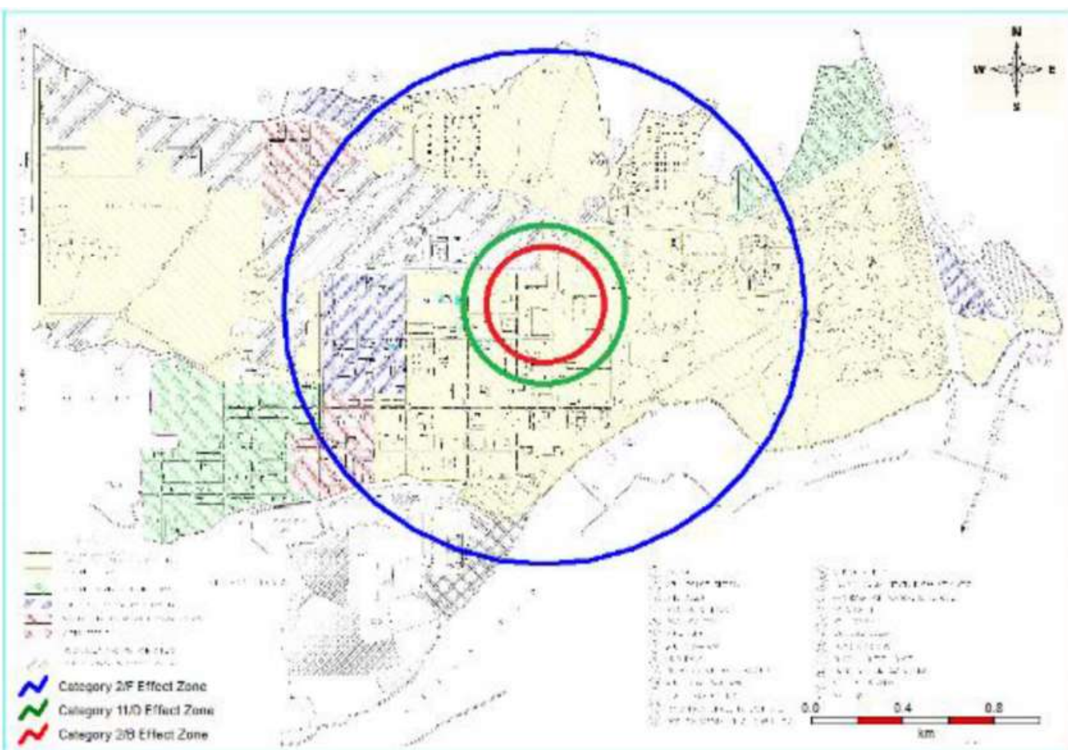


Figure No. 6.19 – Large leak of ammonia from the Shed C

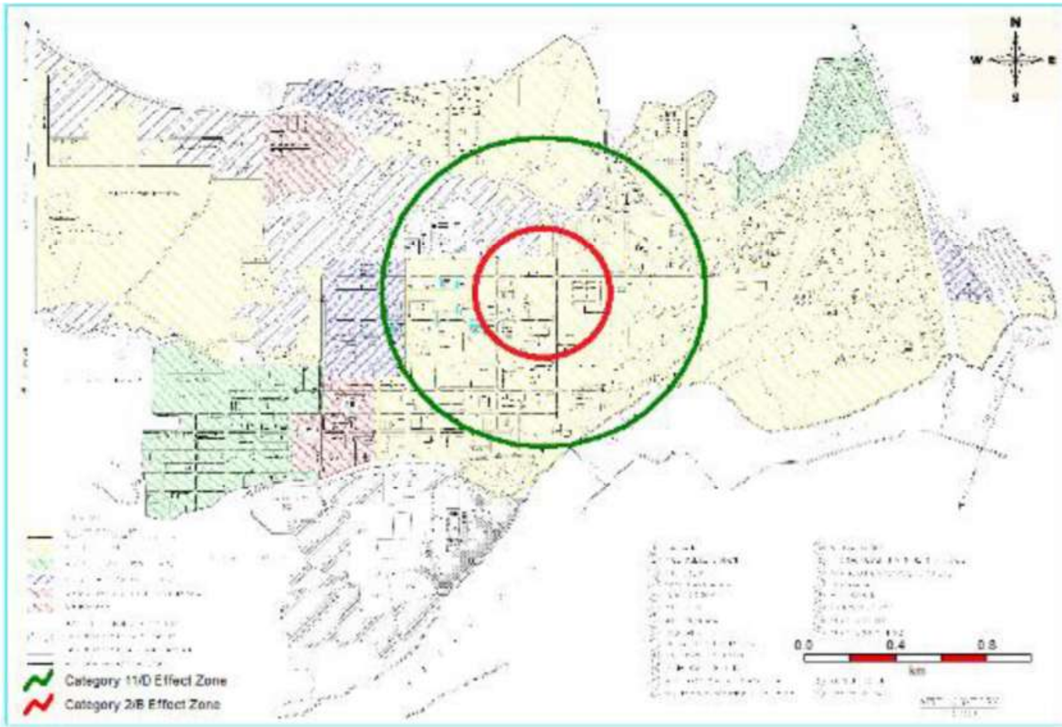


Figure No. 6.20 – Rupture of ammonia from the Shed C

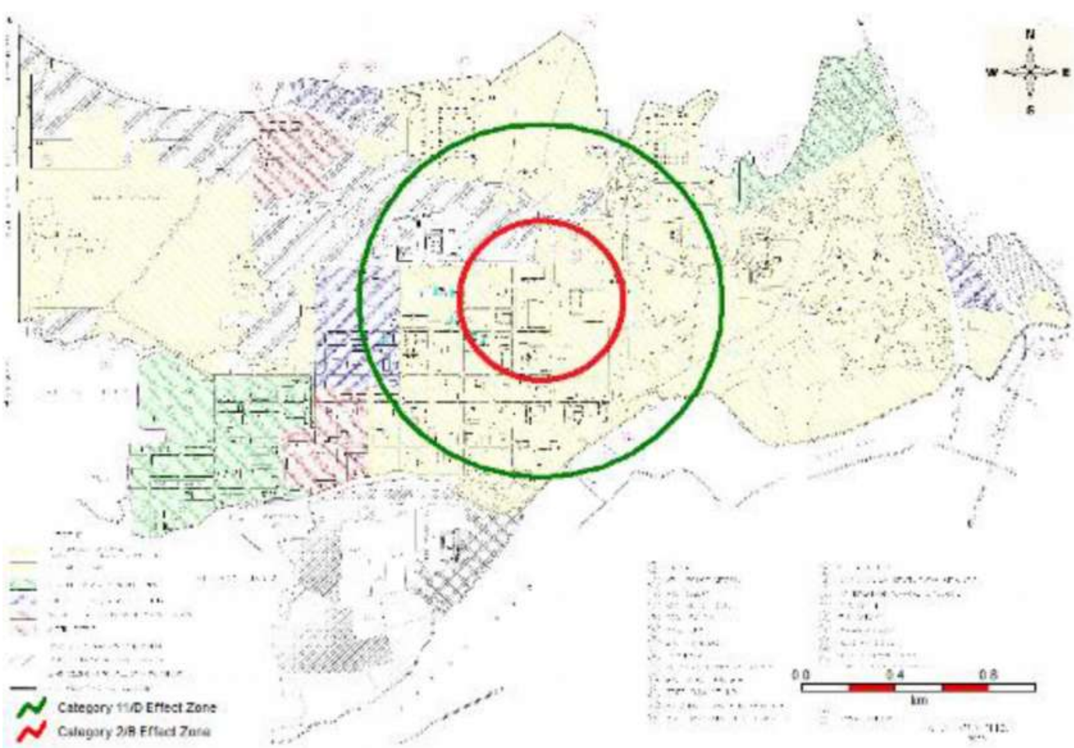


Figure No. 6.21 – Medium leak of Ammonia from the Ammonia cylinder

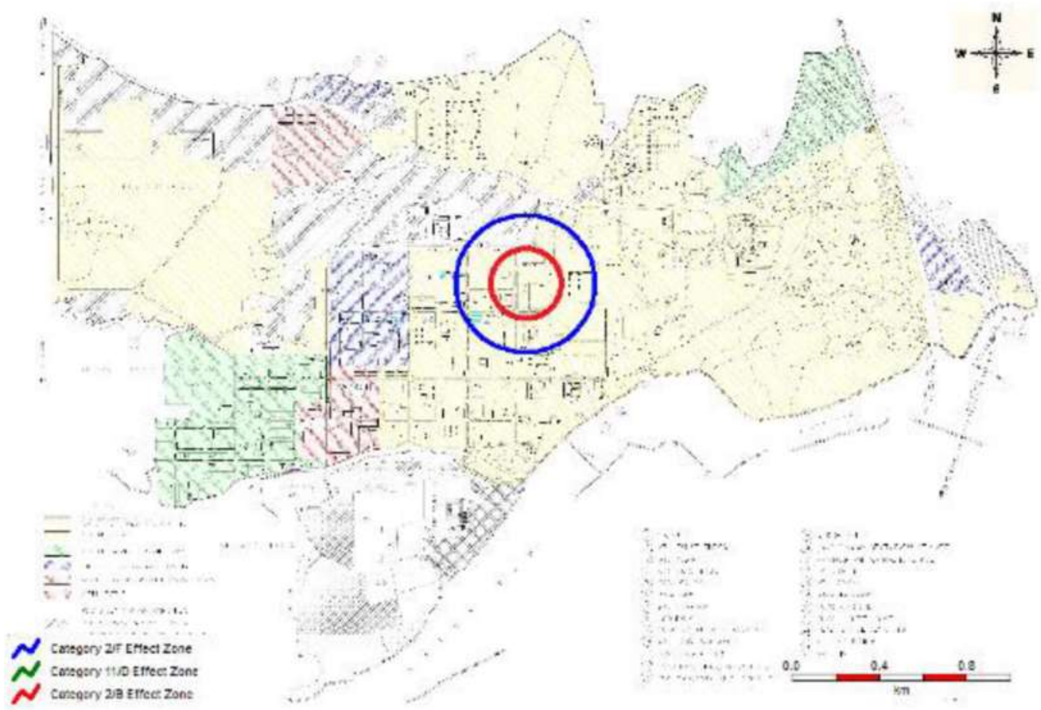


Figure No. 6.22 – Medium leak of Phosgene from the Phosgene cylinder

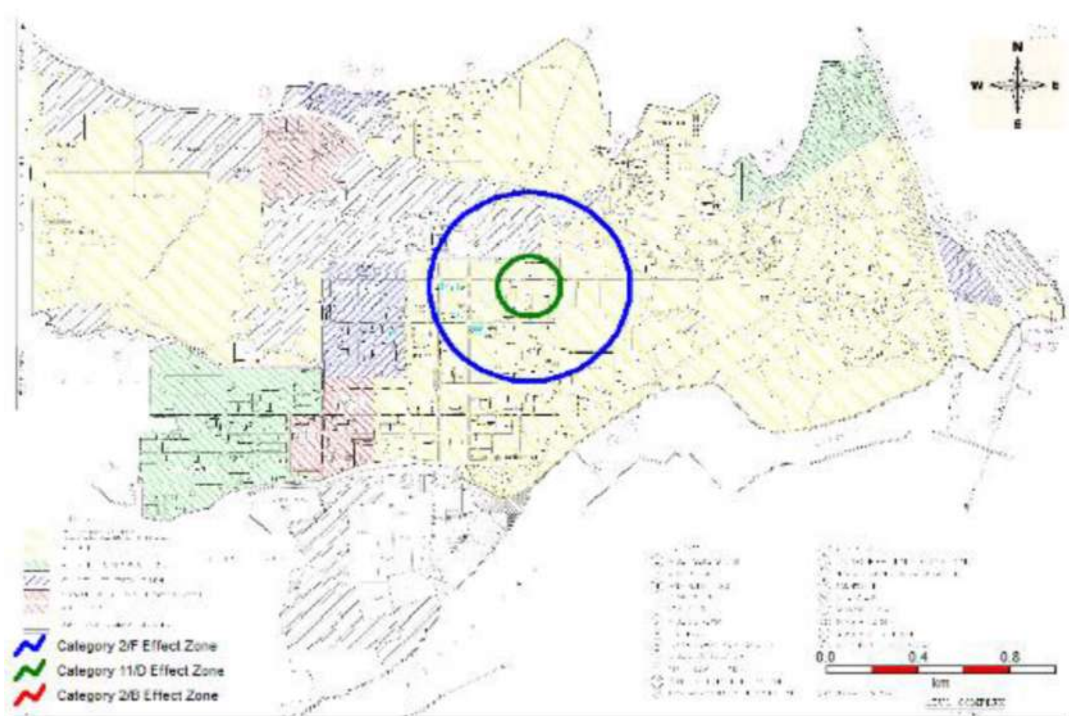


Figure No. 6.23 – Large leak of Phosgene from the Phosgene cylinder

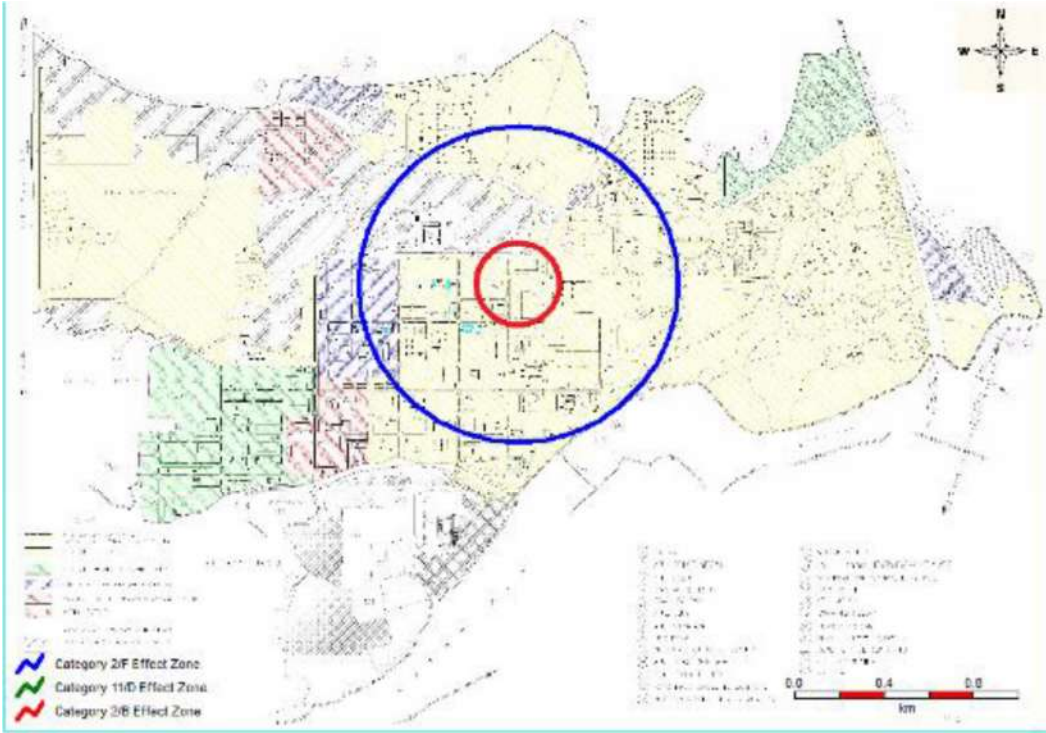


Figure No. 6.24 – Small leak of Ammonia from the Ammonia chilling tank

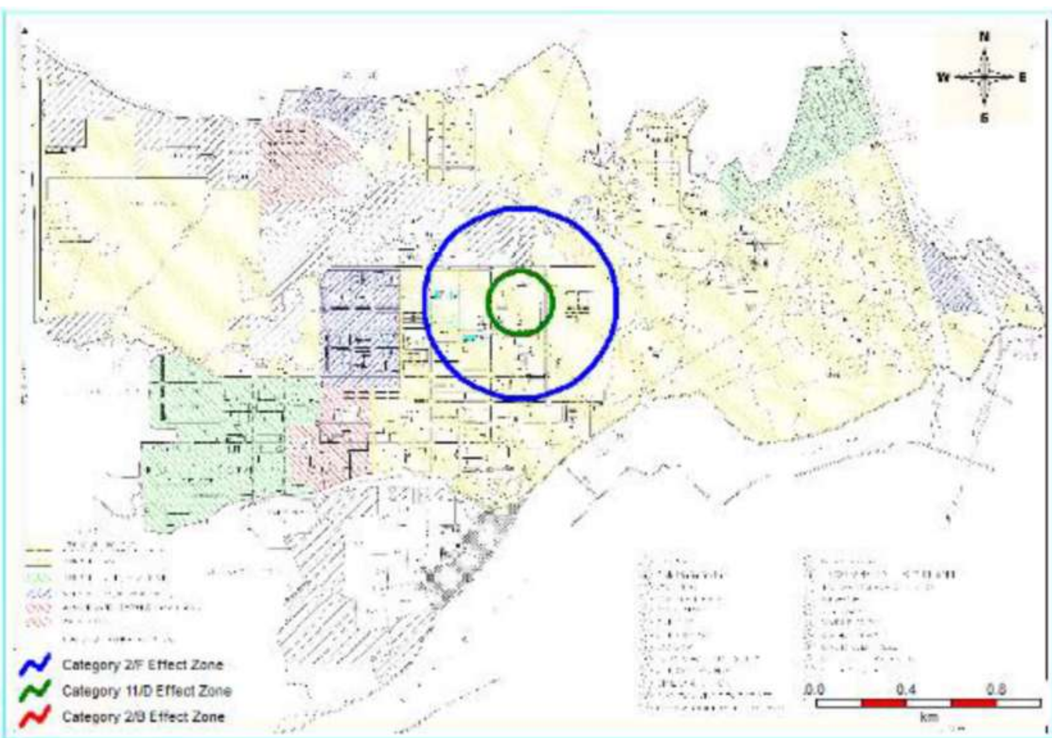


