INTERIM REPORT OF THE HON'BLE NGT CONSTITUTED COMMITTEE ON EXTENT OF DAMAGE TO ENVIRONMENT AND STEPS TO BE TAKEN FOR RESTITUTION OF DAMAGED ENVIRONMENT

1.0 BACKGROUND

Hon'ble NGT, Principal Bench, New Delhi initiated proceedings taking suo moto cognizance of accident with respect to news item published in the Indian Express dated 23.11.2020 entitled "Maharashtra: Two Killed, eight injured in methane gas leak in sugar factory" vide Original Application No. 274/2020. Accordingly, the Hon'ble NGT constituted a six-member Expert committee comprising the MoEF&CC, CPCB, State PCB, NEERI, Nagpur, IIT, Mumbai and the District Magistrate, Solapur, vide order dated 18/12/2020. The Committee has been directed to meet physically or by video conferencing and also to undertake visit of the site and give a report on the following;

a. The sequence of events;
b. Causes of failure and persons and authorities responsible therefor;
c. Extent of damage to life, human and non-human; public health; and environment – including, water, soil, air;
d. Steps to be taken for compensation to victims and restitution of damaged property and environment, including the land, soil, groundwater and surface water, and the cost involved;
e. Remedial measures to prevent recurrence;
f. Any other incidental or allied issues found relevant

Further, it was also directed to suggest the guidelines for safety measures to be adopted in the setting up and maintenance of biodigesters.

The committee has been constituted by MPCB vide office order No. BO/JD(WPC)/TB-210129-FTS-0225, dated 29.01.2021 and comprises of the following officials:

i. District Magistrate, Solapur
ii. Shri Suresh Kumar Adapa, Scientist D, MoEF&CC, Nagpur

iii. Shri Bharat K. Sharma, Regional Director, CPCB Regional Directorate Pune
iv. Prof. Anurag Garg, IIT Bombay, Mumbai
v. Dr. S. Ghuge, Principal Scientist, NEERI Nagpur
vi. Shri Nitin Shinde, Regional Officer, MPCB Pune

The committee conducted site visit of M/s Loknete Baburao Patil Agro Industries Ltd., Solapur – Distillery unit (hereinafter referred as the industry) on 09.02.2021 and gathered information given by the industry, MPCB during the said visit and subsequent meetings held (through video conference) on even dated 02.02.2021, 17.02.2021, 25.03.2021, 07.04.2021, 19.04.2021 and 01.06.2021 respectively.

This report is an INTERIM REPORT OF THE said COMMITTEE ON EXTENT OF DAMAGE TO ENVIRONMENT AND STEPS TO BE TAKEN FOR RESTITUTION OF DAMAGED ENVIRONMENT based on the said site visit of the committee and information given by M/s Loknete Baburao Patil Agro Industries Ltd., Solapur **–** Distillery unit and MPCB and subsequent discussions of the committee.

2.0 INTRODUCTION

Distillery industries are the key contributors to the world's economy, but these industries are also considered as one of the major potential sources of environmental pollution worldwide. Alcohol production in distilleries consists of four main steps viz. feed preparation, fermentation, distillation and packaging. In a distillery, sources of wastewater are stillage, fermenter and condenser cooling water and fermenter wastewater. Various researchers have reported that an average molasses-based distillery generates about 8 to 15 L of spent wash per litre of alcohol produced. The production and characteristics of spent wash are highly variable and dependent on feedstocks and various aspects of the ethanol production process. Wash water used to clean the fermenters, cooling water blow down, and boiler water blow down further contributes to its variability.

The wastewater generated from distillation of fermented mash (spent wash) is in the temperature range of 70–80^0 C, deep brown in colour, acidic in nature (low pH), and has high concentration of organic materials and solids. It is a very complex, caramelized and cumbersome agro industrial waste. However, pollution load of the

distillery effluent depends on the quality of molasses, unit operations for processing of molasses and process recovery of alcohols. Distillery spent wash has very high 5-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD) and high BOD/COD ratio. The amount of inorganic substances such as nitrogen, potassium, phosphates, calcium, sulphates are also very high. The high BOD and COD values of spent wash are mainly due to the presence of high organic content such as proteins, reduced sugars, polysaccharides, lignin, melanoidins, and waxes along with a complex mixture of recalcitrant organic pollutants. Its recalcitrant nature is due to presence of the brown polymers, melanoidins, which are formed by Maillard amino carbonyl reaction. These compounds have antioxidant properties, which render them toxic to many microorganisms such as those typically present in wastewater treatment processes. The defiance of melanoidins to degradation is apparent from the fact that these compounds escape various stages of wastewater treatment plants and finally enters into the environment, if not managed in environmentally sound manner. Apart from melanoidins, the other recalcitrant compounds present in the waste are caramel, variety of sugar decomposition products, anthocyanins, tannins and different xenobiotic compounds. The unpleasant odour of the effluent is due to the presence of skatole, indole and other sulphur compounds, which are not effectively decomposed by yeast during distillation. The chemical composition of spent wash has been studied extensively and each cubic meter of spent wash typically carries N, P, K, Ca, Mg, S, and organic matter to the tune of 1.8, 4, 11.5, 1, 2.2, 2.5 and 30 kg, respectively. The typical characteristics of distillery raw spent wash is depicted in the below Table 1.

Table 1: Characteristics of spent wash

S. No.	Parameters	Raw Spent wash	Bio-methanated Distillery Spent wash
1.	pH	3.8- 4.2	7.2- 7.8
2.	EC	28- 45.2	31- 40
3.	BOD_5	45000- 96000	8000- 9000
4.	COD	90000- 190000	33000- 48000
5.	Total Solids	80000- 190000	49000- 51100
6.	Suspended Solids	8400- 61900	6200- 7000
7.	Nitrogen	1200- 5000	1200- 1900
8.	Phosphorous	225- 3030	280- 400
9.	Potassium	9600- 17400	10500- 12100
10.	Chlorides	5000- 42000	7900- 8500
11.	Sulphates	3400- 9000	1050-3900
12.	Sodium	300- 670	621- 800

13.	Calcium	2100- 7000	1693-2400
14.	Magnesium	1700- 2100	976- 1900
15.	Zinc	3.5- 10	5.2- 7.0
16.	Copper	2.0- 5.0	3.0- 4.5
17.	Iron	28- 87	45- 63
18.	Manganese	4.0-5.0	4.5-7.0

Source: Valliappan, 1998; Murugaragavan, 2002; Rajkishore, 2008; Nandakumar, 2009; S. K. Rajkishore and N. S. Vignesh, 2012.

Note: Concentration of all parameters is expressed in mg/L, except pH.

2.1 ENVIRONMENTAL IMPACTS OF SPENT WASH ON SOIL ENVIRONMENT

When untreated/partially treated distillery wastewater is discharged into the environment, it may cause adverse impact on human health and environment. In water bodies, it reduces the penetration power of sun light causing a reduction in photosynthetic activity and depletion in dissolved oxygen (DO) content. Apart from the potential impacts (viz. eutrophication, depletion of dissolved oxygen, toxicological effects on the aquatic organisms etc.) of discharge of spent wash in water body, disposal/indiscriminate application of distillery spent wash on land is equally hazardous. The uncontrolled application of spent wash also leads to significant levels of soil pollution and acidification of soil. It is reported to inhibit seed germination, reduce soil alkalinity, cause soil manganese deficiency and damage agricultural crops. Further, application of distillery effluent to soil without proper monitoring, perilously affects the groundwater quality by altering its physicochemical properties such as colour, pH, electrical conductivity etc. due to leaching of the organic and inorganic ions.

The important indices indicating soil quality like Sodium Absorption Ratio (SAR), Soluble Sodium Percentage (SSP) and Kelly's ratio were reported to be adversely affected in the soil amended with distillery effluent. Constant disposal/irrigation of the soil with the effluent also led to deleterious effect on the soil properties. In fact, even regular application of anaerobically treated effluent on the soil is reported to cause detrimental effects on the microbial community which are an essential component of the soil ecosystem and are involved in regulating the various processes of nutrient recycling in soil. Thus, causing an impact by lowering of overall bacterial, actinomycetes count and nitrogen fixing bacteria i.e. *Rhizobium* and *Azotobacter also* reduced considerably; thereby interfering with the microbial activity and reducing the

overall fertility, productivity of the soil. The various types of impacts reported by various researchers are summarized in the below Table 2.

Table 2: Impact of raw and treated spent wash on soil characteristics

Impacts	Reference
Adverse effect on water retention, hydraulic conductivity & water stable aggregates	Jadhav and Savant (1975)
Mn deficiency in soil	Agarwal and Pandey (1994)
High potassium in spent wash was deleterious to soil health	Biswas et al. (1998)
Increased organic carbon, Ca, Mg, P, K & micro nutrients	Baskar et al. (2001); Rajkishore (2010)
Dose more than 250 m^3 ha^{-1} was detrimental	Mahimaraja and Bolan (2004)
Increased percent water stable aggregates and water retention capacity, but decreased the penetration resistance and salinity build up observed	Hati et al. (2007)
Fungi and actinomycetes population were inhibited soon after the application of bio-methanated spent wash	Rahkishore (2008)
Macro aggregates high and micro aggregates low in spent wash applied in soil	Biswas et al. (2009)

2.2 ABOUT THE INDUSTRY AND THE ACCIDENT

M/s Loknete Baburao Patil Agro Industries Ltd., Solapur – Distillery unit is engaged in production of Rectified spirit @ 900 kl/Month or Extra neutral alcohol @ 600 kl/Month or Ethanol @ 900 kl/Month and Fusel oil @ 1.8 MT/Month; using molasses as raw material procured from their integrated sugar unit located adjacent to the distillery unit. As per the Consent granted by MPCB, the distillery capacity is shall not exceed 30 KLPD.

