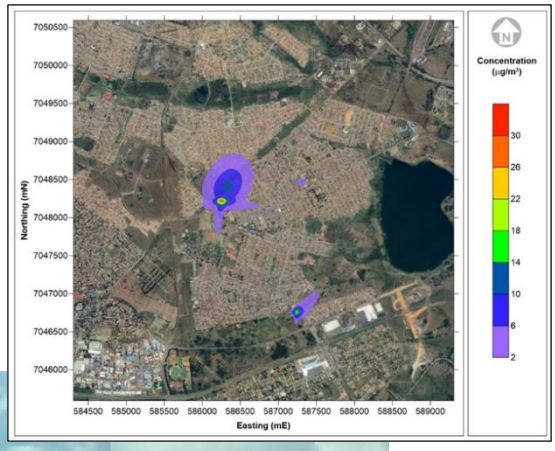
Activity 12.15: Dispersion modelling

Eskom

Activity 12.15: Dispersion modelling for year 2025 - Sharpeville



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AIR RESOURCE MANAGEMENT

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EXECUTIVE SUMMARY

1. BACKGROUND

Globally, approximately half of all household waste is incinerated each year in open, uncontrolled fires (Wang, 2023a). This practice is particularly widespread in various regions of South Africa, where the open burning of municipal solid waste (MSW) remains a common and largely unregulated occurrence. These low-temperature, ground-level fires release a complex mix of pollutants, significantly contributing to air pollution and posing serious health risks to surrounding communities (Wang, 2020). In Sharpeville, the scale of the problem has been well documented. In 2017, Nova identified waste dumping and subsequent burning as the second-largest source of air pollution in the area (Nova, 2018). In response, Eskom has launched a waste clean-up campaign in Sharpeville as part of its Air Quality Offset (AQO) programme linked to the Lethabo Power Station, aiming to mitigate these environmental and health impacts.

Air Resource Management (Pty) Ltd has undertaken a phased study (Figure i) aimed at quantifying the air quality benefits resulting from Eskom's Air Quality Offset (AQO) waste intervention in Sharpeville (ARM, 2024b). Phase 1 focused on evaluating the composition of the collected waste and characterizing the combustion properties at multiple Eskom-managed sites across Sharpeville (ARM, 2024a). Building on this foundation, Phases 2 and 3 concentrated on quantifying the net emissions avoided through the intervention and assessing the corresponding improvements in ambient air quality within the Sharpeville airshed.

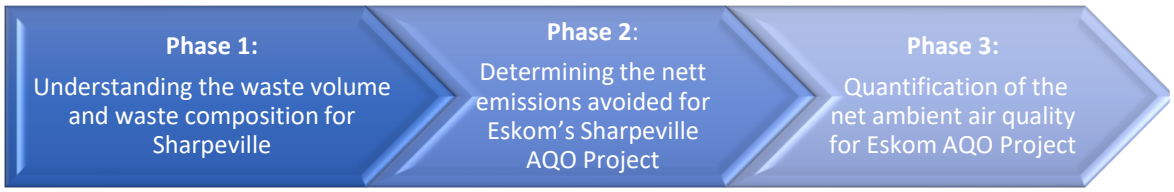


Figure i: ARM phased approach to quantify the air quality impact of Eskom's AQO Sharpeville waste intervention

2. STUDY OBJECTIVE

Phase 1 of the study has been completed (ARM, 2024a). Expanding upon the findings from the Phase 1 study, the objectives for Phases 2 and 3 of this study are:

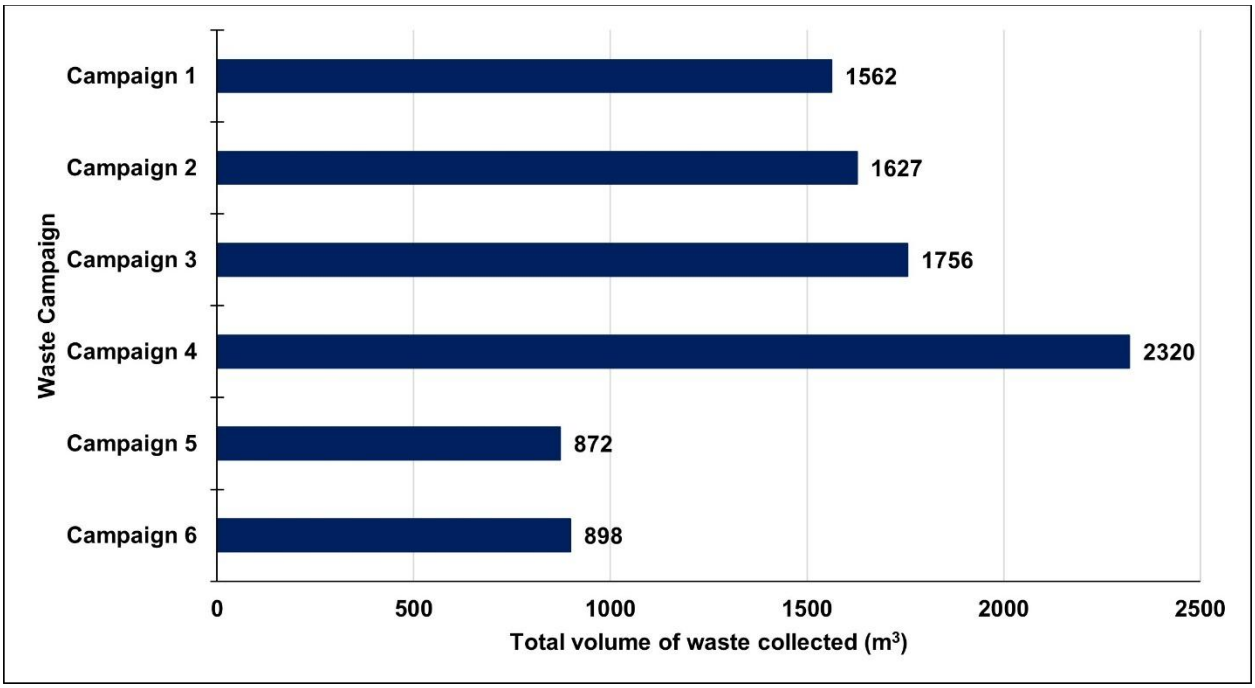
1) To calculate the net reductions in particulate matter (PM), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) emissions attributable to Eskom's Sharpeville AQO Project by applying relevant emission factors.
2) To evaluate the potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project for PM, SO_2, and NO_2 concentrations.

3. STUDY METHODOLOGY

The following section outlines the methodology to calculate: the net reductions in PM, SO_2 and NO_2 emissions as well as the potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project. This was done for six clean-up campaigns (Table i) that Eskom has executed in Sharpeville. The total volume of waste collected for the various campaigns are illustrated in Figure ii.

Table i: Sharpeville waste clean-up campaigns and total waste collected.

Campaign	Start Date	Finish Date	Total volume waste collected/cleaned (m^3)
1st Campaign	17 July 2023	21 July 2023	1562
2nd Campaign	30 October 2023	03 November 2023	1627
3rd Campaign	05 February 2024	09 February 2024	1756
4th Campaign	11 March 2024	15 March 2024	2320
5th Campaign	20 May 2024	21 May 2024	872
6th Campaign	19 August 2024	23 August 2024	898



3.1 CALCULATION OF THE NET REDUCTIONS IN PM, SO_2 AND NO_2 EMISSIONS

Potential emissions reduction due to offset interventions were quantified utilising appropriate emission factors (DRI, 2020). The mathematical expression detailed in Equation 1 was utilised to calculate emissions from waste burning:

$$Ept_x = ARt * EFp * BF$$ **Equation 1** (US-EPA, 1995)

Where:

Ept_x	Total emissions of specific pollutant x (tonnes per annum)
ARt	Activity rate = amount of waste burnt in a year (ton/year) at a given time, t
EFp	Emission factor = amount of pollutant, p (gram) associated with burning of a kilogram of waste
BF	Burning fraction (determinable empirically from combustion test of residual ash)

It was evident from the ARM (2024) study that the bulk of the waste dumped at the Sharpeville illegal waste sites included both highly flammable paper and plastics. These waste streams consist of ~83% to 87% of the total waste collected. Thus, the highly flammable paper and plastic

fractions were utilised to calculate the pollutant emissions. The emission factors (DRI, 2020) in conjunction with the Eskom's Sharpeville AQO waste amounts were utilised in calculating the atmospheric emissions for the paper and plastic waste categories at each site for the specific campaigns.

3.2 Evaluation of the improvement in ambient air quality due to Eskom's Sharpeville AQO project for PM, SO_2 and NO_2 concentrations

Based on the output from the calculated PM, SO_2 and NO_2 emissions inventory (section 3.1), a dispersion modelling assessment aligned to the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (Gazette No 37804, 2014) was utilised to determine the potential nett ambient air quality benefit of Eskom's Sharpeville AQO Project. For this study, a level 3 tier modelling assessment, the US-EPA approved California Puff (CALPUFF) modelling suite was utilised.

4. Study Results

4.1 Calculated net reductions in PM, SO_2 and NO_2 emissions

The net reductions in PM, SO_2 and NO_2 emissions attributable to Eskom's Sharpeville AQO Project during clean-up campaigns 1 to 6 is provided in Table ii and the nett overall reduction in emissions for campaigns 1 to 3 and 4 to 6 are illustrated in Figure iii, whilst Figure iv is displaying the nett overall reduction in emissions for all the campaigns (total, or campaign 1 to 6).

Table ii: Net reduction in emissions attributable to Eskom's Sharpeville AQO Project (tonne) for each campaign

Unburned	NO (as NO_2)	NO_2	NOx (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
	(tonne for each campaign)					
Campaign 1	0.32	0.34	0.66	0.13	6.27	6.28
Campaign 2	0.26	0.28	0.54	0.11	5.23	5.25
Campaign 3	0.22	0.24	0.46	0.09	4.46	4.48
Campaign 4	0.49	0.52	1.01	0.20	9.69	9.72
Campaign 5	0.20	0.22	0.42	0.08	4.06	4.07
Campaign 6	0.07	0.08	0.15	0.03	1.43	1.43

4.2 THE AMBIENT AIR QUALITY BENEFIT ATTRIBUTABLE TO ESKOM'S SHARPEVILLE AQO PROJECT

Table iii summarises the model predicted potential nett ambient air quality benefit of Eskom's Sharpeville AQO Project during the clean-up campaigns. It's noted that the highest impacts are predicted to occur with a close proximity of each site. It is worth noting that the ambient daily PM_{10} and $PM_{2.5}$ standards are 75 $\mu g/m^3$ and 40 $\mu g/m^3$ respectively. Therefore, these results suggest that waste-burning incidents may have the potential to locally increase PM_{10} and $PM_{2.5}$ concentrations in certain instances. However, this hypothesis will be tested as part of ARM Activity 12.13: Dispersion modelling for 2023 and 2024 – Sharpeville wherein the emissions inventory for a myriad of sources (power generation, biomass burning, vehicular emissions, residential fuel burning and waste burning) will be simulated for the Sharpeville airshed.

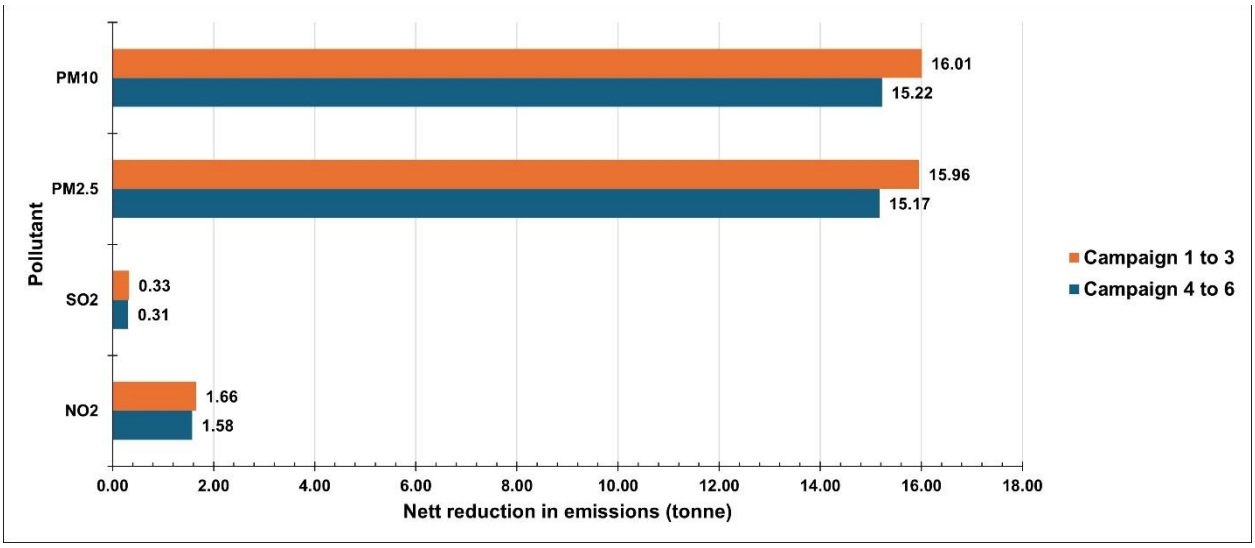


Figure iii: Total net reduction in emissions attributable to Eskom's Sharpeville AQO Project (tons) for campaigns 1 to 3 and 4 to 6

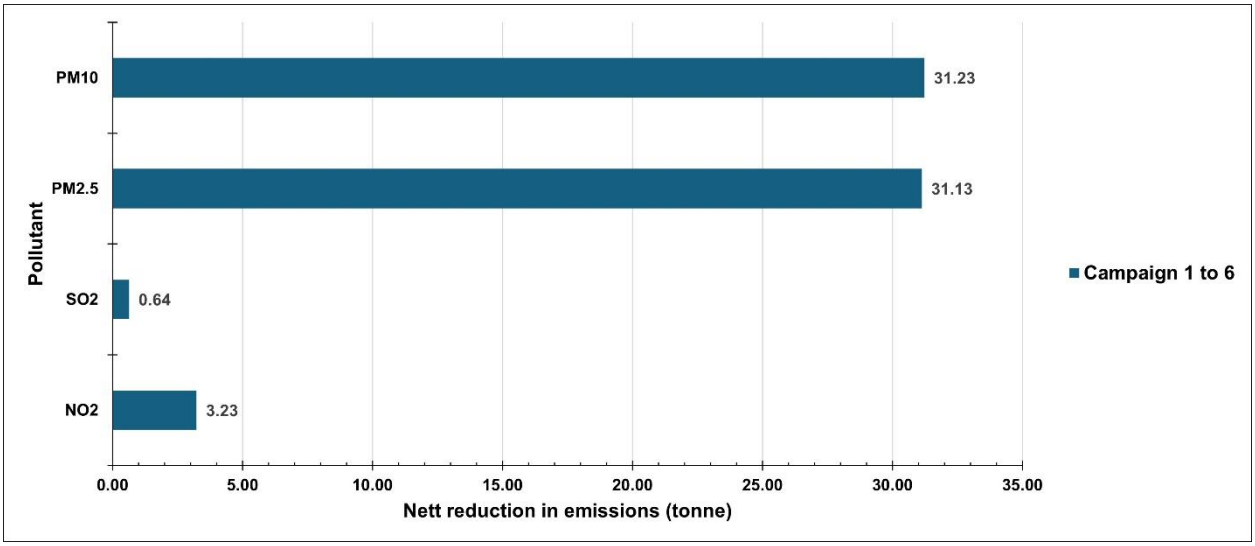


Figure iv: Total net reduction in emissions attributable to Eskom's Sharpeville AQO Project (tonne) for campaigns 1 to 6

Table iii: The potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project

Model predicted maximum concentration in µg/m3							
Pollutant	**PM_{10}**		**$PM_{2.5}$**		**SO_2**		**NO_2**
Averaging period	**1-hour**	**24-hour**	**1-hour**	**24-hour**	**1-hour**	**24-hour**	**1-hour**
Campaign 1	19.10	2.40	19.10	2.30	0.40	0.05	2.10
Campaign 2	33.90	4.40	33.80	4.40	0.60	0.09	3.50
Campaign 3	278.0	28.87	277.45	28.75	5.60	0.58	28.60
Campaign 4	12.99	1.57	12.95	1.56	0.27	0.03	1.35
Campaign 5	78.69	4.01	78.38	3.99	1.59	0.08	8.09
Campaign 6	10.52	1.04	10.48	1.03	0.21	0.02	1.08

5. RECOMMENDATIONS

According to the DFFE's definition (DFFE, 2016), it is crucial for an offset intervention to show a measurable positive impact on ambient air quality in a specific region. However, in campaigns 1 to 6, only 50% of the illegal waste sites where waste burning occurred were addressed (Table 6-1). This presents an opportunity to enhance the air quality benefits of Eskom's Sharpeville AQO initiatives. Its proposed Eskom considers focusing specifically on cleaning up designated illegal waste sites in Sharpeville known for waste burning practices, there is potential to achieve greater reductions in PM, SO_2, and NO_2 emissions linked to Eskom's Sharpeville AQO Project. This targeted approach is expected to lead to significant improvements in ambient air quality relating to these pollutants.

The study has evaluated the reduction in emissions and the corresponding net improvement in ambient air quality resulting from Eskom's Sharpeville AQO Project. This assessment encompassed data from Clean-up Campaigns 1 through 6. Based on the positive outcomes observed, it is recommended that Eskom considers continuing implementing these waste collection initiatives and extend the analysis to quantify the cumulative air quality benefits associated with future Sharpeville AQO interventions.