Figure No. 6.25 – Medium leak of Ammonia from the Ammonia chilling tank

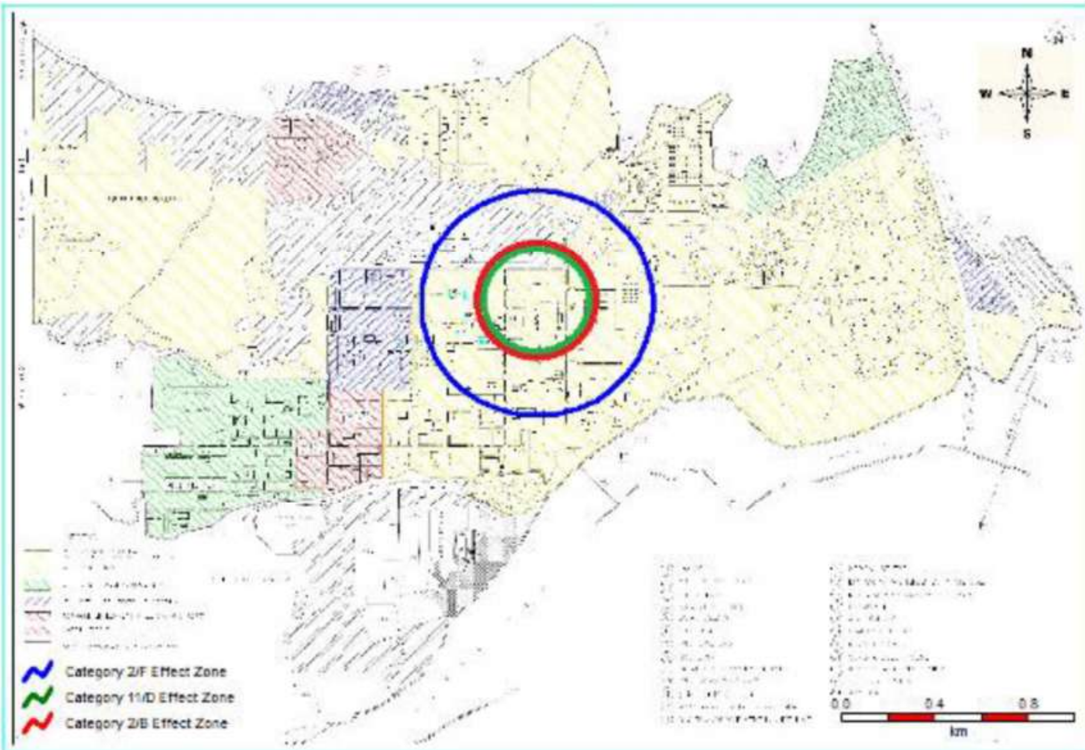


Figure No. 6.26 – Large leak of Ammonia from the Ammonia chilling tank

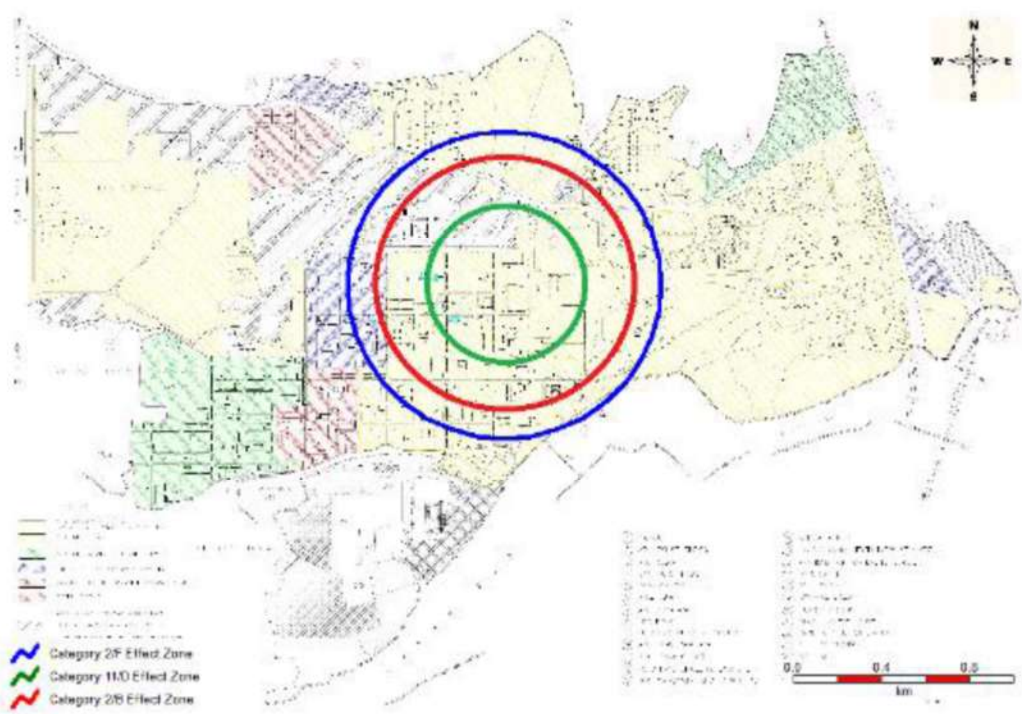


Figure No. 6.27 – Rupture of Ammonia from the Ammonia chilling tank

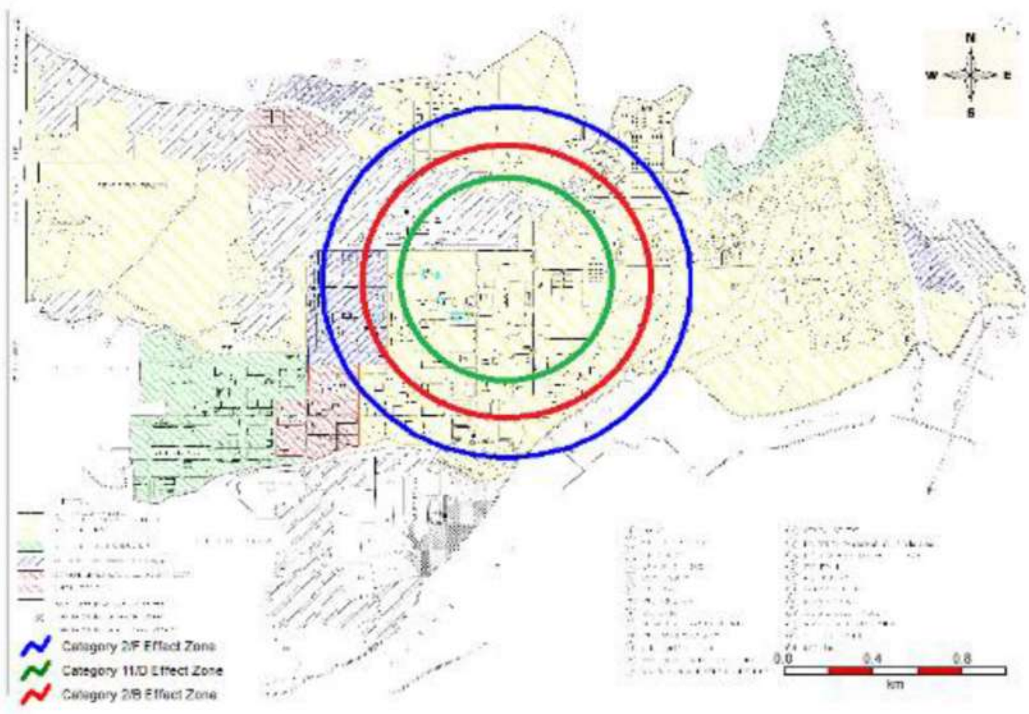


Figure No. 6.28 – Small leak of Chlorine from the Chlorine Toner

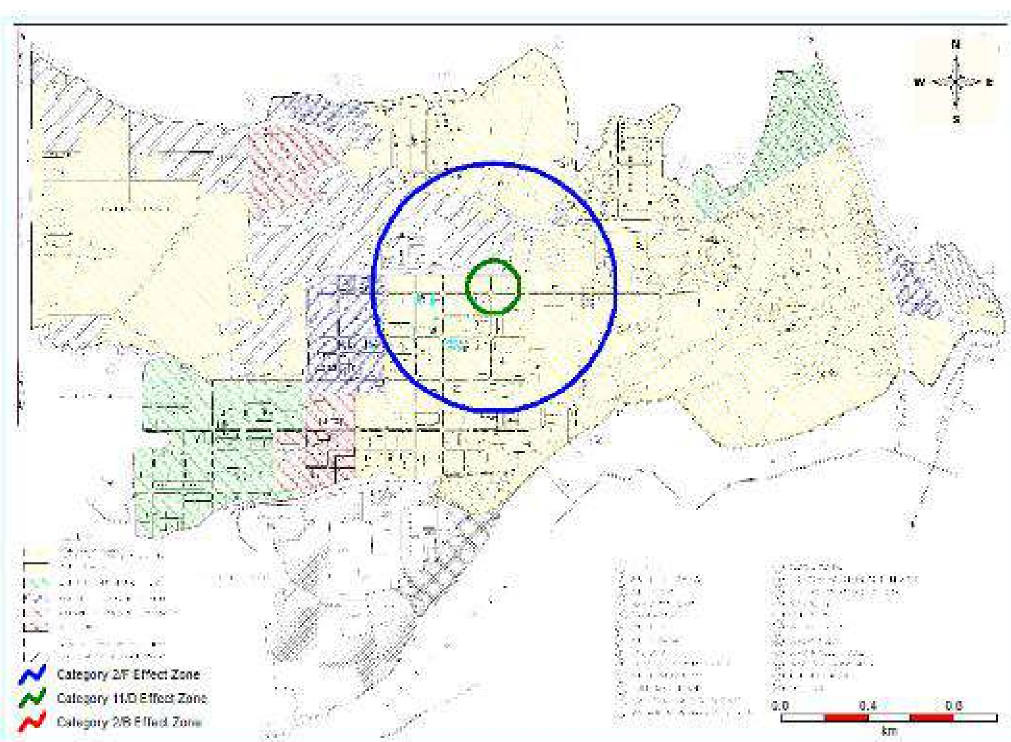


Figure No. 6.29 – Medium leak of Chlorine from the Chlorine Toner

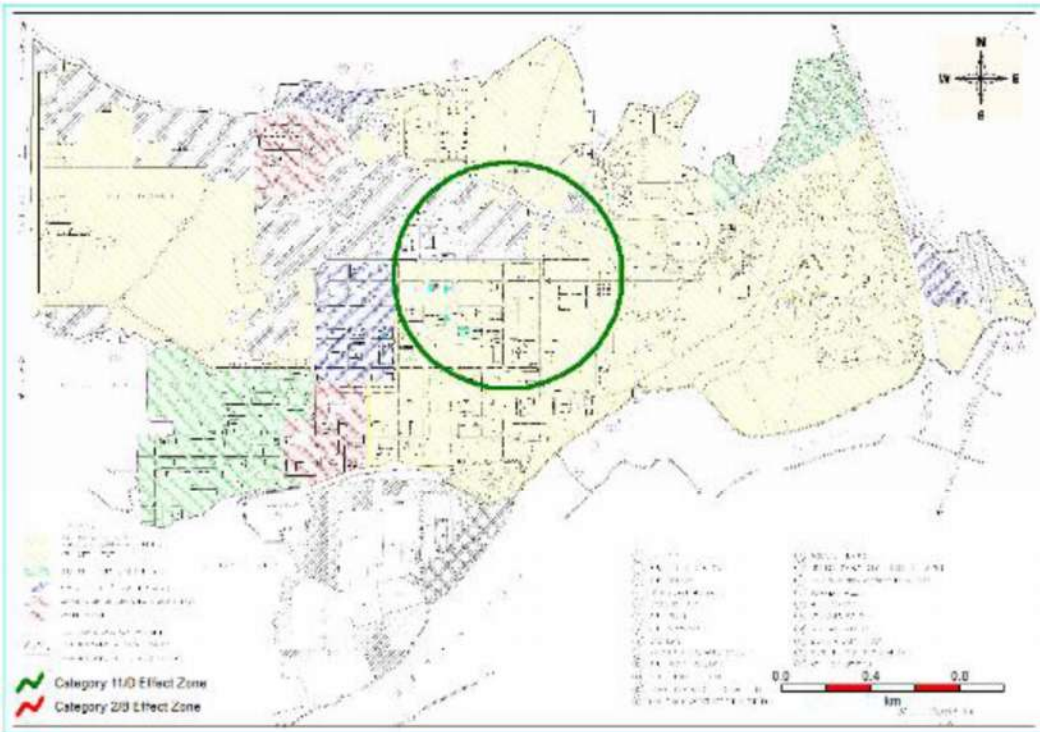


Figure No. 6.30 – Rupture of Chlorine from the Chlorine Toner

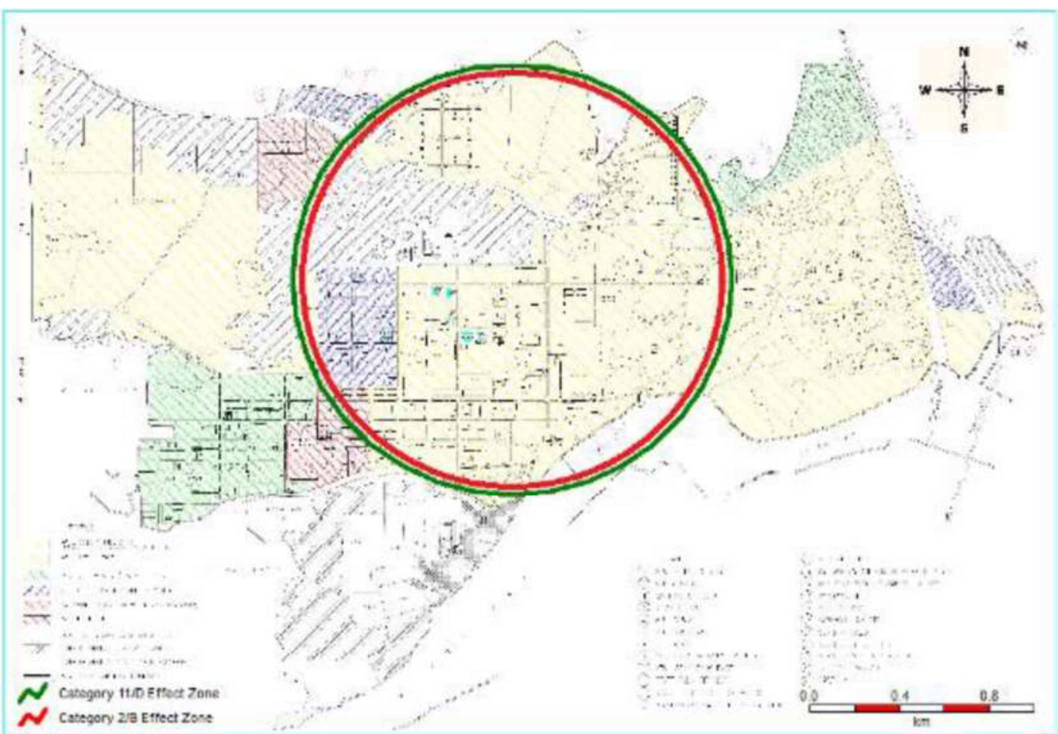


Figure No. 6.31 – Medium leak of CSA from the CSA ST-102