It is gathered from the industry and also from the preliminary inspection report of MPCB Sub Regional Office, Solapur (inspection carried out on 22.11.2020) that the distillery unit was not in operation during 2019-2020 due to shortage of sugar cane and the distillery unit started its operation w.e.f. 02.11.2020. An accident occurred on 21.11.2020 in biodigester of the industry causing collapsing of the biodigester and spillage of spent wash contained therein and death of two persons.

2.3 WASTEWATER GENERATION AND THEIR MANAGEMENT BEFORE THE ACCIDENT

2.3.1 Spent wash generation and storage: It is gathered from the industry and also from the preliminary inspection report of MPCB Sub Regional Office, Solapur (inspection carried out on 22.11.2020) that the distillery started its operation w.e.f. 02.11.2020 and as per records of Police Department, the accident took place on 21.11.2020. Average production of ethyl alcohol as per excise register is 28.123 m^3/day against the consented capacity of 30 m^3/day, and corresponding average daily spent wash generation is 280 to 295 m^3/day. The total spent wash generated w.e.f. 02.11.2020 till 21.11.2020 (20 days) is, therefore, 5,600 m^3. As per information provided by the industry, raw spent wash was fed to the biodigester @ 2 m^3/hr (against the actual feed to the biodigester @ 14 to 16.7 m^3/hr) w.e.f. 07.11.2020, after the level was saturated in 5 days raw spent wash storage lagoon. Accordingly, 720 m^3 of raw spent wash was fed to the biodigester w.e.f. 07.11.2020 to 21.11.2020.

As per the Environment Clearance (EC) granted by MoEF&CC vide F.no. J-11011/473/2006-IA-II (I), dated 19.05.2008; under specific conditions S. no. viii, the industry has provided 30 days impervious (concrete) lagoon for storage of treated effluent (i.e. bio-methanated spent wash). Also, as per CREP guidelines the industry has provided 5 days impervious (concrete) lagoon for storage of raw spent wash. Compliance status and the details of spent wash storage lagoons provided by the industry is depicted in the below Tables 3 & 4.

Table 3: Compliance status of spent wash storage lagoons.

S. no.	Capacity of storage lagoons	
	Installed capacity	**Compliance w.r.t. specific conditions of EC and CREP guidelines**
1.	5 days impervious (concrete) lagoon of 1,500 m^3	Maximum spent wash generation @ 295 m^3/day x 5 days = 1,475 m^3. Hence the provided 5 days impervious (concrete) lagoon capacity is adequate.
2.	30 days impervious (concrete) lagoon of 9,000 m^3	Maximum spent wash generation @ 295 m^3/day x 30 days = 8,850 m^3. Hence the provided 30 days impervious (concrete) lagoon capacity is adequate.

Table 4: Details of raw spent wash stored in lagoons (information as provided by the industry)

S. no.	Particulars	Remarks
1.	5 days impervious (concrete) lagoon of 1,500 m^3	Filled with 1,500 m^3 (@ 280 m^3/day x 5 days) of raw spent wash which is intended for feed into biodigester
2.	30 days impervious (concrete) lagoon of 9,600 m^3	Filled with 3,380 m^3 (280 m^3/day x 15 days) mixture of raw spent wash & partially treated spent wash
Total quantity of raw spent wash stored in 5 and 30 days impervious (concrete) lagoons as on date of accident		4,880 m^3

2.3.2 Mass balance of spent wash generation

The mass balance of spent wash produced during 20 days operation is shown in Table 5.

Table 5: Spent wash generation and disposal

Mass Balance of Spent Wash Generation		
Spent wash generation @ 280 m^3/day	Total spent wash generated during 20 days = 5,600 m^3 (280 m^3/day x 20 days)	A. Raw spent wash feed to the biodigester = 720 m^3
		B. Raw spent wash stored in 5 days storage lagoon @ 1,500 m^3
		C. Balance raw spent wash stored in 30 days storage lagoon @ 3,380 m^3 which is in violation of consent condition as only treated spent wash after bio-methanation is permitted to store in 30 days storage lagoon
Total spent wash generation (A + B + C = 5,600 m^3)		

2.3.3 Spent wash treatment system

As per conditions of CC&A, the industry has provided biodigester followed by bio-composting for the treatment of distillery effluent @ 295 m^3/day. The design capacity of biodigester is 400 m^3/day. The effluent from distillery section is received into a receiving tank (two day holding capacity) where suspended solids is allowed to settle, the settled sludge is used in bio-composting and the supernatant effluent is pumped to biodigester. The supernatant effluent is mixed with recycled biomass from lamella clarifier to maintain a feed temperature of 36-38°C and mixed effluent is fed into the biodigester. The feed rate is controlled by a manual control valve and a flow meter provided in the feed line and the sludge recycling line. In the biodigester the effluent mixed with the recycled biomass from the lamella clarifier get further mixed with contents of the digester with the help of central and lateral agitators, which provide

homogeneous mixing in the biodigester. As per the technical specification, the retention period of the biodigester is 24 days. Anaerobic digestion takes place in the biodigester, as a result of which BOD & COD is reduced and biogas is generated. The digested effluent/biomass mixture overflows into a degassing pond where entrapped gases are released. Degassed effluent flows to lamella clarifier for separation of active biomass from the treated effluent. The clarified effluent from the lamella clarifier is discharged to 30 days spent wash storage lagoon whereas the separated biomass is pumped back continuously into the biodigester to maintain the concentration of active biomass. The excess biomass is removed from the bottom of biodigester regularly to sludge drying beds for disposal, or to be used as manure.

As per the analysis report (dated 22.03.2013) provided by the industry, it is observed that the biogas produced in the biodigester is having the composition of 64.51% methane, 35.31% carbon dioxide and 0.17% hydrogen sulphide and accumulates in digester roof, from where it flows to the gasholder. The gasholder acts as am intermediate gas storage as well as a Pressure Control Vessel (PCV). The biogas is pumped to the boiler house by a biogas blower. Surplus gas, if any, is burnt in a gas flare unit whenever gas is not being utilised in the boiler. 'Flame Arresters' are provided in gas lines to protect the biodigester from backfire from the flare and/or the boiler burner. Also, 'Over/Under' pressure release device is provided on biogas biodigester for its safety from over pressure/vacuum. Information w.r.t. design of biodigester as provided by the industry is depicted in the below Table 6.

Table 6: Technical specification of biodigester tank and gas handling system (information as provided by the industry)

Item	Capacity/Details	UoM
Biodigester	9,600	m^3
Dimensions	26 Diameter x 18 Height	m
Material of construction	MS	--
Make	M/s Eco board Ltd., Pune	--
Gas holder capacity	300	m^3
Dimension	8 Diameter x 6 Height	m
Plate thickness	6	mm
Material of construction	Basin: MS & Floating drum: MS with FRP 2 mm/clear epoxy coating inside and synthetic enamel paint outside	

As per the information provided by the industry, biodigester was filled with previous season's (i.e., 2018-19) spent wash of 5,780 m^3 i.e. ~60% of biodigester capacity. Further, during the current operating season ~720 m^3 of raw spent wash was fed to the biodigester w.e.f. 07.11.2020 to 21.11.2020. Hence, the total content of spent wash in the biodigester i.e. previous season spent wash and current season raw spent wash amounts to 6,500 m^3. Further, the distillery was not in operation during 2019-20 and the distillery resumed its operation w.e.f. 02.11.2020. Therefore, the previous season spent wash and the biomass was in the biodigester from more than a year.

During the last operative season i.e. 2018-19 total biogas generation and utilization is in the tune of 16,56,000 m^3 and during 2019-20, the integrated sugar-distillery unit was not in operation. Whereas during 2020-21, it is informed that the biodigester plant was not yet stabilized and hence biogas was no generated. Also, the industry has supplemented the information as mentioned in the manual provided by the supplier of biodigester i.e. M/s Eco Board that methane gas generation will start after 6-8 weeks from starting of spent wash feed. Information w.r.t. details of quantity of spent wash in the biodigester as provided by the industry is depicted in the below Table 7.

Table 7: Quantity of spent wash in biodigester (information as provided by the industry)

S. No.	Particulars	Quantity, m^3
1.	Designed capacity of biodigester	9,600
2.	Total volume of contents of biodigester in 2020-21 (previous season spent wash of 2018-19 + raw spent wash of 2020-21 as on 21/11/2020)	6,500 (= 5,780 + 720)

Note: Distillery was not in operation during 2019-20.

2.3.4 Bio-compost preparation

As per conditions of CC&A, the industry has provided biodigester for the treatment of distillery effluent @ 295 m^3/day followed by bio-composting on 7.5 acre of land to achieve ZLD conditions. The bio-compost is prepared by utilizing press mud (from their integrated sugar-distillery unit), bio-methanated spent wash, yeast sludge and boiler ash. Reportedly, the industry has maintained logbook to record the operational parameters viz. moisture content, temperature in windrows, details of aero tilling etc.

