REPORT ON AMBIENT AIR QUALITY MONITORING CONDUCTED IN THE KINGSTON METROPOLITAN AREA (KMA)

In Response to the fire at the Riverton City Solid Waste Disposal Facility (11-30 March 2015)

Prepared by:
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LIST OF ACRONYMS

- AQHI - Air Quality Health Index
- AQI -Air Quality Index
- KMA- Kingston Metropolitan Area
- MET- meteorological
- MOH - Ministry of Health
- NEPA - National Environment and Planning Agency
- NO_2 - Nitrogen Dioxide
- PAPs-Priority Air Pollutants
- PM_{10} - Particulate Matter less than 10 microns
- $PM_{2.5}$ -Particulate Matter less than 2.5 microns
- POPs - Persistent Organic Pollutants
- SO_2 -Sulphur Dioxide
- TSP - Total Suspended Particulate Matter
- $\mu g/m^3$ – Micrograms per meter cube
- m/s – meters per second
- USEPA - United States Environment Protection Agency
- VOC - Volatile Organic Compounds
- WHO-World Health Organization

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1.0 EXECUTIVE SUMMARY

This Report contains the findings and analysis of the ambient air quality monitoring data collected over the period 11 – 24 March 2015. Data collection and analysis was extended to 30 March 2015 in order to gauge and account for the lingering effects of the fire which continued to smolder up to 29 March 2015. The Report assesses the extent of the impact of the fire on ambient air quality in the KMA and provides information on the location of the ambient air monitoring stations, the air pollution parameters monitored and the chemical analyses conducted within limitations. The analytical results are intended to establish the bases for assessment of the impact of the emissions released during the fire event.

The location of the ambient air monitoring network is presented in Tables 1 and 2. The monitoring sites included sites operated by the Agency and regulated (industry) facilities within the KMA. Monitoring for Volatile Organic Compounds (VOCs) was done using Passive VOC monitors. The VOC monitors were deployed between 18 March 2015 and 26 March 2015. The monitors were exposed for 24 hours, retrieved, and the badges prepared and subsequently dispatched to an accredited laboratory in Canada where the analyses were done (Table 2).

The parameters analyzed (i.e. PM_{10}, SO_2, NO_2 and VOCs) and the findings are presented herein. A comparative analysis with the 2014 annual average readings for each site monitored, as well as the Jamaica Ambient Air Quality Standards, USEPA Standards, the Canadian Standards and the relevant World Health Organization (WHO) guidelines, are shown in Appendix II.

The Findings may be summarized as follows:

1. The fire at the Riverton Solid Waste Disposal Facility impacted negatively on the ambient air quality and on human health and wellbeing in Kingston and St. Andrew and parts of St. Catherine, including Portmore over the period under review.

2. The fire is ranked as the most detrimental in the history of fires at the Riverton Solid Waste Disposal Facility if its impact on ambient air quality and the zone of influence is considered. Over the first 7 days of the fire, ambient air quality with respect to PM_{10} is categorized as “Very High Risk” according to the Canadian and USEPA Air Quality Index, within a 5km radius of the foci of the fire (Map 2 and Appendix III).

3. Even at distances of up to a 6km radius of the solid waste disposal facility the air quality with respect to PM_{10} is categorized as “High Risk” according to the Canadian and USEPA Air Quality Index (Map 2 and Appendix III).

4. The WHO 24 hour average standard of 50µg/m^3 and the Jamaica Ambient Air Quality 24 hour average Standard of 150µg/m^3 for PM_{10} was exceeded on Friday, 13 March 2015. The exceedances were recorded at both air monitoring sites on Marcus Garvey Drive. On Wednesday, 18 March 2015 the standard was exceeded at the JPSCo Ltd. Spanish Town Road air monitoring site. The JPSCo Ltd site recorded the highest value of PM10 observed during the fire, of 192µg/m^3. The data findings also show that on 13 March 2015, all monitoring locations were significantly impacted by PM_{10} (Table 4 & Figure 2), with readings significantly higher than the annual average readings for the respective sites.

5. Significantly high 24 hour particulate matter (PM_{10}) readings above the WHO 24 hour average Standard (57µg/m^3 - 192µg/m^3) were recorded at all air monitoring locations for the first eight days of the fire, including the Waterford Fire Station, JPSCO Ltd. Spanish Town Road, Marcus Garvey Drive and as far as College Commons in Mona.

6. Data sequestered from meteorological stations located on Marcus Garvey Drive and Spanish Town Road were used to generate three wind rose plots. The three wind rose plots show that the strongest winds were coming from the southeasterly direction during the period of the fire. Notably, very strong winds were experienced in the vicinity of the KMA during this period. The resultant wind vector from all the monitoring sites differed, which resulted in the smoke plume spreading throughout the KMA and further drifting to the southwestern sections of Portmore. Stronger winds were experienced during this fire compared with previous fires, which led to the distance the smoke plume travelled

7. Twenty six (26) VOCs were detected from the analyses done on the samples collected at the three monitoring locations (Table 3). Of the twenty six (26) VOCs detected, sixteen (16) were detected above the lower concentration limit of the analysis method of 0.2 $\mu g/m^3$. Benzene and compounds of benzene showed the highest increase in concentration with values ranging from $2\mu g/m^3$ to $15.3\mu g/m^3$. The results also show that benzene attenuated most significantly during the firefighting efforts. Hence benzene was used as the indicator of the impact of these hazardous air pollutants from the fire. It must be noted that there is no established ambient air quality standard for benzene locally or in other jurisdictions, and so any exposure to benzene is considered a grave risk to public health.

8. The maximum hourly average concentration of SO_2 recorded at Spanish Town Road air monitoring site was 451µg/m3. This finding was recorded on 19 March 2015 along with the highest 24 hour average concentration for SO_2 ($127\mu g/m^3$). This 24 hour reading is significantly higher than the highest 24 hour average reading for SO_2 recorded in 2014 at the Red Stripe monitoring site (highest reading recorded in 2014 was $90\mu g/m^3$). As such the elevated SO_2 concentration may be attributed to the fire. A comparison of the results with the WHO Interim Target-2 and the WHO Air quality Guideline value for the SO_2 24 hour averaging, revealed that there were three exceedances recorded; on the 19th, 22nd, and 23rd of March, of the interim target-2, and exceedances of the WHO Air Quality Guideline Value on 16 out of the 17 days monitored (See table 5). It must be noted that these air monitoring stations are all located east of the disposal site, upwind of the strongest prevailing winds. The latest results have revealed a return to ambient concentrations which existed prior to the commencement of the fire.

9. The maximum hourly average of NO_2 recorded at Marcus Garvey Drive was $82\mu g/m^3$. This finding was recorded on Thursday, 12 March 2015. The highest 24 hour average for NO_2 ($26\mu g/m^3$) was recorded on Friday, 13 March 2015. No significant increase occurred with respect to NO_2 concentrations in the ambient air after the first three days of the fire. A comparison of the results with the WHO standard for the NO_2 1 hour averaging revealed that there was no exceedance.

10. The associated health and socio-economic impacts of the fire are not included in this Report. It is expected that the Ministry of Health will interpret the findings and predict the impact on human health. Similarly, other stakeholders in education and industry and commerce would have made insightful determination on the impact of the fire.

11. $PM_{2.5}$ was not evaluated, which is another particulate matter parameter that can be used to measure aggravated health related risks. Datasets on this parameter is not presently being collected within the KMA due to the unavailability of equipment.
12. The Agency’s information is limited on the background concentrations of the priority air pollutants, which includes VOCs, dioxins, furans and other persistent organic pollutants (POPs). Routine monitoring is required for these pollutants, which would enable the determination of background concentrations to allow conclusive statements of environmental impacts during response monitoring exercises.

2.0 BACKGROUND

On Wednesday, 11 March 2015 the National Environment and Planning Agency (NEPA) observed that the Riverton City Solid Waste Disposal Facility (RCWDF) was on fire. This observation was later confirmed by personnel at the National Solid Waste Management Authority (NSWMA) operators of the Facility, who indicated that sections of the RCWDF were on fire. Consequent upon this fact, the NEPA commenced an emergency ambient air quality monitoring exercise with the aim to gather data in relation to the fire.