6. CONCLUSION

This study calculated the net reductions in PM, SO_2 and NO_2 emissions as well as the potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project. This was done for six clean-up campaigns that Eskom has executed in Sharpeville. According to the DFFE's definition (DFFE, 2016), it is crucial for an offset intervention to show a measurable positive impact on ambient air quality in a specific region. The findings of this study have definitively demonstrated that Eskom's Sharpeville AQO Project shows a clear positive impact on ambient air quality in quantitative terms for the Sharpeville airshed.

1. BACKGROUND

1.1 AIR QUALITY OFFSETS GUIDELINE

An environmental offset is an action(s), designed to compensate for a negative environmental impact of resource use, a discharge, emission, or other activity. The Department of Forestry, Fisheries & Environment (DFFE) defines air emissions offsets as an intervention, or interventions, specifically implemented to counterbalance the adverse and residual environmental impact of atmospheric emissions in order to deliver a net ambient air quality benefit within, but not limited to, the affected airshed where ambient air quality standards are being or have the potential to be exceeded and whereby opportunities and need for offsetting exist (Notice 333 of 2016).

1.2 ESKOM'S APPROACH TO AIR QUALITY OFFSETS

DFFE Air Quality Offset Guideline has shaped and informed Eskom's Air Quality Offsets Implementation Plan. This Plan has been based on a scientific process of feasibility studies, testing and demonstration, and on consultation with key stakeholders. Figure 1-1 illustrates the concept schedule for the phased implementation of Eskom's air quality offsets.

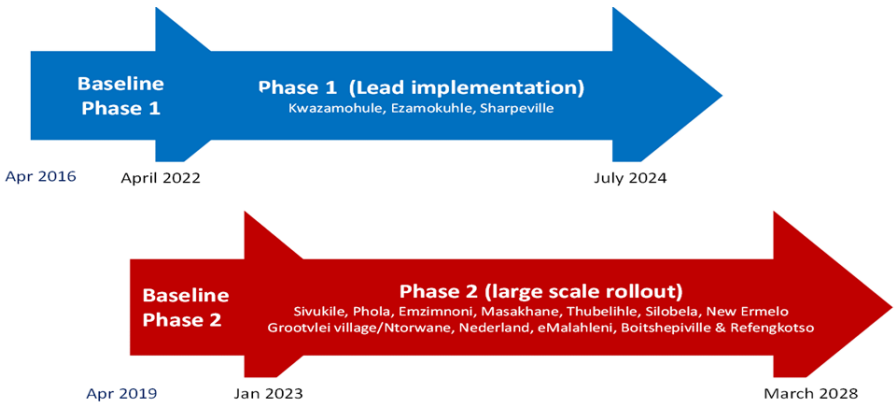


Figure 1-1: Concept Schedule for the implementation of Eskom's air quality offsets (Matimolane, 2023).

Eskom has adopted the phased approach (Figure 1-2) herein to increase the probability of success and to ensure that learnings from early phases are incorporated into the large-scale roll-out. (Matimolane, 2020).

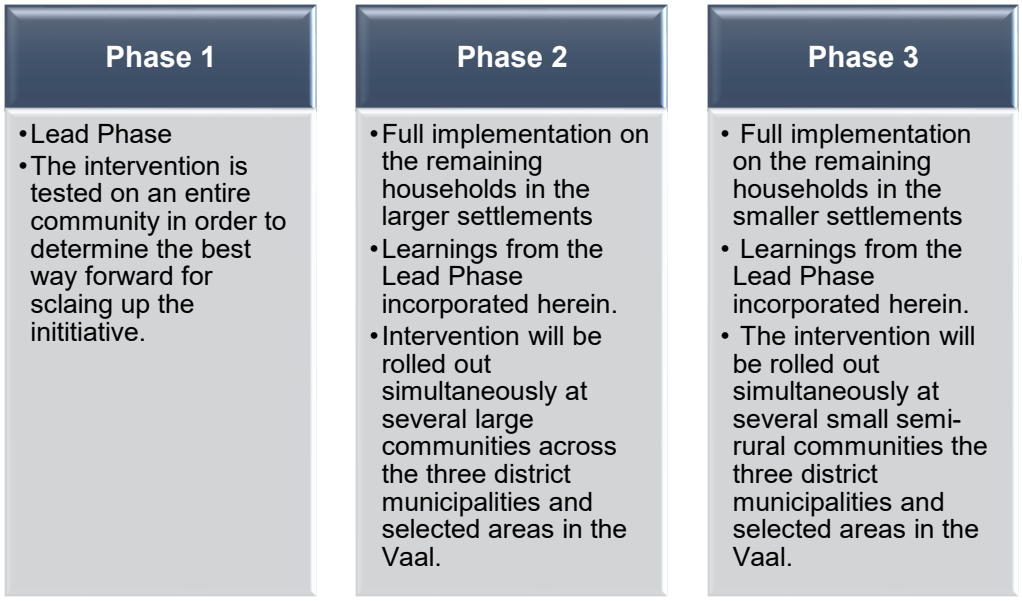


Figure 1-2: Eskom's Phased approach to the rollout of air quality offset interventions (Matimolane, 2020).

Eskom's air quality offsets programme is designed to reduce human exposure to harmful levels of air pollution by reducing emissions from local sources, like domestic coal burning and waste burning. Thus, air quality offsets can improve ambient air quality in low-income communities in the vicinity of Eskom's power stations. Eskom has developed air quality offset (AQO) implementation plans for Majuba Power Station (Ezamokuhle township); Hendrina Power Station (KwaZamokuhle township) and Lethabo Power station (Sharpeville).

1.3 ESKOM'S PLANNING, MONITORING AND VERIFICATION (PMV) PROJECT

For Eskom's PMV Project, interventions to reduce household emissions from domestic coal/wood burning will be rolled out in KwaZamokuhle and Ezamokuhle in the Mpumalanga Highveld. For formal dwellings the intervention will be a thermal insulation retrofit and an electricity starter pack and installation. The intervention for informal dwellings still needs to be selected and tested. Interventions also need to be identified and implemented to improve air quality in Sharpeville, Gauteng. Since domestic coal burning is less prevalent in Sharpeville, it is expected that a community-scale intervention, like reducing waste burning, will be more suitable there.

Air Resource Management (ARM) (Pty) Ltd has been appointed by Eskom to support the PMV services in support of the *Phase 1: Lead implementation* at: KwaZamokuhle; Ezamokuhle and Sharpeville. Its ARM (Pty) Ltd understanding that the overall objective *Lead Implementation Phase* is to benefit the specific local communities, minimize implementation risk, increase practical and scientific knowledge, and develop and refine monitoring, reporting and verifications processes. To achieve this, Eskom has included sixteen targeted work package Activities (Table 1) for these respective communities. This report focuses on *Activity 12.12: Dispersion modelling for Sharpeville.*

Table 1-1: Eskom PMV Activity Schedule (Eskom PMV NEC Contract, 2020)

Activities	Kwazamokuhle	Ezamokuhle	Sharpeville
Activity 1: Preliminary air quality assessment		✓	
Activity 2: Gather Area intelligence		✓	
Activity 3: Rapid in situ assessment		✓	
Activity 4: Obtain ethical clearance		✓	
Activity 5: Census	✓	✓	✓
Activity 6: Community source survey		✓	
Activity 7: Fuel source survey		✓	
Activity 8: Household surveys		✓	
Activity 9: Annual (household/community) surveys and monitoring of project effectiveness	✓	✓	✓
Activity 10: Ambient air quality monitoring	✓	✓	✓
Activity 11: Conduct indoor air quality monitoring	✓	✓	
Activity 12: Atmospheric Dispersion Model	✓	✓	✓
Activity 13: Design of Intervention		✓	✓
Activity 14: Development of Database Reporting	✓	✓	✓
Activity 15: Strategic Assistance and offsets methodology	✓	✓	✓
Activity 16: Research and Development	✓	✓	✓

2 INTRODUCTION

2.1 MUNICIPAL SOLID WASTE MANAGEMENT (MSW)

Solid Waste generation per capita varies widely within South Africa depending on income and location (urban and rural). At present, not all waste is collected and managed formally, with only 61% of the population estimated to have access to kerbside removal of waste (DEA, 2014). The ever-increasing socio-economic activities have brought about an increase in the generation of waste in South Africa beyond effective levels of management (Nwokedi, 2011).

Within South Africa, waste management is the responsibility of local government; however, large discrepancies exist in the level of service provided by different municipalities. Municipalities often encounter problematic situations beyond the ability of the municipal authority to manage (Sujauddin *et al*., 2008) primarily because of the lack of organisation, financial resources, complexity and system multi dimensionality (Rabaji, 2019). Where most larger municipalities provide a complete service, including waste collection and appropriate disposal, many smaller municipalities typically rural lack the capacity for any form of waste service delivery. While the range in waste service delivery is most notable between urban and rural municipalities, it has been suggested that variation can, and does, occur across provinces, district councils and local municipalities (Rodseth, 2020). This is highly skewed to more affluent urban communities, with significantly lower levels in urban informal areas, tribal areas and rural formal areas. (DFFE, 2014).

A lack of formalised waste management can result in unregulated management practices, i.e. waste management or disposal occurring outside of, or separate to, formal waste systems. These include for example, illegal dumping and the associated uncontrolled burning of MSW (Rodseth, 2020).

2.2 THE AIR QUALITY IMPACT OF BURNING MSW

Globally, about half of the household waste (i.e., about 1 x 10^9 tons) is burned in open, uncontrolled fires every year (Wang, 2023a). Open burning of household waste is a common phenomenon in many areas in South Africa. Due to limited resources for collection and proper disposal, household and municipal solid waste is often dumped in neighbourhoods and open burned in piles to reduce odour and create space for incoming waste. This uncontrolled MSW open burning generates a wide range of emissions from these ground-level and low-temperature burns cause air pollution, leading to adverse health effects among community residents (Wang, 2020).

These air contaminants include criteria pollutants, such as carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter with aerodynamic diameter of 2.5 µm ($PM_{2.5}$) and 10 µm (PM_{10}), and lead. Burning also emits other hazardous air emissions, such as heavy metal elements, polychlorinated and polybrominated dioxins and furans, and polycyclic aromatic hydrocarbons (PAHs) (Wang, 2023b). Many of these pollutants are carcinogenic or mutagenic; they may cause immunological and developmental impairments and lead to respirable and cardiovascular diseases. It is estimated that exposure to $PM_{2.5}$ from open burning of solid waste causes at least 270 000 premature deaths in the world every year (Williams et al., 2019; Kodros et al., 2016). In addition, open burning emits large amounts of carbon dioxide (CO_2) and light-absorbing carbon (including black carbon, BC), two of the largest climate forcers of global warming (Bond et al., 2013; IPCC, 2013).

In terms of atmospheric emission, they vary not only based on the type of burning (controlled versus uncontrolled), but also based on the composition of the waste (Rabaji, 2019). MSW includes various waste streams *inter alia*: paper, plastics, glass, metal, organics and other. As demonstrated by Oelofse (2015) MSW composition varies per province and in Sharpeville (ARM, 2024a). Thus, it's important to understand the composition of MSW that is being burned at a specific site.

2.3 ESKOM'S AQO PROJECT TO REDUCE MSW BURNING IN SHARPEVILLE

2.3.1 CONTEXT

According to Rabaji (2019) the Sharpeville Township, being located within the Vaal Triangle region, already experiences significant pollution from surrounding industries and mines. During a Community Source Survey in 2017 (Nova, 2018), when asked to make a list of sources that pollute the air, indicated that the dumping and burning of waste was seen as the second largest source of air pollution (after dust). The emissions from industries in general is noted as being perceived as the fourth largest contributor to air pollution (Nova, 2018). Thus, as part of Eskom's Air Quality Offset (AQO) programme for Lethabo power station, a waste clean-up campaign has been introduced.

2.3.2 SHARPEVILLE AQO GOAL

The primary goal of the Sharpeville AQO initiatives is to clean up designated illegal waste sites (consisting of non-hazardous solid waste) in Sharpeville, along with removing litter in the vicinity of the cleared areas. The waste will be collected and disposed of at approved waste disposal sites, in accordance with the Environment Conservation Act, 73 of 1989, and the National Environmental Waste Management Act (Act 59 of 2008). (Matimolane, 2024). This will prevent waste from being burnt and the consequent release of harmful emissions (Figure 2-1).

Figure 2-1: Waste burning outside a primary school in Sharpeville

The waste clean-up campaigns were executed successfully by Eskom, meeting deadlines without any safety incidents (Matimolane, 2024). Figure 2-2 illustrates the areas wherein waste was collected for each of these campaigns.

Figure 2-2: Map showing the areas wherein waste was collected for each of the campaigns

2.3.3 ARM Study To Determine the Air Quality Benefit of Eskom's AQO Waste Intervention in Sharpeville

ARM has undertaken a study to quantify the air quality impact of Eskom AQO waste intervention at Sharpeville (ARM, 2024b). A phased study (Figure 2-3) was conducted which entailed firstly evaluating the waste composition profile (ARM, 2024a). The next phase of this study (Figure 2-3) is to quantify the nett emissions avoided and finally modelling the resultant impact aligned to the South African Regulations regarding air dispersion modelling (Gazette No 37804, 2014).

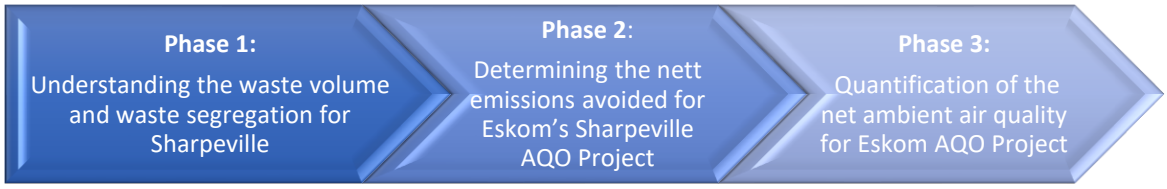


Figure 2-3: ARM phased approach to quantify the air quality impact of Eskom's AQO Sharpeville waste intervention.

2.4 STUDY OBJECTIVE

Phase 1 of the study is finished, during which the waste composition and burn characteristics were identified for different Sharpeville sites where Eskom gathered waste (ARM. 2024a). Using the waste volume, composition data, and waste management survey results from Phase 1, the goals of this Phase 2 & 3 study are:

1) To calculate the net reductions in PM, SO_2 and NO_2 emissions attributable to Eskom's Sharpeville AQO Project by applying relevant emission factors.
2) To evaluate the potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project for PM, SO_2, and NO_2 concentrations

3 METHODOLOGY

The following sections outline the methodology to calculate: the net reductions in PM, SO_2 and NO_2 emissions as well as the potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project. This was done for the first three clean-up campaigns (Table 3-1) that Eskom has executed in Sharpeville. Annexure 1 contains a detailed breakdown of each site that was cleaned up in every campaign.

Table 3-1: Sharpeville waste clean-up campaigns.

Campaign	Start Date	Finish Date	Total volume waste collected/cleaned (m^3)
1st Campaign	17 July 2023	21 July 2023	1562
2nd Campaign	30 October 2023	03 November 2023	1627
3rd Campaign	05 February 2024	09 February 2024	1756
4th Campaign	11 March 2024	15 March 2024	2320
5th Campaign	20 May 2024	21 May 2024	872
6th Campaign	19 August 2024	23 August 2024	898

3.1 CALCULATION OF THE NET REDUCTIONS IN PM, SO_2 AND NO_2 EMISSIONS

Potential emissions reduction due to offset interventions were quantified from net reduction in activity rate over a specified period (e.g. the quantity of fuel burnt per period). Emission rates (in g/s) were quantified from the activity rate using emission factors.

3.1.1 BACKGROUND TO EMISSION FACTORS

An emission factor (EF) is a quantity of a pollutant emitted relative to an activity metric, such as the quantity of fuel or material burned. It is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere, with an activity associated with the release of that pollutant. For instance, an EF for the release of SO_2 from

combustion of coal would be expressed in grams (g) SO_2 emitted per kilogram (kg) of coal combusted. EFs are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. EFs are generally used in calculating the rate at which a pollutant is being released from a source (emission rate), which can be used to simulate the concentration of the pollutant at a receptor. The general equation (3-1) for emissions estimation is:

$$E = A * EF * (1 - \frac{ER}{100})$$ **Equation 3-1** (US-EPA)

where:

E = emissions;
A = activity rate;
EF = emission factor, and
ER =overall emission reduction efficiency, %

3.1.2 EMISSION FACTORS UTILISED IN THIS STUDY

Sasol embarked on an emission offset initiative utilising domestic waste removal in 2019 and 2020 in Sasolburg. Due to the lack of representative emission factors EF, several categories of materials that are common in waste burned in South Africa townships were collected during this study. Samples of these waste streams were shipped to the Desert Research Institute (DRI) in Reno Nevada to characterise in an emission testing chamber under controlled conditions. A comprehensive emission factor report was issued to Sasol detailing the emissions under various burning conditions.

Table 3-2 summarises the measured emission factors reported for the Sasol study, whilst Tables 3-3 and 3-4 summarises the emissions factors utilised in this study. Unfortunately, no discrepancy is made in the plastic category (between plastics bottles and plastic bags) during the waste collection. These two subcategories (plastic bottles and bags) were combined to one plastic category in Table 3-4. An assumption was made that the burning represents the smouldering phase, to be conservative.

Table 3-2: Measured emission factors (average ± standard deviation) for waste materials tested (DRI, August 2020).