During committee inspection the industry informed that the logbook was destroyed in the accident and no records are available. The industry has provided impervious open compost yard, which is allowed to operate for only 270 days (excluding rainy season). The technical details of bio-compost yard and ratio for preparation of bio-compost is depicted in the below Table 8.

Table 8: Technical details of bio-compost yard and ratio of bio-compost (information as provided by the industry)

Item	Dimensions
Length and width	182 m x 168 m
No. of windrows	36 nos.
Length of windrow	178 m
Height of windrow	1.5 m
Width at bottom & top of windrow	3 m & 1.5 m
Date of formation of windrows	25.10.2020
Date of inoculation of bio-culture	26.10.2020
Ratio of press mud to spent wash	1: 0.42
Ratio of press mud to boiler ash	1: 0.05
Date of maturity	40 – 45 days

The details of utilization of press mud, boiler ash and spent wash, for preparation of bio-compost w.e.f. 23.10.2020 to 15.12.2020 are depicted in Table 9.

Table 9: Details of utilization of raw materials for preparation of bio-compost (information as provided by the industry)

S. No.	Particulars	Quantity, MT
1.	Total quantity of spent wash utilized w.e.f. 02.11.2020 to 15.12.2020	3,568 m^3
2.	Total quantity of press mud utilized w.e.f. 23.10.2020 to 15.12.2020	8,480
3.	Total quantity of boiler ash utilized w.e.f. 23.10.2020 to 15.12.2020	424

As per Office Memorandum of MoEF&CC vide F. No. J-11013/55/2017-IA-II (I), dated 04.09.2018; bio-compost prepared has to be analysed for parameters as per the Fertilizer Control Order (FCO) with latest amendments. The industry has provided

copy of analysis results of two bio-compost samples and the analysis results were compared with the standards prescribed in FCO.

The parameters analysed in bio-compost are only pH, colour, odour, electrical conductivity, particle size, total nitrogen, potassium, phosphorous, C/N ratio, moisture content, bulk density and total organic carbon. Rest of the parameters as per FCO i.e. total heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni & Zn) are not analysed. The concentration of total nitrogen, potassium, phosphorous and total organic carbon in all the samples of bio-compost is reported above the minimum required values as specified in the FCO standards. Similarly, C/N ratio in all the samples of bio-compost is reported within the values as specified in the FCO standards. However, electrical conductivity was found to be more than the standard prescribed in the FCO standards (i.e 9.54 and 9.12 dS/m against the prescribed standard of 4 dS/m). Moisture content in the bio-compost samples were also found to be higher than the standards prescribed in the FCO standards (i.e. 38 and 32 % against the prescribed standard of 25%).

2.4 SPENT WASH SPILLAGE DURING THE ACCIDENT AND THEIR MANAGEMENT AFTER THE ACCIDENT

It is gathered from the industry and also from the preliminary and follow-up inspection reports of MPCB Sub Regional Office, Solapur (inspections carried out on 22.11.2020 & 11.12.2020) that on the day of accident, ~6,500 m^3 (previous season spent wash of 2018-19 @ 5,780 m^3 and raw spent wash of 2020-21 @ 720 m^3) of spent wash was spilled from the biodigester and spread within the industry premises.

In order to contain spread of spilled spent wash, the industry constructed two pits to collect the spilled spent wash. It has been reported that the industry has collected ~4,400 m^3 of spent wash by excavating two temporary pits of 2,700 m^3 & 1,800 m^3 capacity each. The spilled spent wash from the earthen pits was filled in tankers through pumps and stored in 30 days spent wash impervious (concrete) lagoon. In addition to this, spent wash also spread in nearby nalah; wherein the industry had constructed temporary bunds and recollected ~600 m^3 of spent wash and in tankers through pumps and stored in 30 days spent wash impervious (concrete) lagoon. It is estimated that ~5,000 m^3 of spilled spent wash was recollected and stored in 30 days

spent wash impervious (concrete) lagoon. Hence, the total spent wash quantity in 30 days spent wash impervious (concrete) lagoon is 8,480 m^3 against the designed capacity of 9,000 m^3. Remaining spilled spent wash (i.e. 1,500 m^3 out of 6,500 m^3), which couldn't be collected, remained within the biodigester area and adjoining areas viz. bagasse yard, mango orchard, bio-compost yard, distillery premises and cane yard. The industry has reported estimated affected area with spilled spent wash of about 6 acres i.e. 24,282 m^2 area. The reported affected area-wise break-ups (approximate) of spread spent wash are as follows: bagasse yard: 1 acre; mango orchard: 1 acre; bio-compost yard: 1 acre; distillery premises: 1 acre, and; cane yard: 2 acres; respectively. The spent wash-soaked soil from these areas were collected. It has been informed that the top surface of the soil (~10 cm depth) from the said areas were also scrapped using excavators and the scrapped contaminated soil of ~4,700 MT was stored in the existing bio-compost preparation yard. The spent wash spread in the bagasse was recollected as such and after drying it was utilized in captive boiler of the unit, however, the data on exact quantification of bagasse utilized could not be provided by the industry.

Further, the industry had also scrapped ~1,050 MT spent wash contaminated soil from the nalah and stored in the existing bio-compost preparation yard. In total, the industry had scrapped out ~5,750 MT of spent wash contaminated soil within the unit premises. The industry has supplemented the details of no. of vehicles utilized, date and no. of trips covered regarding quantification for collection of spent wash and contaminated soil. The details of the same is provided at **Annexure-I.** The spent wash spread areas is delineated in the below Google image (Figure 1).

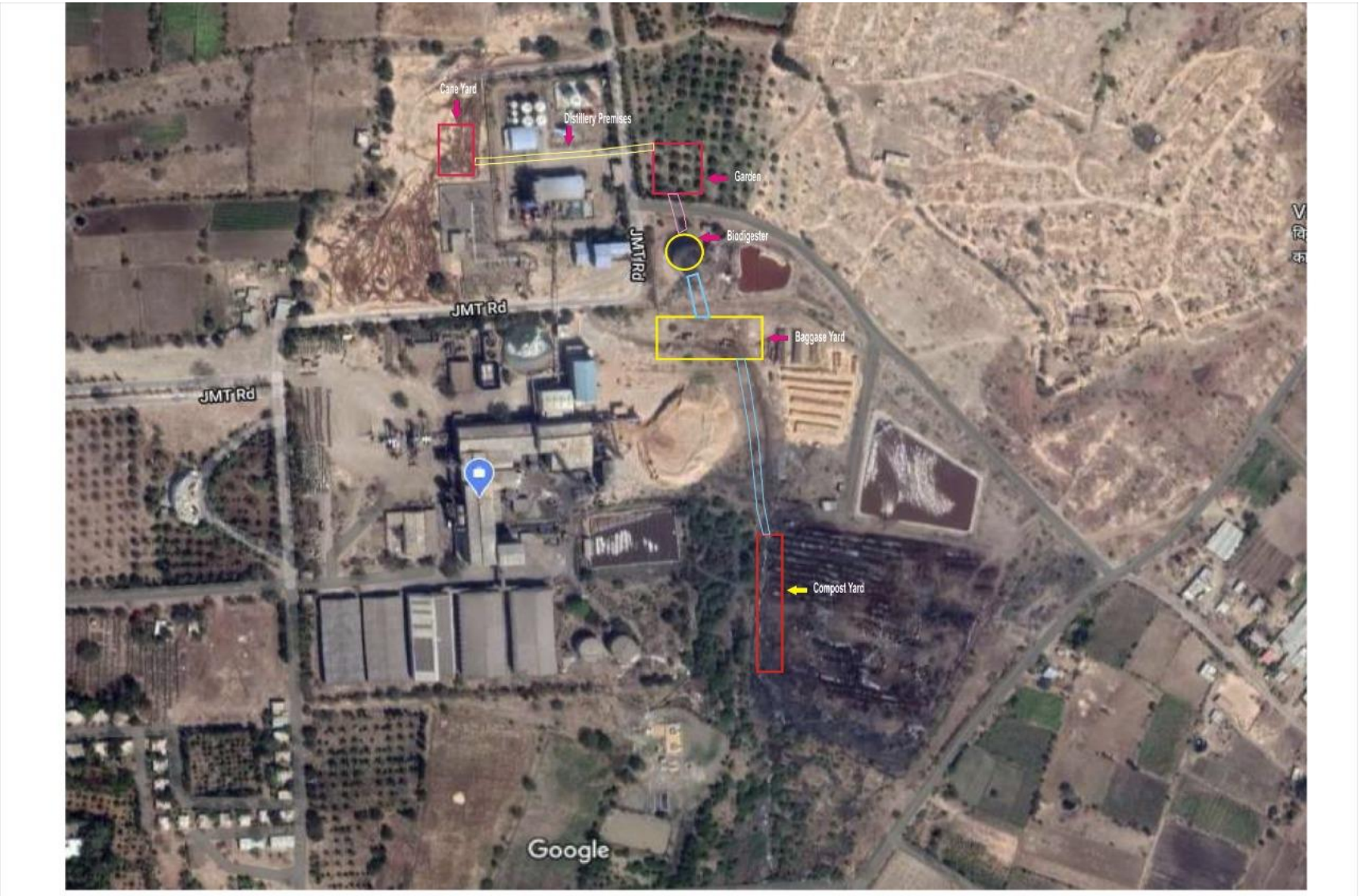


Figure 1: Google imagery indicating the spread of spent wash within the industry premises.