2.1 DATA SEQUESTRATION

As a part of the ambient air quality monitoring exercise, the NEPA, in seeking to sequester additional data in relation to the incident, requested private (industry) facilities in the Kingston and St. Andrew region to provide data from their permanent ambient air monitoring sites. The selected facilities are the holders of current Air Licences from the Natural Resources Conservation Authority (NRCA). A positive response was obtained from the licencees and the NEPA subsequently received ambient air monitoring data commencing 12 March 2015. Permanent monitoring sites previously erected in critical areas to facilitate routine ambient air monitoring in the event of a fire at the RCWDF were inspected and calibrated to facilitate an increased frequency of monitoring during this incident. Monitoring for Volatile Organic Compounds (VOC) was also done using Passive VOC monitors. These VOC monitors were exposed for 24 hours and subsequently the samples were retrieved, prepared and dispatched to a laboratory in Canada for analyses.

2.2 SAMPLING LOCATIONS

The sampling sites were selected based on critical analysis of public complaints, impact zones, high density populated areas, general wind direction from the RCWDF, as well as availability of hosts for the equipment. Eleven (11) permanent ambient air monitoring sites were utilized during this monitoring exercise (Table 1 and Map 1). An additional monitoring site was erected in Meadowbrook to facilitate ambient air quality monitoring for VOCS during the fire (Table 2 and Map 1).

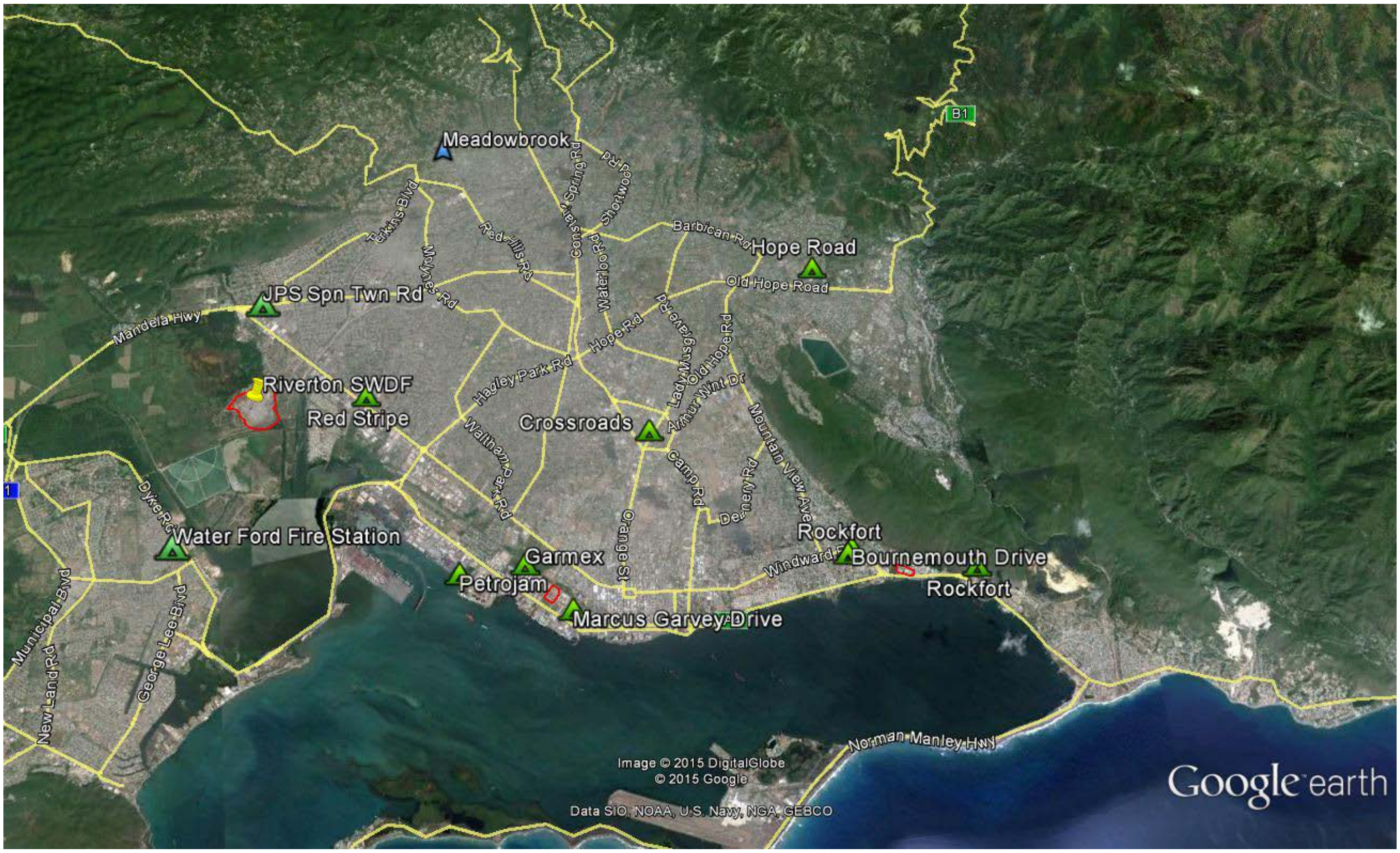
Table 1: Locations of Ambient Air Quality Monitoring Sites

SITE LOCATIONS	STATUS
1. JPSCO Ltd. Offices, Spanish Town Road	Permanent Routine Ambient Air Monitoring Sites
2. Water Ford Fire Station, Portmore	
3. Cross Roads (NEPA Building)	
4. 191 Old Hope Road	
5. Garmex, Marcus Garvey Drive	Permanent Private Ambient Air Monitoring Sites
6. Petrojam, Marcus Garvey Drive	
7. Carib Cement, Rockfort	
8. Red Stripe Brewery, Spanish Town Road.	
9. JPSCO Ltd. Monitoring Site, Rockfort, Kingston	
10. Carib Cement, Harbour View	
11. College Commons, Mona	

The samples were analyzed for twenty nine (29) pollutants. This included priority air pollutants and critical air pollutants. Twenty six (26) VOCs were detected after analysis of the VOC badges (see Appendix I).

Table 2: Ambient Air Quality Monitoring Sites and Parameters Monitored

	MONITORING SITES	PARAMETERS MONITORED			
		SO_2	NO_2	PM_{10}	VOCs
PERMANENT STATIONARY SITES	Garmex,, Marcus Garvey Drive	×	×	×	
	Petrojam , Marcus Garvey Drive	×	×	×	
	Crossroads			×	×
	191 Old Hope Road			×	×
	Harbour View			×	
	College Commons, Mona			×	
	JPSCO Ltd. Ltd., Spanish Town Road			×	×
	Waterford, Portmore			×	×
	JPSCO Ltd., Rockfort	×	×	×	
	Red Stripe, Spanish Town Road	×			
RESPONSE SITES	Meadowbrook				×



- *Permanent Ambient Monitoring Stations*

Map1: Showing the Monitoring sites in the KMA and Portmore in relation to the Riverton Solid Waste Disposal Facility (SWDF)

2.3 SAMPLING METHODOLOGY

The sampling methodology utilized various methods of data collection, employing a selected variety of air monitors (Table 3) for use at the monitoring sites. Samples from the Hi-Volume samplers and the Mini-Volume sampler were collected based on specific sampling frequencies (Table 3). Gravimetric methods were used to the determine concentrations of $PM_{10.}$

All non-continuous stations were set up to run for 24 hours i.e. JPSCO Ltd. Offices, Spanish Town Road; Waterford Fire Station, Portmore; 10 Caledonia Avenue, Cross Roads and 191 Old Hope Road. Prior to deployment, all equipment used were calibrated based on the manufacturers' specifications. The NEPA commenced VOC sampling on 18 March 2015 as a continuation of the sampling activities started by the Ministry of Health within the first week of the fire. The NEPA continued VOC sampling up to 26 March 2015.