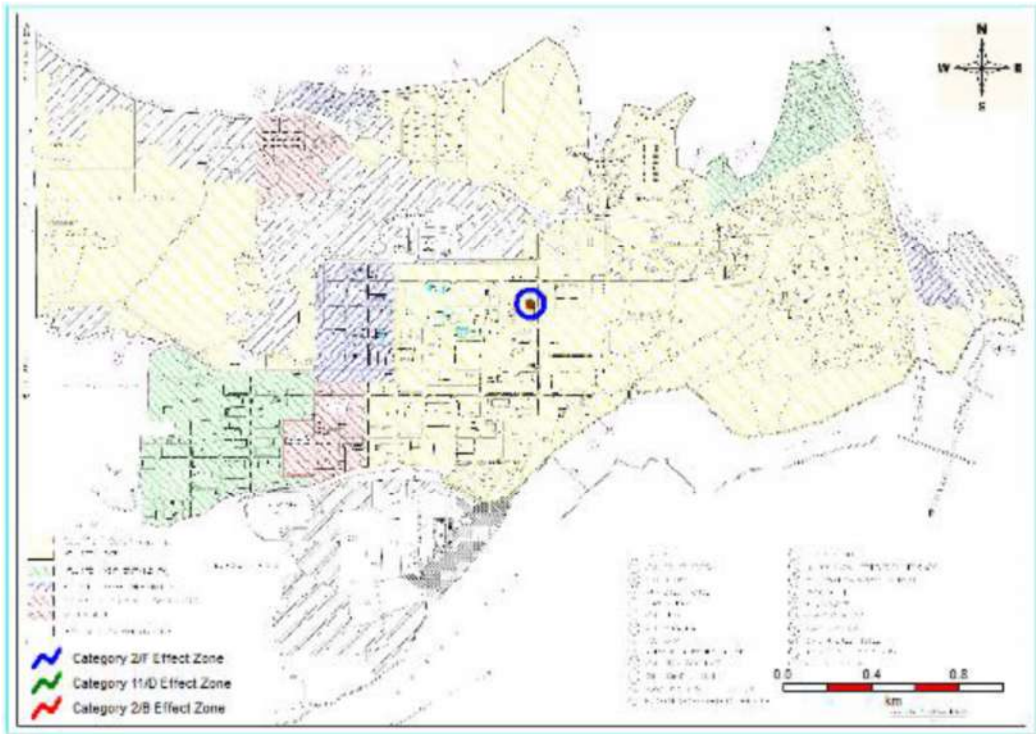


Figure No. 6.32 – Large leak of CSA from the CSA ST-102

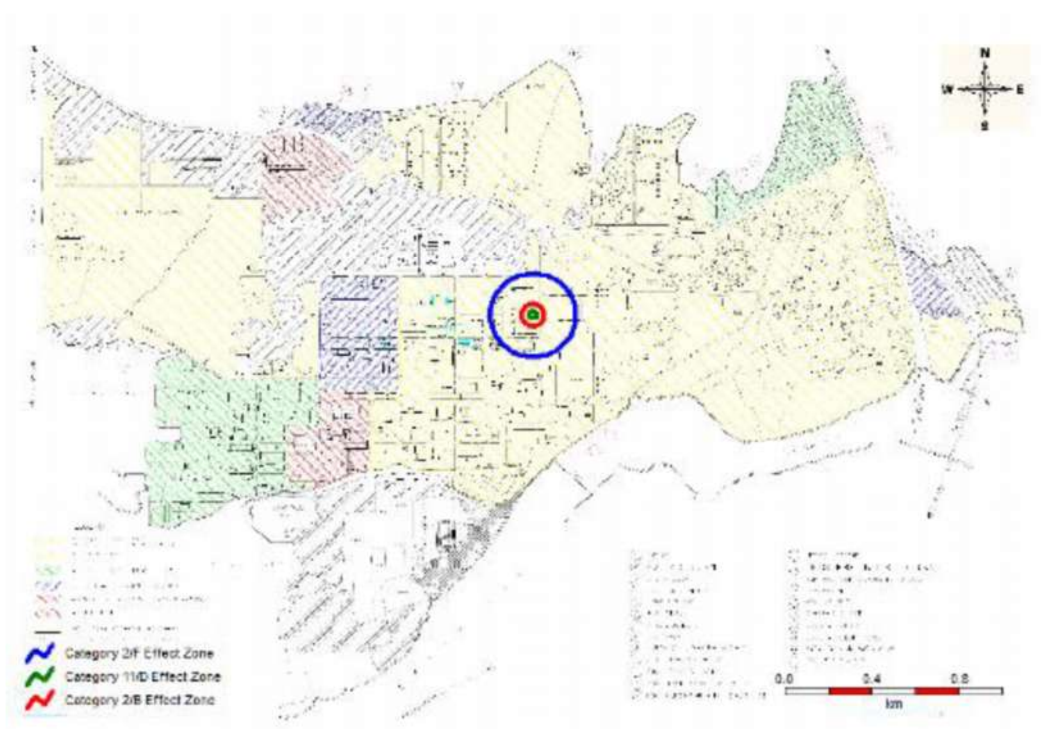


Figure No. 6.33 – Rupture of CSA from the CSA ST-102

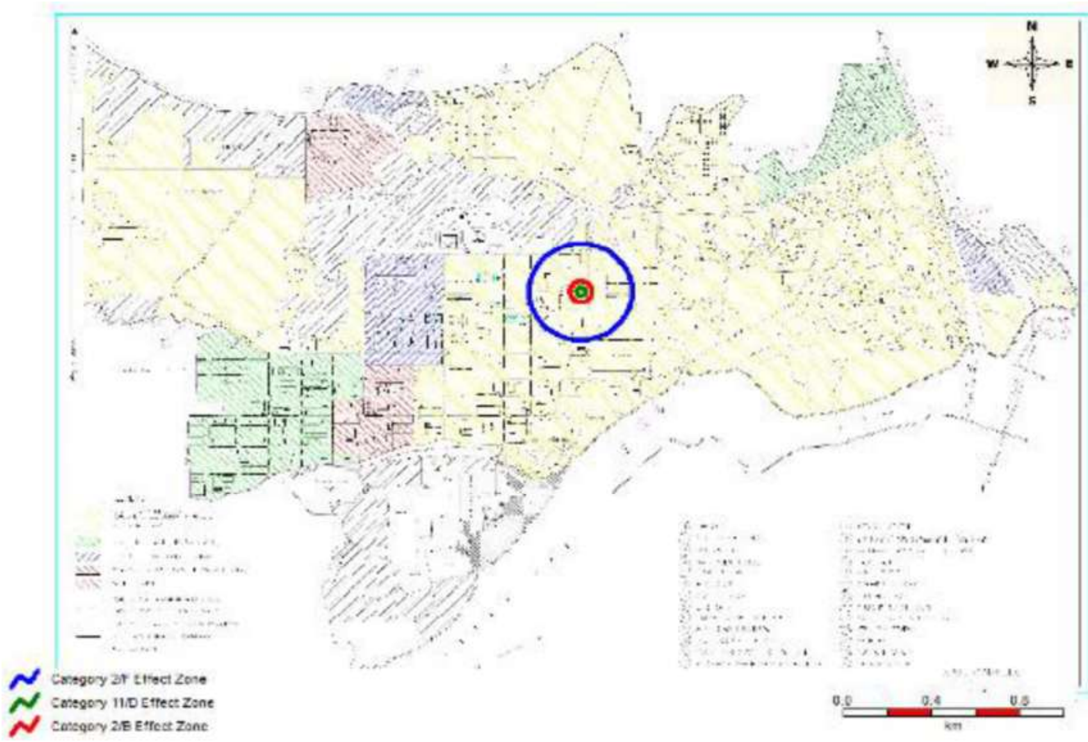


Figure No. 6.34 – Medium leak of CSA from the CSA 6710

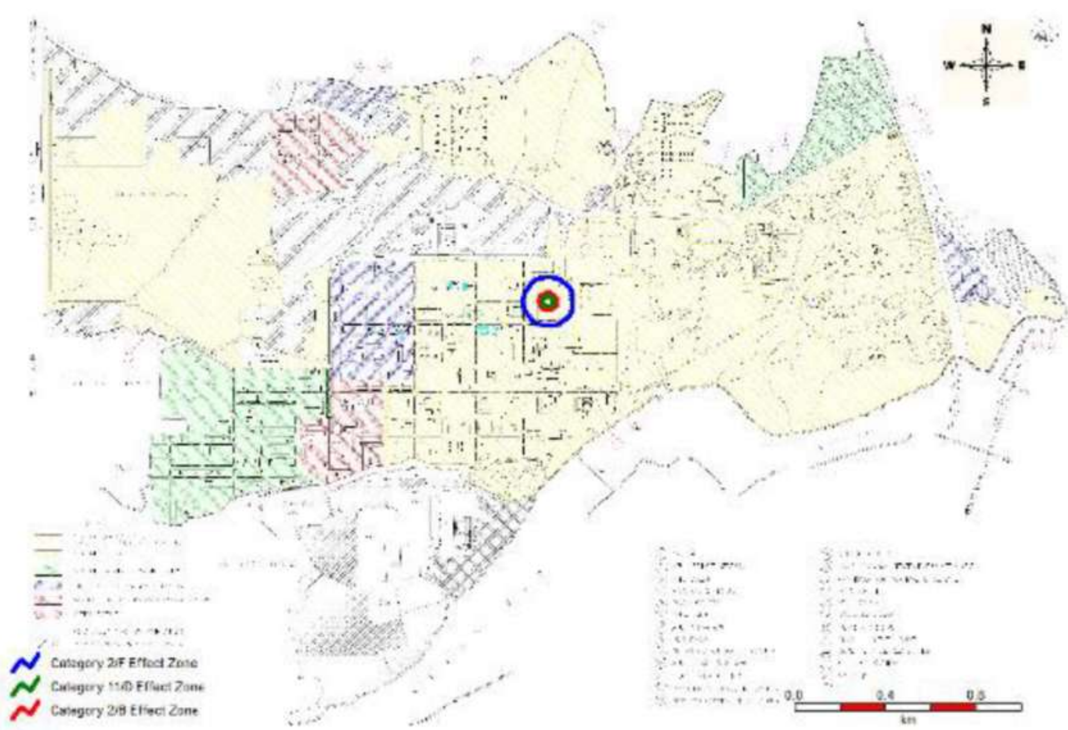


Figure No. 6.35 – Large leak of CSA from the CSA 6710

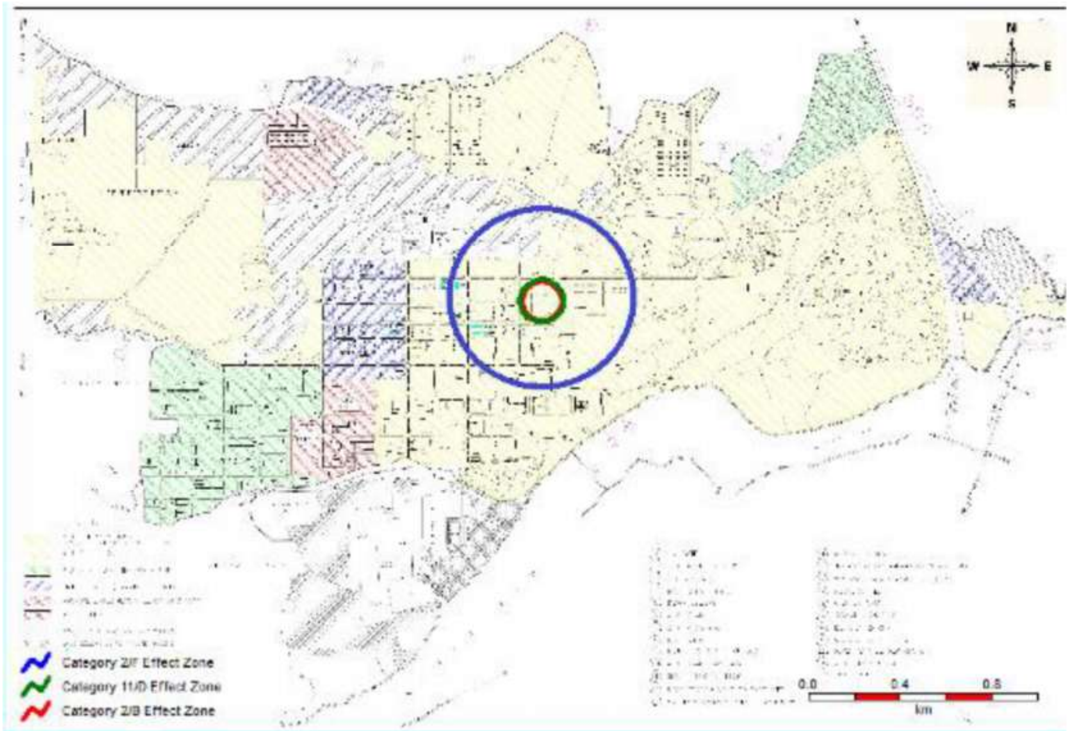


Figure No. 6.36 – Rupture of CSA from the CSA 6710

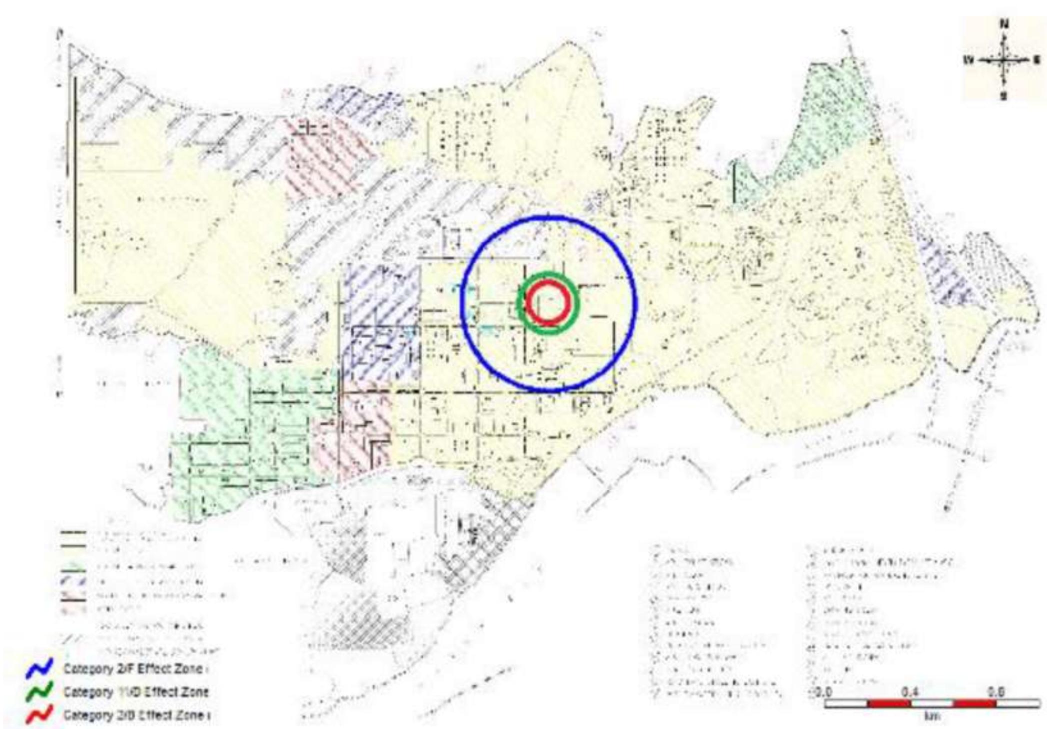


Figure No. 6.37 – Small leak Epichlohydrine from the Epoxy 601

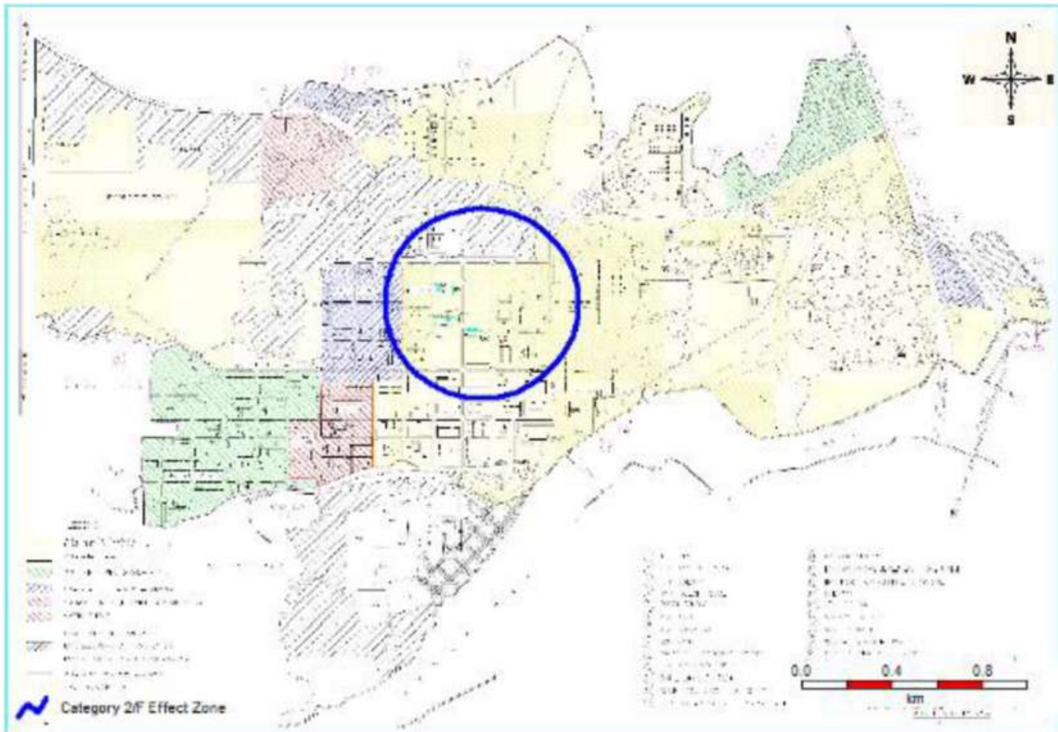