Fuel	Burn Type	Emission Factor (g/kg fuel)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_x (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Paper	Flaming	1530 ± 24	26.2 ± 6.9	0.58 ± 0.04	0.42 ± 0.15	1.00 ± 0.15	0.68 ± 0.58	12.05 ± 3.28	12.19 ± 3.70
	Smouldering	1406 ± 22	101.2 ± 13.3	0.81 ± 0.51	0.86 ± 0.53	1.66 ± 1.00	0.33 ± 0.08	15.21 ± 6.96	15.16 ± 6.67
	Total	1498 ± 7	44.9 ± 3.2	0.63 ± 0.16	0.52 ± 0.19	1.14 ± 0.31	0.57 ± 0.41	13.31 ± 0.77	13.42 ± 1.21
Rubber	Flaming	No Flaming Phase							
	Smouldering	456 ± 41	28.1 ± 3.9	0.31 ± 0.15	2.75 ± 4.44	3.06 ± 4.59	0.16 ± 0.04	141.34 ± 23.01	153.19 ± 20.26
	Total	456 ± 41	28.1 ± 3.9	0.31 ± 0.15	2.75 ± 4.44	3.06 ± 4.59	0.16 ± 0.04	141.34 ± 23.01	153.19 ± 20.26
Textile	Flaming	1540 ± 129	27.3 ± 8.9	9.53 ± 1.95	1.17 ± 0.19	10.70 ± 5.58	4.43 ± 2.12	37.20 ± 22.65	42.78 ± 31.32
	Smouldering	1227 ± 59	149.5 ± 34.5	11.57 ± 8.73	1.19 ± 0.53	12.76 ± 9.87	1.68 ± 0.45	75.56 ± 15.33	87.55 ± 24.71
	Total	1467 ± 104	54.9 ± 7.4	10.37 ± 3.72	1.21 ± 0.15	11.58 ± 6.57	3.72 ± 1.48	47.04 ± 16.83	53.95 ± 26.96
Plastic Bottles	Flaming	No Flaming Phase							
	Smouldering	182 ± 42	90.4 ± 10.6	0.22 ± 0.26	0.12 ± 0.08	0.35 ± 0.34	0.22 ± 0.02	651.00 ± 38.45	722.47 ± 17.98
	Total	182 ± 42	90.4 ± 10.6	0.22 ± 0.26	0.12 ± 0.08	0.35 ± 0.34	0.22 ± 0.02	651.00 ± 38.45	722.47 ± 17.98
Plastic Bags	Flaming	2938 ± 26	21.0 ± 5.1	0.70 ± 0.17	0.72 ± 0.04	1.42 ± 0.14	0.08 ± 0.01	33.48 ± 9.22	36.01 ± 9.62
	Smouldering	2506 ± 247	183.9 ± 13.7	3.74 ± 0.82	6.87 ± 2.62	10.61 ± 3.15	0.36 ± 0.17	85.75 ± 76.56	89.47 ± 76.47
	Total	2934 ± 24	22.4 ± 5.4	0.72 ± 0.17	0.77 ± 0.06	1.50 ± 0.12	0.08 ± 0.01	34.00 ± 8.55	36.55 ± 8.88
Vegetation	Flaming	1574 ± 16	20.1 ± 4.8	3.17 ± 0.19	0.31 ± 0.01	3.49 ± 0.21	0.75 ± 0.18	3.18 ± 0.15	3.14 ± 0.30
	Smouldering	1372 ± 20	152.7 ± 17.2	1.94 ± 0.15	0.28 ± 0.02	2.22 ± 0.12	0.13 ± 0.00	0.73 ± 0.25	0.72 ± 0.21
	Total	1518 ± 17	57.1 ± 5.9	2.82 ± 0.11	0.30 ± 0.00	3.12 ± 0.11	0.57 ± 0.09	2.48 ± 0.10	2.44 ± 0.02
Food	Flaming	No Flaming Phase							
	Smouldering	955 ± 30	76.1 ± 7.6	1.71 ± 0.34	0.27 ± 0.01	1.98 ± 0.34	0.16 ± 0.02	82.97 ± 18.36	87.23 ± 20.76
	Total	955 ± 30	76.1 ± 7.6	1.71 ± 0.34	0.27 ± 0.01	1.98 ± 0.34	0.16 ± 0.02	82.97 ± 18.36	87.23 ± 20.76
Combined	Flaming	1443 ± 8	14.9 ± 0.7	1.66 ± 0.14	0.63 ± 0.03	2.29 ± 0.16	1.13 ± 0.15	6.94 ± 2.32	7.34 ± 2.36
	Smouldering	1302 ± 28	105.1 ± 11.0	2.40 ± 0.19	0.55 ± 0.09	2.95 ± 0.26	0.17 ± 0.06	6.55 ± 3.01	6.95 ± 3.22
	Total	1417 ± 8	31.6 ± 1.8	1.80 ± 0.11	0.61 ± 0.00	2.41 ± 0.11	0.95 ± 0.13	6.86 ± 2.08	7.26 ± 2.12

Table 3-3: Measured emission factors (average) for paper and plastic tested (DRI, August 2020).

Fuel	Burn Type	Emission Factor (g/kg fuel)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_x (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Paper	Flaming	1530	26.2	0.58	0.42	1	0.68	12.05	12.19
	Smouldering	1406	101.2	0.81	0.86	1.66	0.33	15.21	15.16
	Total	1498	44.9	0.63	0.52	1.14	0.57	13.31	13.42
Plastic Bottles	Flaming	No Flaming Phase							
	Smouldering	182	90.4	0.22	0.12	0.35	0.22	651	722.47
	Total	182	90.4	0.22	0.12	0.35	0.22	651	722.47
Plastic Bags	Flaming	2938	21	0.7	0.72	1.42	0.08	33.48	36.01
	Smouldering	2506	183.9	3.74	6.87	10.61	0.36	85.75	89.47
	Total	2934	22.4	0.72	0.77	1.5	0.08	34	36.55

Table 3-4: Emission Factors (EFs) utilised in this study.

Fuel	Emission Factor (g/kg fuel)					
	NO (as NO_2)	NO_2	NO_x (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Paper	0.81	0.86	1.66	0.33	15.21	15.16
Plastic	3.74	6.87	10.61	0.36	651	722.47

3.1.3 EQUATION UTILISED TO CALCULATE EMISSIONS

The mathematical expression detailed in Equation 3-2 was utilised to calculate emissions from waste burning:

$$Ept_x = ARt * EFp * BF$$ **Equation 3-2** (US-EPA, 1995)

Where:

Ept_x	Total emissions of specific pollutant x (tonnes per annum)
ARt	Activity rate = amount of waste burnt in a year (ton/year) at a given time, t
EFp	Emission factor = amount of pollutant, p (gram) associated with burning of a kilogram of waste
BF	Burning fraction (determinable empirically from combustion test of residual ash)

It's evident from the ARM (2024) study that the bulk of the waste dumped at the Sharpeville illegal waste sites included both highly flammable paper and plastics. These waste streams consist of ~83% to 87% of the total waste collected (Figure 3-1). Thus, the highly flammable paper and plastic fractions were utilised to calculate the pollutant emissions. The emission factors summarised in Table 3-4 in conjunction with the waste amounts (Annexure 2) were utilised in calculating the atmospheric emissions for the paper and plastic waste categories at each site for the specific campaigns.

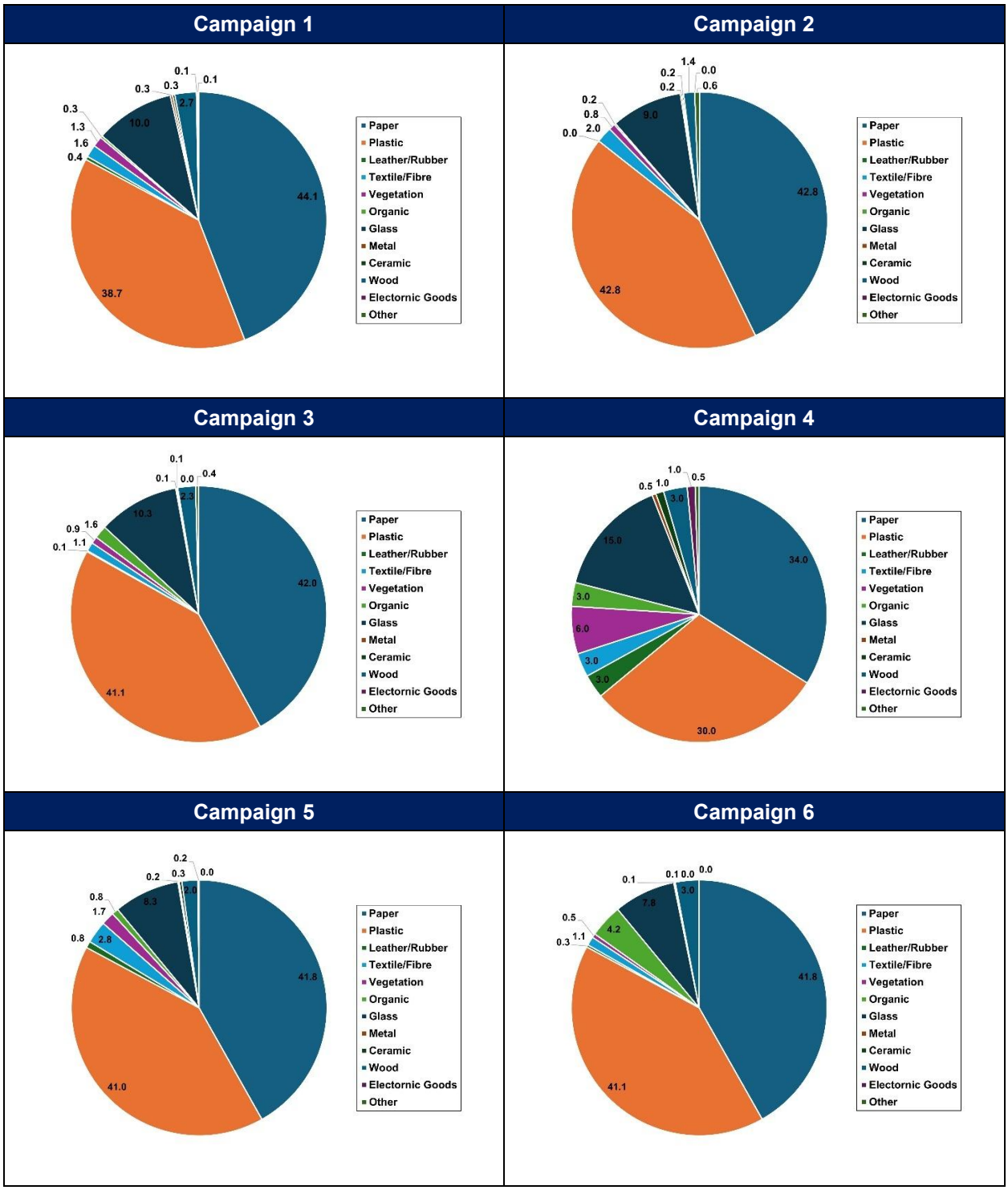


Figure 3-1: The average waste composition for the Eskom waste clean-up Campaigns 1 to 6

3.2 EVALUATION OF THE IMPROVEMENT IN AMBIENT AIR QUALITY DUE TO ESKOM'S SHARPEVILLE AQO PROJECT FOR PM, SO_2, AND NO_2 CONCENTRATIONS

Based on the output from the calculated PM, SO_2 and NO_2 emissions inventory (section 3.1), a dispersion modelling assessment aligned to the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (Gazette No 37804, 2014) was utilised to determine the potential nett ambient air quality benefit of Eskom's Sharpeville AQO Project. For this study, a level 3 tier modelling assessment, the US-EPA approved California Puff (CALPUFF) modelling suite will be utilised.

3.2.1 CALPUFF MODEL

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. CALPUFF is an advanced non-steady-state meteorological and air quality modelling system. The model has been adopted by the U.S. Environmental Protection Agency (US-EPA) in its Guideline on Air Quality Models as the preferred model for assessing long range transport of pollutants and their impacts on Federal Class I areas and on a case-by-case basis for certain near-field applications involving complex meteorological conditions. The modelling system consists of three main components and a set of preprocessing and post processing programs. The main components of the modelling system are CALMET (a diagnostic 3-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post processing package). Figure 3-2 illustrates the CALPUFF modelling structure, whilst Figure 3-3 is a simplified CALPUFF modelling structure.

CALPUFF is also a recommended Level 3 (Tier 3) model in terms of the National Environmental Management: Air Quality Act 39 OF 2004, Regulations Regarding Air

Dispersion Modelling (Government Notice R533 in Government Gazette 37804 dated 11 July 2014).

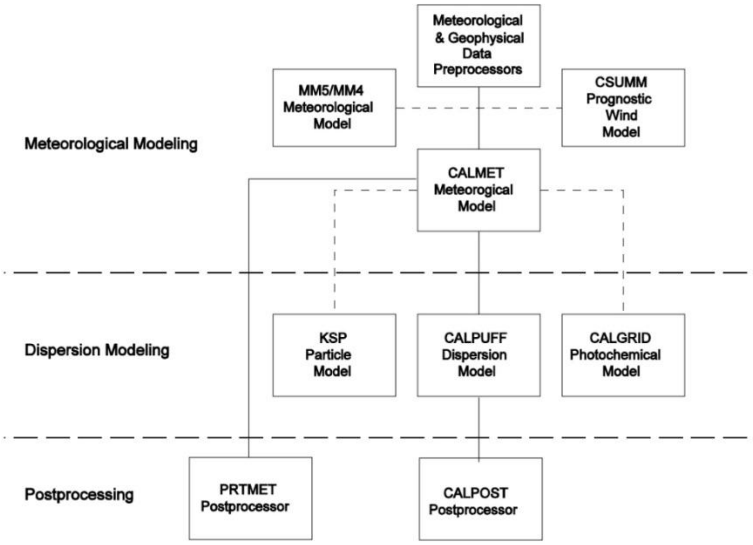


Figure 3-2: CALPUFF modelling structure.

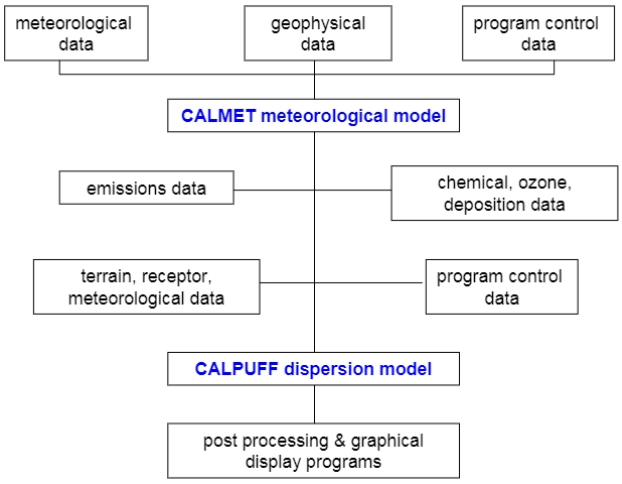


Figure 3-3: Simplified CALPUFF modelling structure.

3.2.2 METEOROLOGY

In the absence of upper air site-specific meteorological data, TAPM was utilised in this study to simulate on-site and upper air meteorological conditions as input for the CALMET model. The Air Pollution Model (TAPM), developed by the Australian CSIRO Atmospheric Research Division, is a prognostic meteorological and air pollution dispersion model developed by Australian CSIRO. The meteorological component of TAPM predicts the local-scale flow, such as sea breezes and terrain-induced circulations, given larger-scale synoptic meteorology. On-site meteorological data was simulated on a 500m resolution at 13 vertical levels for the modelling domain for a period from July 2023 to August 2024.

3.2.3 EMISSIONS

The emission sources (areas) were defined as buoyant area sources in the CALPUFF simulations, with time varying parameters. The pollutant emissions summarised in Tables 4-8 and 4-9 were utilised as input for the CALPUFF model for each campaign, based on the duration of the burning events. The details of the burn events for each campaign are outlined in Annexure 1. The burning events typically took place from 06:00 to 09:00 or 06:00 to 17:00. An assumption was made that no emissions occur after 18:00 in the evening. Due to the nature of the burning events, the following emission temperature profile was adopted (Table 3-3) for the simulations.

3.2.4 MODELLING ASSUMPTIONS

It should be noted that any dispersion model will have an associated degree of error in the predictions due to simplifications in the model algorithms which are used to describe complex and inherently random atmospheric dispersion processes. Thus, the accuracy of the emissions and meteorological data which are input to the model have a significant effect upon the accuracy of the predicted concentrations, this level of uncertainty will be transferred to any pollutant concentration predictions. Predictions of the pollutant

concentrations are at the very best +/- 50% of the true value. As such no background ambient air quality concentrations were included in the modelling results to assist in quantifying the exact contribution of this waste collection and burning campaigns on the receiving environment.

Table 3-3: Emission temperature profile for the simulations.

Hour of Day	Emission Temperature (°C)	Emission Temperature (°K)
06:00	250	523.15
07:00	200	473.15
08:00	150	423.15
09:00	100	373.15
10:00	100	373.15
11:00	100	373.15
12:00	100	373.15
13:00	100	373.15
14:00	100	373.15
15:00	100	373.15
16:00	100	373.15
17:00	100	373.15

The CALPUFF simulations were conducted for each waste-cleanup campaign highlighted in Table 3-5.

Table 3-4: Modelling periods for the Sharpeville waste clean-up campaigns.

Campaign	Start Date	Finish Date
1st Campaign	17 July 2023	21 July 2023
2nd Campaign	30 October 2023	03 November 2023
3rd Campaign	05 February 2024	09 February 2024
4th Campaign	11 March 2024	15 March 2024
5th Campaign	20 May 2024	21 May 2024
6th Campaign	19 August 2024	23 August 2024

The assessment focused on specific waste collection and burning campaigns, and the associated risk and impact of these waste burning events on the receiving environment. Table 3-5 is an indication of the seasonal representation of the waste burning campaigns.