Table 3: Types of Monitors and Frequency of Sampling at the Ambient Air Quality Monitoring Sites

SITE LOCATIONS	TYPE OF MONITOR	SAMPLING FREQUENCY
1. JPSCO Ltd. Offices, Spanish Town Road	• TISCH® PM_{10} Hi-vol Sampler • 3M®Passive VOC badges	Every 2 days
2. Water Ford Fire Station, Portmore	• AERMETRICS® PM_{10} Mini-vol Sampler • 3M® Passive VOC badges	Every 2 days
3. Cross Roads (NEPA Building)	• TISCH® PM_{10} Hi-vol Sampler	Every 2 days
4. 191 Old Hope Road	• TISCH® PM_{10} Hi-vol sampler • 3M® Passive VOC badges	Every 2 days
5. Garmex, Marcus Garvey Drive	• BAM PM_{10}, SO_2 and NO_2 samplers	Continuously
6. Petrojam, Marcus Garvey Drive	• BAM PM_{10}, • Thermo® SO_2 and NO_2 samplers	Continuously
7. College Commons, Mona	• Tisch® PM_{10} Hi-vol sampler	Every 6 days
8. Red Stripe Brewery, Spanish Town Road.	• Thermo® Continuous SO_2 sampler	Continuously
9. JPSCO Ltd. Monitoring Site, Rockfort, Kingston	• BAM PM_{10}, • Thermo® SO_2 and NO_2 samplers	Every 2 days
10. Carib Cement, Harbour View	• Tisch® PM_{10} Hi-vol sampler	Every six days

3.0 PRESENTATION OF RESULTS

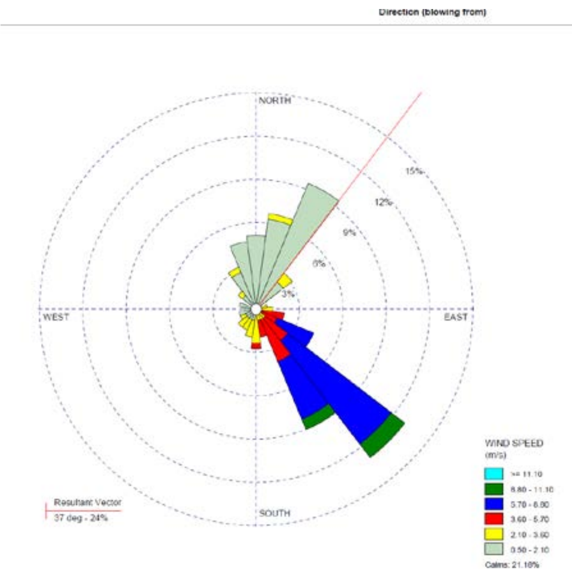
3.1 METEOROLOGY

Wind Rose Plots

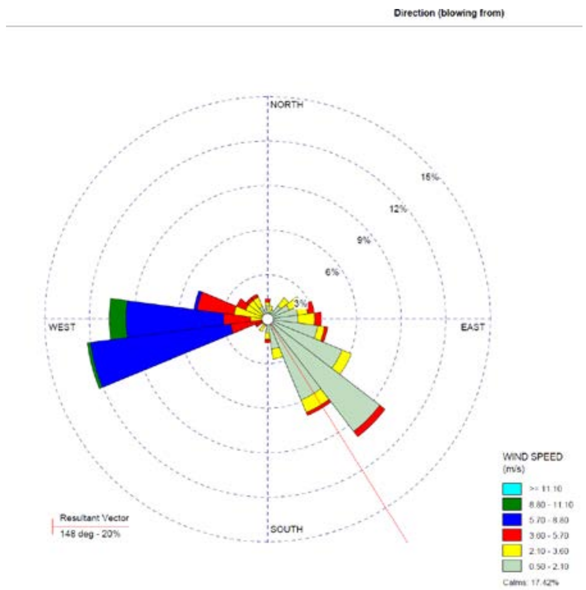
Data sequestered from meteorological stations located on Marcus Garvey Drive were used to generate three wind rose plots (Figure 1). The three wind rose plots show that the strongest winds were coming from the southeasterly direction during the period of the fire. Notably, very strong winds were experienced in the vicinity of the KMA during this period. The resultant wind vector from all the monitoring sites differed. This difference resulted in the smoke plume spreading throughout the KMA and further drifting to the southwestern sections of Portmore.

Figure 1: Wind Rose Plots using Data from Marcus Garvey Drive Meteorological Stations from 11-19 March 2015

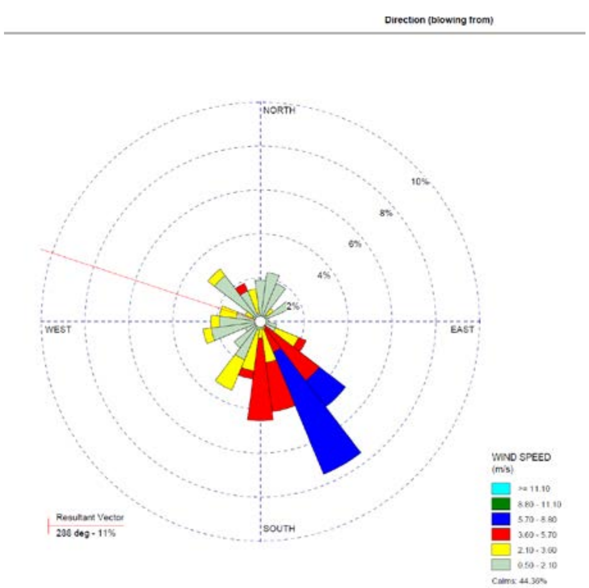
GARMEX



PETROJAM Ltd



RED STRIPE



3.2 FINDINGS OF AMBIENT AIR QUALITY MONITORING EXERCISE

The results of the air monitoring exercise are represented in graphical as well as tabular format. The graphs represent data gathered during the ongoing monitoring period i.e. 11-30 March 2015 (Figure 2) while the tables display the data gathered daily from each sampling location for each pollutant (Tables 4 – 7).

3.2.1 Particulate Matter (PM_{10})

Exceedance of the Jamaica Ambient Air Quality 24 Hour Standard for PM_{10} (150µg/m^3) was observed at three (3) monitoring locations (Figure 2):

a. JPSCO Ltd. Marcus Garvey Drive
b. JPSCO Ltd. Rockfort
c. JPSCO Ltd. Spanish Town Road

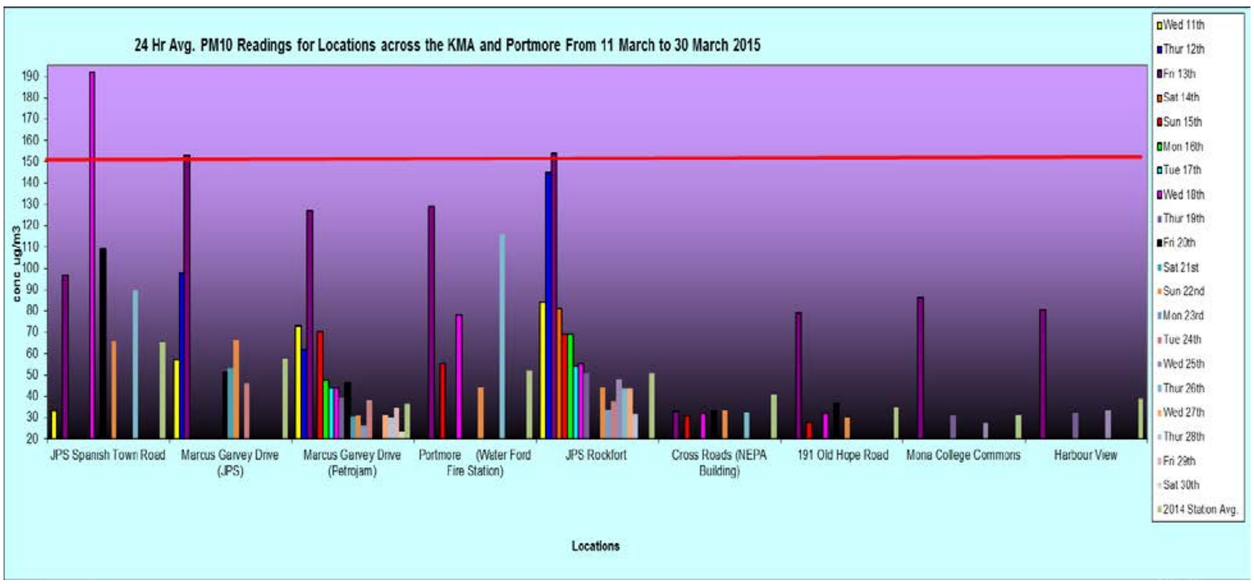


Figure 2: PM_{10} Data recorded at various locations across the KMA and Portmore (11 – 30 March 2015)