Figure No. 6.38 – Medium leak of Epichlorohydrine from the Epoxy 601

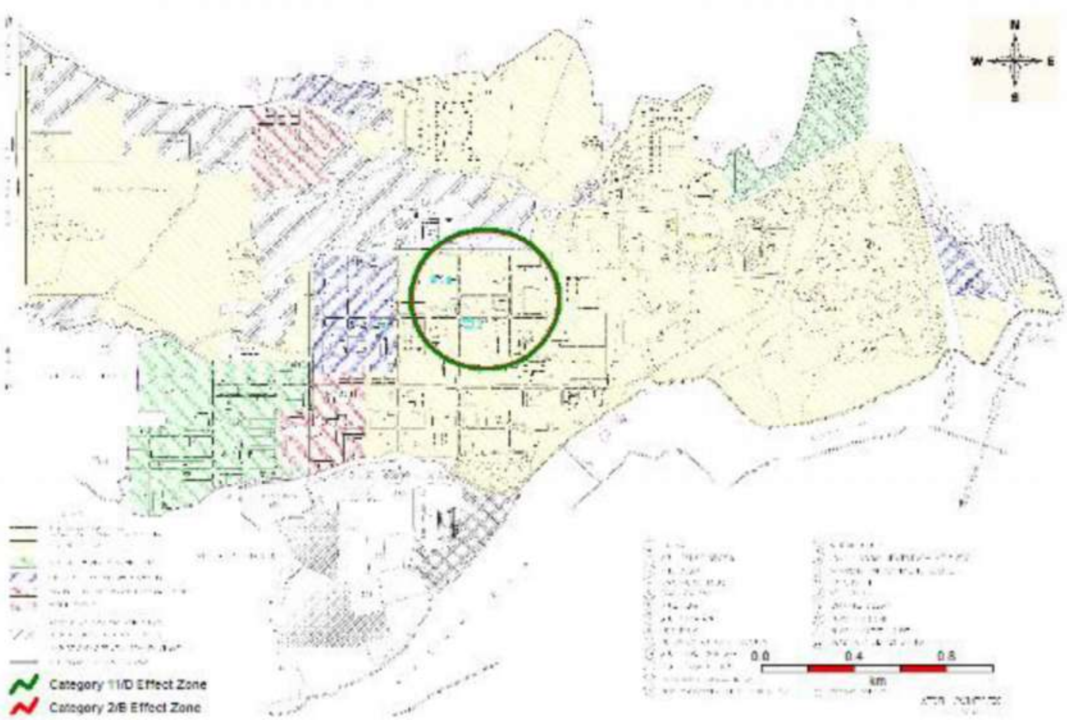


Figure No. 6.39 – Large leak of Epichlorohydrine from the Epoxy 601

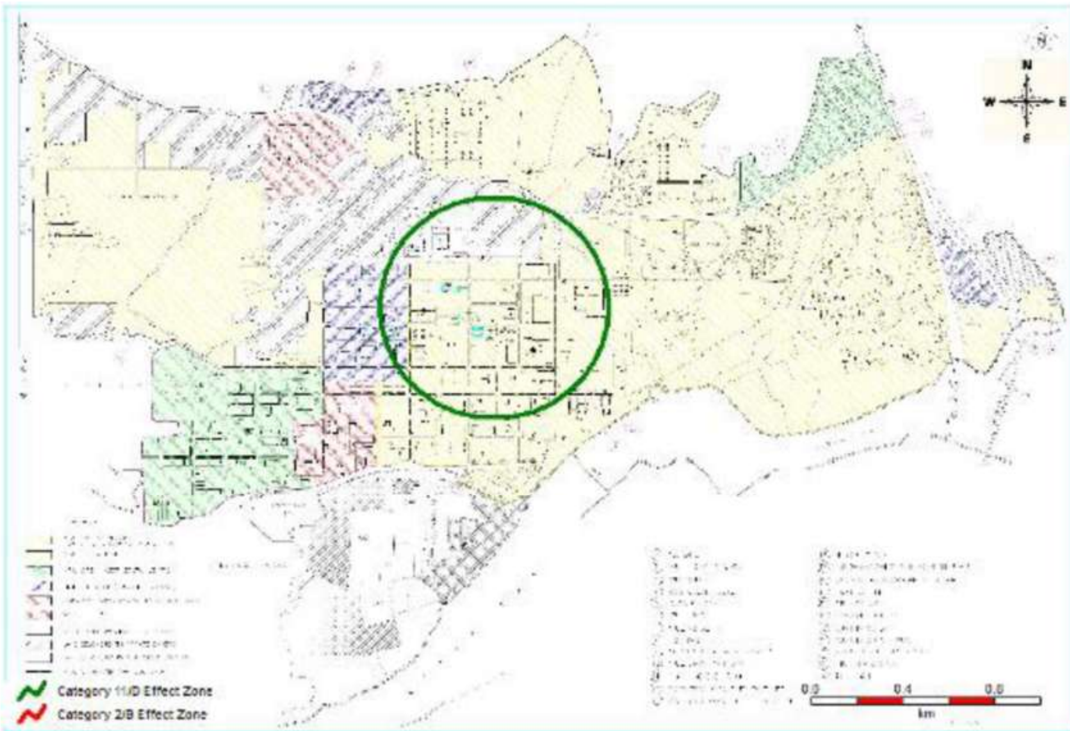


Figure No. 6.40 – Rupture of Epichlorohydrine from the Epoxy 601

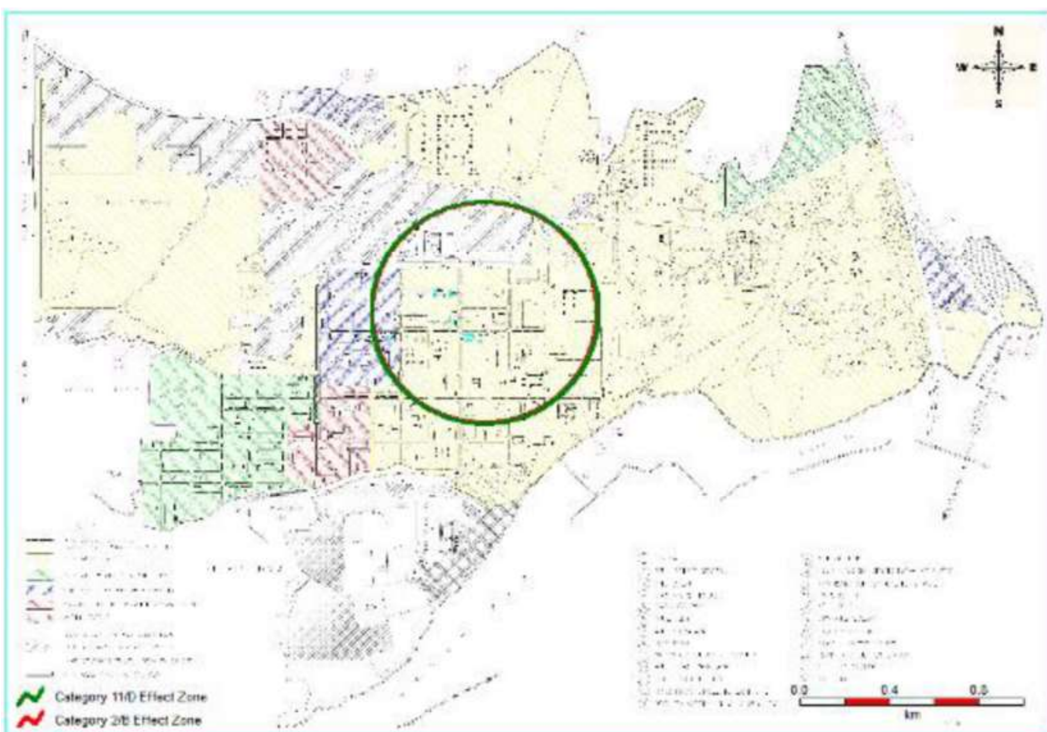


Figure No. 6.41 – Small leak of Phosgene from the Phosgene tank 18 1&2

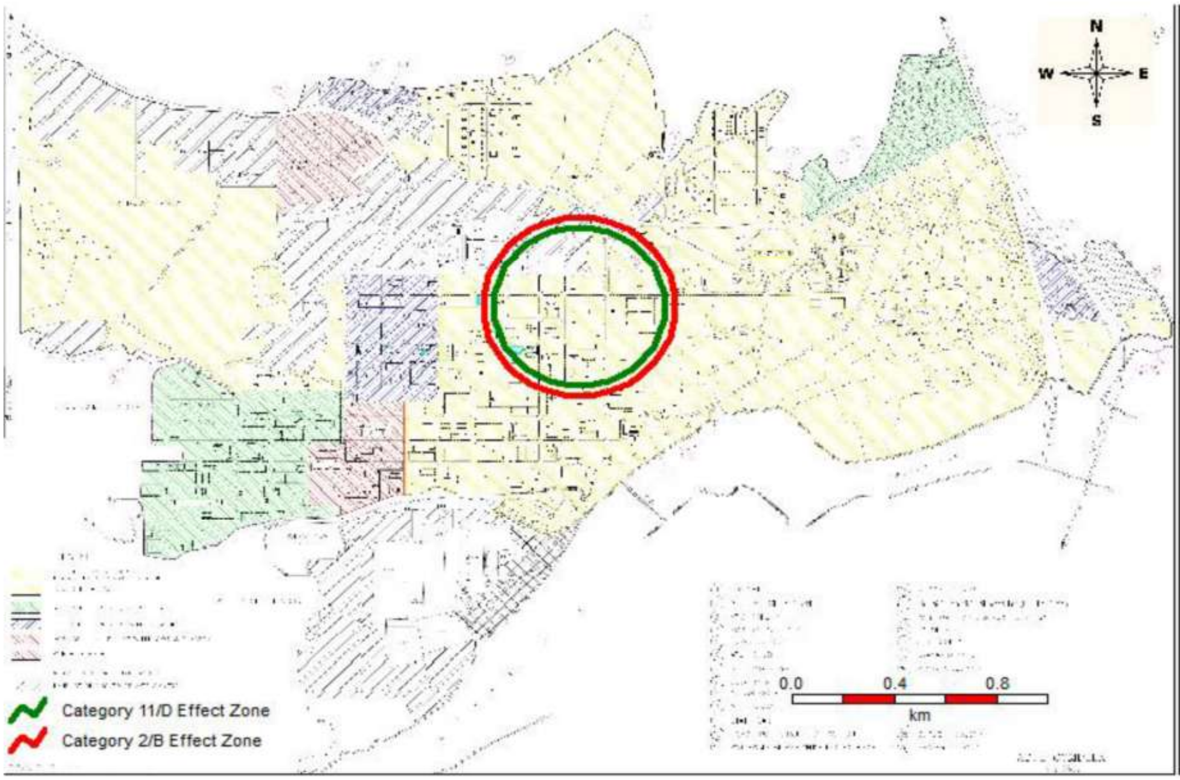


Figure No. 6.42 – Medium leak of Phosgene from the Phosgene tank 18 1&2

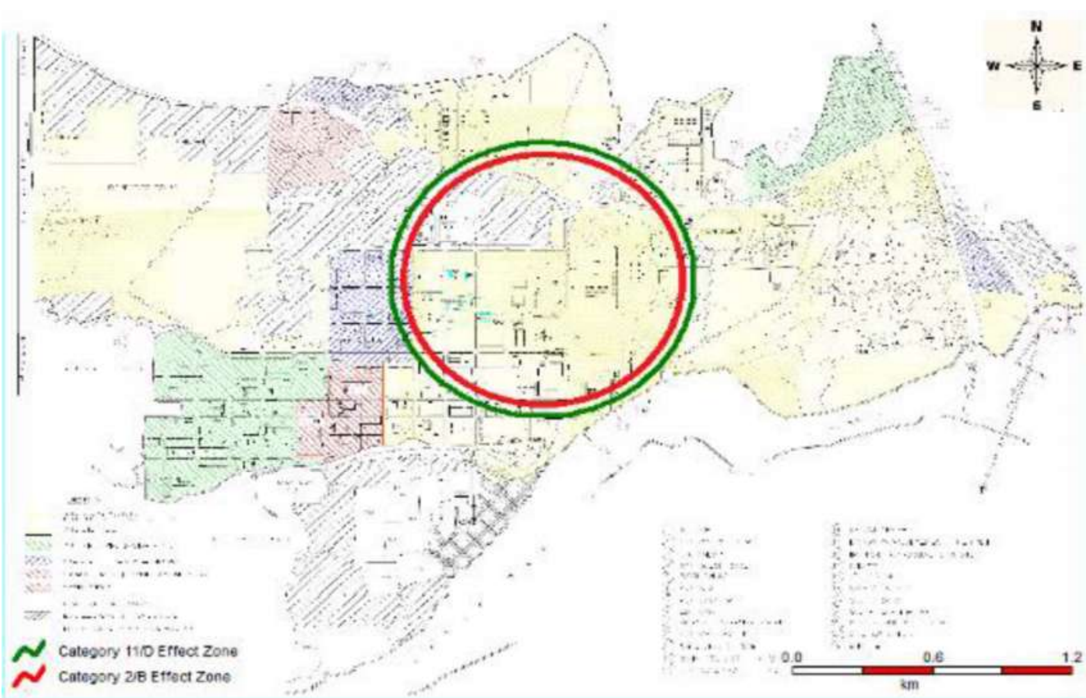


Figure No. 6.43 – Large leak of Phosgene from the Phosgene tank 18 1&2

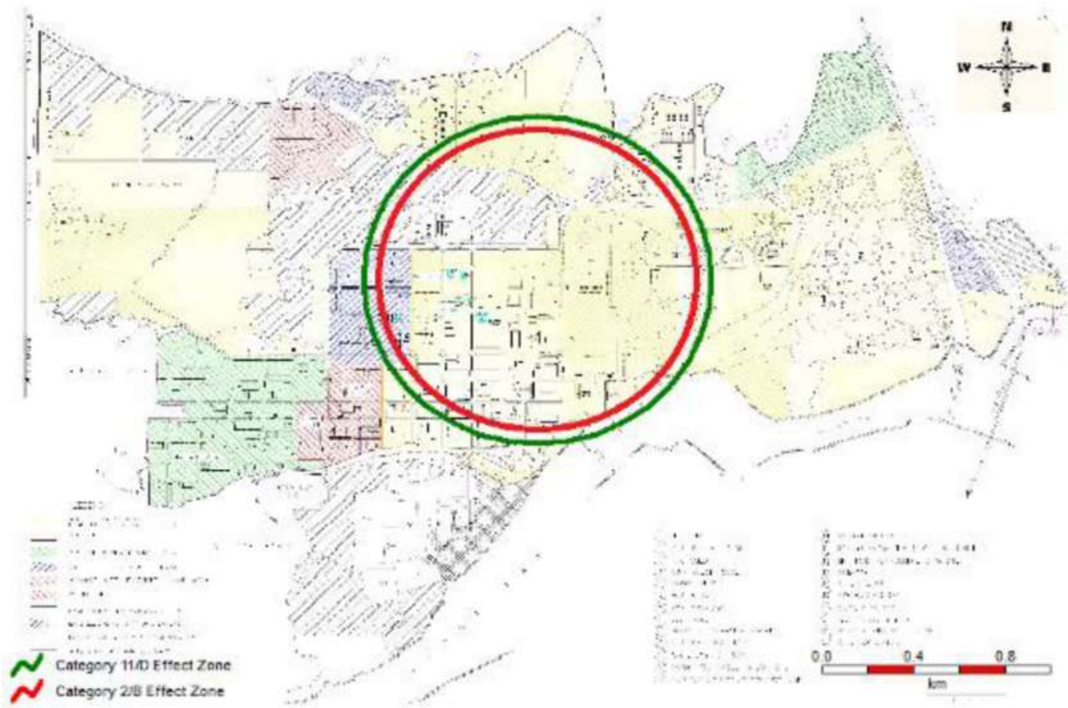


Figure No. 6.44 – Rupture of Phosgene from the Phosgene tank 18 1&2