Table 10: Details of Spent wash storage in lagoons and their use in bio-compost during November, 2020 to March 2021 (information as provided by the industry)

S. No.	Particulars	Stored in 5 days storage Lagoons, m^3	Stored in 30 days storage lagoons, m^3	Used in composting, m^3
1.	Spent wash stored prior to accident	1,500	3,380	3,568
2.	Spent wash stored after the accident (including collected spilled spent wash from the biodigester)	1,500	8,380 (3,380 + 5,000)	6,312
Net Spent wash		**Nil**	**Nil**	**9,880**

Based on the preliminary inspection report of MPCB Sub Regional Office, Solapur (inspection carried out on 22.11.2020); MPCB Regional Office, Pune issued directions to the industry vide dated 01.12.2020 u/s 32 and 33 (A) of the Water (Prevention and Control of Pollution) Act, 1974 & u/s 31 (A) of the Air (Prevention and Control of Pollution) Act, 1981 to submit action plan for remediation and restoration of the soil. In response to MPCB directions, the industry submitted a proposal to utilize 5,750 MT of contaminated soil by proportionating @ 20% with the press mud for preparation of bio-compost in consultation with M/s Vasantdada Sugar Institute (VSI), Pune. However, the industry didn't provide the official correspondence between the industry and VSI, Pune regarding the proposal and suggestion for utilization of contaminated soil for preparation of bio-compost. It is gathered that the industry had started proportionating of contaminated soil @ 20% with the press mud w.e.f. 15.12.2020 for preparation of bio-compost. The technical details of bio-compost yard and ratio for preparation of bio-compost is depicted in the below Table 11.

Table 11: Technical details of bio-compost yard and ratio of bio-compost (information as provided by the industry)

Item	Dimensions
Length and width	182 m x 168 m
No. of windrows	36 nos.
Length of windrow	178 m
Height of windrow	1.5 m

Width at bottom & top of windrow	3 m & 1.5 m
Date of formation of windrows	25.10.2020
Date of inoculation of bio-culture	26.10.2020
Ratio of press mud to spent wash	1: 0.42
Ratio of press mud to boiler ash	1: 0.05
Ratio of press mud to contaminated soil	1: 0.2
Date of maturity	40 – 45 days

The details of utilization of spent wash, press mud, boiler ash and contaminated soil for preparation of bio-compost w.e.f. 15.12.2020 to 24.03.2021 is depicted in the below Table 12.

Table 12: Details of utilization of raw materials for preparation of bio-compost

S. No.	Particulars	Quantity, MT
1.	Total quantity of contaminated soil scrapped and available as on 15.12.2020	5,750
2.	Total quantity of spent wash utilized w.e.f. 15.12.2020 to 24.03.2021	6,312 m^3
3.	Total quantity of press mud utilized w.e.f. 15.12.2020 to 24.03.2021	15,001
4.	Total quantity of boiler ash utilized w.e.f. 15.12.2020 to 24.03.2021	750
5.	Total quantity of contaminated soil utilized (proportionating of contaminated soil @ 31.3% with press mud) w.e.f. 15.12.2020 to 24.03.2021	4,696.2
6.	Balance quantity of contaminated soil lying in compost yard as on 24.03.2021	1,053.8

The parameters analysed in bio-compost (produced using the contaminated soil) are only pH, colour, odour, electrical conductivity, particle size, total nitrogen, potassium, phosphorous, C/N ratio, moisture content, bulk density and total organic carbon. Rest of the parameters as per FCO i.e. total heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni & Zn) are not analysed. The concentration of total nitrogen, potassium, phosphorous and total organic carbon in all the samples of bio-compost is reported above the minimum required values as specified in the FCO standards. Similarly, C/N ratio in all the samples of bio-compost is reported within the values as specified in the FCO standards. However, electrical conductivity was found to be more than the standard prescribed in the FCO standards (i.e 9.45 and 9.30 dS/m against the prescribed

standard of 4 dS/m. Moisture content in the bio-compost samples was also found to be higher than the standards prescribed in the FCO standards (i.e. 37 and 30 % against the prescribed standard of 25%).

2.5 CHARACTERIZATION AND ASSESSMENT OF SOIL QUALITY

The committee, during its visit on 09.02.2021 collected samples of soil from 08 different locations covering the entire impacted area due to the accident and also from one area not having any impact due to accident as reference/background soil sample. The impact area was delineated based on the spill occurred during the accident. Initially, the committee collected the location map and made a reconnaissance survey of the impact area. Based on the discussion and spill profile of spent wash in the area, the committee decided to collect the soil samples at various depths ranging from the surface level, at 20 cm depth and at 40 cm depth.

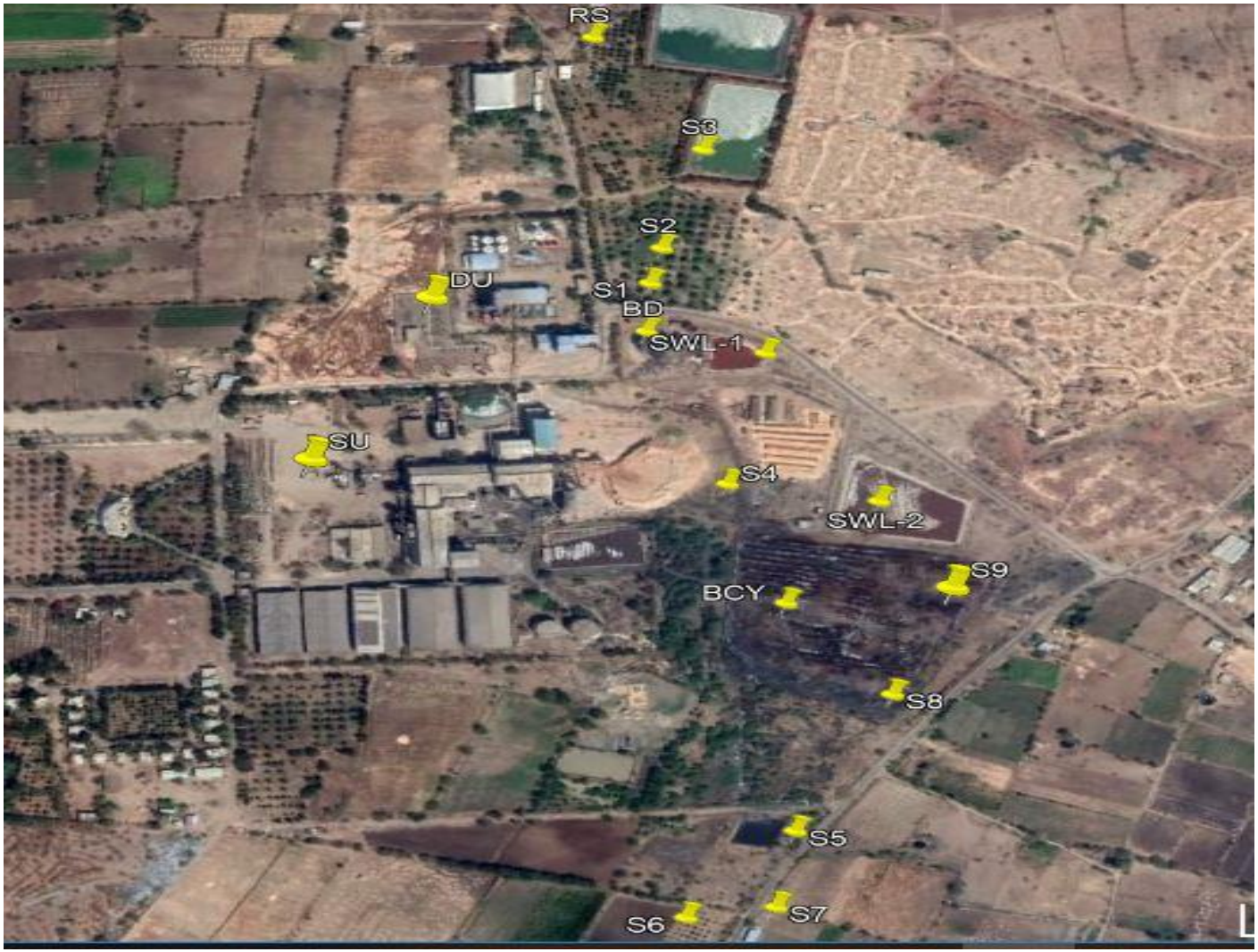
In addition to the above soil samples, composite soil (contaminated with spent wash and scrapped as 10 cm top soil) sample was collected from the bio-compost yard. The details of soil sampling locations along with geographical coordinates are depicted in the below Table 13.