The highest reading for PM_{10} (192 µg/m^3) was recorded at the JPSCO Ltd. Spanish Town Road air monitoring site (Figure 2). PM_{10} concentrations at this site were significantly higher than the 2014 annual average concentrations of PM_{10} at all sites monitored. This exceedance was observed at the JPSCO Ltd. Spanish Town Road monitoring site ten (10) days after the start of the fire.

Table 4: 24-hour Average PM_{10} Concentrations detected during the period 11 – 30 March 2015

24 HOUR AVERAGE PM10 CONCENTRATIONS MEASURED DURING FIRE FROM 11 Mar TO 30 Mar 2015 (µg/m³)									
	JPS Spanish Town Road	Marcus Garvey Drive (JPS)	Marcus Garvey Drive (Petrojam)	Portmore (Water Ford Fire Station)	JPS Rockfort	Cross Roads (NEPA Building)	191 Old Hope Road	Mona College Commons	Harbour View
Wed 11th	33.5	57	73		84				
Thur 12th		98	62		145				
Fri 13th	97	153	127	129	154	33	79	86	80.6
Sat 14th					81				
Sun 15th			70.08	55	69	31	28		
Mon 16th			47.83		69				
Tue 17th			44.12		54.13				
Wed 18th	192		44.12	78.14	55.14	32	32		
Thur 19th			39.29		50.67			31.1	32.2
Fri 20th	109	51.14	46.54			33.39	36.46		
Sat 21st		53.11	30.79						
Sun 22nd	66.06	66.19	30.87	43.9	43.9	33.39	30.08		
Mon 23rd			26.25		33.9				
Tue 24th		46.18	38.09		37.65				
Wed 25th					48.03			27.4	33.4
Thur 26th	89.78			116.05	43.79	32.72			
Wed 27th			31.58		43.59				
Thur 28th			30.29		31.88				
Fri 29th			34.5						
Sat 30th			23.4						
2014 Station Avg.	65.65	57.55	36.42	52.2	50.96	41	34.9	31.51	39.1

NB: The Jamaica Ambient Air Quality PM_{10} Standard for the 24 hour Averaging period is 150µg/m^3
The WHO Guideline for PM_{10} for the 24 hour Averaging period is 50µg/m^3

In comparison with the 2014 annual averages at all monitoring sites, the ambient air quality deteriorated most significantly between the first and the fourth days of the fire (Table 4). This deterioration was noted for the JPSCO Ltd. Marcus Garvey Drive, Petrojam Marcus Garvey Drive and JPSCO Ltd. Rockfort monitoring sites (Table 4).

3.2.2 Sulphur Dioxide (SO_2) and Nitrogen Oxides (NO_2)

Sulphur Dioxide concentrations were analyzed based on data from three (3) ambient air monitors located on Spanish Town Road (Red Stripe operated) and on Marcus Garvey Drive (JPSCO Ltd. monitoring site at Garmex and PETROJAM monitoring site). For the purposes of this Report, the SO_2 concentrations presented are in relation to the Red Stripe Spanish Town Road monitoring site which is closest to the Riverton Solid Waste Disposal Facility (Table 5).

No breaches of the Jamaica Ambient Air Quality 1 Hour or 24 Hour Standards were detected during this monitoring exercise. Notwithstanding, the results showed elevated SO_2 concentrations above the annual average (15.93µg/m^3) recorded for 2014. The highest 24 hour average SO_2 concentrations detected (127µg/m^3) was recorded on 19 March 2015. A comparison of this data with the World Health Organization Interim Target-2 for the 24 hour averaging period (50µg/m^3) reveals that the results obtained for SO_2 concentrations exceeded the referenced WHO standard on the 19th, 22nd, and 23rd of March. A further comparison was made with the WHO proposed Air quality Guideline value for the SO_2 24 hour averaging(20µg/m^3) , which revealed that there were exceedances recorded; on 16 out of the 17 days monitored (See table 5).

Nitrogen Oxides data (measured as NO_2) were analyzed from the ambient air quality monitors located at Marcus Garvey Drive i.e. Garmex and Petrojam Limited (Table 6). The data generated for NO_2 shows that the maximum values for both the 24 Hour and 1 Hour standards were observed during the period 13 to 22 March 2015. However, no breaches of the Jamaica Ambient Air Quality Standards or the WHO standard were recorded in these monitoring locations during the period. The trend observed in the hourly data collected at these sites was noted to be similar to data collected during 2014.

Table 5: 24Hr and Maximum 1Hr concentration for SO_2 detected at Red Stripe Monitoring Station during the period 13 - 30 March 2015

	Readings	
Dates (March 2015)	**Max 1Hr SO_2 (µg/m^3)**	**24Hr Avg. SO_2 (µg/m^3)**
Wed 11th	161	21.74
Thur 12th	195	34.46
Fri 13th	332	44.26
Sat 14th	140	27.29
Sun 15th	220	44.04
Mon 16th	152	34.04
Tue 17th	109	33.82
Wed 18th	52	15.9
Thur 19th	451	127
Fri 20th	114	28.04
Sat 21st	137	21.5
Sun 22nd	244	59.22
Mon 23rd	206	59.33
Tue 24th	110	25.73
Wed 25th	-	-
Thur 26th	252	79.66
Fri 27th	84	24.9
Jamaica Ambient Air Quality Standard	**700**	**280**
WHO Interim target - 2		**50**
WHO Air Quality Guideline Value		**20**