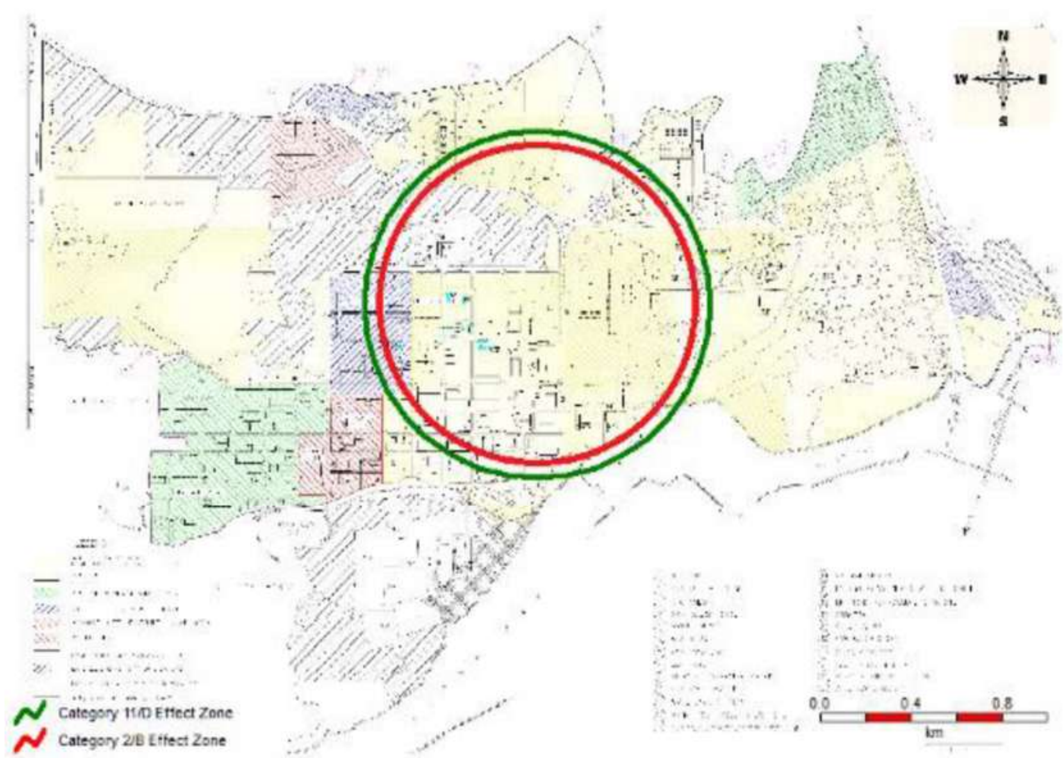


Figure No. 6.45 – Small Leak of SO3 from the SO3 ST12-106

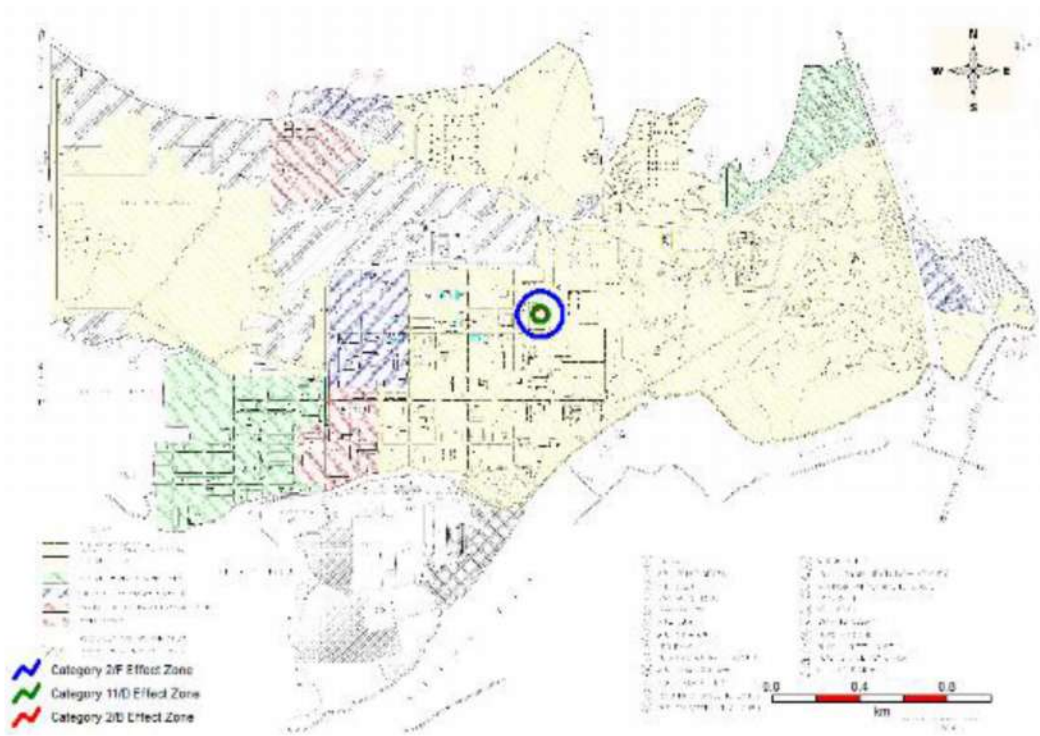


Figure No. 6.46 – Medium Leak of SO3 from the SO3 ST12-106

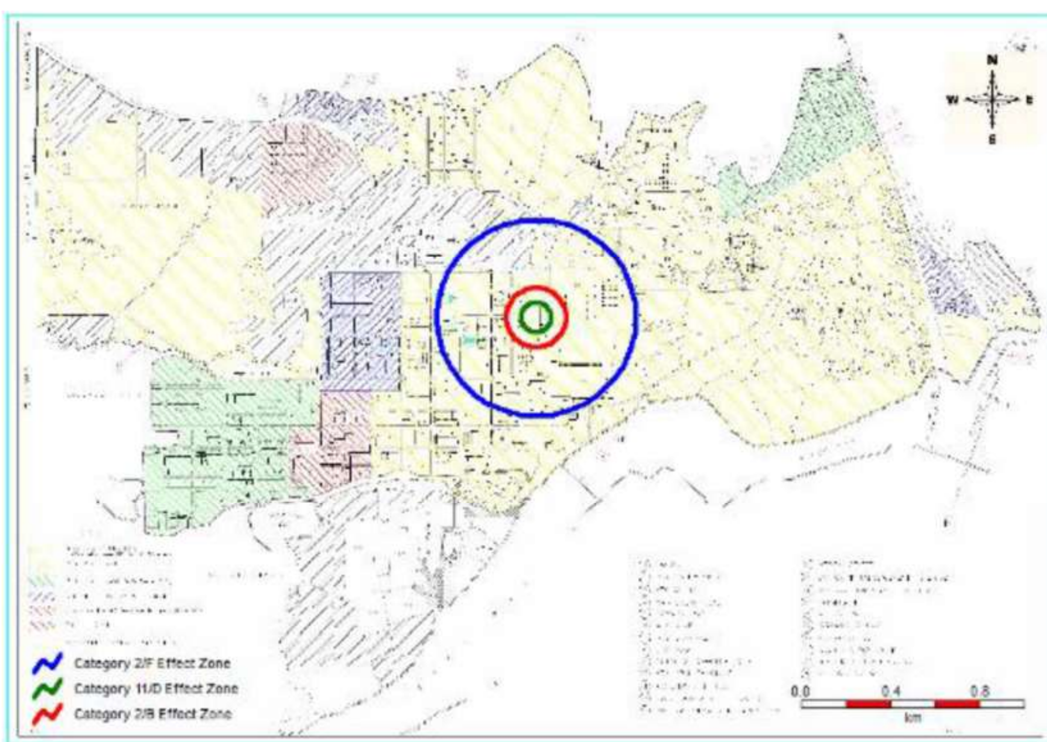


Figure No. 6.47 – Large Leak of SO3 from the SO3 ST12-106

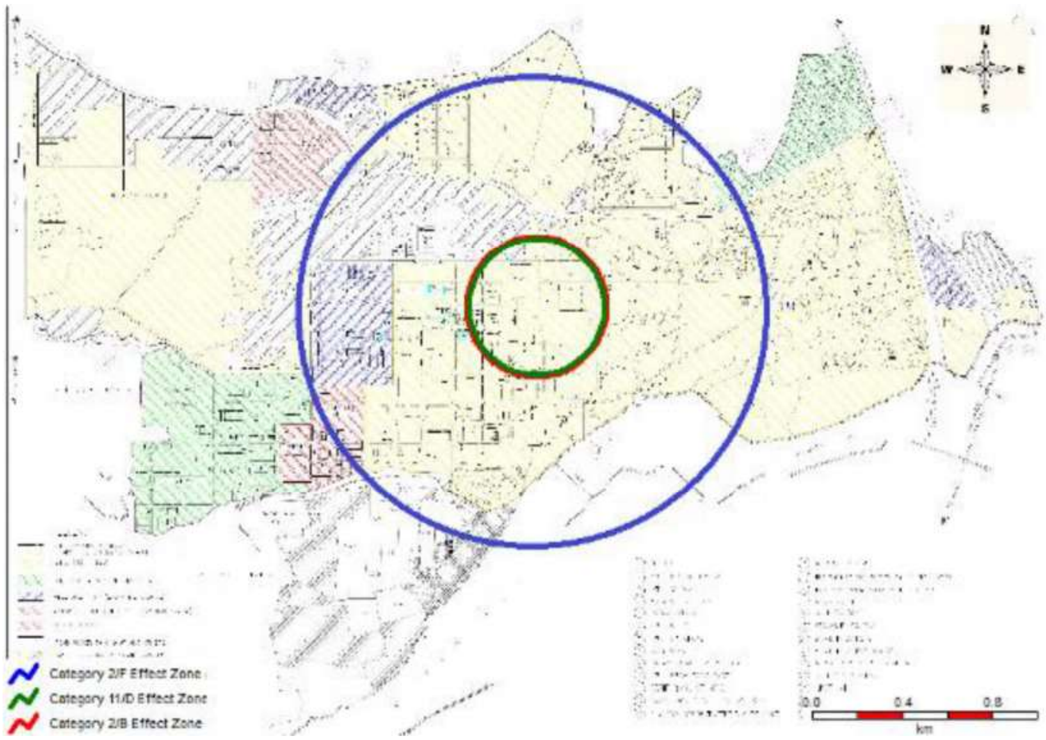
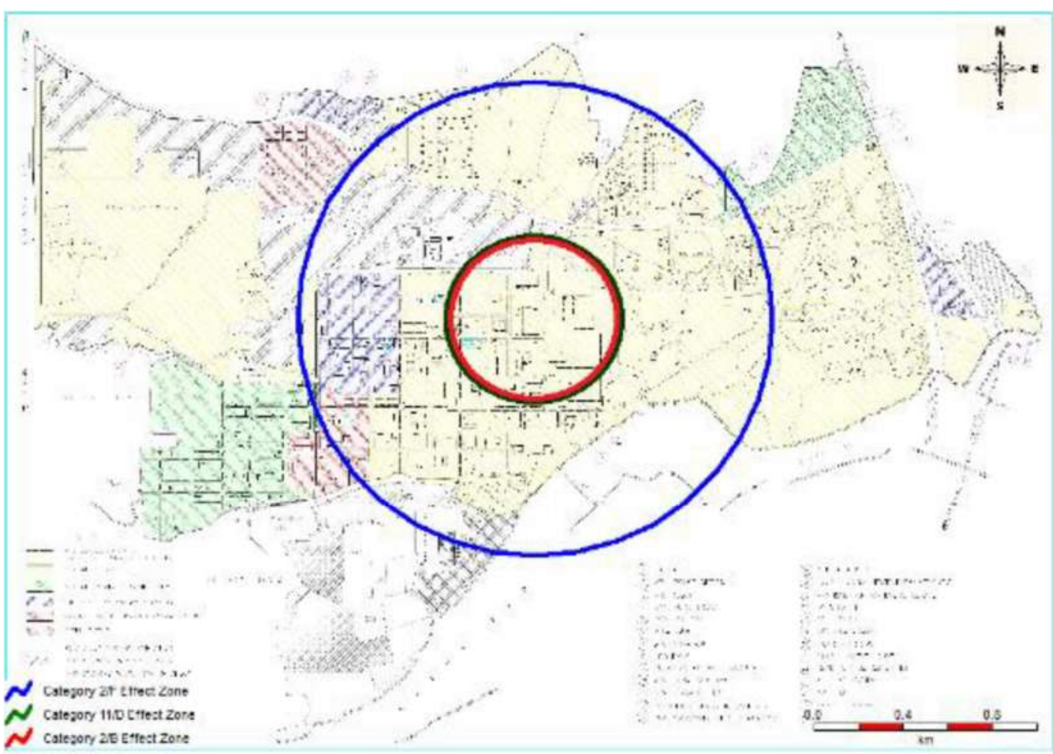


Figure No. 6.48 – Rupture of SO3 from the SO3 ST12-106



6.8 CONCLUSIONS AND RECOMMENDATIONS

The consequence distances were calculated, and have been summarized in this report. The tabulated distances give a fair idea of the impact that would be caused by the identified scenario.