Table 13: Details of soil sampling locations

Sampling location	Geographic location, Degree decimals		Details of sampling locations
	Latitude	Longitude	
S1	17.87411 N	75.59058 E	Top soil sample taken from the mango orchard (Northern side of biodigester)
			Soil sample taken at 20 cm depth from the mango orchard (Northern side of biodigester)
S2	17.87448 N	75.59066 E	Top soil sample taken from the mango orchard (Northern side of biodigester, middle of mango orchard)
			Soil sample taken at 20 cm depth from the mango orchard (Northern side of biodigester, middle of mango orchard)
S3	17.87552 N	75.59095 E	Top soil sample taken from the area, opp. distillery gate (North-eastern side of biodigester)
			Soil sample taken at 20 cm depth from the area, opp. distillery gate (North-eastern side of biodigester)
			Soil sample taken at 40 cm depth from the area, opp. distillery gate (North-eastern side of biodigester)

S4	17.87203 N	75.59113 E	Top soil sample taken from the area, Southern side of biodigester
			Soil sample taken at 20 cm depth from the area, Southern side of biodigester
S5	17.86855 N	75.5916 E	Top soil sample taken from the Bitale Mohol Road, Near Kaccha Pit (Southern side of biodigester)
			Soil sample taken at 20 cm depth from the Bitale Mohol Road, Near Kaccha Pit (South side of biodigester)
S6	17.86771 N	75.59086 E	Top soil sample taken from the lemon farm (D/S of Kaccha Pit, South-western side of biodigester)
			Soil sample taken at 20 cm depth from the lemon farm (D/S of Kaccha Pit, South-western side of biodigester)
S7	17.86781 N	75.59147 E	Top soil sample taken from the maize farm (D/S of Kaccha Pit, Southern side of biodigester)
			Soil sample taken at 20 cm depth from the maize farm (D/S of Kaccha Pit, Southern side of biodigester)
S8	17.8699 N	75.59227 E	Top soil sample taken from the downstream of compost yard (South-eastern side of biodigester)
			Soil sample taken at 20 cm depth from the downstream of compost yard (South-eastern side of biodigester)
			Soil sample taken at 40 cm depth from downstream of compost yard (South-eastern side of biodigester)
S9	17.87092 N	75.59267 E	Composite soil (contaminated with spent wash) sample collected from the bio-compost yard
RS	17.87675 N	75.59015 E	Reference top soil sample (Northern side of mango orchard)
			Reference soil sample taken at 20 cm depth (Northern side of mango orchard)

The soil sampling locations are depicted in following Google earth image. As it is evident from the Google earth image (Figure 2), soil sampling locations S-1, S-2, S-3 and reference soil sampling location are towards the Northern side of biodigester and well within 1 km radius from the biodigester. The locations S-4, S-5, S-6, S-7, S-8 and S-9 are towards the Southern side of the biodigester and also located within 1 km radius from the biodigester. The maximum spent wash was found towards the Southern side of the biodigester and the industry had contained the spent wash by excavating temporary pits and re-collected the spilled spent wash into 30 days impervious (concrete) lagoon.



Legend

S1	**:**	**Soil sampling location-1**
S2	**:**	**Soil sampling location-2**
S3	**:**	**Soil sampling location-3**
S4	**:**	**Soil sampling location-4**
S5	**:**	**Soil sampling location-5**
S6	**:**	**Soil sampling location-6**
S7	**:**	**Soil sampling location-7**
S8	**:**	**Soil sampling location-8**
S9	**:**	**Soil sampling location-9**
RS	**:**	**Reference soil sampling location**
DU	**:**	**Distillery unit**
SU	**:**	**Sugar unit**
BD	**:**	**Biodigester**
SWL-1	**:**	**Spent wash lagoon-1**
SWL-2	**:**	**Spent wash lagoon-2**
BCY	**:**	**Bio-compost yard**

Figure 2: Google imagery of the soil sampling locations in and around the industry and other environmental infrastructure provided.

The collected soil samples were analysed for parameters viz. pH, electrical conductivity, organic carbon, available nitrogen, available phosphorous, available potassium, available sulphur, sodium absorption ratio and cation exchange capacity so as assess residual impact (after scrapping of 10 cm top soil by the industry) on soil quality due to spillage of spent wash. The collected composite soil (contaminated with spent wash) sample from the bio-compost yard was also analysed for various physico-chemical parameters viz. pH, electrical conductivity, moisture content, organic carbon, ash content, total nitrogen, total phosphorous, total potassium, total iron, total manganese, total zinc, total copper and C/N ratio.

The soil samples were submitted to Mahatma Phule Krishi Vidyapeeth, Pune – an Agricultural University, for analysis. The analysis results of the aforesaid soil samples collected at surface level, at 20 cm depth and at 40 cm depth along with the comments provided by M/s Mahatma Phule Krishi Vidyapeeth, Pune, are depicted in Tables 14, 15 & 16, respectively. The physico-chemical properties of the soil sample collected from bio-compost yard (i.e., S9) are presented in Table 17.

Table 14: Analysis results of soil samples taken at surface level

S. No.	Sampling location	Parameters								
		pH	EC, dS/m	OC (%)	N, Kg/ha	P, Kg/ha	K, Kg/ha	S, ppm	SAR	CEC Cmol/kg
1.	S1	6.70	3.92	0.89	338	51	3407	20	42.66	55.30
	Rating	Neutral	*	High	Medium	Very High	Very High	Sufficient	--	--
2.	S2	7.14	1.92	0.36	248	43	1753	38	45.87	55.10
	Rating	Neutral	*	Low	Low	Very High	Very High	Sufficient	--	--
3.	S3	7.06	7.68	0.50	169	14	2573	19	47.96	54.20
	Rating	Neutral	*	Medium	Low	Low	Very High	Sufficient	--	--
4.	S4	7.20	13.52	0.54	394	114	8075	47	38.23	54.40
	Rating	Neutral	*	Medium	Medium	Very High	Very High	Sufficient	--	--
5.	S5	7.09	5.96	0.56	405	31	3917	40	32.24	54.70
	Rating	Neutral	*	Medium	Medium	High	Very High	Sufficient	--	--
6.	S6	7.46	0.71	0.47	259	20	916	39	12.78	54.40
	Rating	Neutral	Normal	Medium	Low	Medium	Very High	Sufficient	--	--
7.	S7	7.27	1.48	0.44	79	39	1028	57	29.77	54
	Rating	Neutral	*	Medium	Very Low	Very High	Very High	Sufficient	--	--
8.	S8	7.01	5.59	0.57	124	31	293	31	42.53	51.80
	Rating	Neutral	*	Medium	Very Low	High	High	Sufficient	--	--
9.	**RS**	**7.67**	**0.32**	**0.20**	**124**	**2**	**224**	**35**	**29.05**	**52.80**
	Rating	**Mildly Alkaline**	**Normal**	**Low**	**Very Low**	**Very Low**	**Mod. High**	**Sufficient**	**--**	**--**

Table 15: Analysis results of soil samples taken at 20 cm depth

S. No.	Sampling location	Parameters								
		pH	EC, dS/m	OC (%)	N, Kg/ha	P, Kg/ha	K, Kg/ha	S, ppm	SAR	CEC Cmol/kg
1.	S1	7.24	1.07	0.20	124	35	659	35	28.65	54.60
	Rating	Neutral	*	Low	Very low	High	Very High	Sufficient	--	--
2.	S2	7.46	0.63	0.10	135	8	717	39	21.15	56.40
	Rating	Neutral	Normal	Very Low	Very Low	Low	Very High	Sufficient	--	--
3.	S3	7.03	3.21	0.83	158	7	3520	34	32.20	54.60
	Rating	Neutral	*	High	Low	Low	Normal	Sufficient	--	--
4.	S4	8.42	3.88	0.14	101	22	7095	75	27.44	55.10
	Rating	Neutral	*	Very Low	Very Low	Very High	Very High	Sufficient	--	--
5.	S5	7.20	4.85	0.27	473	27	3017	46	30.88	55.20
	Rating	Neutral	*	Low	Mod. High	Mod. High	Very High	Sufficient	--	--
6.	S6	7.62	0.42	0.39	180	27	449	42	21.14	54.60
	Rating	Mildly Alkaline	Normal	Low	Low	Mod. High	Very High	Sufficient	--	--
7.	S7	7.03	2.44	0.56	214	73	1893	55	36.25	52.10
	Rating	Neutral	*	Medium	Low	Very High	Very High	Sufficient	--	--
8.	S8	7.06	4.10	0.54	135	45	263	27	40.52	55
	Rating	Neutral	*	Medium	Very Low	Very High	High	Sufficient	--	--
9.	**RS**	**7.83**	**0.20**	**0.17**	**102**	**20**	**114**	**39**	**27.71**	**55.50**
	Rating	**Mildly Alkaline**	**Normal**	**Normal**	**Very Low**	**Medium**	**Low**	**Sufficient**	--	--

Table 16: Analysis results of soil samples taken at 40 cm depth

S. No.	Sampling location	Parameters								
		pH	EC, dS/m	OC (%)	N, Kg/ha	P, Kg/ha	K, Kg/ha	S, ppm	SAR	CEC Cmol/kg
1.	S3	6.77	2.68	1.09	158	4	2412	50	36.95	53.60
	Rating	Neutral	*	Very High	Low	Very Low	Very High	Sufficient	--	--
2.	S8	7.11	3.03	0.18	203	45	447	57	19.23	54.70
	Rating	Neutral	*	Very Low	Low	Very High	Very High	Sufficient	--	--
3.	**RS**	**7.83**	**0.20**	**0.17**	**102**	**20**	**114**	**39**	**27.71**	**55.50**
	Rating	**Mildly Alkaline**	**Normal**	**Normal**	**Very Low**	**Medium**	**Low**	**Sufficient**	--	--

Note: The rating has been reported by M/s Mahatma Phule Krishi Vidyapeeth, Pune – an agricultural university

Table 17: Analysis of physico-chemical parameters of composite soil (contaminated with spent wash) sample, S9 collected from bio-compost yard.