3.2.3 Volatile Organic Compounds (VOCs)

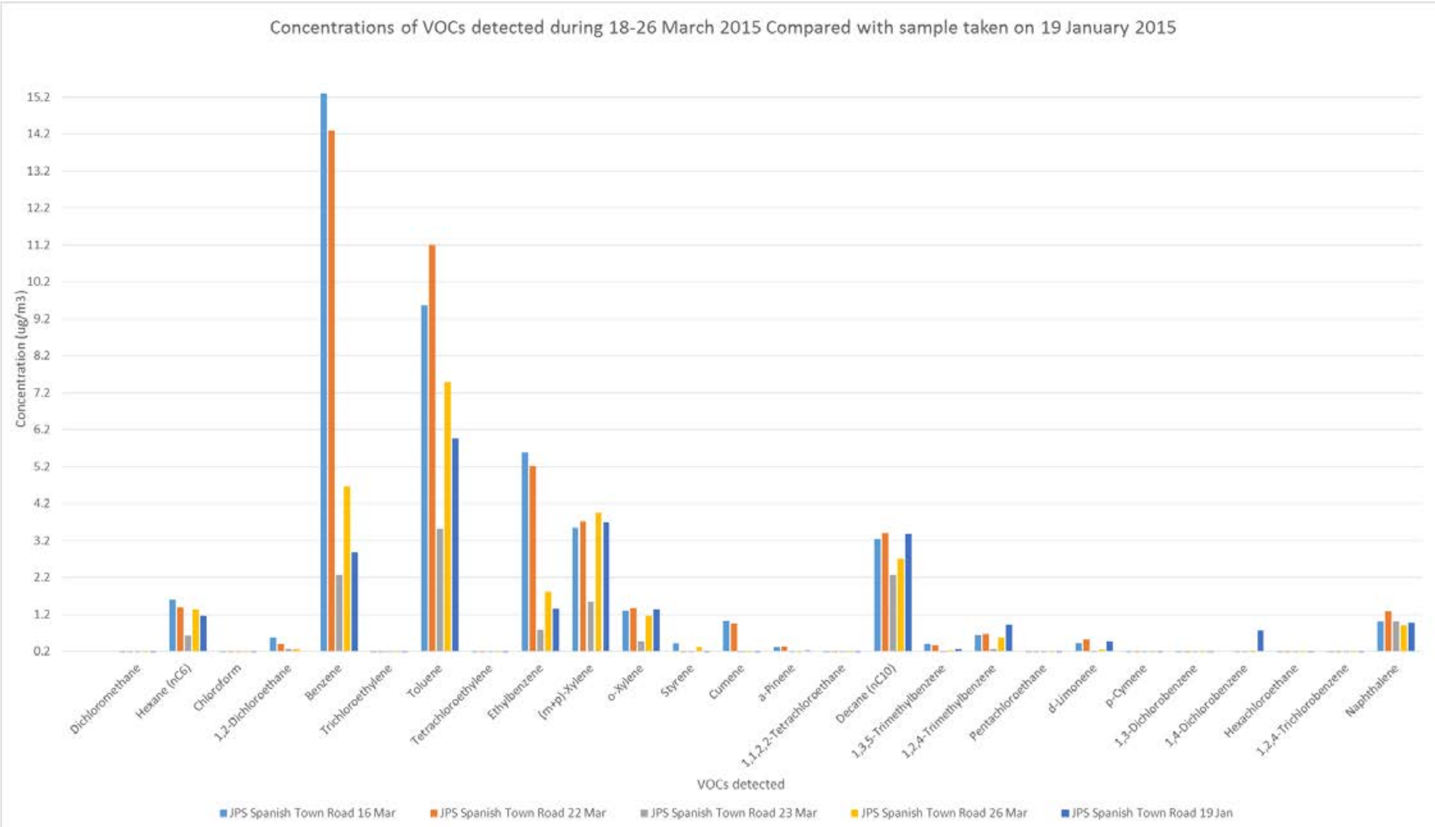
VOC sampling was done at four(4) locations i.e. Waterford Fire Station, Portmore; JPSCO Ltd., Spanish Town Road, 191 Old Hope Road and Meadowbrook (Table 7). Twenty six (26) VOCs were detected from the analyses done on these samples. Of the twenty six (26) VOCs detected, sixteen were detected above the lower concentration limit of the analysis method i.e. 0.2 µg/m^3. This result was similar to the results obtained in the Riverton Fire of February 2012, and compares to a list of forty six (46) VOCs detected in the Riverton fire of March 2014. The concentration of VOCs varied during the period of monitoring with the highest concentrations being observed generally for benzene (Figure 3).

Table 6: 24-hour and Maximum 1-hr concentration for NO_2 detected at the Petrojam Marcus Garvey Drive Monitoring station during the period 13 - 22 March 2015

	Readings	
Date	**Maximum 1-Hour NO_2 ($\mu g/m^3$)**	**24-Hour NO_2 ($\mu g/m^3$)**
Wed 11, 2015	37	17.95
Thur 12th	82	25.35
Fri 13th	48	26.04
Sat 14th	40	18
Sun 15th	29	13.29
Mon 16th	42	17.625
Tue 17th	45	19.58
Wed 18th	44	19.55
Thur 19th	25	14.54
Fri 20th	39	17.18
Sat 21st	27	14.58
Sun 22nd	33	8.54
Jamaica Ambient Air Quality Standard	**400**	**None**
WHO Standard	**200**	

Table 7: Results of VOCs detected during monitoring: 18 – 26 March 2015 compared with sample taken on 19 January 2015

	Wednesday, March 18, 2015				Sunday, March 22, 2015				Monday, March 23, 2015	Thursday March 26, 2015			Monday, January 19 2015	
VOC detected (ug/m3)	Waterford Fire Station	Waterford Fire Station (repeat)	191 Old Hope Road	JPS Spanish Town Road	Waterford Fire Station (repeat)	JPS Spanish Town Road Day 2	191 Old Hope Road	Meadow brook	JPS Spanish Town Road	Waterford Fire Station	JPS Spanish Town Road		Waterford Fire Station	JPS Spanish Town Road
Dichloromethane	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
Hexane (nC6)	0.91	0.92	0.68	1.6	0.76	1.39	0.57	0.42	0.64	0.65	1.34		0.9	1.17
Chloroform	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
1,2-Dichloroethane	0.21	0.24	0.2	0.58	0.25	0.4	< 0.2	0.25	0.26	< 0.2	0.27		< 0.2	0.21
Benzene	3.52	3.69	2.86	15.3	3.61	14.3	1.66	2.48	2.27	2.26	4.67		2.23	2.88
Trichloroethylene	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
Toluene	4.59	4.87	5.86	9.56	6.79	11.2	5.13	4.5	3.53	4.02	7.49		5.43	5.96
Tetrachloroethylene	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
Ethylbenzene	0.89	0.93	0.76	5.58	1.17	5.22	0.56	0.8	0.79	0.63	1.82		0.75	1.36
(m+p)-Xylene	2.05	2.15	1.88	3.55	2.16	3.71	1.49	0.95	1.54	1.31	3.95		2.82	3.7
o-Xylene	0.71	0.73	0.68	1.3	0.7	1.37	0.56	0.35	0.48	0.44	1.17		1.01	1.33
Styrene	< 0.2	< 0.2	< 0.2	0.43	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.31		< 0.2	< 0.2
Cumene	< 0.2	< 0.2	< 0.2	1.04	< 0.2	0.95	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
a-Pinene	< 0.2	< 0.2	< 0.2	0.3	< 0.2	0.32	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	0.23
,1,2,2-Tetrachloroethan	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
Decane (nC10)	5.74	6.03	3.25	3.24	2.81	3.4	2.75	2.65	2.27	2.32	2.71		2.15	3.37
1,3,5-Trimethylbenzene	< 0.2	< 0.2	< 0.2	0.4	< 0.2	0.36	< 0.2	< 0.2	< 0.2	< 0.2	0.23		0.28	0.27
1,2,4-Trimethylbenzene	0.4	0.4	0.5	0.65	0.44	0.66	0.32	< 0.2	0.26	0.29	0.58		0.6	0.92
Pentachloroethane	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
d-Limonene	0.56	0.58	< 0.2	0.42	0.39	0.52	0.35	< 0.2	< 0.2	0.22	0.25		0.3	0.47
p-Cymene	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
1,3-Dichlorobenzene	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
1,4-Dichlorobenzene	0.59	0.61	0.29	0.2	< 0.2	< 0.2	0.32	< 0.2	< 0.2	< 0.2	< 0.2		0.55	0.77
Hexachloroethane	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
1,2,4-Trichlorobenzene	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2
Naphthalene	< 0.2	< 0.2	0.72	1.01	1.63	1.27	0.98	1.45	1.01	0.33	0.9		0.32	0.97


Concentrations of VOCs detected during 18-26 March 2015 Compared with sample taken on 19 January 2015
Concentration (ug/m3)
15.2
14.2
13.2
12.2
11.2
10.2
9.2
8.2
7.2
6.2
5.2
4.2
3.2
2.2
1.2
0.2
Dichloromethane
Hexane (nC6)
Chloroform
1,2-Dichloroethane
Benzene
Trichloroethylene
Toluene
Tetrachloroethylene
Ethylbenzene
(m+p)-Xylene
o-Xylene
Styrene
Cumene
a-Pinene
1,1,2,2-Tetrachloroethane
Decane (nC10)
1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene
Pentachloroethane
d-Limonene
p-Cymene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Hexachloroethane
1,2,4-Trichlorobenzene
Naphthalene
VOCs detected
JPS Spanish Town Road 16 Mar
JPS Spanish Town Road 22 Mar
JPS Spanish Town Road 23 Mar
JPS Spanish Town Road 26 Mar
JPS Spanish Town Road 19 Jan

4.0 ANALYSIS OF FINDINGS

4.1 Particulate Matter (PM)

The fire resulted in significant negative impacts associated with particulate matter. This is validated by observations of exceedances in the 24 hour standard of 150µg/m^3 for PM_{10} on 13 March 2015 at the monitoring locations on Marcus Garvey Drive as well as exceedances of the standards at the JPSCO Ltd. Spanish Town Road site. The data further revealed that on the 13 March 2015 all monitoring locations were significantly impacted by PM_{10} concentrations with readings significantly higher than the annual average readings for the respective sites.