Table 3-5: Seasonal representation of the waste burning campaigns.

Season			
Summer	**Autumn**	**Winter**	**Spring**
		Campaign 1 (17 to 21 July)	
			Campaign 2 (30 October to 3 November)
Campaign 3 (5 to 9 February)			
	Campaign 4 (11 to 15 March)		
	Campaign 5 (20 to 21 May)		
		Campaign 6 (19 to 23 August)	

4 STUDY RESULTS

The air quality impact of Eskom's AQO waste intervention at Sharpeville during clean-up campaigns 1 to 3 is detailed herein.

4.1 CALCULATED NET REDUCTIONS IN PM, SO_2 AND NO_2 EMISSIONS

The emission factors summarised in Table 3-4 in conjunction with the waste amounts (Annexure 2) were utilised in calculating the atmospheric emissions for the paper and plastic waste categories at each site for the specific campaigns. Tables 4-1 to 4-6 summarises the pollutant emissions for both paper and plastic for clean-up campaigns 1 to 6. It's noted that the individual emissions for paper or plastic are provided in Annexure 3.

Table 4-1: Pollutant emissions (kg) for the paper and plastic (combined) waste during Campaign 1.

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Mareka Ward 13	Unburned	34.08	36.18	69.84	13.88	639.96	637.85
	Burned	18.35	19.48	37.61	7.48	344.59	343.46
Ward 12 / Ward 13 Police Station	Unburned	1.03	1.10	2.12	0.42	20.55	20.63
	Burned	9.29	9.91	19.08	3.76	184.93	185.66
Phumasibathe	Unburned	246.63	262.96	506.57	100.03	4 853.26	4 865.46
	Burned	61.66	65.74	126.64	25.01	1 213.32	1 216.36
Ward 14 Ascot Sasol Garage	Unburned	38.00	40.56	78.10	15.40	756.87	759.87
	Burned	4.22	4.51	8.68	1.71	84.10	84.43

Table 4-2: Pollutant emissions (kg) for the paper and plastic (combined) waste during Campaign 2.

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	136.07	145.25	279.65	55.13	2710.11	2720.84
	Burned	15.12	16.14	31.07	6.13	301.12	302.32
Mareka Ward 13	Unburned	122.74	131.01	252.24	49.72	2 444.49	2 454.17
	Burned	66.09	70.54	135.82	26.77	1 316.26	1 321.48
Ward 12 / Ward 13 Police Station	Unburned	3.69	3.94	7.59	1.50	73.57	73.87

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
	Burned	33.25	35.49	68.33	13.47	662.16	664.79

Table 4-3: Pollutant emissions (kg) for the paper and plastic (combined) waste during Campaign 3.

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	169.34	180.75	348.01	68.60	3 372.58	3 385.94
	Burned	18.82	20.08	38.67	7.62	374.73	376.22
Ward 12 / Ward 13 Police Station	Unburned	4.60	4.91	9.45	1.86	91.56	91.92
	Burned	41.37	44.16	85.03	16.76	824.03	827.29
Kgomocho Primary School	Unburned	50.00	53.37	102.75	20.26	995.77	999.72
	Burned	2.63	2.81	5.41	1.07	52.41	52.62

Table 4-4: Pollutant emissions (kg) for the paper and plastic (combined) waste during Campaign 4.

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Vuka Cemetary Ward 14	Unburned	92.53	98.77	190.17	37.49	1842.93	1850.23
	Burned	10.28	10.97	21.13	4.17	204.77	205.58
Phumasibathe	Unburned	398.76	425.17	819.03	161.74	7846.86	7866.57
	Burned	99.69	106.29	204.75	40.43	1961.71	1966.64

Table 4-5: Pollutant emissions (kg) for the paper and plastic (combined) waste during Campaign 5.

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	124.34	132.72	255.54	50.37	2476.44	2486.25
	Burned	13.82	14.75	28.39	5.60	275.16	276.25
Vuka Cemetary Ward 14	Unburned	54.71	58.40	112.44	22.17	1089.70	1094.02
	Burned	6.08	6.49	12.49	2.46	121.08	121.56
Matsie Steyn Primary School	Unburned	0.54	0.58	1.11	0.22	10.74	10.78
	Burned	4.85	5.18	9.97	1.97	96.65	97.03

Mareke Street Ward 13	Unburned	17.91	19.12	36.82	7.26	356.79	358.20
	Burned	9.65	10.30	19.82	3.91	192.12	192.88
Putswatsene	Unburned	6.21	6.63	12.77	2.52	123.76	124.25
	Burned	0.69	0.74	1.42	0.28	13.75	13.81

Table 4-6: Pollutant emissions (kg) for the paper and plastic (combined) waste during Campaign 6.

Site	Unburned / Burned	Emissions (kg of pollutant / kg of fuel burnt)					
	Fraction	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	65.93	70.37	135.50	26.71	1313.09	1318.29
	Burned	7.33	7.82	15.06	2.97	145.90	146.48
Matsie Steyn Primary School	Unburned	5.76	6.14	11.83	2.33	114.65	115.11
	Burned	51.81	55.30	106.48	20.99	1031.88	1035.97
Mareka Street Ward 13	Unburned	27.54	29.40	56.61	11.16	548.57	550.75
	Burned	14.83	15.83	30.48	6.01	295.39	296.56

The net reductions in PM, SO_2 and NO_2 emissions attributable to Eskom's Sharpeville AQO Project during clean-up campaigns 1 to 6 is provided in Table 4-8, whilst Table 4-9 presents a summary of the past emissions produced by the burned waste that was collected in the specific campaigns.

Table 4-8: Net reduction in emissions attributable to Eskom's Sharpeville AQO Project (tons).

Unburned	NO (as NO_2)	NO_2	NOx (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Campaign 1	0.32	0.34	0.66	0.13	6.27	6.28
Campaign 2	0.26	0.28	0.54	0.11	5.23	5.25
Campaign 3	0.22	0.24	0.46	0.09	4.46	4.48
Campaign 4	0.49	0.52	1.01	0.20	9.69	9.72
Campaign 5	0.20	0.22	0.42	0.08	4.06	4.07
Campaign 6	0.07	0.08	0.15	0.03	1.43	1.43
Total	**1.57**	**1.68**	**3.23**	**0.64**	**31.13**	**31.23**

Table 4-9: Emissions generated from the burned waste that was collected for the specific campaigns (tons).

Burned	NO (as NO_2)	NO_2	NOx (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Campaign 1	0.09	0.10	0.19	0.04	1.83	1.83
Campaign 2	0.11	0.12	0.24	0.05	2.28	2.29
Campaign 3	0.06	0.07	0.13	0.03	1.25	1.26
Campaign 4	0.11	0.12	0.23	0.04	2.17	2.17
Campaign 5	0.04	0.04	0.07	0.01	0.70	0.70
Campaign 6	0.07	0.08	0.15	0.03	1.47	1.48
Total	**0.49**	**0.52**	**1.01**	**0.20**	**9.70**	**9.73**

The next section of this report will focus on illustrating the effects of these emissions (Table 4-8 & Table 4-9) on the receiving environment.

4.2 THE MODEL PREDICTED IMPROVEMENT IN AMBIENT AIR QUALITY DUE TO ESKOM'S SHARPEVILLE AQO PROJECT FOR PM, SO2, AND NO2 CONCENTRATIONS

The US-EPA approved CALPUFF modelling suite was to determine the potential nett ambient air quality benefit of Eskom's Sharpeville AQO Project. The pollutant emissions listed in Tables 4-8 and 4-9 were used as data inputs for the CALPUFF model for each specific campaign (sections 4.2.1 to 4.2.3).

4.2.1 CAMPAIGN 1

Figure 4-1 is a map detailing the seven waste collection sites during campaign 1, whilst Figure 4-2 is indicative of the four sites where waste burning practices were conducted.

Figure 4-1: Location of the waste collection sites during Campaign 1.

Figure 4-2: Location of the waste burning sites during Campaign 1.

Figures 4-3 to 4-6 are detailed maps of the sites where waste burning practices were conducted, as well as the location of sensitive receptors around the burning sites.

Figure 4-3: Mareka Ward 13 waste burning site and sensitive receptors near the site.

Figure 4-4: Ward 12 / 13 Police Station waste burning site and sensitive receptors near the site.

Figure 4-5: Phumasibathe waste burning site and sensitive receptors near the site.

Figure 4-6: Ascot Sasol Garage waste burning site and sensitive receptors near the site.

4.2.1.1 Particulate Matter (PM_{10})

Figure 4-7 illustrates the simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 1 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 2.53 $\mu g/m^3$ and 0.79 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-8 illustrates the simulated maximum 24-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 1. Maximum 24-hour concentrations of 10.29 $\mu g/m^3$ and 2.40 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for a 24-hour time average is 75 $\mu g/m^3$.

Figure 4-9 illustrates the simulated maximum 1-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 1. Maximum 1-hour concentrations of 109.29 $\mu g/m^3$ and 19.10 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No PM_{10} NAAQS standard exist for a 1-hour time average.

Table 4-1 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-10 to 4-12 is a graphical representation of Table 4-1.

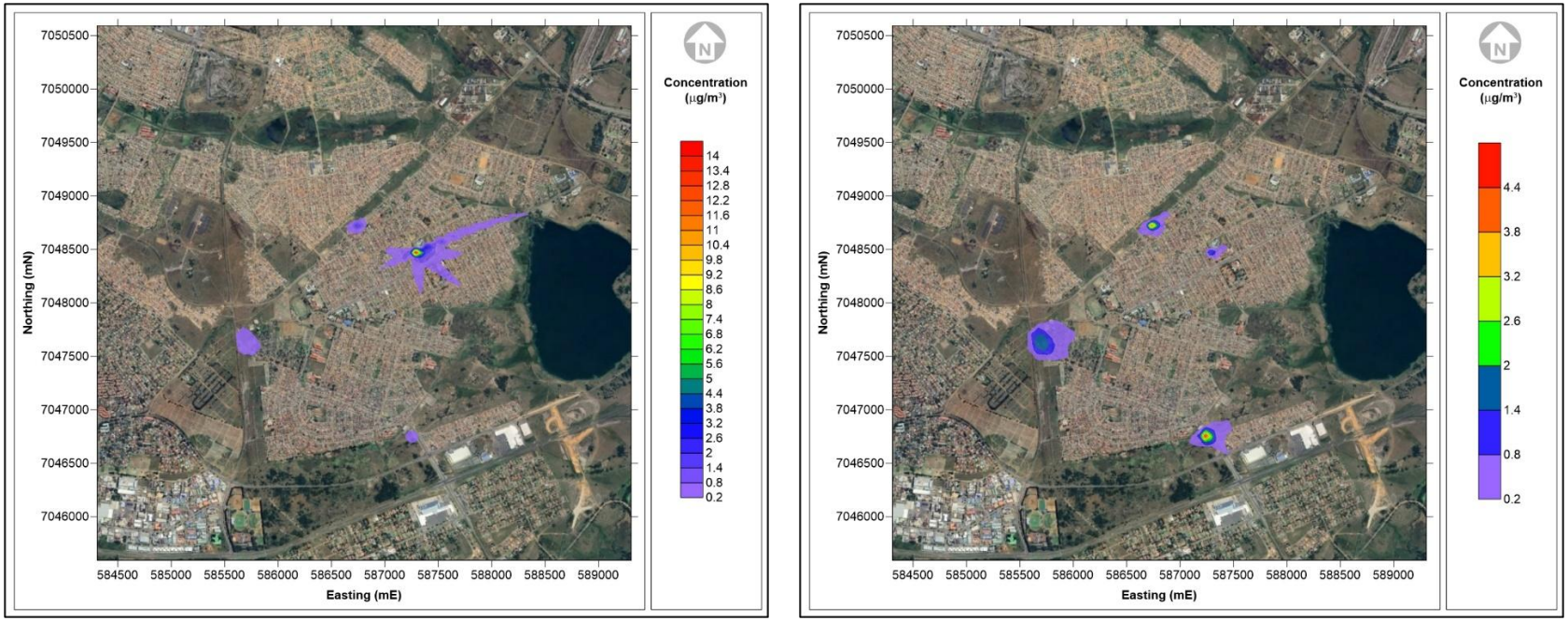


Figure 4-7: Simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 1 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

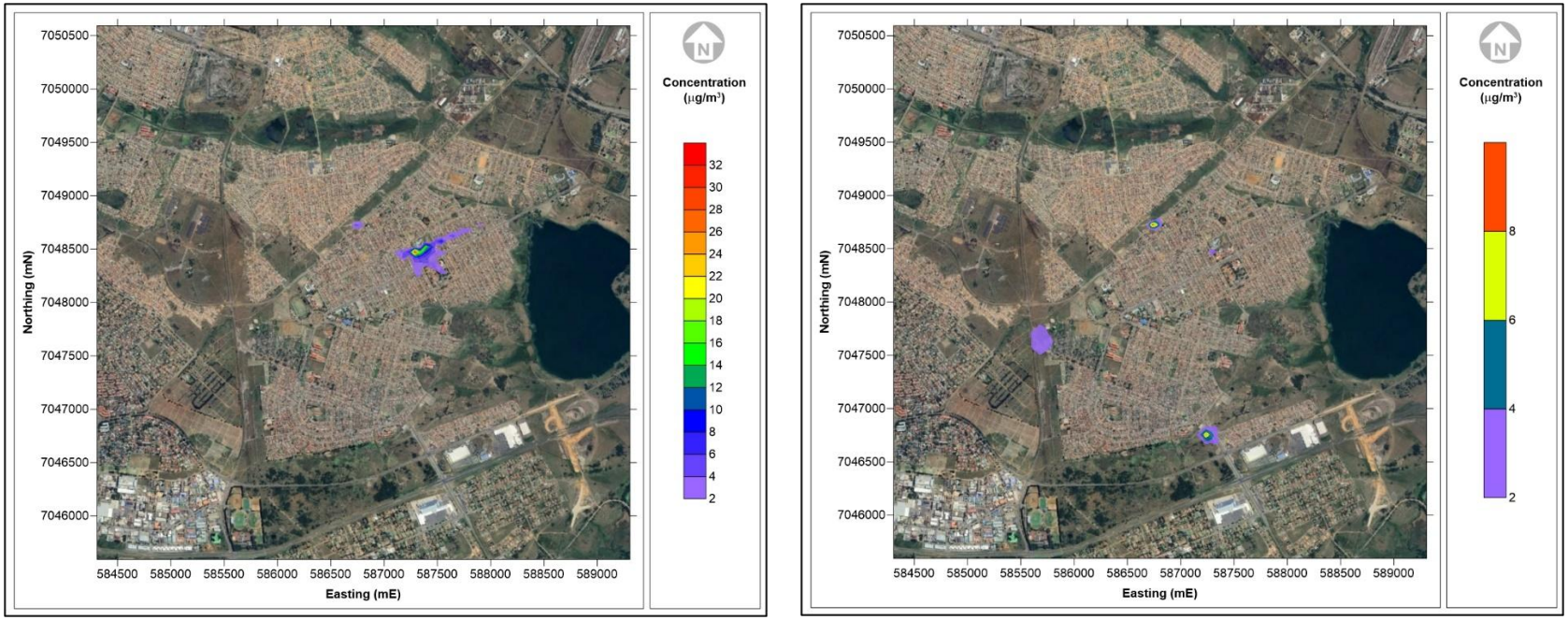


Figure 4-8: Simulated maximum 24-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