S. No.	Parameter	Concentration	Unit
1.	pH	7.49	--
2.	Electrical Conductivity	5.25	dS/m
3.	Moisture	62.75	%
4.	Organic Carbon	12.39	%
5.	Ash	15.89	%
6.	Total Nitrogen	1.32	%
7.	Total Phosphorus	0.55	%
8.	Total Potassium	0.63	%
9.	Total Fe	1596	mg/Kg
10.	Total Mn	318	mg/Kg
11.	Total Zn	172	mg/Kg
12.	Total Cu	68	mg/Kg
13.	C:N ratio	9.39	--

3.0 RESULTS AND DISCUSSION

It is inferred from the soil quality analysis results that;

- Reference soil sample collected from the top surface and at 20 cm depth (Northern side of mango orchard) reveals that pH was mildly alkaline (7.67 and 7.83), electrical conductivity was normal (0.32 dS/m and 0.2 dS/m), very low percentage of organic carbon (0.2% and 0.17%), very low concentration of nitrogen (124 Kg/ha and 102 Kg/ha), very low and medium concentration of phosphorous (2 Kg/ha and 20 Kg/ha) and moderately high and low concentration of potassium (224 Kg/ha and 114 Kg/ha) respectively. Hence, it is evident that the soil sample collected at this location is not having significant impact of organic carbon and nutrients from spent wash.

- Soil sample collected at location no.1 i.e., top soil taken from the mango orchard (Northern side of biodigester) reveals that it contains higher percentage of organic carbon (0.89%), very high concentration of phosphorous (51 Kg/ha) and potassium (3407 Kg/ha). Similarly, the soil sample collected at location no.1 mango orchard (Northern side of biodigester) at 20 cm depth revealed high concentration of phosphorous (35 Kg/ha) and very high concentration of

potassium (659 Kg/ha). As it is evident from the analysis results that the top soil is contaminated with spent wash, even after the industry had initially scrapped ~10 cm of top soil where the spent wash has been spread in that area. Hence the probability of contamination of soil with potassium beneath the 20 cm soil layer cannot be ruled-out.

- Soil sample collected at location no. 2 i.e. at 20 cm depth taken from the middle of mango orchard (Northern side of biodigester) reveals that it contains very higher concentration of potassium (717 Kg/ha).

- Soil sample collected at location no. 3 i.e. at three different depths from the area, opp. Distillery main gate reveals that it contains medium to very high percentage of organic carbon (0.5%, 0.83% and 1.09%) and very high concentration of potassium (2573 Kg/ha, 520 Kg/ha and 2412 Kg/ha). As it is evident from the analysis results that the soil sample collected at 40 cm depth also has been contaminated with organic carbon and potassium.

- Soil sample collected at location no.4 i.e. top soil taken from the area, southern side of biodigester reveals that it contains very high concentration of phosphorous (114 Kg/ha) and potassium (8075 Kg/ha). Similarly, the soil sample collected at location no.4 i.e. soil sample taken at 20 cm depth from the area, southern side of biodigester reveals that it contains high concentration of phosphorous (22 Kg/ha) and very high concentration of potassium (7095 Kg/ha).

- Soil sample collected at location no. 5 and 6 i.e. at 20 cm depths i.e. soil sample taken from the Bitale Mohol Road, Near Kaccha Pit (Southern side of biodigester) and soil sample taken from the lemon farm (D/S of Kaccha Pit, Eastern side of biodigester) reveals that it contains low percentage of organic carbon (0.27% and 0.39%), moderately high concentration of phosphorous (27 Kg/ha and 27 Kg/ha) and very high concentration of potassium (3017 Kg/ha and 449 Kg/ha) respectively.

- Soil sample collected at location no. 7 i.e. at two different depths i.e. soil sample taken from the maize farm (D/S of Kaccha Pit, Southern side of biodigester) reveals that it contains medium percentage of organic carbon (0.44% and 0.56%), very high concentration of phosphorous (39 Kg/ha and 73 Kg/ha) and potassium (1028 Kg/ha and 1893 Kg/ha) respectively.

- Soil sample collected at location no. 8 i.e. at three different depths i.e. soil samples taken from the downstream of compost yard reveals that it contains medium to very low percentage of organic carbon (0.57%, 0.54% and 0.18%), high to very high concentration of phosphorous (31 Kg/ha, 45 Kg/ha and 45 Kg/ha) and high to very high concentration of potassium (293 Kg/ha, 263 Kg/ha and 447 Kg/ha) respectively.

- S. K. Rajkishore and N. S. Vignesh in the review article entitled “Distillery Spentwash in the Context of Crop Production – A Review” mentioned that heavy dose of application of organic carbon due to distillery waste disposal may cause high oxygen demand by bacterial activity under anaerobic condition, which will in turn cause a decrease in infiltration rate and a reduction in hydraulic conductivity due to accumulation of solids. Also, high concentration of potassium results in the decreased hydraulic conductivity of soils. An increase in electrical conductivity was reported after application of distillery effluent to agriculture fields. It is a fact on record that the all the soil samples collected are reported with high concentration of electrical conductivity except the reference soil sample (wherein it is reported electrical conductivity of 0.32 dS/m and 0.2 dS/m) and the soil sample collected at location no. 6 (wherein it is reported electrical conductivity of 0.71 dS/m and 0.42 dS/m) respectively. The high concentration of electrical conductivity results in restriction of yield of crops.

4.0 CONCLUSIONS

(i) As per Excise register, the industry started its distillery operation w.e.f. 02.11.2020 and as per the record of Police Department accident happened on 21.11.2020. The average production of ethyl alcohol is 28.123 m^3/day against the consented capacity of 30 m^3/day and corresponding daily spent wash

generation is 280 to 295 m^3/day. Total spent wash generated w.e.f. 02.11.2020 to 21.11.2020 is about 5,600 m^3

(ii) The industry has violated by not stabilizing the biodigester using organic matter, active culture, etc. prior to the operation of the distillery unit and hence was not having necessary preparedness to meet the required treatment of spent wash prescribed under the consent issued by MPCB.

(iii) The industry has provided two 5 days and 30 days spent wash impervious (concrete) lagoons of 1,500 and 9,000 m^3 capacity, respectively as per conditions of CREP norms and Environmental Clearance dated 19.05.2008. However, it is gathered that 30 days spent wash impervious (concrete) lagoon was found filled with raw spent wash of 3,380 m^3 without treatment in the biodigester. Hence the industry is non-complied w.r.t. specific conditions of S. no. viii of the Environment Clearance (EC) granted by MoEF&CC vide F.no. J-11011/473/2006-IA-II (I), dated 19.05.2008.

(iv) As per CC&A conditions, the industry has provided biodigester for the treatment of distillery effluent @ 295 m^3/day followed by bio-composting on 7.5 acre of land to achieve ZLD conditions. The design capacity of biodigester is 400 m^3/day and the volumetric design capacity of biodigester is 9,600 m^3. The biodigester was filled with previous season's (i.e. 2018-19) spent wash of 5,780 m^3 i.e. ~60% of biodigester capacity and present season's (w.e.f. 02.11.2020 to 21.11.2020) fresh spent wash of 720 m^3, which amounts to be total 6,500 m^3 of spent wash in the biodigester.

(v) After the accident, the aforesaid 6,500 m^3 of spent wash from the biodigester has reportedly been spread within the industry premises. The spilled area has been reported of about 06 acres and their approx. break-ups are as below:

(a) Bagasse yard: 1 acre;
(b) Mango orchard: 1 acre;
(c) Bio-compost yard: 1 acre;
(d) Distillery premises: 1 acre, and;
(e) Cane yard: 2 acres

However, the areas of excavated earthen pits, drains/nalah and constructed bunds may also have been affected due to contact with spent wash. Details of the same have not yet been accounted by the industry.

(vi) Approximately 4,400 m^3 of spent wash was re-collected by excavating two nos. of temporary earthen pits and in addition to 600 m^3 of spent wash was re-collected from the nalah by constructing temporary bunds.

It has also been reported that spilled spent wash did not escape from the industry premises due to containment of the spent wash by constructing the said temporary pits and bunds.