Communities as far as College Commons in Mona (approximately 11km from the RCWDF) experienced PM_{10} concentrations which were more than twice the annual average of 31.51 µg/m^3 for 2014. This is indicative of the magnitude and extent of the impact of the smoke emanating from the fire. The extent of the fire is also illustrated in the data which revealed that significantly elevated concentrations of PM_{10}, observed at the Spanish Town Road site, persisted for approximately ten (10) days.

A comparison of this PM_{10} data with the USEPA Air Quality Index as well as the Canadian Air Quality Health Index (Appendix III) revealed that the ambient air quality with respect to PM_{10}, was ranked as "very high risk" within 5km radius of the RCWDF while at a distance greater than six (6) km it was ranked as "high risk" (Map 2). The risk is related to health impacts expected to be experienced by humans within a few days of inhaling polluted air. Health impacts usually include respiratory irritation, and for individuals with pre-existing heart conditions, can lead to irritation of existing cardio-pulmonary conditions. Long term health effects of human exposure to pollution events, require further monitoring and epidemiology studies.

The latest data from the monitoring sites located on Marcus Garvey Drive have indicated a return to pre-existing ambient air concentrations for PM_{10} (Table 4).

4.2 Sulphur Dioxide (SO_2)

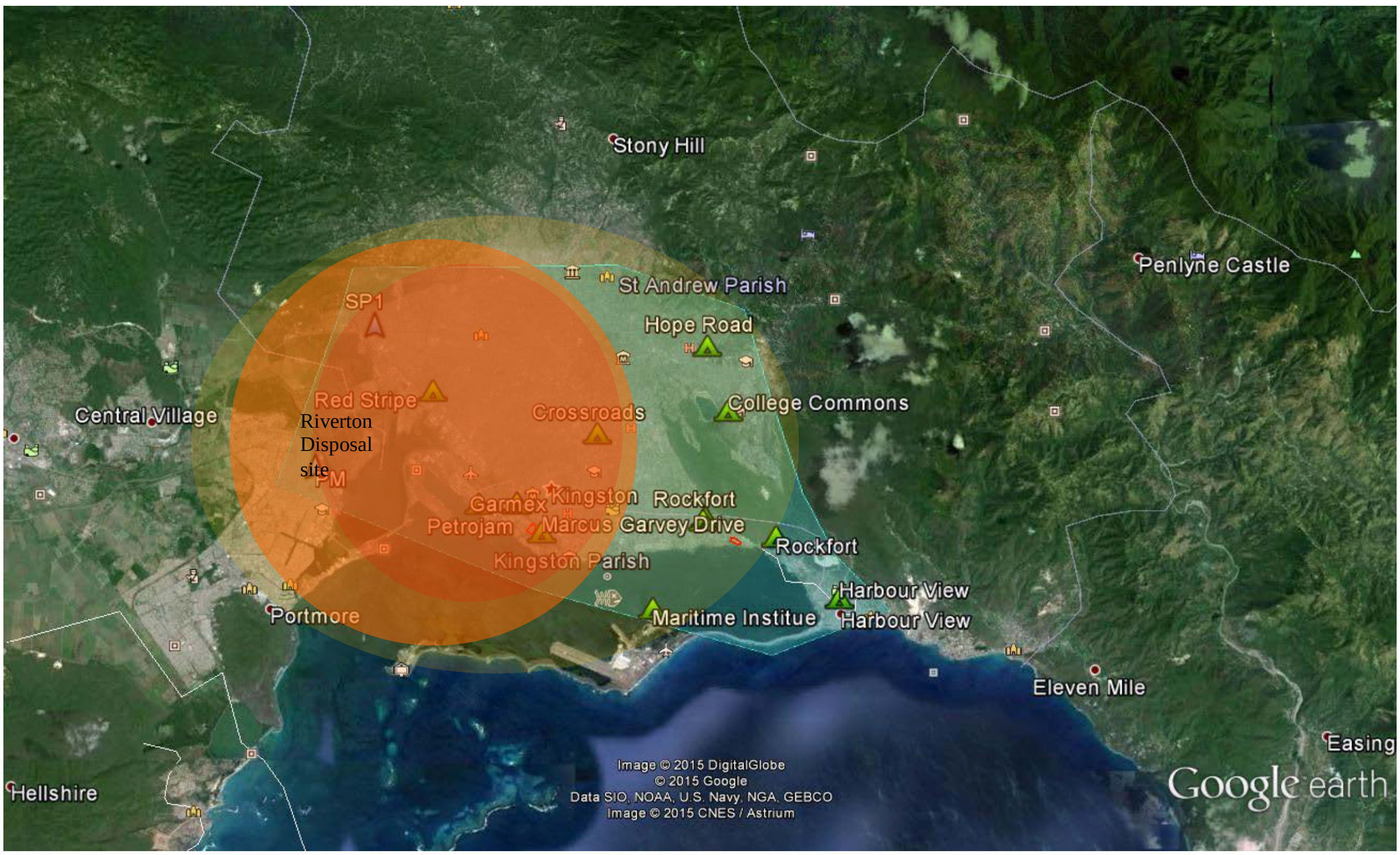
The ambient air quality was negatively impacted by elevated concentrations of SO_2 attributable to the fire. The maximum hourly average of SO_2 (451µg/m^3) was detected at Marcus Garvey Drive on 19 March 2015 concurrently with the highest 24 hour average for SO_2 (127 µg/m^3). This 24 hour reading is significantly higher than the highest 24 hour average reading for SO_2 recorded in 2014 at the Red Stripe monitoring site (highest reading recorded in 2014 was 90µg/m^3). The results obtained for SO_2 concentrations were compared with the World Health Organization Interim Target-2 for the SO_2 24 hour average (Table 5). Exceedance of the referenced standard were observed on three occasions (i.e. 19, 22, and 23 March 2015). Exceedances of the proposed WHO Air Quality Guideline Value (20µg/m^3) were recorded on 16 out of the 17 days monitored. It must be noted that these air monitoring stations are all located east of the disposal site, upwind of the strongest prevailing winds. The latest results have revealed a return to ambient concentrations which existed prior to the commencement of the fire.

4.3 Nitrogen Oxides (NO_2)

There was no significant increase in NO_2 concentrations in at the ambient air monitoring sites during the first three days of the fire. The maximum hourly average of NO_2 concentration (82µg/m^3) was recorded for Marcus Garvey Drive on 12 March 2015 (Table 6). The highest 24 hour average for NO_2 concentration was 26µg/m^3 and was recorded on 13 March 2015.

4.4 Volatile Organic Compounds (VOCs)

Twenty Six (26) VOCs were detected based on laboratory analyses conducted on the samples collected at the four locations (Table 7). Of the twenty six (26) VOCs detected, sixteen (16) were detected above the lower concentration limit of the analysis method (0.2 µg/m^3). Benzene and compounds of benzene showed the highest increase in concentration with values ranging from 2µg/m^3 to 15.3µg/m^3. The results also show that benzene attenuated most significantly during the firefighting efforts. Hence benzene is used as the indicator of the impact of these hazardous air pollutants from the fire.