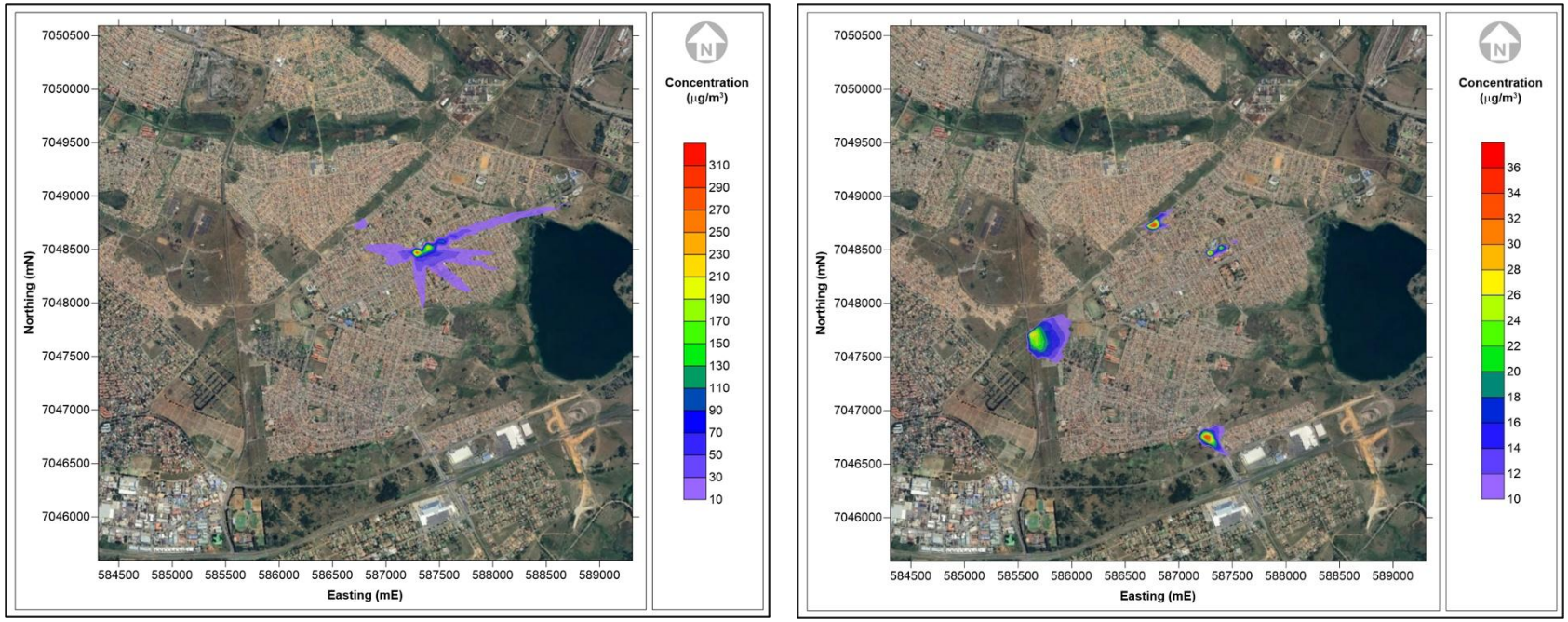


Figure 4-9: Simulated maximum 1-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-1: Simulated ambient PM_{10} concentrations at the sensitive receptors for Campaign 1.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.01	0.02	0.06	0.10	0.82	1.49
Mareka Ward 13_2	0.00	0.01	0.02	0.04	0.54	0.98
Mareka Ward 13_3	0.06	0.11	0.37	0.67	3.87	6.99
Mareka Ward 13_4	0.51	0.93	1.18	2.13	10.59	19.10
Mareka Ward 13_5	0.32	0.58	0.84	1.52	8.73	15.74
Mareka Ward 13_6	0.05	0.09	0.27	0.49	2.27	4.10
Ward 13 Police Station_1	0.15	0.04	0.67	0.09	7.99	1.25
Ward 13 Police Station_2	3.89	0.45	9.81	1.09	109.27	12.15
Ward 13 Police Station_3	2.10	0.26	7.14	0.84	54.17	6.14
Ward 13 Police Station_4	0.68	0.10	4.02	0.45	47.70	5.30
Ward 13 Police Station_5	2.53	0.31	10.29	1.14	95.88	10.66
Ward 13 Police Station_6	0.44	0.08	2.05	0.23	18.10	2.01
Phumasibathe_1	0.12	0.46	0.37	1.45	3.63	14.32
Phumasibathe_2	0.20	0.79	0.41	1.60	3.79	14.94
Phumasibathe_3	0.10	0.40	0.34	1.35	3.12	12.28
Phumasibathe_4	0.06	0.22	0.32	1.25	3.01	11.86
Phumasibathe_5	0.01	0.00	0.02	0.01	0.28	0.08
Phumasibathe_6	0.01	0.00	0.02	0.01	0.24	0.07
Ascot Sasol Garage_1	0.00	0.00	0.00	0.00	0.04	0.04
Ascot Sasol Garage_2	0.12	0.99	0.27	2.31	1.56	13.57
Ascot Sasol Garage_3	0.08	0.56	0.28	2.40	1.99	17.34
Ascot Sasol Garage_4	0.05	0.33	0.19	1.65	1.73	15.07
Ascot Sasol Garage_5	0.02	0.16	0.06	0.50	0.28	2.47
Ascot Sasol Garage_6	0.01	0.04	0.03	0.25	0.46	4.02

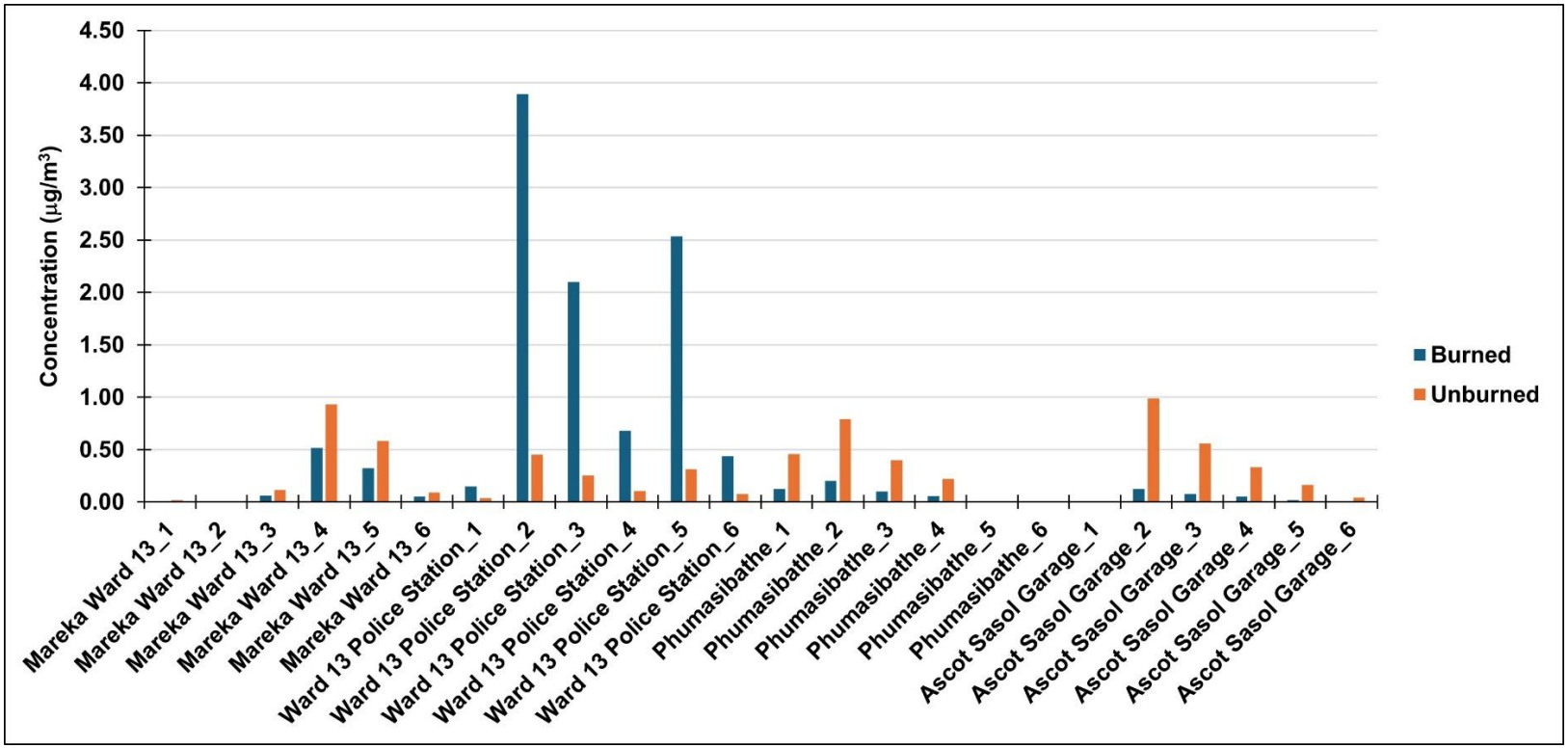


Figure 4-10: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 1 (1-hour averages).

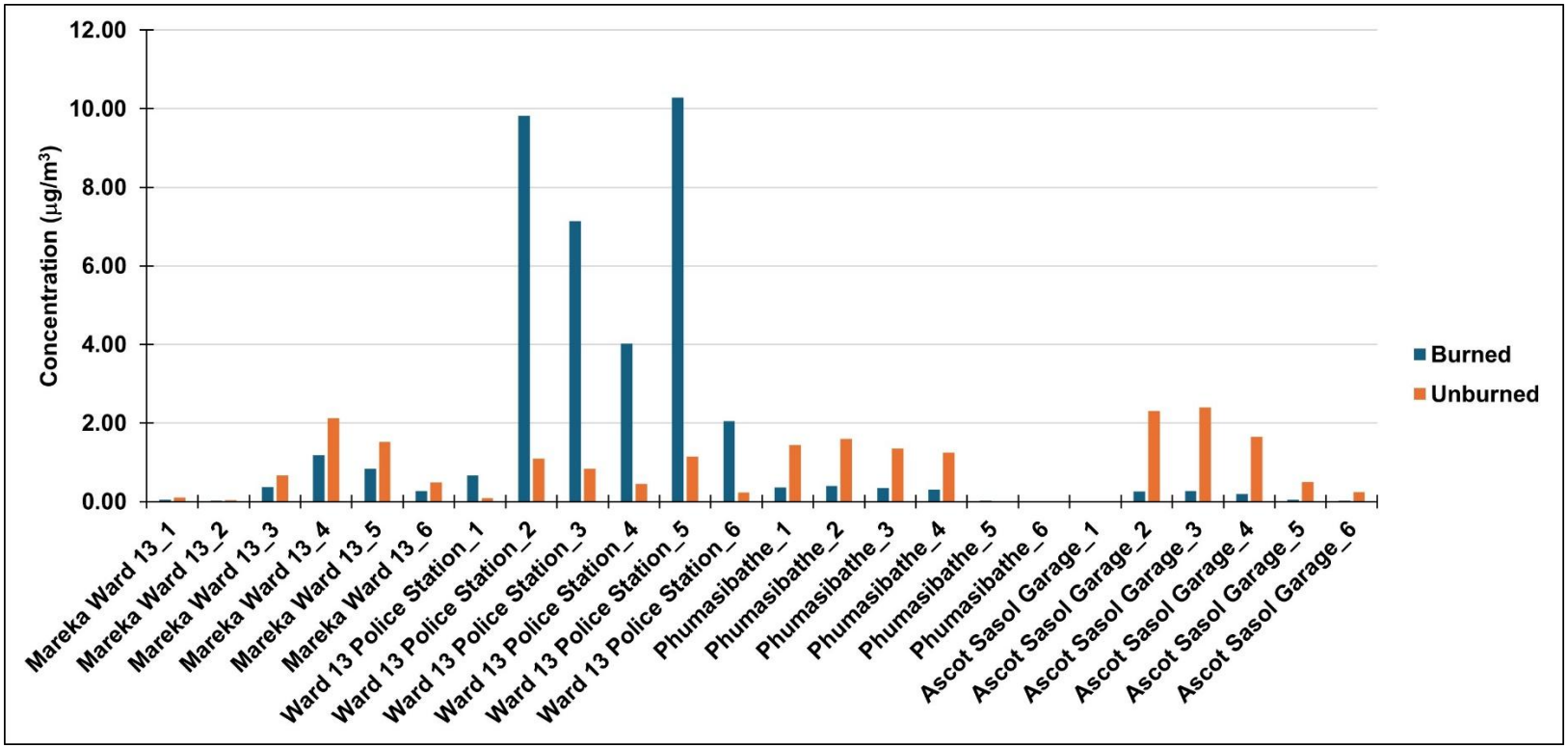


Figure 4-11: Simulated maximum 24-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 1 (5-days).

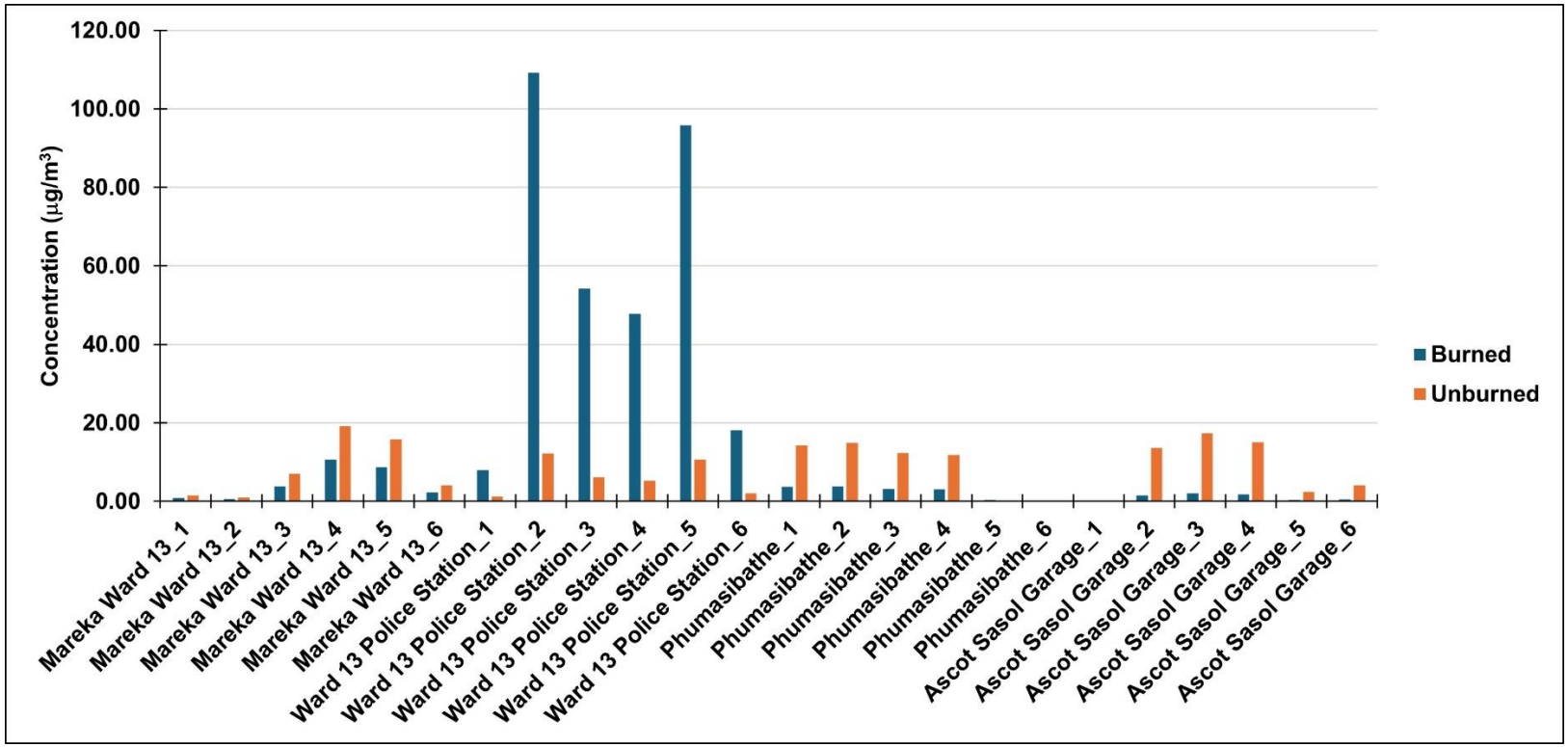


Figure 4-12: Simulated maximum 1-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 1 (5-days).

4.2.1.2 Particulate Matter ($PM_{2.5}$)

Figure 4-13 illustrates the simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 1 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 2.50 $\mu g/m^3$ and 0.90 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for an annual time average is 20 $\mu g/m^3$.

Figure 4-14 illustrates the simulated maximum 24-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 1. Maximum 24-hour concentrations of 10.20 $\mu g/m^3$ and 2.30 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for a 24-hour time average is 40 $\mu g/m^3$.

Figure 4-15 illustrates the simulated maximum 1-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 1. Maximum 1-hour concentrations of 109.00 $\mu g/m^3$ and 19.00 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No $PM_{2.5}$ NAAQS standard exist for a 1-hour time average.

Table 4-2 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-16 to 4-18 is a graphical representation of Table 4-2.