(vii) The re-collected spent wash in the tune of 5,000 m^3 was pumped and stored in the existing 30 days spent wash impervious (concrete) lagoon of 9,000 m^3 capacity. The details of spent wash storage in the said lagoons are as below:

Item	**Spent wash storage and utilization**					
	Prior to accident on 02.11.2020			**After the accident and collection of spilled spent wash**		
	05 days lagoon	**Bio-digester**	**30 days lagoon**	**05 days lagoon**	**Bio-digester**	**30 days lagoon**
Spent Wash stored (in m^3)	1,500	5,780 + 720 = 6500	3,380 as raw spent wash and bypassed without imparting bio-methanation	1,500	Not applicable	3,380 + 5,000 = 8,380
spent wash utilized (in m^3)	3,568 spent wash was utilized for preparation of bio-compost along with press mud @ 1: 0.42 (1 MT of press mud requires 0.42 m^3 of spent wash. Hence, total 8,480 MT of press mud was consumed.			6,312 spent wash was utilized for preparation of bio-compost along with press mud @ 1: 0.42 (1 MT of press mud requires 0.42 m^3 of spent wash. Hence, total 15,001 MT of press mud was consumed.		
net spent available (in m^3)	Out of 11,380 total spent wash, 9,880 spent wash was utilized for preparation of bio-compost and 1,500 spent wash was recovered/re-collected as soil-soaked spent wash and utilized as soil amendment for the preparation of bio-compost.					

(viii) The remaining spilled spent wash of about 1,500 m^3 either seeped into soil or evaporated or both at the aforesaid affected areas.

(ix) Top surface i.e. 10 cm of the soil was scrapped from the said affected area of about 6 acres and also from the nalah Quantity of the said top layer excavated soil contaminated with spent wash has been reported to be total of about 5,750 MT.

(x) It is informed by the industry that after the accident, proportionating of spent wash contaminated soil was done @ 20% along with the spent wash and press mud to prepare bio-compost. Accordingly, the industry has utilized 6,312 m^3 of spent wash, 15,001 MT of press mud, 750 MT of boiler ash and 4,696.2 MT of spent wash contaminated soil to prepare the bio-compost. Whereas, as per the above information, proportionating of spent wash contaminated soil was done @ 31.3% along with the spent wash and press mud to prepare bio-compost.

(xi) The produced Bio-compost samples were analysed only for pH, colour, odour, electrical conductivity, particle size, total nitrogen, potassium, phosphorous, C/N ratio, moisture content, bulk density and total organic carbon. Whereas other prescribed parameters i.e. total heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni & Zn) were not analysed. Hence, the industry has non-complied w.r.t. the Office Memorandum of MoEF&CC vide F.No. J-11013/55/2017-IA-II (I), dated 04.09.2018.

(xii) The analysis results of the produced compost reveal that not all the parameters have been analyses as applicable under the FCO standards. However, all the measured parameters are above the minimum required values or within the prescribed limits prescribed under FCO standards except electrical conductivity and moisture. The same were found to be 9.54 dS/m & 9.12 dS/m and 38% & 32% which are higher than the prescribed maximum limit of 4 dS/m and 25% prescribed for organic manure under the FCO standard.

(xiii) The industry has not yet provided the data on total quantity of bio-compost produced prior to the accident and also data on total quantity of bio-compost produced after the accident, their current storage in the premises and quantity sold.

(xiv) Soil samples were collated from 8 different locations of the spent wash spilled affected areas due to the accident and also from one area not having any impact due to the accident as reference/background soil sample.

(xv) Analysis results of 8 soil samples taken from the spent wash spilled affected areas and the reference soil samples taken from non-impacted area reveal that, except pH and CEC, all the measured parameters (viz. electrical conductivity, organic carbon, available nitrogen, phosphorous, potassium, sulphur and sodium absorption ratio) have higher concentration in the spent wash spilled affected area when compared with the reference soil samples collected at surface level and at 20 cm and 40 cm depths. It may, therefore, be inferred that the affected spent wash spilled area still has impact of spent wash despite excavation of 10 cm soil after the spill. The concentration of such parameters was found to be significantly high at soil sampling locations S3, S4, S5 and S8 [viz. opp. distillery gate (North-eastern side of biodigester), Southern side of biodigester, Bitale Mohol Road, Near Kaccha Pit (Southern side of biodigester) and downstream of compost yard where bund was constructed].

5.0 RECOMMENDATIONS

In view of the observations/findings that:

(i) surface soil and soil samples taken from 20 cm to 40 cm depth of the spent wash spilled affected areas have higher electrical conductivity and higher percentage of organic content, higher concentration of nitrogen, phosphorous and potassium (even after scrapping of 10 cm top soil layer) to that of unaffected soil samples indicating that there still exists impacts on soil;

(ii) no study has been conducted to assess impact on soil & other receptors due to higher concentration as (i) above and remedial measures required thereof;

There is immediate need of carrying out detailed studies and take short-term measures to contain further impact, if any. The committee, therefore, recommends the following as immediate measures:

1. A detailed study shall be conducted through reputed institute like College of Engineering, Pune/ Mahatma Phule Krishi Vidyapeeth, Pune/etc. to prepare Detailed Project Report (DPR) which may include:

(a) delineation of impacted area due to spillage of spent wash including pits/drains/nallahs/bunds;

(b) detailed soil characteristics analysis/investigation with assessment of soil qualities in the affected areas and depth levels to which the same are affected;

(c) The soil samples beneath the ground surface (up to 50 cm) should also be collected around 1 m from periphery of the affected area as after percolation, the wastewater will travel horizontally so the actual affected area needs to be determined.

(d) receptors and pathways analysis;

(e) requirement of remediation, if any, based on the above receptors and pathways analysis;

(f) In case remediation is required, details of required remediation treatment such as in-situ treatment (bio-remediation/phyto-remediation/air purging/etc.) or off-site treatment (soil excavation and management of excavated soil) along with engineering details & time period and cost thereof with expected target quality/goals in terms of various parameters of concern.

(g) Feasibility of utilizing the remaining 1,053.8 MT of excavated contaminated soil in bio-compost making ensuring compliance of all parameters stipulated under FCO standards. In case bio-composting is not feasible, details of alternate management options of the same be also provided.

The above studies be completed as early as possible preferably within two months and initiate necessary required remedial measures. A brief write-up on soil characteristics and removal mechanism of pollutants present in spilled spent wash is given at **Annexure-II** which may be helpful in preparing the said DPR.

2. Till the above DPR is prepared and suggested remedial measures therein are implemented, necessary arrangement shall be made for temporary cover of the spilled spent wash affected area during rain/monsoon, wherever feasible. Otherwise, the runoff shall be contained by constructing suitable bunds/ periphery drains at slopes in the affected areas and preventing discharge of run-offs from the industry premises by channelizing & storing the collected run-offs to the 5 days or 30 days storage lagoons. In case expected run-off (based on local monsoon data) is more than the installed capacities of lagoons, a guard pond be constructed for the same.

   The contained water in lagoons/guard pond be analysed for various parameters as prescribed applicable for general standards for discharge of environmental pollutants notified under the Environment (Protection) Act, 1986, and be managed accordingly as per directions of MPCB.

3. The industry should ensure to store the previously scrapped spent wash contaminated soil and the spent wash contaminated soil which is scrapped from the affected areas in an environmentally sound manner i.e. the spent wash contaminated soil should be stored and stockpiled under the covered shed on the impervious layer in order to prevent the leaching form the soil during monsoon season.

4. The industry shall provide information on total quantity of bio-compost produced prior to the accident and also data on total quantity of bio-compost produced after the accident, their current storage in the premises and quantity sold.
   The compost shall not be sold/used until the same meets the prescribed FCO standards.

5. The industry should provide adequate leachate collection facility around the compost plant and leachate be collected and stored in 30 days storage lagoons followed by management of the same as per the norms.

6. Ground water quality monitoring in and around the industry premises shall be monitored at least two times year (pre-monsoon and post-monsoon) for a minimum period of 2 to 3 years. The no. of monitoring wells in and around the industry premises should be near as far as possible, at least 03 no. of monitoring wells should be so selected.

7. The industry shall inventorise plants/greeneries damaged due to the accident and shall substantiate the same.

(Milind Shambharkar)
Collector & Dist. Magistrate,
Solapur

(Suresh Kumar Adapa)
Scientist D,
MoEF&CC Nagpur

(Bharat K. Sharma)
Regional Director,
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(Prof. Anurag Garg)
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(Dr. S. Ghuge)
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Regional Officer,
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Annexure- I

LokneteBaburao Patil Agro Industries Ltd. Laxminagar, Angar, Tal. Mohol, Dist. Solapur 413 214.