The following are recommended based on the assumptions, main findings and conclusion drawn from this consequence study. The following best practices to be followed to demonstrate the ALARP (As Low as Reasonably Practicable) performance:

- The existing safety measures are maintained at their expected level of performance or better to ensure all these safety measures are in a good condition. Hence, the same shall be continued even after the proposed expansion.
- In this facility, particularly the detection, isolation, spill containment, and ventilation etc., are to be maintained at their expected level of performance or better. A regular inspection should be performed to ensure all these safety measures are in a good condition throughout the facility lifecycle.
- Regular maintenance and inspection should be performed for all critical equipment, having higher consequence damage distance. This is to minimize potential failure due to material degradation or fatigue.
- Ensure availability and effectiveness of Fire & Gas system and the emergency alarm system and means of communication, which would enable early warning to all personnel in the event of accidental release and subsequently enable all personnel to take appropriate action.
- Review arrangements focusing on worst case scenarios, offsite and onsite.

6.9 DETAILS OF STORAGE FACILITIES

Table No. 6.2 – Tank details at Atul

Plant	Chemical	Operation		Inventory (MT)	Temp. (^{O}C)	Pressure (kg/cm^2)	Elevation (mm)	Phase	Tank volume or Full Volume (m^3)
		Storage	Tank No.						
Caustic-Chlorine plant	Chlorine	Storage	ST 3	30	-18	1 to 1.5	(-775)	Liquid	55
	Chlorine	Storage	ST 5	30	-18	1 to 1.5	(-750)	Liquid	69
	Chlorine	Tonner storage	0.90mt * 200 nos cylinder	180	32 to 35	8	0	Liquid	1.02

Plant	Chemical	Operation		Inventory (MT)	Temp. (^{O}C)	Pressure (kg/cm^2)	Elevation (mm)	Phase	Tank volume or Full Volume (m^3)
		Storage	Tank No.						
Sulphuric acid plant	CSA liquid SO3	Storage	ST 6	55	40 to 42	Atmospheric	900	Liquid	41
			ST 7	55			900	Liquid	41
			ST 10	55			900	Liquid	41
			ST 102	200			0	Liquid	445
		Storage	ST 12	16	38 to 40	Atmospheric	7000	Liquid	11
			ST 106	16			7000	Liquid	11
			ST 11	0			4100		
	25 % Oleum	Storage	ST 1	80	45 to 48	Atmospheric	0	Liquid	54
			ST 2	150			0	Liquid	85
			ST 9	17			750	Liquid	11
	65 % Oleum	Storage	ST 101	65	45 to 48	Atmospheric	600	Liquid	41
			ST 103	65			600	Liquid	41
Phosgene	Chlorine	Feeding to reactor through Chlorine tonner	Tonner	900 kg* 5 tonner	Ambient	5-8 kg/cm2	On the ground	Liquid & gas	1.02
	Phosgene	Storage in Tank 18-1 / 18-2 (2 identical tank)	18-1 / 18-2 (Two identical tank)	Maximum 1 T in each.	- 16' C	Atmospheric	1 meter	liquid	7
	Phosgene	Service tank (3 identical tank)	19-1 / 19-2/ 19-3 (three identical tank)	Maximum 1 T in each.	-10 ' C	1.2 kg/cm2	1 meter	liquid	2
	Phosgene	Reactor	R-1 / R-2 (two identical reactor in series)	2 kg	50 ' C	0.015 kg/cm2	3 metre	gas	0
	Phosgene	Cylinder storage	cylinder	32 kg * 20 cylinder	Ambient	1.5 kg/cm2	On the ground	Liquid & gas	
	CO	CO holder	Holder	40 m3	Ambient	0.015 kg/cm2	2 meter dome ht. (holder height is 6 meters)	gas	33
	Phosgene	Line transfer to PHIN /NBD	Line to NBD plant	5 kg	40' C	0.4 kg/cm2	5 meter	gas	0
	Ammonia	Feeding to chilling system	Cylinder	40 kg x 5 cyls.	Ambient	10 kg/cm2	On the ground	Liquid	
	Ammonia	Chilling system	Chilling tank	200 KG	Ambient	15 kg/cm2	On the ground	Liquid & gas	
	MDC	chilling	Chilling tank	1000 kg	-17' C	2 kg/cm2	1 meter	Liquid	3

Plant	Chemical	Operation		Inventory (MT)	Temp. (^{O}C)	Pressure (kg/cm^2)	Elevation (mm)	Phase	Tank volume or Full Volume (m^3)
		Storage	Tank No.						
SHED C	Anhydrous ammonia	Storage	C03/03/30	10 MT	Ambient	10.5 kg/cm2	In a sump 1 meter below ground level	liquid	22
Epoxy	Epichlorohydrine	Storage	T-601	90 KL	Ambient	50 mm of H2O with N2	Above ground	liquid	126
			T-601-A	100 KL	Ambient	50 mm of H2O with N2	Above ground	liquid	123
			T-608	25 KL	Below 25 °C.	50 mm of H2O with N2	Above ground	liquid	28
			T-609	50 KL	Below 25 °C.	50 mm of H2O with N2	Above ground	liquid	50
FDH	Methanol	Storage		380 KL	Ambient	Atmospheric	Above ground	liquid	387
				90 KL	Ambient	Atmospheric	Underground	liquid	
				90 KL	Ambient	Atmospheric	Underground	liquid	

Table No. 6.3 – Raw Materials Consumption details

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
DYES						
1.	Sulfur Black	250	833.33	2,4-DNCB	132.26	440.85
				Caustic Soda lye 32%	539.94	1799.80
				Sulphur	159.09	530.30
				Sodium Chloride	46.82	156.08
				Sodium Sulphide	30.12	100.40
				Soda Ash	8.21	27.38
CHLORO – ALKALI INDUSTRY						
1.	Caustic soda / Potash & Sodium Sulfide	3400	7500	NaCl (100%)	2592.50	5718.75
2.	Liquid Chlorine / HCl			Barium carbonate (100%)	26.69	58.88
				Sodium Carbonate	9.86	21.75

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				(100%)		
				HCl (100%)	30.60	67.50
				NaOH(100%)	25.50	56.25
				$NaHSO_3$ (100%)	0.68	1.50
				Flocculating agent	0.07	0.15
				Precoat alfa cellulose	0.60	1.31
				Water	6409.00	14137.50
				Sulfuric acid (100%)	25.50	56.25
PESTICIDE TECHNICAL						
1.	Carbamate group of Agrochemicals	33.3	43.3	Toluene	13.77	17.91
				Sodium methoxide	0.89	1.15
				Dimethyl carbonate	2.87	3.73
				Indanone	1.78	2.32
				HCl	1.70	2.21
				$NaHCO_3$ soln.	1.59	2.07
				Cinconine	0.32	0.42
				TBHP	1.23	1.60
				Toluene	0.37	0.48
				HCl	9.25	12.03
				NaOH	1.33	1.72
				Ethylene Dichloride	9.34	12.14
				BCZ	0.62	0.80
				PTSA	0.04	0.06
				HyFlow	1.18	1.54
				P_2O_5	1.18	1.54
				Methylal	1.52	1.98
				IPA	2.66	3.46
				$ZnBr_2$	0.06	0.08
				Pd/C	0.04	0.06
				MA	20.06	26.08
				Citric acid	1.91	2.48
				Caustic flakes	0.36	0.47

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				H_2	0.06	0.08
				N_2	0.03	0.04
				$NaHCO_3$	0.36	0.47
				Silica	0.56	0.73
				Hexane	16.71	21.73
2.	Diuron	20	220	MCB	111.24	1223.60
				Dichloro aniline	13.76	151.40
				Phosgene	12.08	132.87
				Charcoal	0.28	3.09
				DMA	4.07	44.80
3.	Pyridine based insecticides & Herbicides chemical Imidacloprid	25	29.16	Sulphuric acid	12.50	14.58
				Guanidine Nitrate	16.25	18.95
				Nitro guanidine	45.00	52.49
				EDA	32.85	38.32
				HCl	200.00	233.28
				KOH	125.00	145.80
				2-[Nitroimino] imidazolidine	12.71	14.82
				2-chloro-5-methylchloro-pyridine	18.65	21.75
				Sodium Methoxide	10.00	11.66
				DMF	28.13	32.81
4.	Sulphonyl Urea	25	35.25	PCF	10.88	15.35
				2-Amino-4,6 dimethoxy pyridine	10.60	14.95
				Dioxane	36.09	50.89
				NN Dimethyl Aniline	12.46	17.57
				IPA	56.39	79.51
				SNA	15.66	22.09
				Acetonitrile	71.43	100.71
				DBU	10.10	14.24
				HCl Solution (30%)	25.06	35.34
5.	Glyphosate	50	65	PMIDA	69.06	89.78

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				Sodium tung state	0.21	0.27
				50% H_2O_2	24.17	31.42
				10% $FeSO_4$	10.36	13.47
6.	Isoprothiolane	8.3	18.3	Di Isopropyl Malonate	7.58	16.72
				CS_2	3.67	8.09
				Acetone	22.35	49.27
				NaOH	7.98	17.60
				TBAB	0.04	0.09
				Ethylene Dibromide	7.02	15.48
				n-Hexane	16.84	37.13
7.	Pyrazosulfurone	0	0.5	Acetonitrile	0.00	1.47
				Pyrimidine carbamate	0.00	0.35
				1-methyl-4-ethoxycarbonyl pyrazole -5-sulfonamide	0.00	0.29
				TEA	0.00	0.19
				Methanol	0.00	0.59
8.	Bis Pyribac Sodium	0	0.83	THF	0.00	1.74
				2,6-DHBA	0.00	0.40
				4,6-DMMSP	0.00	0.81
				Sodium hydride	0.00	0.34
9.	Azoxystrobin	0	2.08	Toluene	0.00	6.74
				DMF	0.00	0.58
				CPOPMA	0.00	1.87
				2-Cyanophenol	0.00	0.85
				K_2CO_3	0.00	1.21
				DABCO	0.00	0.01
				Methanol	0.00	3.17
10.	Quizalofop	0	1.25	Ethyl-2-(4-hydroxy phenoxy) -propionate	0.00	0.75
				2,6-dichloro quinoxaline	0.00	0.83

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				Potassium carbonate	0.00	0.56
				DMF	0.00	0.76
				Ethanol	0.00	0.63
11.	Thiamethoxam	0	10	2-chloro-5-chloro methyl thiazole	0.00	7.80
				3-methyl-4-nitroimino perhydro-1,3,5-oxadiazine	0.00	7.60
				Potassium hydroxide	0.00	2.00
				Dimethyl carbonate	0.00	2.00
				Ethanol	0.00	3.40
12.	Metribuzine	0	10	4-amino-6-tertiary-butyl-3-mercapto-1,2,4-triazinone	0.00	10.10
				98% Sulfuric acid	0.00	16.15
				Methanol	0.00	2.02
				48% Caustic lye	0.00	28.37
13.	Diafenthiurone	0	4.17	4-phenoxy-2, 6-diisopropyl phenyl isothiocyanate	0.00	3.80
				Tertiary butyl amine	0.00	0.89
				Toluene	0.00	3.00
				Hexane	0.00	7.59
RESIN						
1.	Epoxy Resin	2500	2600	BPA (Solid)	1746.76	1816.63
				ECH /recovered ECH	5325.49	5538.51
				CSL (48%w/w)	1250.00	1300.00
				IPA	25.56	26.58
2.	Polygrip rubber based	0	300	Solvents	0.00	240.00
				Chlroprine rubber	0.00	45.00
				PTBP Resin	0.00	12.00
				Rosin modified resin	0.00	3.00
3.	Polygrip TPU based	0	41.67	Solvents	0.00	35.42
				TPU	0.00	6.25

Sr. No.	Product	Quantity Existing (TPM)	Quantity Total after expansion (TPM)	Raw Material	Quantity Existing (TPM)	Quantity Total after expansion (TPM)
OTHER CHEMICALS						
1.	Anisole	0	166	Phenol	0.00	150.56
				Di-methyl Sulfate	0.00	138.44
				CS Lye (48%)	0.00	162.51
2.	1,3 Cyclohexanedione	0	80	Resorcinol	0.00	84.48
				Caustic soda flakes	0.00	30.72
				Hydrogen	0.00	1.68
				Catalyst	0.00	0.74
				HCl (36%)	0.00	84.48
3.	Resoform P-18	0	85	Acetone	0.00	37.57
				Reso - Tar	0.00	15.05
				Hyflo	0.00	0.68
				Resorcinol	0.00	64.60
				Formaldehyde	0.00	30.26
				Powerflex Oil	0.00	0.85
4.	Resoform P-19			Acetone	0.00	74.29
				Reso - Tar	0.00	30.35
				Hyflo	0.00	0.68
				Resorcinol	0.00	50.07
				37% Formaldehyde	0.00	24.82
				Powerflex Oil	0.00	0.85
5.	Resoform P-20			Acetone	0.00	11.39
				Reso - Tar	0.00	3.83
				Hyflo	0.00	0.68
				Resorcinol	0.00	47.09
				Formaldehyde	0.00	20.49
				Powerflex Oil	0.00	0.85
				Para toluene sulfonic acid	0.00	0.17
				Styrene	0.00	29.92
				Ethanol	0.00	1.28
				CS Lye	0.00	0.09

Sr. No.	Product	Quantity (TPM) Existing	Quantity (TPM) Total after expansion	Raw Material	Quantity (TPM) Existing	Quantity (TPM) Total after expansion
6.	Trans-4-MCHI	0	415	P-cresol	0.00	731.69
				Ra-Ni catalyst	0.00	43.90
				Hydrogen	0.00	35.26
				Glacial acetic acid	0.00	543.03
				Sodium hypochlorite 14.3w/w solution	0.00	3622.31
				Sodium bisulphate 5% solution	0.00	541.75
				Caustic lye 48%w/w	0.00	487.01
				10% Brine solution	0.00	676.72
				Sodium hydroxide	0.00	485.33
				Hydroxyl amine.HCl	0.00	475.03
				Sodium metal	0.00	659.85
				n- Butanol	0.00	9877.00
				H_2 (g)	0.00	6.38
				30 % HCl	0.00	510.45
				Acetone	0.00	5104.50
				Phosgene	0.00	723.76
				Toluene	0.00	1785.33
7.	p-Anisyl chloroformate			4-Methoxybenzyl alcohol	0.00	376.41
				Phosgene	0.00	346.11
				MDC	0.00	406.29
8.	DI-TERT-BUTYL DICARBONATE (Boc. anhydride)			Sodium-t-butoxide	0.00	755.30
				Carbon dioxide gas	0.00	346.53
				Phosgene	0.00	369.35
				Ethyl acetate	0.00	4096.05
				Triethyl amine	0.00	136.95
				Hyflo	0.00	107.07
9.	N, N-Disuccinimidyl Carbonate			N-Hydroxy Succinimide	0.00	419.15
				Tribtyl Amine	0.00	778.13
				Phosgene	0.00	228.25