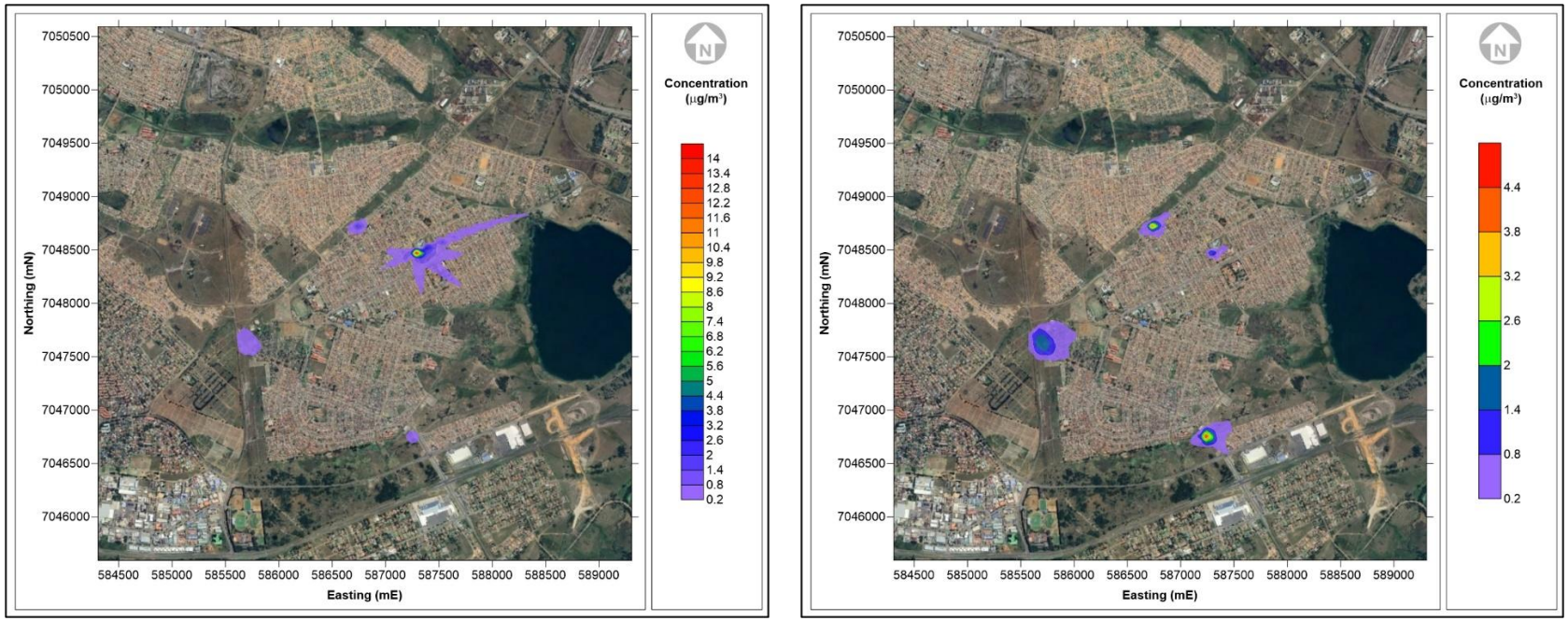


Figure 4-13 Simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 1 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

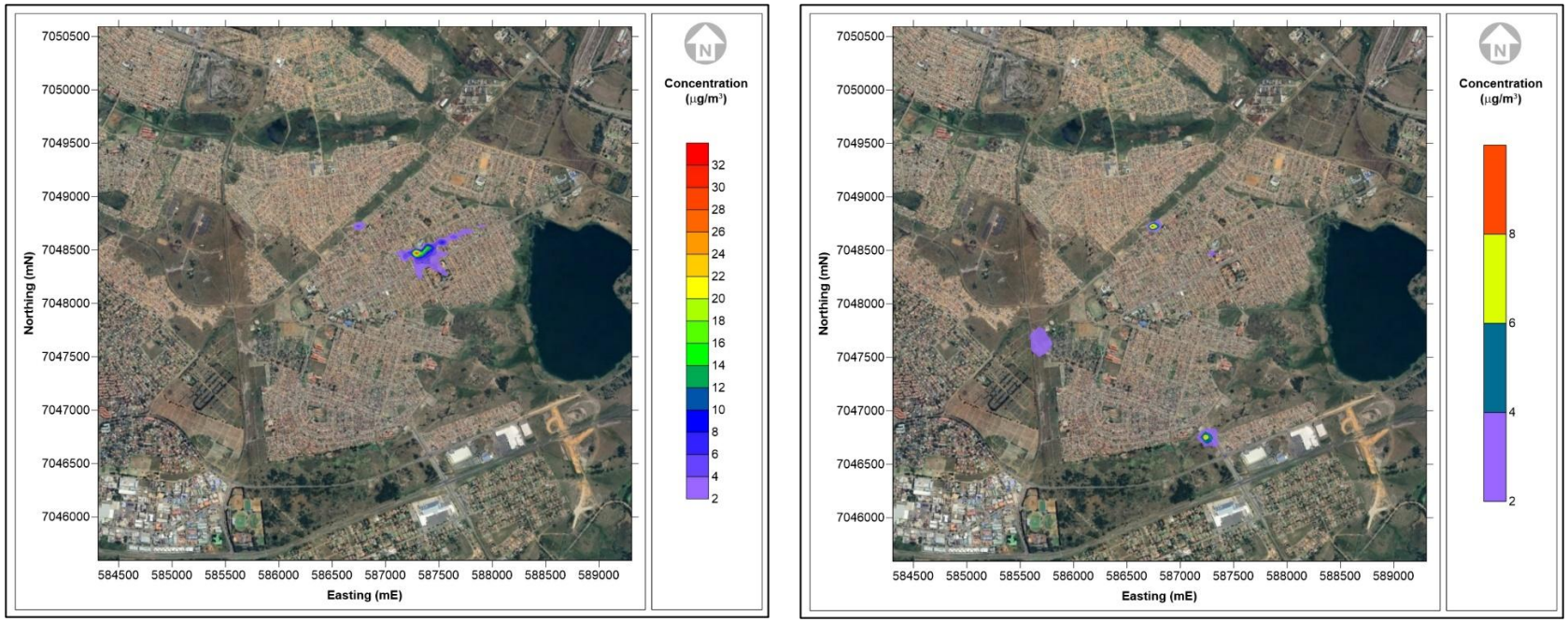


Figure 4-14: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

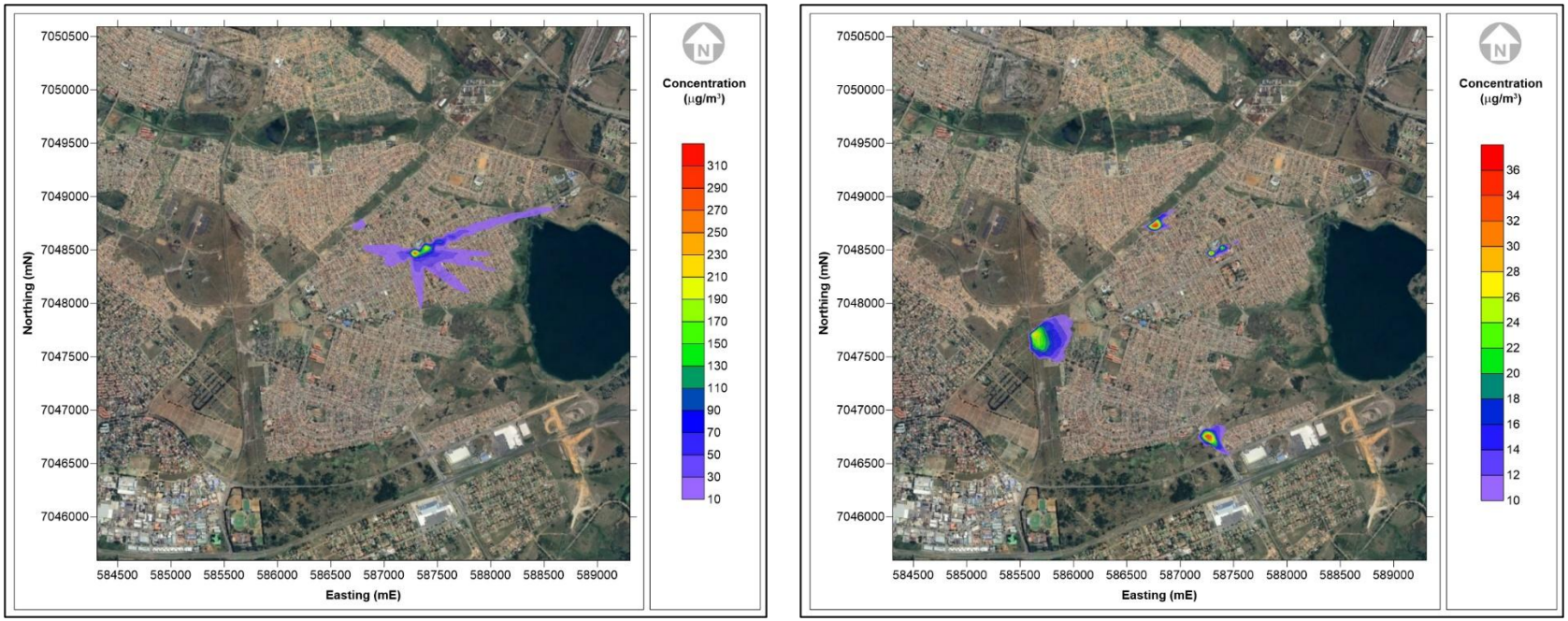


Figure 4-15: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-2: Simulated ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 1.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.01	0.02	0.06	0.10	0.82	1.49
Mareka Ward 13_2	0.00	0.01	0.02	0.04	0.54	0.98
Mareka Ward 13_3	0.06	0.11	0.37	0.68	3.87	7.02
Mareka Ward 13_4	0.51	0.93	1.18	2.14	10.59	19.18
Mareka Ward 13_5	0.32	0.58	0.84	1.53	8.73	15.81
Mareka Ward 13_6	0.05	0.09	0.27	0.49	2.27	4.11
Ward 13 Police Station_1	0.15	0.04	0.67	0.09	7.99	1.24
Ward 13 Police Station_2	3.89	0.45	9.81	1.09	109.27	12.10
Ward 13 Police Station_3	2.10	0.26	7.14	0.84	54.17	6.11
Ward 13 Police Station_4	0.68	0.10	4.02	0.45	47.70	5.28
Ward 13 Police Station_5	2.53	0.31	10.29	1.14	95.88	10.62
Ward 13 Police Station_6	0.44	0.08	2.05	0.23	18.10	2.00
Phumasibathe_1	0.12	0.46	0.37	1.44	3.63	14.28
Phumasibathe_2	0.20	0.79	0.41	1.60	3.79	14.90
Phumasibathe_3	0.10	0.40	0.34	1.35	3.12	12.24
Phumasibathe_4	0.06	0.22	0.32	1.24	3.01	11.83
Phumasibathe_5	0.01	0.00	0.02	0.01	0.28	0.08
Phumasibathe_6	0.01	0.00	0.02	0.01	0.24	0.07
Ascot Sasol Garage_1	0.00	0.00	0.00	0.00	0.04	0.04
Ascot Sasol Garage_2	0.12	0.98	0.27	2.30	1.56	13.51
Ascot Sasol Garage_3	0.08	0.56	0.28	2.39	1.99	17.27
Ascot Sasol Garage_4	0.05	0.33	0.19	1.64	1.73	15.00
Ascot Sasol Garage_5	0.02	0.16	0.06	0.50	0.28	2.46
Ascot Sasol Garage_6	0.01	0.04	0.03	0.25	0.46	4.01

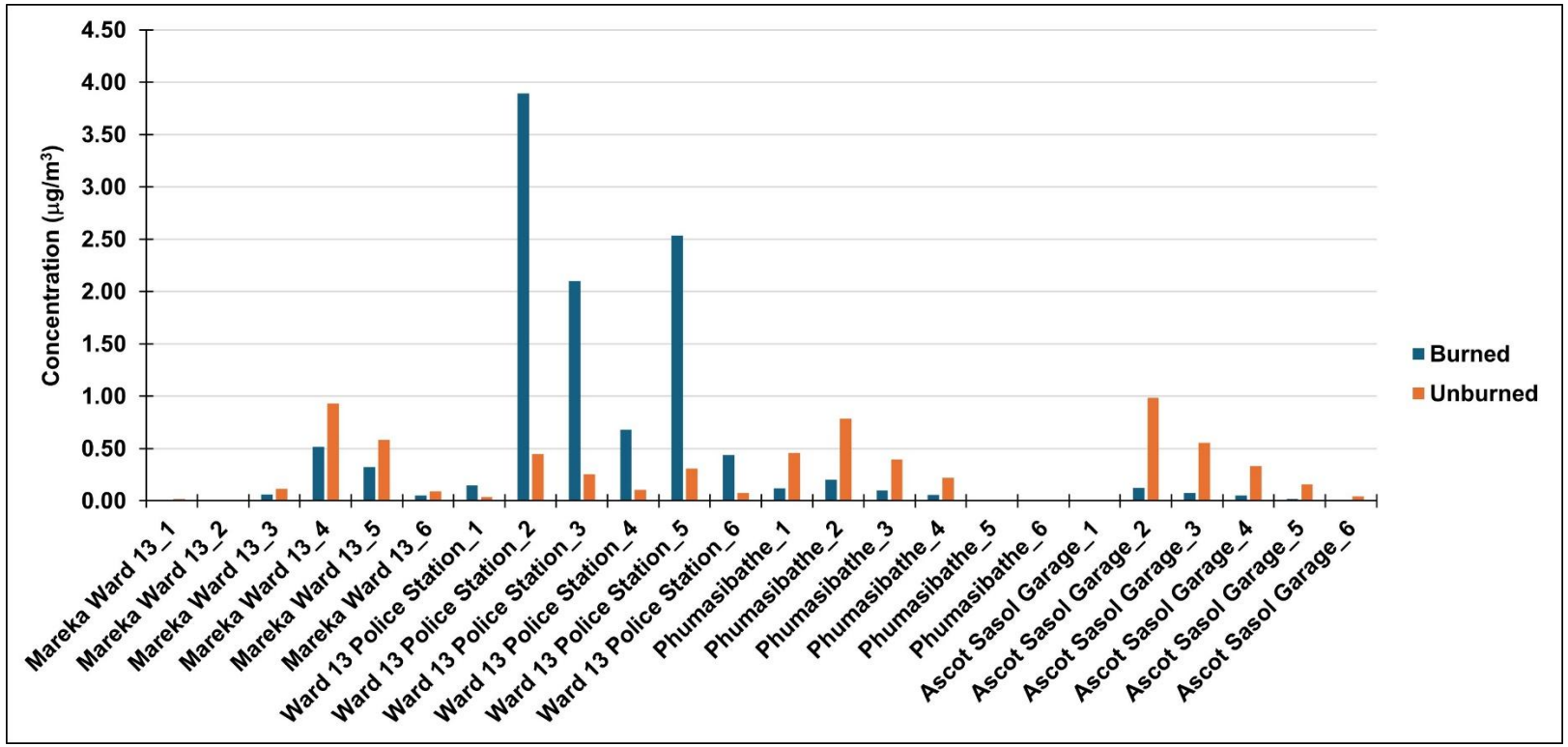


Figure 4-16: Simulated 5-day mean ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 1 (1-hour averages).

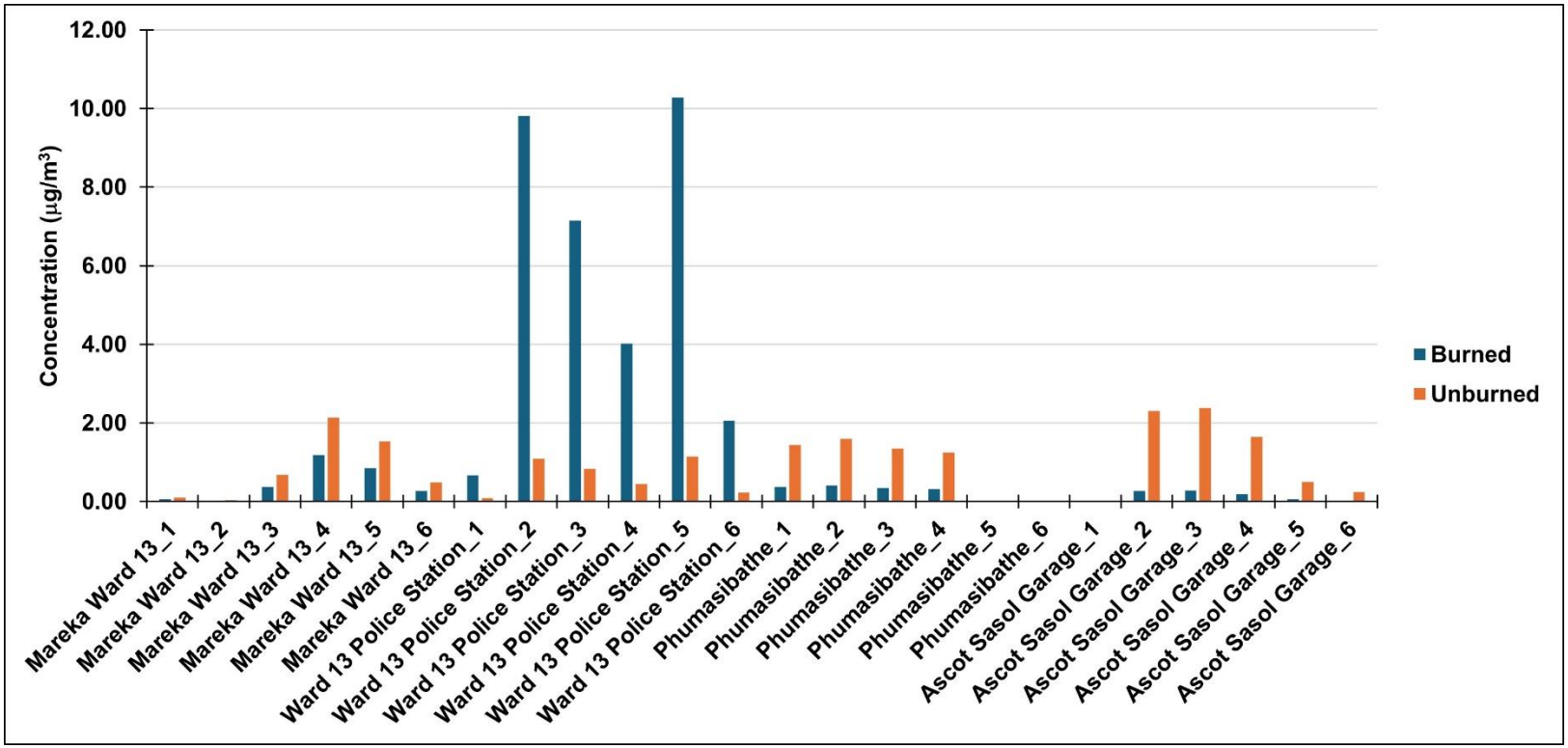


Figure 4-17: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 1 (5-days).