Spentwash recovery Details.(05 Dec-2020 to 11 Dec-2020)

Sr.No	Date	Vehicle No	Capacity ofVehicle	Total Trips	Total
1	5/12/2020	MH-06-AC-6899	20000	6	120000
2	5/12/2020	MH-12-EF-8908	20000	7	140000
3	5/12/2020	MH-45-599	20000	5	100000
4	5/12/2020	MH-43-E-146	20000	4	80000
5	5/12/2020	MH-12-FC-8071	20000	6	120000
6	5/12/2020	MH-25-5601	7000	7	49000
7	5/12/2020	MH-06-G-6786	2500	6	15000
				Total	**624000**
1	6/12/2020	MH-06-AC-6899	20000	6	120000
2	6/12/2020	MH-12-EF-8908	20000	7	140000
3	6/12/2020	MH-45-599	20000	6	120000
4	6/12/2020	MH-43-E-146	20000	8	160000
5	6/12/2020	MH-12-FC-8071	20000	6	120000
6	6/12/2020	MH-25-5601	7000	7	49000
7	6/12/2020	MH-06-G-6786	2500	9	22500
				Total	**731500**
1	7/12/2020	MH-06-AC-6899	20000	7	140000
2	7/12/2020	MH-12-EF-8908	20000	6	120000
3	7/12/2020	MH-45-599	20000	8	160000
4	7/12/2020	MH-43-E-146	20000	7	140000
5	7/12/2020	MH-12-FC-8071	20000	5	100000
6	7/12/2020	MH-25-5601	7000	6	42000
7	7/12/2020	MH-06-G-6786	2500	7	17500
				Total	**719500**
1	8/12/2020	MH-06-AC-6899	20000	5	100000
2	8/12/2020	MH-12-EF-8908	20000	7	140000
3	8/12/2020	MH-45-599	20000	8	160000
4	8/12/2020	MH-43-E-146	20000	6	120000
5	8/12/2020	MH-12-FC-8071	20000	7	140000
6	8/12/2020	MH-25-5601	7000	8	56000
7	8/12/2020	MH-06-G-6786	2500	7	17500
				Total	**733500**
1	9/12/2020	MH-06-AC-6899	20000	6	120000
2	9/12/2020	MH-12-EF-8908	20000	6	120000
3	9/12/2020	MH-45-599	20000	8	160000
4	9/12/2020	MH-43-E-146	20000	6	120000
5	9/12/2020	MH-12-FC-8071	20000	7	140000
6	9/12/2020	MH-25-5601	7000	8	56000
7	9/12/2020	MH-06-G-6786	2500	7	17500
				Total	**733500**
1	10//12/2020	MH-06-AC-6899	20000	5	100000

2	10//12/2020	MH-12-EF-8908	20000	6	120000
3	10//12/2020	MH-45-599	20000	8	160000
4	10//12/2020	MH-43-E-146	20000	6	120000
5	10//12/2020	MH-12-FC-8071	20000	7	140000
6	10//12/2020	MH-25-5601	7000	7	49000
7	10//12/2020	MH-06-G-6786	2500	8	20000
				Total	**709000**
1	11/12/2020	MH-06-AC-6899	20000	6	120000
2	11/12/2020	MH-12-EF-8908	20000	7	140000
3	11/12/2020	MH-45-599	20000	6	120000
4	11/12/2020	MH-43-E-146	20000	7	140000
5	11/12/2020	MH-12-FC-8071	20000	8	160000
6	11/12/2020	MH-25-5601	7000	7	49000
7	11/12/2020	MH-06-G-6786	2500	8	20000
				Total	**749000**
Total recovery of Spent wash = 5000000/- liters (5000 m3)					

LokneteBaburao Patil Agro Industries Ltd. Laxminagar, Angar, Tal. Mohol, Dist. Solapur 413 214.			
Scrapping Soil Collection Details.(06 Dec-2020 to 11 Dec-2020)			
Sr.No	Date	Tipar No	Total Trips
1	6/12/2020	MH-25-GC-521	15
2	6/12/2020	MH-04-FD-8164	14
3	6/12/2020	MH-25-B-7940	10
4	6/12/2020	MH-25-520	8
5	6/12/2020	MH-25-9799	8
Total			**55**
1	7/12/2020	MH-25-GC-521	15
2	7/12/2020	MH-04-FD-8164	16
3	7/12/2020	MH-25-B-7940	14
4	7/12/2020	MH-25-520	15
5	7/12/2020	MH-25-9799	15
Total			**75**
1	8/12/2020	MH-25-GC-521	17
2	8/12/2020	MH-04-FD-8164	16
3	8/12/2020	MH-25-B-7940	15
4	8/12/2020	MH-25-520	17
5	8/12/2020	MH-25-9799	16
Total			**81**
1	9/12/2020	MH-25-GC-521	18
2	9/12/2020	MH-04-FD-8164	17
3	9/12/2020	MH-25-B-7940	15
4	9/12/2020	MH-25-520	16
5	9/12/2020	MH-25-9799	17
Total			**83**

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1	10/12/2020	MH-25-GC-521	20
2	10/12/2020	MH-04-FD-8164	15
3	10/12/2020	MH-25-B-7940	13
4	10/12/2020	MH-25-520	15
5	10/12/2020	MH-25-9799	18
Total			**81**
1	11/12/2020	MH-25-GC-521	21
2	11/12/2020	MH-04-FD-8164	19
3	11/12/2020	MH-25-B-7940	20
4	11/12/2020	MH-25-520	21
5	11/12/2020	MH-25-9799	18
Total			**99**
TotalTrips			**474**

This is for your information and kind consideration.

Thanking you.
Yours faithfully,

(O.S.Jogade)
CHIEF EXECUTIVE OFFICER

Copy to : SRO, MPCB,Solapur

Annexure- II

A BRIEF WRITE-UP ON SOIL CHARACTERISTICS AND REMOVAL MECHANISM OF POLLUTANTS PRESENT IN SPILLED SPENT WASH

(A) Soil Type and its characteristics

In Mohol Tahshil, the soil type is classified as black cotton soil (URL 01). In this region, the soil depth is 22.5 cm – 90 cm (i.e., medium deep soil) (URL02; District Survey Report, 2018). Below this depth rock formation may be expected. Generally, soils are usually low in total nitrogen, low to medium in available phosphorous and high in available potash. The normal rainfall in this region is 575 mm (URL 03). In general, the soil formation is clayey loam in texture with equally high in calcium carbonate. It is highly poros however its permeability is moderate to low. Due to which it has low to moderate infiltration capacity. Water infiltration is highly dependent on two soil water conductivity and soil absorptivity. It decreases with increase in moisture content.

Water retention capacity of soils of Mohol Agricultural Research Station, Solapur are reported by Durgude et al. (2004). At the 6 sampling locations, clay and silt constituted 56-95% of the total particles. Only at two locations, ~44% sand particles were present. The permeability of this type of soil can be considered as 10^{-7} m/s (i.e., 0.0864 m/d) (URL 04). Theoretically, the wastewater will take around 105 days (i.e., 3.5 months) to percolate 90 cm depth (maximum limit of medium deep soil). However, as mentioned above the actual percolation rate is likely to be much slower hence it is expected to take much longer than 105 days. The prediction of exact duration of wastewater percolation is difficult due to following reasons:

- Non-uniform sub-surface soil profile (e.g., rock may appear at much lower depth beneath the ground level).
- The solids present in the spilled distillery spent wash may block the pores of soil which will further reduce the seepage of water.
- The ground water level in Mohol Tahsil is 2.8 m below ground level in post-monsoon season (as per the information provided by MPCB). In the view of

above discussion, it can be deduced that the chances of wastewater mixing with groundwater is very low.

- **Hence, the infiltration capacity of the contaminated soil measurement may be helpful in understanding the percolation rate of wastewater and be compared with that of uncontaminated soil in the same region. The standard Double Ring Infiltrometer method may be used to measure the infiltration capacity. The reference for this method is as follows:**

ASTM Standards, Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer. D: 3385 – 9403

(B) Removal mechanisms of Pollutants present in spilled spent wash

Various organic and inorganic pollutants present in the wastewater can be removed or transformed by several mechanisms:

Volatilization – Some volatile organics present in the spent wash may volatilize when exposed to atmosphere. Higher contact area between ground surface and atmosphere may increase the rate of volatilization.

Filtration/screening – the impurities larger than the pore size of soil will be removed by filtration.

Precipitation – The pH of soil water may remove some dissolved inorganics by forming their insoluble precipitates.

Adsorption - Some dissolved organic as well as inorganic impurities may be adsorbed on the clay particles. Though some compounds may be desorbed after converting into non-adsorbable compound by some transformation mechanism.

Chemical oxidation – A fraction of complex organic compounds may be converted into lower molecular weight compounds due to the presence of oxidizing agent (e.g., oxygen though in low concentrations may be initially present in water).

Ion-exchange process – Some of the inorganic cations may be removed by replacing sodium ions present in soil.

Microbial degradation – The indigenous microbes present in soil may play an important role in the removal of various dissolved/ adsorbed organic or inorganic impurities.

However, lateral and vertical movement is likely to occur, hence commenting on the impact on quality of sub-surface water (in vadose zone) or in dug wells is difficult. **Therefore, it may be helpful to conduct a study for monitoring sub-surface water quality (particularly in unconfined aquifer) by identifying appropriate number of observation wells near the site.**

References:

URL 01:
http://environmentclearance.nic.in/writereaddata/District/surveyreport/041020187BMFWJKTFINALDMPINTERATGLANCE2.pdf (Accessed on 9th June 2021)

URL02: District Survey Report, 2018.
https://cdn.s3waas.gov.in/s3acc3e0404646c57502b480dc052c4fe1/uploads/2018/09/2018090491.pdf (Accessed on 9th June 2021)

URL 03:

http://cgwb.gov.in/AQM/NAQUIM_REPORT/Maharshtra/Karmala,%20Madha,%20Malshiras,%20Mohol,%20Pandharpur,%20South%20solapur,%20Solapur%20District.pdf (Accessed on 9th June 2021)

A. G. Durgude, V. K. Kharche and J. D. Patil. Water retention characteristics of soils of Mohol Agricultural Research Station, Solapur, Maharashtra. Agropedology 2004, 14(1), 60-64.

URL 04:
http://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm (Accessed on 9th June 2021)