Key

CONC. PM10 = >148 µg/m^3 — INDEX RATING: **VERY HIGH**

CONC. PM10 = 99-148 µg/m^3 — INDEX RATING: **HIGH RISK***

CONC. PM10 = 19-98 µg/m^3 — INDEX RATING: **MODERATE-LOW RISK***

Possible further Impact

Index ratings were based on USEPA & Canadian air quality indices

- **Permanent Ambient Monitoring Stations**
- **Response Sites**

Map2: Showing the Monitoring sites in the KMA and Portmore and the estimated PM_{10} impact level

The highest benzene concentration detected (15.3 µg/m^3) was recorded at the JPSCO Ltd. Spanish Town Road Location on 18 March 2015[1]. This value was notably three (3) times the highest value for benzene concentration recorded at the same location during the fire at the RCWDF in 2014. As was recorded for previous fires, this location detected the highest benzene concentrations and concurrently the broadest spectrum of VOCs of all the sites monitored. The high readings persisted for a further 5 days, where there was an eventual decrease to 2.27 µg/m^3 on 23 March 2015. Follow-up sampling for benzene (done on 26 March 2015) revealed a concentration of 4.67 µg/m^3. Considering the contribution of traffic and illicit burning as sources of benzene, further monitoring is required to determine if the benzene concentrations detected are solely attributable to the subject fire.

VOC concentrations detected at the Portmore monitoring location showed a similarity to that detected in the March 2014 fire. The highest reading recorded at Portmore was on the first day of sampling (3.69 µg/m^3) with no notable decrease after five (5) days. While at the Old Hope Road location, VOC concentration of 2.48 µg/m^3 was detected which decreased to 1.66 µg/m^3after 5 days. Toluene and Decane, which are VOCs, were also detected (Table 7). Additional ambient air sampling and monitoring is required to determine the background concentrations of these VOCs in these locations in order to ascertain if the concentrations detected during this monitoring exercise are solely as a result of the fire at RCWDF.

[1] This showed an attenuation in the concentrations of benzene recorded by the Ministry of Health (MOH) in the first week of the fire.

5.0 RISK ASSESSMENT

The areas which experienced the greatest impact of the fire are shown in Table 8. The wind factor discussed previously, would have influenced the areas of greatest impact. The acreage reported to be on fire (90 acres), coupled with the strong winds reported by the Meteorological Service of Jamaica during the period, resulted in the smoke emanating from the fire at the RCWDF covering the entire KMA as well as Portmore, St. Catherine. Reports of smoke cover were received from communities as far north as Stony Hill and northeast at the University of the West Indies, Mona. Reports were also received from the Bridgeport and Edge Water communities in Portmore, making the zone of influence of the fire, 11km radius in all directions. This represents the widest zone of influence to date caused by a fire at the RCWDF. As can be expected, due to the relatively low emission point of the smoke from the fire, the communities closest to the Facility would be most severely impacted.

As outlined in the USEPA Air Quality Index and the Canadian Air Quality Health Index, the risk is related to health impacts expected to be experienced by humans within a few days of inhaling polluted air. Health impacts usually include respiratory irritation, and for individuals with pre-existing heart conditions, can lead to irritation of existing cardio-pulmonary conditions.

Long term health effects of human exposure to pollution events, require further monitoring and epidemiology studies.

Table 8: Zoning of impacted Communities based on USEPA and Canadian Air Quality Indices

	ZONES	
	VERY HIGH RISK	**HIGH RISK**
Communities **and Places**	All locations up to 5Km in the North, North East and Northwest direction of the dump including but not limited to: • Spanish Town Road • Molynes Gardens • Pembroke Hall • Washington gardens • Duhaney Park • Riverton Meadows • Greenwich Town • JPSCO Office • Seaview Gardens • Richmond Gardens • Plantation heights • Marcus Garvey Drive	All locations up to 6km in all directions from the dump including but not limited to: • Half Way Tree • Eastwood park gardens • Edgewater • Bridgeport • Caymanas gardens • Downtown, Kingston • Trench Town • Jones Town • Meadowbrook • Havendale

6.0 SUMMARY OF THE FINDINGS

The following represents a summary of the findings of the air quality monitoring exercise:

1. The fire at the Riverton Solid Waste Disposal Facility impacted negatively on the ambient air quality and on human health and wellbeing in Kingston and St. Andrew and parts of St. Catherine, including Portmore over the period under review.

2. The fire is ranked as the most detrimental in the history of fires at the Riverton Solid Waste Disposal Facility if its impact on ambient air quality and the zone of influence is considered. Over the first 7 days of the fire, ambient air quality with respect to PM_{10} is categorized as "Very High Risk" according to the Canadian and USEPA Air Quality Index, within a 5km radius of the subject fire (Map 2 and Appendix III).

3. Even at distances of up to a 6km radius of the solid waste disposal facility the air quality with respect to PM_{10} is categorized as "High Risk" according to the Canadian and USEPA Air Quality Index (Map 2 and Appendix III).

4. The WHO 24 hour average standard of 50µg/m^3 and the Jamaica Ambient Air Quality 24 hour average Standard of 150µg/m^3 for PM_{10} was exceeded on Friday, 13 March 2015. The exceedances were recorded at both air monitoring sites on Marcus Garvey Drive. On Wednesday, 18 March 2015 the standard was exceeded at the JPSCO Ltd. Spanish Town Road air monitoring site. The JPSCO Ltd site recorded the highest value of PM10 observed during the fire, of 192µg/m^3. The data findings also show that on 13 March 2015, all monitoring locations were significantly impacted by PM_{10} (Table 4 & Figure 2), with readings significantly higher than the annual average readings for the respective sites.

5. Significantly high 24 hour particulate matter (PM_{10}) readings above the WHO 24 hour average Standard (57µg/m^3 - 192µg/m^3) were recorded at all air monitoring locations for the first eight days of the fire, including the Waterford Fire Station, JPSCO Ltd. Spanish Town Road, Marcus Garvey Drive and as far as College Commons in Mona.

6. Twenty six (26) VOCs were detected from the analyses done on the samples collected at the three monitoring locations (Table 3). Of the twenty six (26) VOCs detected, sixteen (16) were detected above the lower concentration limit of the analysis method of 0.2 µg/m^3. Benzene and compounds of benzene showed the highest increase in concentration with values ranging from 2µg/m^3 to 15.3µg/m^3. The results also show that benzene attenuated most significantly during the firefighting efforts. Hence benzene was used as the indicator of the impact of these hazardous air pollutants from the fire. It must be noted that there is no established ambient air quality standard for benzene locally or in other jurisdictions, and so any exposure to benzene is considered a grave risk to public health.

7. The maximum hourly average concentration of SO_2 recorded at Spanish Town Road air monitoring site was 451µg/m3. This finding was recorded on 19 March 2015 along with the highest 24 hour average concentration for SO_2 (127µg/m^3). This 24 hour reading is significantly higher than the highest 24 hour average reading for SO_2 recorded in 2014 at the Red Stripe monitoring site (highest reading recorded in 2014 was 90µg/m^3). As such the elevated SO_2 concentration is directly attributed to the fire. A comparison of the results with the WHO Interim

Target-2 and the WHO Air quality Guideline value for the SO_2 24 hour averaging, revealed that there were three exceedances recorded; on the 19th, 22nd, and 23rd of March, of the intermit target-2, and exceedances of the WHO Air Quality Guideline Value on 16 out of the 17 days monitored (See table 5). It must be noted that these air monitoring stations are all located east of the disposal site, upwind of the strongest prevailing winds. The latest results have revealed a return to ambient concentrations which existed prior to the commencement of the fire.

8. The maximum hourly average of NO_2 recorded at Marcus Garvey Drive was 82µg/m^3. This finding was recorded on Thursday, 12 March 2015. The highest 24 hour average for NO_2 (26µg/m^3) was recorded on Friday, 13 March 2015. No significant increase occurred with respect to NO_2 concentrations in the ambient air after the first three days of the fire. A comparison of the results with the WHO standard for the NO_2 1 hour averaging, revealed that there was no exceedances.

7.0 LIMITATIONS OF RESPONSE MONITORING PROGRAMME

The Agency was unable to conduct monitoring on Dioxins, Furans and other Persistent Organic Pollutants, as it currently does not have the necessary equipment to do so.

The Agency's information is limited on the background concentrations of the priority air pollutants, which includes VOCs, dioxins, furans and other persistent organic pollutants (POPs). Routine monitoring is required for these pollutants, which would enable the determination of background concentrations to allow conclusive statements of environmental impacts during response monitoring exercises.