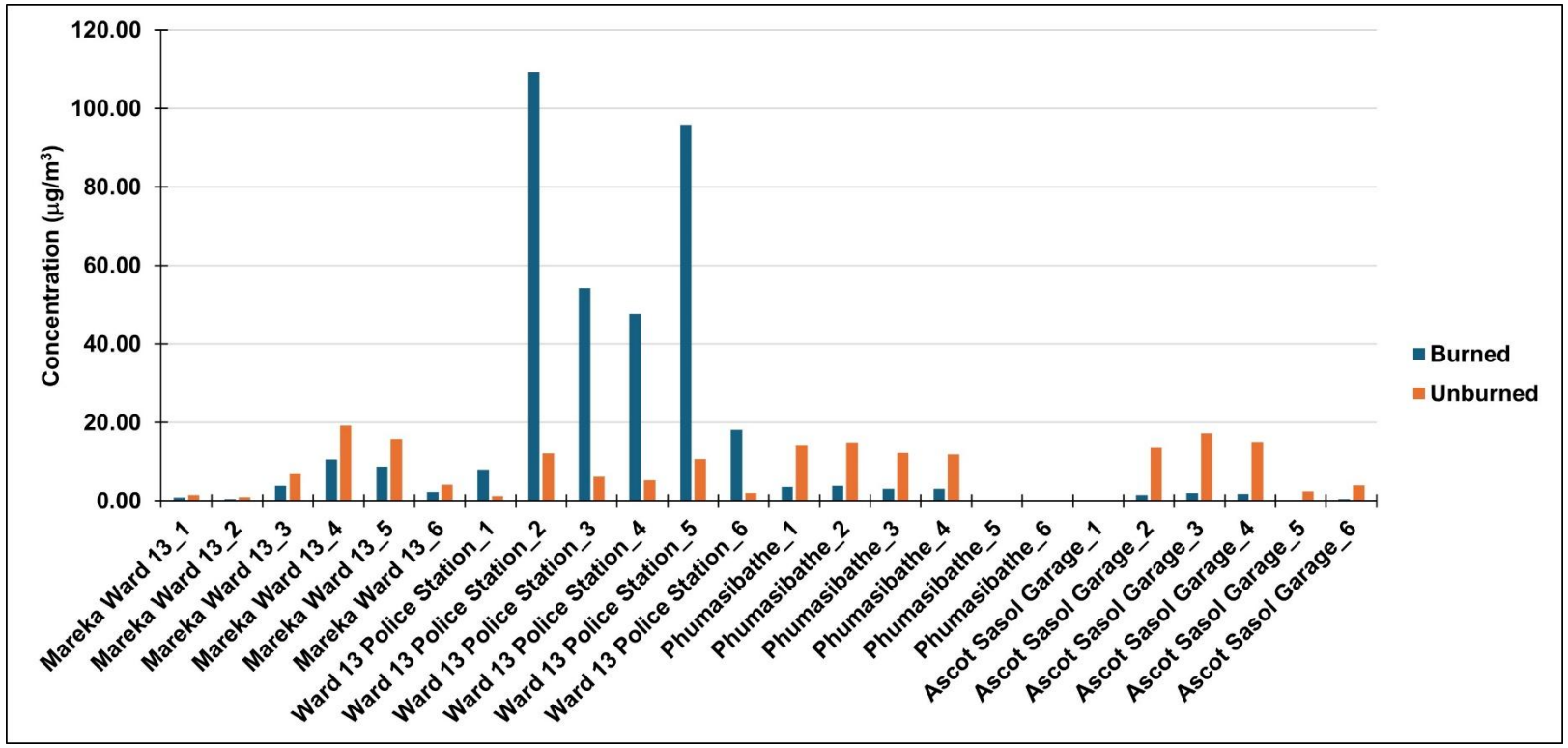


Figure 4-18: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 1 (5-days).

4.2.1.3 Sulphur Dioxide (SO_2)

Figure 4-19 illustrates the simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 1 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 0.05 $\mu g/m^3$ and 0.02 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for an annual time average is 50 $\mu g/m^3$.

Figure 4-20 illustrates the simulated maximum 24-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 1. Maximum 24-hour concentrations of 0.20 $\mu g/m^3$ and 0.05 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 24-hour time average is 125 $\mu g/m^3$.

Figure 4-21 illustrates the simulated maximum 1-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 1. Maximum 1-hour concentrations of 2.30 $\mu g/m^3$ and 0.40 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Table 4-3 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-22 to 4-24 is a graphical representation of Table 4-3.

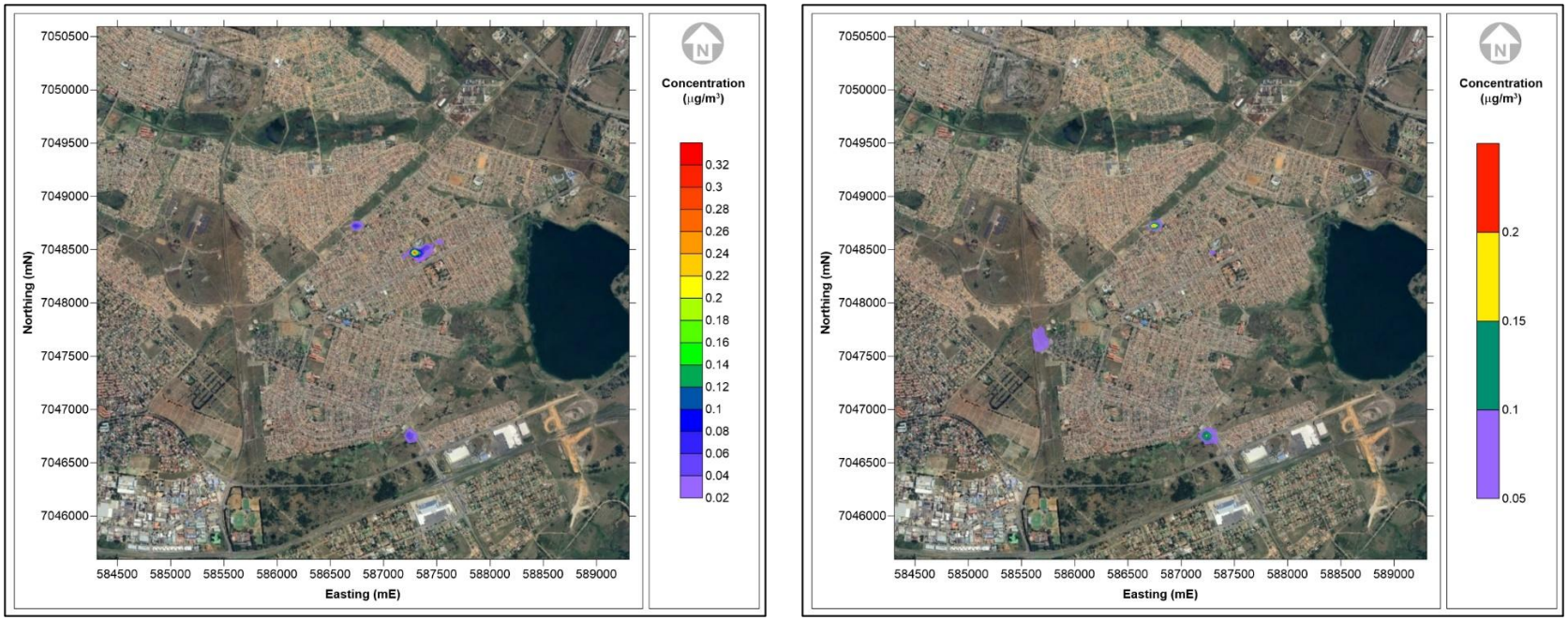


Figure 4-19 Simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 1 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

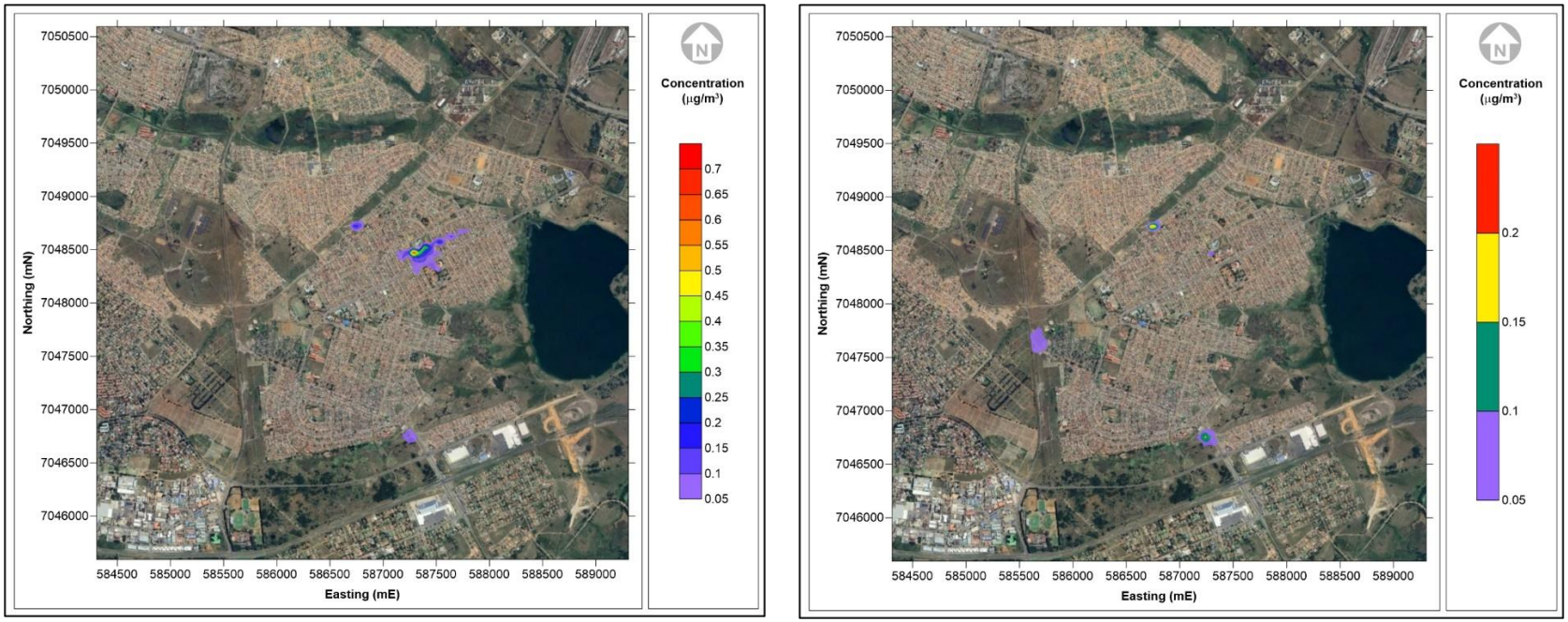


Figure 4-20: Simulated maximum 24-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

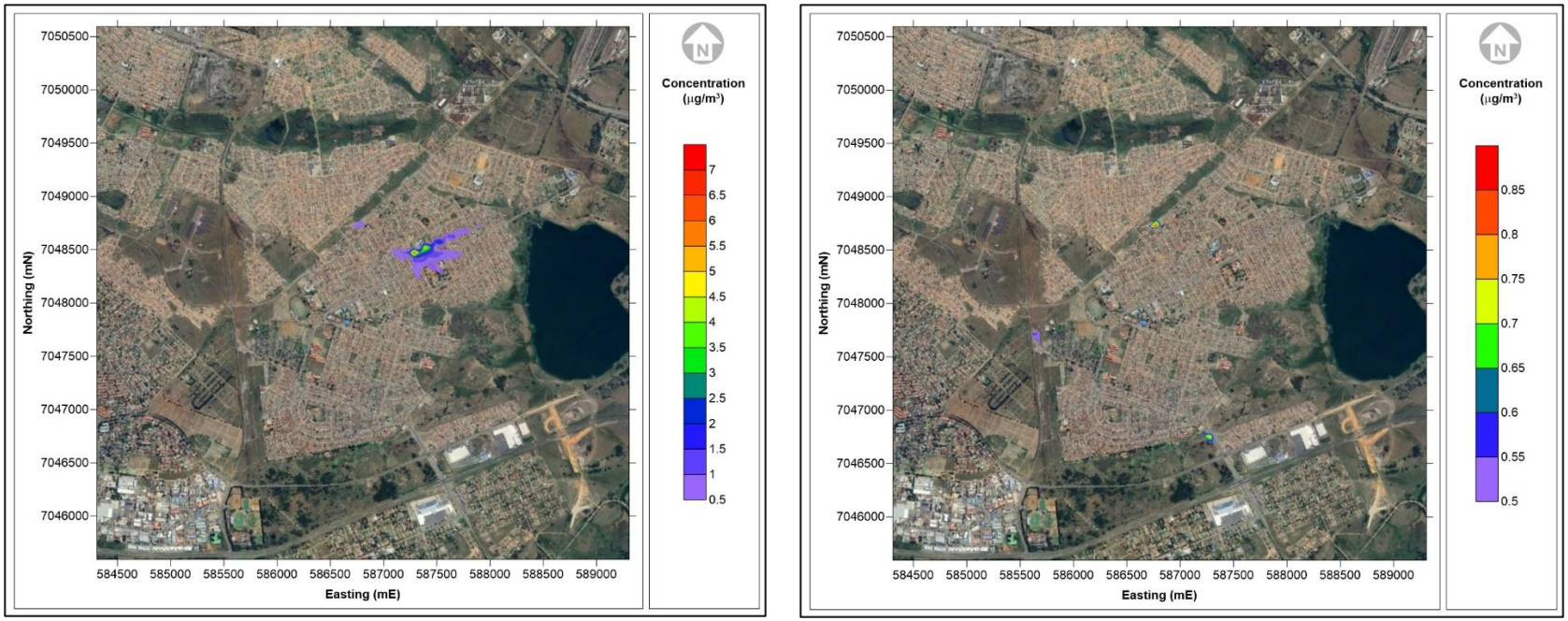


Figure 4-21: Simulated maximum 1-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-3: Simulated ambient SO_2 concentrations at the sensitive receptors for Campaign 1.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.000	0.0004	0.002	0.002	0.032	0.035
Mareka Ward 13_2	0.000	0.0002	0.001	0.001	0.021	0.023
Mareka Ward 13_3	0.002	0.0026	0.014	0.016	0.149	0.164
Mareka Ward 13_4	0.020	0.0218	0.045	0.050	0.407	0.448
Mareka Ward 13_5	0.012	0.0136	0.032	0.036	0.336	0.369
Mareka Ward 13_6	0.002	0.0021	0.010	0.011	0.087	0.096
Ward 13 Police Station_1	0.003	0.0008	0.014	0.002	0.171	0.026
Ward 13 Police Station_2	0.084	0.0104	0.211	0.025	2.345	0.281
Ward 13 Police Station_3	0.045	0.0059	0.154	0.019	1.164	0.142
Ward 13 Police Station_4	0.015	0.0024	0.086	0.010	1.024	0.123
Ward 13 Police Station_5	0.055	0.0072	0.221	0.026	2.058	0.247
Ward 13 Police Station_6	0.010	0.0018	0.044	0.005	0.389	0.047
Phumasibathe_1	0.003	0.0095	0.008	0.030	0.076	0.295
Phumasibathe_2	0.004	0.0163	0.008	0.033	0.079	0.308
Phumasibathe_3	0.002	0.0082	0.007	0.028	0.065	0.253
Phumasibathe_4	0.001	0.0046	0.007	0.026	0.063	0.245
Phumasibathe_5	0.000	0.0001	0.001	0.000	0.006	0.002
Phumasibathe_6	0.000	0.0001	0.000	0.000	0.005	0.002
Ascot Sasol Garage_1	0.000	0.0000	0.000	0.000	0.001	0.001
Ascot Sasol Garage_2	0.014	0.0212	0.033	0.050	0.194	0.292
Ascot Sasol Garage_3	0.008	0.0120	0.034	0.052	0.248	0.373
Ascot Sasol Garage_4	0.005	0.0072	0.024	0.035	0.216	0.324
Ascot Sasol Garage_5	0.002	0.0035	0.007	0.011	0.035	0.053
Ascot Sasol Garage_6	0.001	0.0009	0.004	0.005	0.058	0.086

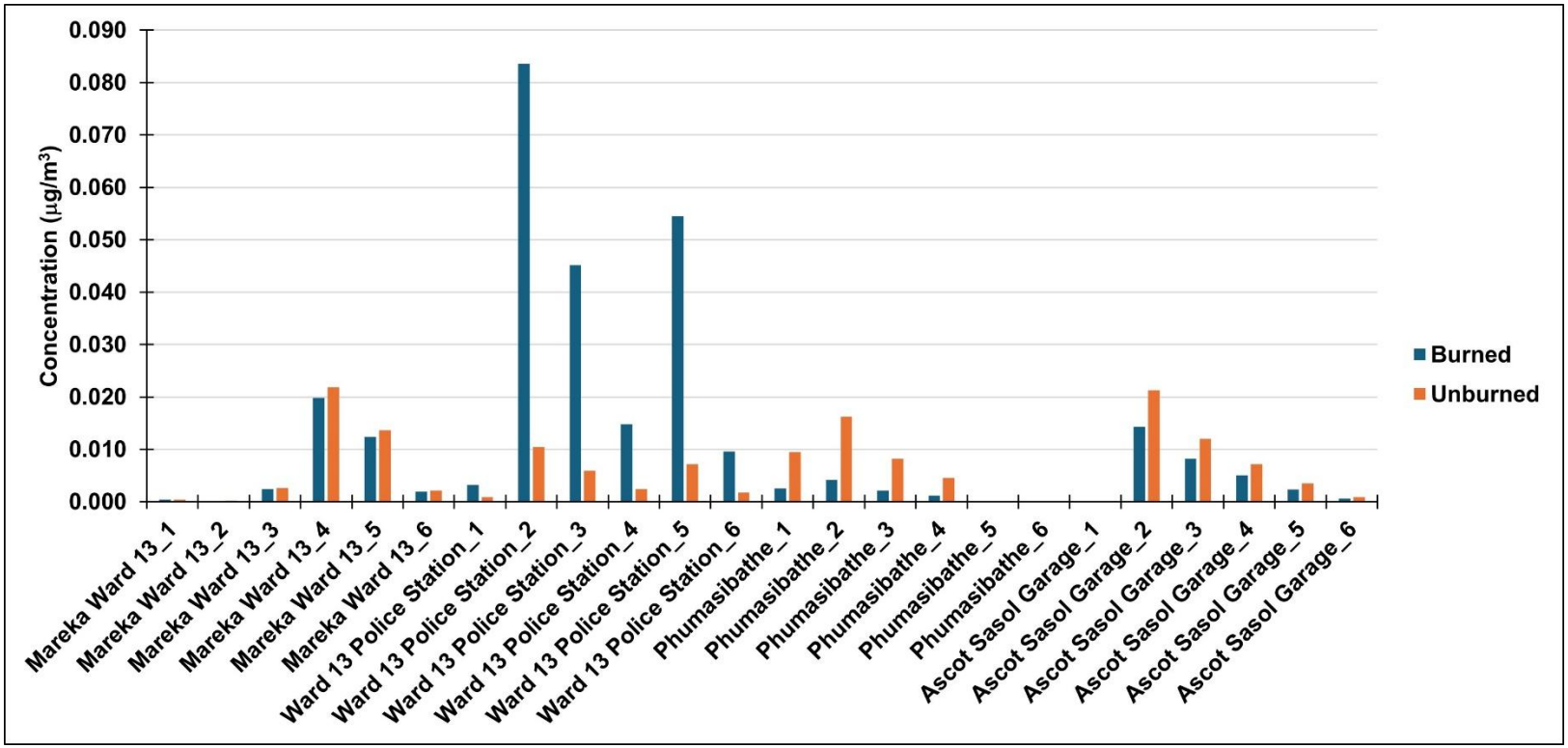


Figure 4-22: Simulated 5-day mean ambient SO_2 concentrations at the sensitive receptors for Campaign 1 (1-hour averages).