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				THF	0.00	4150.00
10.	HX-13059	0	5	2-4 Di chloro Aniline	0.00	5.50
				$NaNO_2$	0.00	2.50
				toluene	0.00	2.50
				HCL	0.00	10.00
				Na_2SO_3	0.00	10.50
				H_2SO_4	0.00	0.50
				HCl soln.	0.00	34.00
				NaOH soln.	0.00	33.00
				t-Butyl alcohol	0.00	29.00
				HCHO	0.00	2.50
				Sodium Cynate	0.00	3.50
				Acetic Acid	0.00	3.00
				13% Hypochlorite Solution	0.00	17.00
				NaOH flakes	0.00	2.50
				HCl	0.00	13.00
				Pure 4-Methyl cyclohexyanol	0.00	8.15
				Glacial acetic acid	0.00	6.54
				Sodium hypochlorite 14.3 w/w solution	0.00	43.64
				Sodium bisulphate 5% solution	0.00	6.53
				Caustic lye 48% w/w	0.00	5.87
				10% Brine solution	0.00	8.15
				Sodium hydroxide	0.00	5.85
				Hydroxyl amine.HCl	0.00	5.72
				Sodium metal	0.00	7.95
				n- Butanol	0.00	119.00
				H_2 (g)	0.00	0.08
				30 % HCl	0.00	6.15
				Acetone	0.00	61.50

Sr. No.	Product	Quantity Existing	Quantity Total after expansion	Raw Material	Quantity Existing	Quantity Total after expansion
		TPM			TPM	
				Phosgene	0.00	8.72
				Toluene	0.00	21.51
FLAVORS & FRAGRANCES						
1.	Anethole	0	166.66	Anisole	0.00	173.33
				Propionyl chloride	0.00	167.16
				$AlCl_3$	0.00	223.32
				EDC	0.00	331.99
				13% NaCl	0.00	277.82
				10% $NaHCO_3$	0.00	127.33
				Rainey Ni	0.00	5.15
				TEA	0.00	0.51
				Methanol	0.00	208.33
				H_2 (g)	0.00	2.86
				$KHSO_4$	0.00	2.08
				Paraffin oil	0.00	9.13
2.	Avobenzone	0	83.33	4-t-butylbenzoicacid	0.00	82.81
				Methanol	0.00	74.63
				98% H_2SO_4	0.00	10.14
				5% Na_2CO_3	0.00	33.12
				4-methoxyacetophenone	0.00	60.88
				Sodium methoxide	0.00	26.84
				Toluene	0.00	460.09
				Methanol	0.00	405.77
				10% H_2SO_4	0.00	272.71
3.	Raspberry Ketone	0	100	p-cresol	0.00	129.22
				NaOH (flaks)	0.00	167.00
				Methanol	0.00	803.18
				Cobalt acetate	0.00	1.99
				Copper oxide	0.00	0.48
				Oxygen	0.00	49.70
				Acetone	0.00	119.28

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				30% HCl	0.00	273.36
				Ra-Ni (1961)	0.00	1.29
				Hydrogen	0.00	2.98
				Triethyl amine	0.00	1.57
				Divyol oil	0.00	4.97
4.	P-Anisyl Propanal	0	100	p-Anisic aldehyde	0.00	179.00
				Propanaldehyde	0.00	51.00
				Sodium hydroxide	0.00	1.54
				Methanol	0.00	462.00
				Sulfuric acid	0.00	1.32
				sodium bicarbonate	0.00	2.20
				Sodium carbonate	0.00	2.22
				Toluene	0.00	150.00
				5% Palladium Carbon	0.00	1.43
				Divyol Oil	0.00	2.20
				BHT	0.00	0.35
				H_2 (g)	0.00	1.11
5.	Octacrylene	0	83.33	Cyanoacetic acid	0.00	32.92
				2 - Ethyl hexanol	0.00	56.50
				p - Toluenesulfonic acid	0.00	1.08
				Benzophenone	0.00	101.50
				Acetic acid	0.00	71.08
				Ammonium acetate	0.00	20.58
				Cyclohexane	0.00	57.08
				Methanol	0.00	194.99
				NaCl	0.00	7.08
				Darco	0.00	7.17
				Hyflowsupper cell	0.00	1.92
				Anhyd. Na_2SO_4	0.00	1.92
6.	Octyl Methoxy Cinnamate	0	200	*p*-Anisaldehyde	0.00	118.60
				Ethyl acetate	0.00	436.00

Sr. No.	Product	Quantity		Raw Material	Quantity	
		Existing	Total after expansion		Existing	Total after expansion
		TPM			TPM	
				Ethyl hexanol	0.00	135.00
				Sodium methoxide powder	0.00	60.40
				Sodium methoxide solution	0.00	22.80
				Phosphoric acid	0.00	4.50
				Formic acid	0.00	1.30
				Divyol 460	0.00	21.60
				Darco	0.00	2.60
				Hyflo supercell	0.00	1.10

Table No. 6.4 – Products details

Sr. No.	Product	Capacity (TPM)		
		Existing	Proposed	Total
A.	**DYES**			
1.	Azo dyes	550.00	0.00	550.00
2.	Sulfur Black	250.00	583.33	833.33
3.	Sulfur Dyes Range	25.00	0.00	25.00
4.	Napthol Range	75.00	0.00	75.00
5.	Fast Color Bases	40.00	0.00	40.00
6.	Disperse Dyes (Atul-East) + Disperse Dyes (Atul-West)	118.50	0.00	118.50
7.	Optical Brighteners	10.00	0.00	10.00
8.	Reactive Dyes	127.30	0.00	127.30
9.	Vat dyes	105.00	---	105.00
	Total Production Capacity of Dyes	**1,300.80**	**583.33**	**1,884.13**
B.	**CHLORO – ALKALI INDUSTRY**			
10.	Caustic soda / Potash & Sodium Sulfide	1,800.00	2,200.00	4,000.00
11.	Liquid Chlorine / HCl	1,600.00	1,900.00	3,500.00
	Total Production Capacity of Chloro – Alkali Industry	**3,400.00**	**4,100.00**	**7,500.00**
C.	**PESTICIDE TECHNICAL**			
12.	Carbamate group of Agrochemicals	33.3	10	43.3
13.	Diuron	20	200	220

Sr. No.	Product	Capacity (TPM)		
		Existing	Proposed	Total
14.	Isoproturon	8.30	-8.30	0.00
15.	Metoxuron	8.30	-8.30	0.00
16.	Trichlo Carbon	8.30	0.00	8.30
17.	Cartap. HCl	50.00	0.00	50.00
18.	Carbendazim	20.90	0.00	20.90
19.	Herbicides (2,4 – D & related products)	1,670.00	0.00	1,670.00
20.	Pyridine based insecticides & Herbicides chemical Imidacloprid	25.00	4.16	29.16
21.	Triazole based Fungiside	1.67	0.00	1.67
22.	Pyrethroides	10.00	0.00	10.00
23.	Sulphonyl Urea	25.00	10.25	35.25
24.	MCPA	500.00	0.00	500.00
25.	Glyphosate	50.00	15.00	65.00
26.	Isoprothiolane	8.30	10.00	18.30
27.	Fipronil	5.00	0.00	5.00
28.	Formulation	200.00	0.00	200.00
29.	Pyrazosulfurone	0.00	0.50	0.50
30.	BisPyribac Sodium	0.00	0.83	0.83
31.	Azoxystrobin	0.00	2.08	2.08
32.	Quizalofop	0.00	1.25	1.25
33.	Thiamethoxam	0.00	10.00	10.00
34.	Metribuzine	0.00	10.00	10.00
35.	Diafenthiurone	0.00	4.17	4.17
	Total Production Capacity of Pesticide Technical	**2,644.07**	**261.64**	**2,905.71**
D.	**BULK DRUGS & PHARMACEUTICALS**			
36.	Mabendazole	2.00	0.00	2.00
37.	Tolbutamide	2.50	0.00	2.50
38.	Quiniodochlor	15.00	0.00	15.00
39.	Bulk drugs & intermediates	9.60	0.00	9.60
40.	Diclofenac Sodium / Potassium	2.50	0.00	2.50
41.	Atenolol	1.70	0.00	1.70
42.	Fresamide	1.30	0.00	1.30
43.	Trimethoprim	0.90	0.00	0.90

Sr. No.	Product	Capacity (TPM)		
		Existing	Proposed	Total
44.	Para Hydroxyacetophenone	1.70	0.00	1.70
45.	Para Hydroxy Phenyl acetamide	3.00	0.00	3.00
46.	Acyclovir	5.20	0.00	5.20
47.	Bathenechol	5.20	0.00	5.20
48.	Pharma Intermediates and chemicals	300.00	0.00	300.00
	Total Production Capacity of Bulk Drugs & Pharmaceuticals	**350.60**	**0.00**	**350.60**
E.	**RESIN**			
49.	Epoxy Resin	2,500.00	100.00	2,600.00
50.	Vinyl Ester Resins	37.50	0.00	37.50
51.	Ketone Formaldehyde Resins &Sulphonamide, Formaldehyde Resins	20.80	0.00	20.80
52.	UF/MF/PF/ Di Cyanadiamide Resins	270.90	0.00	270.90
53.	Polyamide Resins	161.70	0.00	161.70
54.	Polygrip rubber based	0.00	300.00	300.00
55.	Polygrip TPU based	0.00	41.67	41.67
	Total Production Capacity of Resin	**2,990.90**	**441.67**	**3,432.57**
F.	**OTHER CHEMICALS**			
56.	Anthraquinone, Naphthalene, Benzene Intermediates. (including Beta – Napthol& BON Acid	740.00	0.00	740.00
57.	M Hydroxy Phenol	460.00	0.00	460.00
58.	Anisole	0.00	166.00	166.00
59.	1,3 Cyclohexanedione	0.00	80.00	80.00
60.	Resoform P-18	0.00	85.00	85.00
61.	Resoform P-19			
62.	Resoform P-20			
63.	Carbamite	30.00	0.00	30.00
64.	Chlorzoxazone& other related products	5.00	0.00	5.00
65.	Agro, Pharma intermediates, Isocyanats& Carbonate esters, chloroformats etc.	100.00	315.00	415.00
	Trans-4-MCHI	----		
	p-Anisylchloroformate			
	DI-TERT-BUTYL DICARBONATE (Boc. anhydride)			
	N, N- Disuccinimidyl Carbonate			

Sr. No.	Product	Capacity (TPM)		
		Existing	Proposed	Total
66.	HX-13059	0.00	5.00	5.00
67.	4 Ethyl 2,3 – Diocopiperazino carbonyl chloride	3.30	0.00	3.30
68.	IminoDibenzyl 5 Carbonyl Chloride	0.80	0.00	0.80
69.	Other chemicals (DCP, MCA, MEA, DEA, PCl3, PAA, MAP etc.)	425.00	0.00	425.00
70.	Formaldehyde and base products	3200.00	0.00	3200.00
71.	Sulfuric acid / Oleum / Chlorosulphonic acid & salts	11,550.00	0.00	11,550.00
72.	Sulpha drug intermediates	193.80	0.00	193.80
73.	Acetyl Sulphanilyl Chloride & its derivatives	1,500.00	0.00	1,500.00
74.	Acetanilide	500.00	0.00	500.00
75.	Sulpha Methyl Phenazole Sodium	1.10	0.00	1.10
76.	Pyrazole Base	10.50	0.00	10.50
77.	Sulphanilic acid	25.00	0.00	25.00
78.	Bis Phenol A	416.70	0.00	416.70
79.	Hexamine	150.00	0.00	150.00
80.	Epoxy Intermediates	23.80	0.00	23.80
81.	Hardener & Auxiliaries	500.00	0.00	500.00
82.	Hardener & Intermediates	700.00	0.00	700.00
83.	Bisphenol S & Intermediate Chemicals	16.60	0.00	16.60
	Total Production Capacity of Other Chemicals	**20,551.60**	**651.00**	**21,202.60**
G.	**FLAVORS & FRAGRANCES**			
84.	Anethole	0.00	166.66	166.66
85.	Avobenzone	0.00	83.33	83.33
86.	Raspberry Ketone	0.00	100.00	100.00
87.	P-AnisylPropanal	0.00	100.00	100.00
88.	Octacrylene	0.00	83.33	83.33
89.	OctylMethoxyCinnamate	0.00	200.00	200.00
	Total Production Capacity of Flavors & Fragrances	**0.00**	**733.32**	**733.32**
	Grand Total	**31,237.96**	**6,770.95**	**38,008.91**

6.10 SAFETY MEASURES

It is practically impossible to reduce the risk to zero. However, effective measures can certainly reduce the risk considerably. The safety measures intends to reduce the risk related to various hazards present at the work place.

The details of various safety measures to be considered by Atul Ltd. at various stages of project are as detailed below:

6.10.1 Process safety measures

The following Safety measures have been adopted from the design stage itself.

- Provision of Safety Valve and pressure gauge on reactor and its jacket.
- Availability of utilities like Chilling water, chilled Brine, Nitrogen, cooling water, vacuum lines, steam supply and its alternatives to control reaction parameters and avoid undesired reactions, are/shall be made available.
- Provision of Static earthing at design stage to all solvent handling equipment, reactors, vessels & powder handling equipment.
- Appropriate Earthing to all the vessels and equipment and protection against Static Electricity. Also provision of proper earthing facilities for draining in drums.
- Easy access to all emergency valves and switches and emergency handling facilities.
- No free fall of any flammable material in the vessel.
- Safe distance between all solvents and flammable material storage tanks and the process plant.
- Provision of PPEs to all the employees to protect against any adverse health effect during operations, leakage, spillages or splash.
- Provision of PPE like Helmets, Safety Shoes, Safety Glasses, Acid-Alkali Proof Gloves etc. to the employees.
- Availability of Material Safety Data Sheets of Raw Materials & Products on the shop floor.
- Provision of Flame arrestor for solvent wherever required for solvent storage and handling.

6.10.2 Safety measures to be considered during transportation of raw materials

- Transportation of raw materials in drums on pallets (through trucks) for liquid raw materials and solvents.
- Provision of static earthing for tanker unloading.
- Use of only earthed flexible steel hose for solvent unloading from the road tanker.
- Provision of fixed pipelines with pumps for solvent transfer up to day tanks/reactors.
- Installation of Double mechanical seal type pumps.
- Provision of NRV on all pump discharge line.

Control Measures for Sulfuric Acid (H_2SO_4)

Sr. No.	Process/ Activity	Hazard involved	Risk	Control Measures
1.	Transportation of Sulfuric acid in the road tanker	Road Accident and leakage of sulfuric acid	Exposure to sulfuric vapors and harm to human beings, general public and animals Air pollution	The Sulfuric acid to be transported in the special containers with a competent driver. The transport route to be preplanned to avoid accidents and transported in the less populated areas.
2.	Unloading of Sulfuric acid from road taker	Leakages of sulfuric acid during Transfer – unloading using hose	Exposure to sulfuric acid vapors and harm to workers/ employees Air pollution	The unloading is to be done under nitrogen pressure with a suitable high pressure hose. The unloading crew has to be competent and with proper training. USE of required PPE to be done while unloading.
3.	Storage of Sulfuric acid in the designated area	Risk due to leakage and over pressurization, Safety valve gets operated	Exposure to sulfuric acid vapors and harm to workers/ employees Air pollution	The concentration of the acid to be marinated above 90 % all the time as the dilute is corrosive to the ordinary Mild steel tank Corrosion monitoring of the tank (Thickness testing) to be done periodically.
4.	Rupture of Sulfuric acid line	Heavy leakage of sulfuric acid	Injury and Health effect	Maintain acid concentration above 90% all the time.