The monitoring of the impacts of SO_2 and NO_2 monitoring were limited, as the present locations of the SO_2 and NO_2 ambient monitoring sites are all located upwind of the stronger prevailing winds.

8.0 APPENDICES

APPENDIX I

LIST OF AIR POLLUTANTS ANALYZED (11-30 March 2015)

CRITERIA AIR POLLUTANTS

1. Sulphur Dioxide
2. Nitrogen dioxide
3. Particulate Matter less than 10 microns

VOLATILE ORGANICS

4. Dichloromethane
5. Hexane
6. Chloroform
7. 1,2-Dichloroethane
8. Benzene
9. Trichloroethylene
10. Toluene
11. Tetrachloroethylene
12. Ethylbenzene
13. (m+p)-Xylene
14. o-Xylene
15. Styrene
16. Cumene
17. a-Pinene
18. 1,1,2,2-Tetrchloroethane
19. n-Decane
20. 1,3,5-Trimethylbenzene
21. 1,2,4-Trimethylbenzene
22. Pentachloroethane
23. d-Limonene
24. p-Cymene
25. 1,3-Dichlorobenzene
26. 1,4-Dichlorobenzene
27. Hexachloroethane
28. 1,2,4-Trichlorobenzene
29. Naphthalene

APPENDIX II

Comparative Ambient Air Quality Standards/Guidelines

Parameter	Averaging time	USA Standard	Canadian Standard	WHO Guidelines	Jamaican Ambient Air Quality Standard
PM_{10}	Annual 24hrs	n.a. 150µg/m^3	n.a. 150 µg/m^3	20 µg/m^3 50 µg/m^3	50 µg/m^3 150 µg/m^3
SO_2	Annual 24hrs 1hr	 75 µg/m^3	60 µg/m^3 300 µg/m^3 75 µg/m^3	 20 µg/m^3 (*50 µg/m^3)	60 µg/m^3 280 µg/m^3 700 µg/m^3
NO_2	Annual 24hrs 1hr	100 µg/m^3 n.a. 53	100 µg/m^3 n.a. 400 µg/m^3	40 µg/m^3 n.a. 200 µg/m^3	100 µg/m^3 n.a. 400 µg/m^3
VOC	1hr	n/a	n/a	(1-17) µg/m^3	n/a

**An interim target of 50µg/m^3 was established by the WHO to be a target for developing countries*

Table II-2: Ambient Air Quality Standards for Jamaica

Pollutant	**Averaging Time**	**Standard (maximum concentration in µg/m^3)**
TSP	Annual 24h	60 150
PM_{10}	Annual 24h	50 150
Lead	Calendar Quarter	2
Sulphur Dioxide	Annual 24h 1h	80 primary, 60 secondary 365 primary, 280 secondary 700
Photochemical Oxidants (Ozone)	1h	235
Carbon Monoxide	8h 1h	10,000 40,000
Nitrogen Dioxide	Annual 1h	100 400

APPENDIX III

AIR QUALITY INDEX FOR CANADA (Taken from the Environment Canada website: https://ec.gc.ca/cas-aqhi/default.asp?Lang=En&n=065BE995-1#calculated)

What is the Air Quality Health Index (AQHI)?

The Air Quality Health Index or "AQHI" is a scale designed to help you understand what the air quality around you means to your health.

It is a health protection tool that is designed to help you make decisions to protect your health by limiting short-term exposure to air pollution and adjusting your activity levels during increased levels of air pollution. It also provides advice on how you can improve the quality of the air you breathe.

This index pays particular attention to people who are sensitive to air pollution and provides them with advice on how to protect their health during air quality levels associated with low, moderate, high and very high health risks.

The AQHI communicates four primary things;

1. It measures the air quality in relation to your health on a scale from 1 to 10. The higher the number, the greater the health risk associated with the air quality. When the amount of air pollution is very high, the number will be reported as 10+.
2. A category that describes the level of health risk associated with the index reading (e.g. Low, Moderate, High, or Very High Health Risk).
3. Health messages customized to each category for both the general population and the 'at risk' population.
4. Current hourly AQHI readings and maximum forecast values for today, tonight and tomorrow.

The AQHI is designed to give you this information along with some suggestions on how you might adjust your activity levels depending on your individual health risk from air pollution.

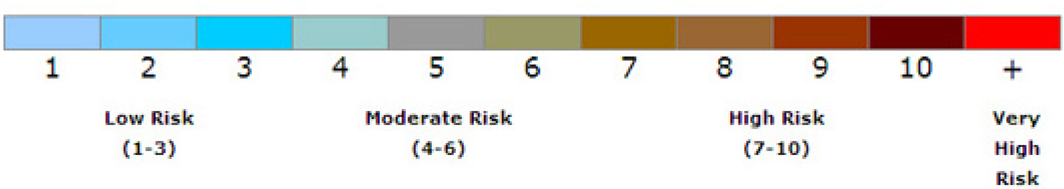
How is the AQHI calculated?

The AQHI is calculated based on the relative risks of a combination of common air pollutants that is known to harm human health. These pollutants are:

- Ozone (O_3) at ground level,
- Particulate Matter ($PM_{2.5}/PM_{10}$) and
- Nitrogen Dioxide (NO_2).

What is the scale for the AQHI

The AQHI is measured on a scale ranging from 1-10+. The AQHI index values are grouped into health risk categories as shown below. These categories help you to easily and quickly identify your level of risk.



- 1-3 Low health risk
- 4-6 Moderate health risk
- 7-10 High health risk
- 10 + Very high health risk

1.0 Air Quality Health Index Categories and Health Messages

The AQHI uses a scale to show the health risk associated with the air pollution we breathe.

The following table provides the health messages for 'at risk' individuals and the general public for each of the AQHIHealth Risk Categories.

Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population*	**General Population**
Low	1 - 3	Enjoy your usual outdoor activities.	Ideal air quality for outdoor activities.
Moderate	4 - 6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7 - 10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High	Above 10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

*** People with heart or breathing problems are at greater risk. Follow your doctor's usual advice about exercising and managing your condition.**

USEPA Air Quality Index (AQI) Basics (taken from USEPA website: http://airnow.gov/index.cfm?action=aqibasics.aqi)

The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health .Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.

How Does the AQI Work?

Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy-at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Understanding the AQI

The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six categories:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	***..air quality conditions are:***	***...as symbolized by this color:***
0-50	**Good**	**Green**
51-100	**Moderate**	**Yellow**
101-150	**Unhealthy for Sensitive Groups**	**Orange**
151 to 200	**Unhealthy**	**Red**
201 to 300	**Very Unhealthy**	**Purple**
301 to 500	**Hazardous**	**Maroon**

Each category corresponds to a different level of health concern. The six levels of health concern and what they mean are:

- "Good" AQI is 0 - 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- "Moderate" AQI is 51 - 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.

- "Unhealthy for Sensitive Groups" AQI is 101 - 150. Although general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air. .
- "Unhealthy" AQI is 151 - 200. Everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects. .
- "Very Unhealthy" AQI is 201 - 300. This would trigger a health alert signifying that everyone may experience more serious health effects.
- "Hazardous" AQI greater than 300. This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.

AQI colors

EPA has assigned a specific color to each AQI category to make it easier for people to understand quickly whether air pollution is reaching unhealthy levels in their communities. For example, the color orange means that conditions are "unhealthy for sensitive groups," while red means that conditions may be "unhealthy for everyone," and so on.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	**0 to 50**	**Air quality is considered satisfactory, and air pollution poses little or no risk**
Moderate	**51 to 100**	**Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.**
Unhealthy for Sensitive Groups	**101 to 150**	**Members of sensitive groups may experience health effects. The general public is not likely to be affected.**
Unhealthy	**151 to 200**	**Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.**
Very Unhealthy	**201 to 300**	**Health warnings of emergency conditions. The entire population is more likely to be affected.**
Hazardous	**301 to 500**	**Health alert: everyone may experience more serious health effects**