Sr. No.	Process/ Activity	Hazard involved	Risk	Control Measures
			on the employees/workers and nearby surroundings	The acid lines to inspect regularly. Corrosion proof MOC should be selected e.g. HDPE pipe line instead of MS line.
5.	Reactive with oxidizing agents, reducing agents, combustible materials, organic materials,	Unwanted reactions	Can result in fire, Injury to employees and surrounding people	Operational control to be exercised to avoid mixing of acid with other agents like wood, paper cloth to be avoided. Training of the operating staff to be given

Safety Measures for Hydrogen

Brief description of the safety measures taken for Hydrogen storage

- Preventive inspection and maintenance
- Flame proof electrical appliances, tools.
- Earthing strip to be provided at entry to discharge electrostatic charge.
- Earthing have to be provided form both sides of the trucks during filling & being followed.
- Hydrogen sensors with alarm for immediate detection provided on all hydrogen compressor.
- Jumpers provided on all the flange joints.
- Storage system - approved by CCE.

Brief description of the safety measures taken for Hydrogen gas pipe line

- Use of schedule 40, CS seamless pipeline;
- Pipeline is to be laid above ground on firm & fixed supports, except at road crossing.
- Pipeline is to be protected against overpressure by two stage Pressure Reducing Valves and Pressure Control Valve.
- Control valve is to be connected with the most advanced Distributed Control System, which can stop hydrogen supply immediately from control room.
- Pipe-line is to be duly hydro-tested at 1.5 times the operating pressure.

- Fixed schedule for the regular inspection and maintenance of this piping.

6.10.3 Systems for Fire Fighting

The risk to people after a fire has started largely depends on the adequacy and maintenance of means to escape, the alarm system, training of the workforce in fire routine and evacuation procedures. At Atul Ltd., the company has proposed to employ well-resourced and adequate fire fighting network.

Details regarding the fire fighting capacity of the unit are given below:

Table No. 6.5 – Fire Fighting Details

Type of Fire Extinguishers	Number of Fire extinguishers	Fire water Reservoir Capacity	Fire pump capacity	Hydrant Pressure	Details Deluge valve arrangements	Foam type and quantity	Other relevant details
1) CO_2 2) ABC 3) Foam 4) Water CO_2	145	45000 m^3	275 m^3/hr	7Kg/m^2	04	Mechanical Foam Concentrate 200 lit	Fire hydrant system covering Raw material storage, fuel & finish good storage area

Figure No. 6.49 – Fire Hydrant Layout

Figure No. 6.50 – Photographs of Onsite Mock Drill & Fire Fighting Training

Fire Tender

Onsite Mock Drill

Fire Fighting Training

6.10.4 Additional firefighting measures for proposed expansion

- Safety Sirens with Alarm System in case of emergency shall be provided.
- Emergency Control Room shall be established.
- Assembly points shall be identified.
- First Aid Facility and training shall be provided for the proposed project.
- Personal protective gears and equipment shall be provided for the proposed project.
- Health checkups shall be organized at regular intervals.

- Safety Training shall be provided to the employees.
- Sprinkler Systems shall be provided as and when needed.
- Mock drills shall be periodically conducted and factors like response time shall be evaluated.
- Fire squad team shall be formed for handling any emergency situation.
- Fire Hydrant System shall be installed which shall be used for the proposed project.
- Fire Extinguishers shall be provided.

6.10.5 Other safety measures to be employed during the Proposed Project

To maintain high standards in Health, Safety and Environment, various activities shall be undertaken at the site.

The following key safety measures shall be a part of the proposed project to be implemented by the proponent:

A. Personnel Safety Measures

- Safety Training shall be regularly provided to the employees.
- Safety Sirens with Alarm System in case of emergency shall be provided.
- Emergency Control Room shall be established.
- Assembly point shall be predetermined and provided as per the requirement.
- Sprinkler Systems shall be provided as per the need.
- Fire Hydrant System shall be installed.
- Fire Extinguishers are also proposed to be provided.
- Mock drills shall be periodically conducted and factors like response time to be evaluated.
- Fire squad team shall be formed for handling any emergency situation.
- First Aid Facility and training shall be regularly provided.
- Personal protective gears and equipments shall be provided to the employees.

- Health checkups shall be organized at regular intervals.
- Safety / Health records and MSDS shall be maintained.

B. Noise Environment

- Use of PPE like ear plugs and ear muffs shall be made compulsory near the high noise generating machines.
- Moreover, the personnel shall be provided breaks in their working hours with the continuous exposure not increasing more than three (3) hours.
- The plant and equipments are designed with a view to minimize noise pollution.
- To reduce noise, pipe lines shall be liberally sized for low velocities.
- Safety blow off valves, discharge pipes, relief valves, etc. shall be equipped with silencers. Hearing Conservation program shall be imparted where noise level exceeds 90 dB (A).

PART 02 – DISASTER MANAGEMENT PLAN

6.11 ON SITE EMERGENCY PLAN

DMP for Hydrogen

- On -line monitoring of Hydrogen in Chlorine
- Flame arrester on Hydrogen gas line
- In Hydrogen compressors area all electrical appliances should be flameproof. Electrical motor should be with Earthing at both side.
- Hydrogen gas detectors should be installed at Hydrogen compressor and activates alarm in case of Hydrogen leakage
- TAC approved Fire hydrant system throughout the plant.
- Water Sprinkler should be provided around transformers
- Round the clock availability of full size own Fire Tender
- Mutual aid schemes with the adjoining industries
- Product storage tanks should be provided with dyke wall
- Four levels of communication (Telephone, P A system, Walkie talkie, Siren system)
- Incident investigation and corrective system including near-miss cases

Handling and Storage of Hydrogen

- Use adequate ventilation.
- Separate Hydrogen cylinders from oxygen, chlorine, and other oxidizers by at least 20 feet (6.1 meters) or use an approved gas cabinet.
- Store only where temperatures will not exceed 125° F (52° C).
- The must be no sources of ignition in areas where Hydrogen is being stored
- Segregate empty cylinders from full cylinders.
- When a cylinder is not in use, screw the valve protection cap firmly in place.
- Secure cylinders upright at the top and bottom. Adjust the cylinder racks so that cylinders are tightly secured.

Safe handling of hydrogen cylinders

The following should also be noted when handling hydrogen cylinders and bundles:

- Cylinder and bundle valves are only to be opened when the pressure reducer with undamaged sealings has been carefully connected. The points of connection should be checked to ensure they don‘t leak.
- Cylinder and bundle valves are to be closed when not in use in order to prevent gas leakage from leaking connections.
- If a cylinder or bundle valve is leaking or when hydrogen escape cannot be stopped by closing the valve, the hydrogen container has to be transported outside where it is to be emptied. Repairs on hydrogen cylinders or bundles, including the valves, are only to be carried through by the gas supplier.

6.12 OFF SITE EMERGENCY

6.12.1 Communication in case of Major Emergency

On declaration of major emergency, the Atul complex Disaster Control Plan becomes operative. The GM Corporate-SHE/Factory Manager who are members of the Main Control sub Committee of Atul Complex Disaster Control plan (ACDCP) will inform the following persons about the disaster and ask for help to combat the situation. They will remain in touch with Director /Occupier for guidance if needed.

Name	Designation	Telephone No.	Represent
District Collector,Valsad	Chairman D.C.C. of ACDCP	O-0262-253613,	Government
Occupier / Director, Atul, Ltd.	Vice Chairman DCC of ACDCP	O-233261 233241	Atul Ltd.
Dy. DISH Valsad	Secretary DCC of ACDCP,Valsad	O-253612,	Government
District Supdt. of Police, Valsad	Chairman P&G Sub Committee of ACDCP	O-254222,	Government
Atul Police Station, Atul		233515	Government
Atul Gram Panchayat, Atul		O-234562	Government
GPCB Vapi	Regional Office	O-0260-2432089	Government

D.C.C. = Disaster Control Committee, P & G:

The District Collector Valsad shall arrange help from Valsad Municipality, Zilla Panchayat, and other Government/Non-Government Organizations. The District authorities shall inform nearby villages for evacuation and / or other measures in case of emergency arose.

6.12.2 Mutual Aid

We have arrangements with the neighboring sites situated in the campus namely Atul – (East, PP Site & West Site), to help each other in case of any emergency. The transport facilities, firefighting facilities/ equipment, personal protective equipment and other emergency equipment shall be available for mutual aid.

6.12.3 Mock Drills & Training

The success of this plan will depend upon the education of all concerned and practice of the same at regular intervals. Periodic drill is carried out to check performance of the manpower and equipments. Regular training programs on firefighting, Use of gas masks and first aid are conducted. This training also include tabletop and functional drill of the plan. The full-scale drill is carried out in presence of statutory authorities, press, and police for handling situation effectively.

PART 03 – OCCUPATIONAL HEALTH AND SAFETY

6.13 GENERAL

For large industries, where various activities are involved during construction, erection, testing, commissioning, operation and maintenance; the men, materials and machines are the basic inputs. Industrialization generally brings problems of occupational health and safety.

The proponent therefore has properly planned and taken steps to minimize the impacts of industrialization and to ensure appropriate occupational health and safety including fire plans.

The key safety measures mentioned under shall be a part of proposed expansion project.

6.14 OCCUPATIONAL HEALTH

Occupational health needs attention both during construction/erection and operation/maintenance phases. However, the problem varies both in magnitude and variety in the above phases.

6.14.1 Construction and Erection

The occupational health problems envisaged at this stage can mainly be due to constructional accidents and noise generation. To overcome these hazards, in addition to arrangements to reduce it within the Threshold Limit Values (TLVs), necessary protective equipment shall be supplied to the workers.

6.14.2 Operation and Maintenance

The problem of occupational health in the operation and maintenance phase is primarily due to noise which could affect consultation. The necessary personal protective equipment shall be given to all the workers exposed to high noise. The working personnel shall be given the following **appropriate personnel** protective equipment.

- Industrial Safety Helmet;
- Welders equipment for eye and face protection;
- Cylindrical type earplug;
- Ear muffs;
- Safety belt/line man's safety belt;

- Leather hand gloves;
- Asbestos hand gloves;
- Electrically tested electrical resistance hand gloves; and
- Industrial safety shoes with steel toe.

Atul also has a **Department of Health (DoH)** for regularly checking health of the employeesand providing medical aid in case of injury to the personnel. The DoH is responsible for taking care of the Occupational Health & Safety of the employees at Atul Ltd.

A) DEPARTMENT OF HEALTH (DOH) at ATUL LTD

1. **Medical Centres**
   - DoH Main (Department of Health) within Atul complex
   - OHC (Occupational Health Centre, 24x7) within Factory premises.
2. **Scope of Services**
   - Primary healthcare for employees & family
   - Occupational healthcare
   - Health monitoring
   - Employee health check-ups
   - EMS (Emergency) 24x7
   - AOD (Accident on duty) management 24x7
   - OHC services 24x7
   - Medical Laboratory
   - Referrals
3. **Systems & facilities available**
   - HMIS (Hospital management & information systems)
   - Office automation

- ECG machine (two)
- Multipara Monitor with O2 Saturation (one)
- Finger pulse oximeter (one)
- Glucometer (two)
- Otoscope cum Ophthalmoscope (one)
- AED (automated external defibrillator) (one)
- Suction machine (two)
- Fully automated biochemistry analyzer (one)
- Fully automated hematology analyzer (5-part) (one)
- Automated Centrifuge (two)
- Microscopes (two)
- Blood Roller Mixers (two), Pipettes & Other Lab accessories
- Needle cutters (three)
- Oxygen cylinders (ten)
- Ambulance van with stretcher (two)
- Emergency observation beds (five)
- Medical assistance/aid visit bag (two)
- Dr Consultation equipment
- Antidotes as applicable
- First aid boxes as required

4. Manpower

- Full-time Doctors – Three (residing in campus)
- Contract Doctor – One (Medical Advisor) (residing at Valsad)
- Lab Technician – One

- Nurse – One (Male)
- Medical Assistants – Five (Male)

5. **Software Use**

- Online software for health monitoring and medical history for all employees

EMP for the Occupational Safety & Health hazards so that such exposure can be kept within Permissible Exposure Level (PEL)/Threshold Level Value (TLV) so as to protect health of workers.

1. An EMP for Occupational Safety and Health shall be proposed to implement with the following objectives:

- To keep air-borne concentration of toxic and hazardous chemicals below PEL and TLV
- Protect general health of the workers likely to be exposed to such chemicals.
- Providing training, guidelines, resources and facilities to the concerned department for occupational health hazards
- Permanent changes to workplace procedures or work location to be done, if it is found necessary on the basis of findings from the Workplace Monitoring Plan.
- It is proposed that this EMP be formulated on the guidelines issued by the Bureau of Indian Standards on OH&S Management Systems: IS 18001:2000 Occupational Health and Safety Management Systems
- Proposed EMP shall be incorporated in Standard Operating Procedure also.
- The proposed EMP shall also include measures to keep air-borne concentration of toxic and hazardous chemicals below its PEL and TLV, like…
  - Leak Surveys
  - Separate storage for toxic chemicals
  - Exhaust Ventilation
  - Proper illumination
  - Close processes to avoid spills and exposures

- Atomization of process operations to hazards of manual handling of chemicals
- Supply of proper PPEs like Air mask, Berating canisters, SCBA sets, On-line breathing apparatus at the places where there is possibility of presence of toxic chemicals
- Regular maintenance program for pumps, equipment, instruments handling toxic and corrosive chemicals
- Display of warning boards
- Training to persons handling toxic and combustible materials/chemicals.

Workplace Monitoring Plan

- It is proposed that a Workplace Monitoring Plan shall be prepared & implemented in consultation with FMO.
- Each workplace must be evaluated to identify potential hazards from toxic substances or harmful physical agents. Air-borne concentration of combustible material shall be measured and records shall be maintained.

Health Evaluation of Workers

- It is proposed that management shall device a plan to check and evaluate the exposure specific health status evaluation of the workers.
- Workers shall be checked for physical fitness with special reference to the possible health hazards likely to be present where he/she is being expected to work before being employed for that purpose. Basic examinations/tests like Liver Function tests, chest x ray, Audiometry, Spirometry, Vision testing (Far & Near vision, color vision and any other ocular defects) ECG, etc. shall be carried out. However, the parameters and frequency of such examination shall be decided in consultation with Factory Medical Officer.
- While in work, all the workers shall be periodically examined for the health with specific reference to the hazards which they are likely to be exposed to during work. Health evaluation shall be carried out considering the bodily functions likely to be affected during work. The parameters and frequency of such examination shall be decided in consultation with Factory Medical Officer and Industrial Hygienists. Plan of monthly and yearly report of the health status of workers with special reference to Occupational Health and Safety shall be prepared.

6.15 SAFETY PLAN DURING PROJECT EXECUTION STAGE (CONSTRUCTION & COMMISSIONING)

Safety of both men and materials during construction and operation phases is of concern. Safety plan shall be prepared and implemented in the proposed project activity. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster in the plant is possible due to collapse of structures and fire/explosion etc. The proposed project would formulate safety policy keeping in view the safety requirement during the construction, operation and maintenance phases, with the following regulations:

- To allocate sufficient resources to maintain safe and healthy conditions of work;
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment;
- To ensure that adequate safety instructions are given to all employees;
- To provide wherever necessary protective equipment, safety appliances and clothing as well as to ensure their proper use;
- To inform employees about materials, equipment or processes used in their work which are known to be potentially hazardous to health or safety;
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge;
- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work;
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters;
- To ensure proper implementation of fire prevention methods and an appropriate fire-fighting service together with training facilities for personnel involved in this service;
- To organize collection, analysis and presentation of data on accident, sickness and incident involving people injury or injury to health with a view to take corrective, remedial and preventive action;

- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees;
- To publish/notify regulations, instructions and notices in the common language of employees;
- To prepare separate safety rules for each type of occupation/processes involved in a plant; and
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipment, work places and operations.