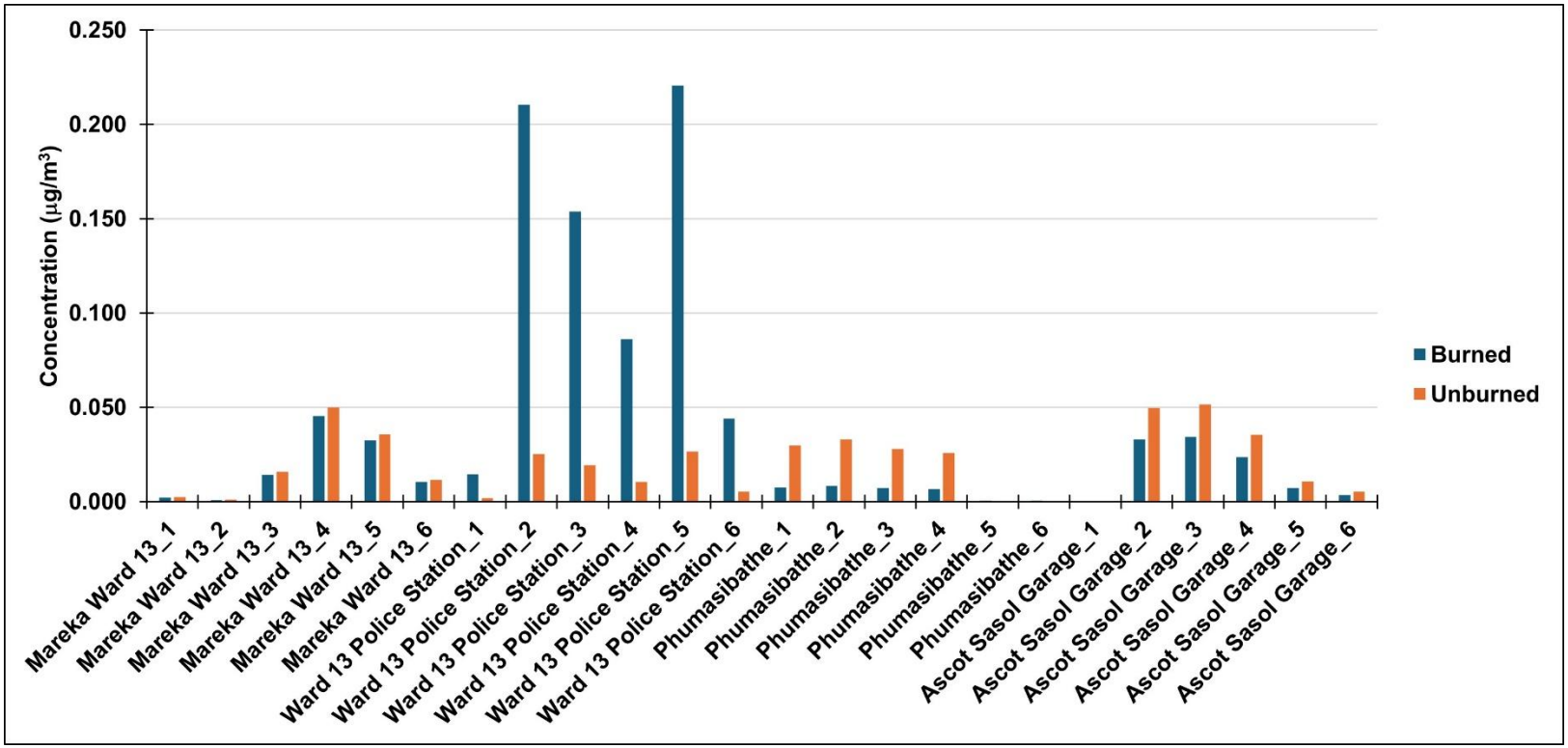


Figure 4-23: Simulated maximum 24-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 1 (5-days).

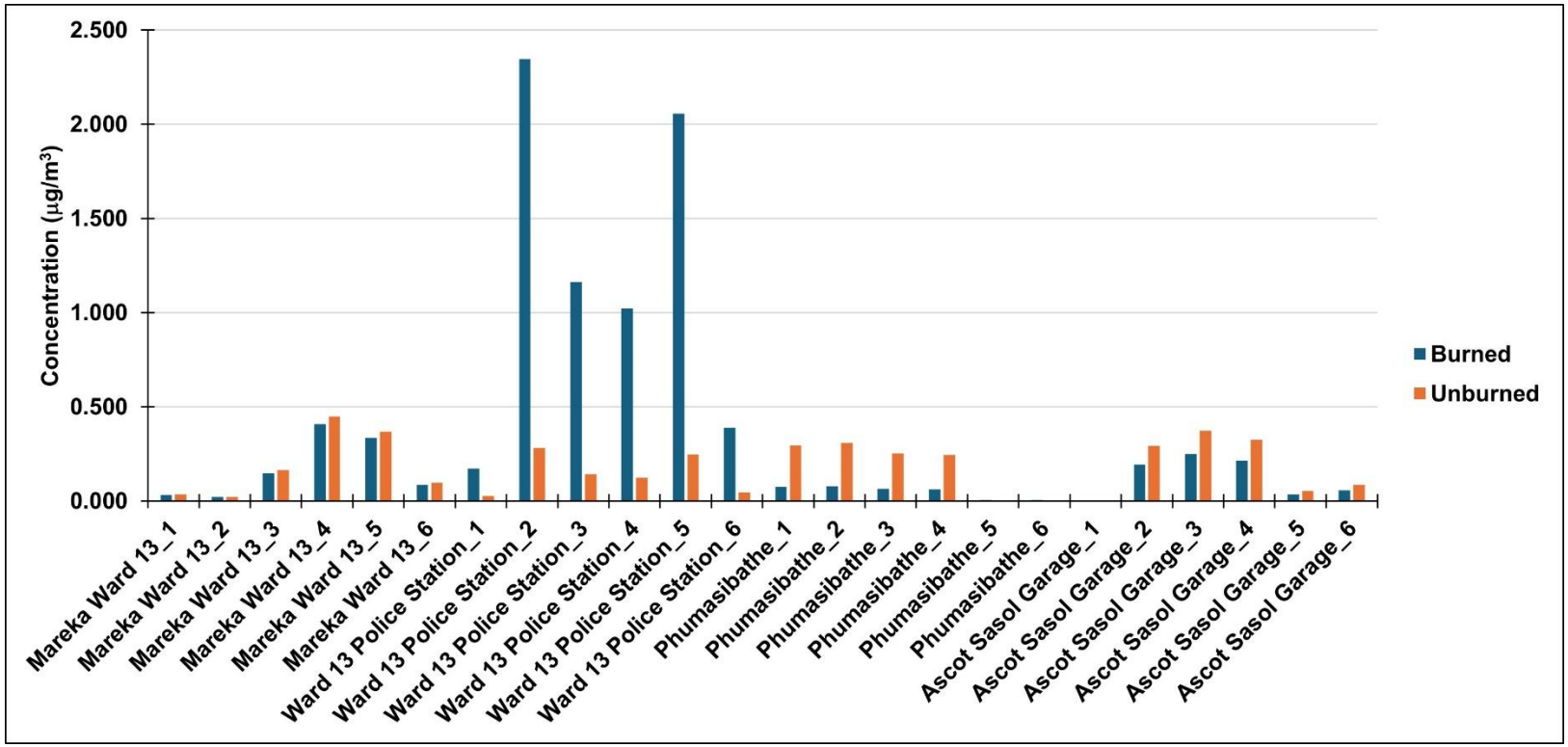


Figure 4-24: Simulated maximum 1-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 1 (5-days).

4.2.1.4 Nitrogen (NO_2)

Figure 4-25 illustrates the simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 1 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.20 $\mu g/m^3$ and 0.10 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-26 illustrates the simulated maximum 1-hour ambient NO_2 concentrations over the Sharpeville region for Campaign 1. Maximum 1-hour concentrations of 11.2 $\mu g/m^3$ and 2.10 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for a 1-hour time average is 200 $\mu g/m^3$.

Table 4-4 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-27 and 4-28 is a graphical representation of Table 4-4.

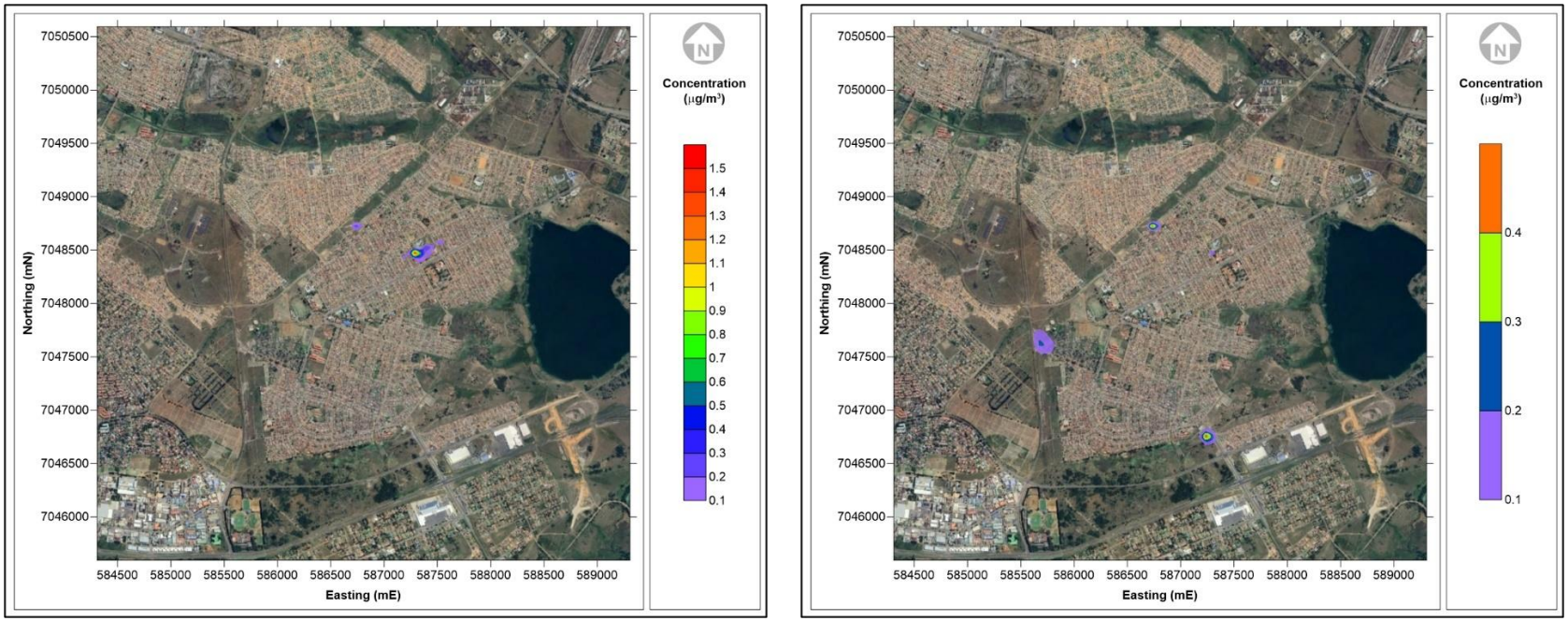


Figure 4-25: Simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 1 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

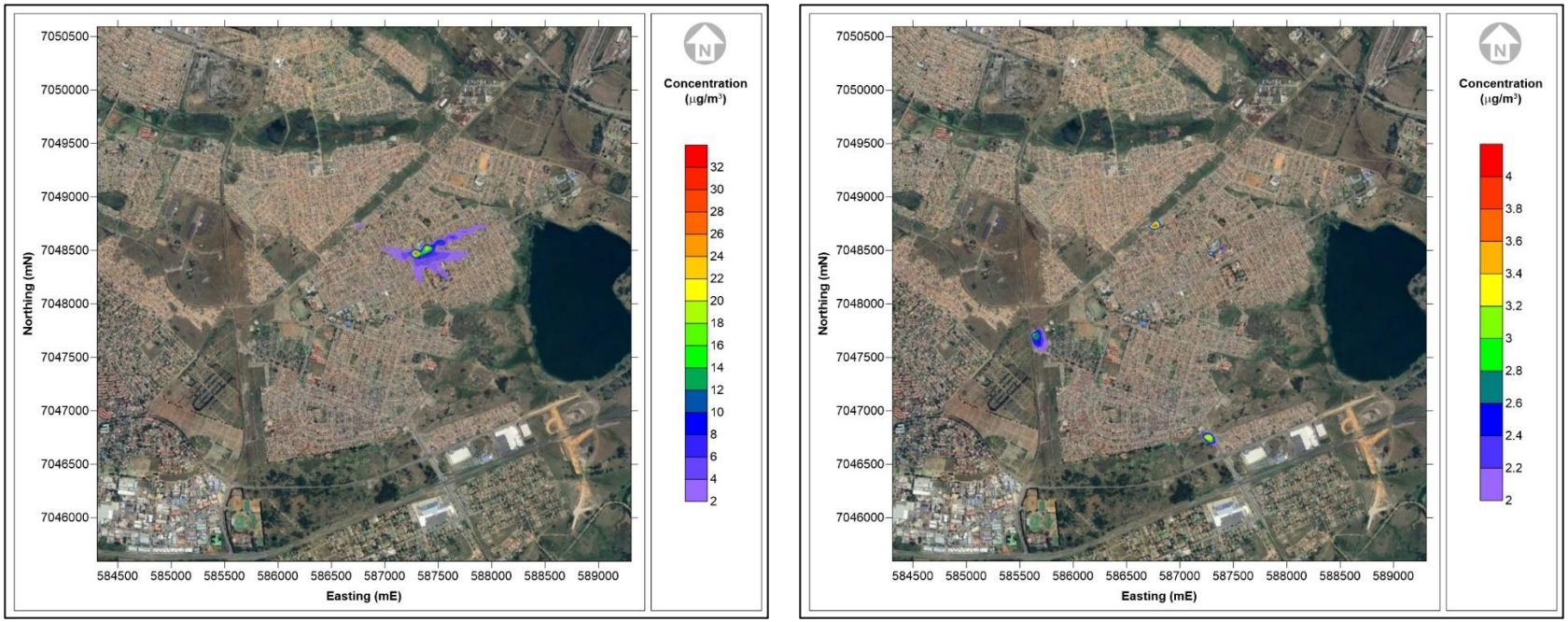


Figure 4-26: Simulated maximum 1-Hour ambient NO_2 concentrations over the Sharpeville region for Campaign 1 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-4: Simulated ambient NO_2 concentrations at the sensitive receptors for Campaign 1.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.001	0.002	0.095	0.165
Mareka Ward 13_2	0.000	0.001	0.063	0.109
Mareka Ward 13_3	0.007	0.012	0.447	0.775
Mareka Ward 13_4	0.059	0.103	1.222	2.118
Mareka Ward 13_5	0.037	0.064	1.007	1.745
Mareka Ward 13_6	0.006	0.010	0.262	0.454
Ward 13 Police Station_1	0.015	0.004	0.823	0.130
Ward 13 Police Station_2	0.401	0.047	11.256	1.266
Ward 13 Police Station_3	0.216	0.027	5.581	0.641
Ward 13 Police Station_4	0.070	0.011	4.914	0.553
Ward 13 Police Station_5	0.261	0.032	9.876	1.111
Ward 13 Police Station_6	0.045	0.008	1.865	0.210
Phumasibathe_1	0.013	0.048	0.379	1.492
Phumasibathe_2	0.021	0.082	0.395	1.556
Phumasibathe_3	0.011	0.041	0.325	1.279
Phumasibathe_4	0.006	0.023	0.314	1.236
Phumasibathe_5	0.001	0.000	0.029	0.008
Phumasibathe_6	0.001	0.000	0.025	0.007
Ascot Sasol Garage_1	0.000	0.000	0.004	0.004
Ascot Sasol Garage_2	0.015	0.102	0.194	1.400
Ascot Sasol Garage_3	0.009	0.058	0.248	1.789
Ascot Sasol Garage_4	0.006	0.034	0.216	1.554
Ascot Sasol Garage_5	0.002	0.017	0.035	0.254
Ascot Sasol Garage_6	0.001	0.004	0.058	0.415

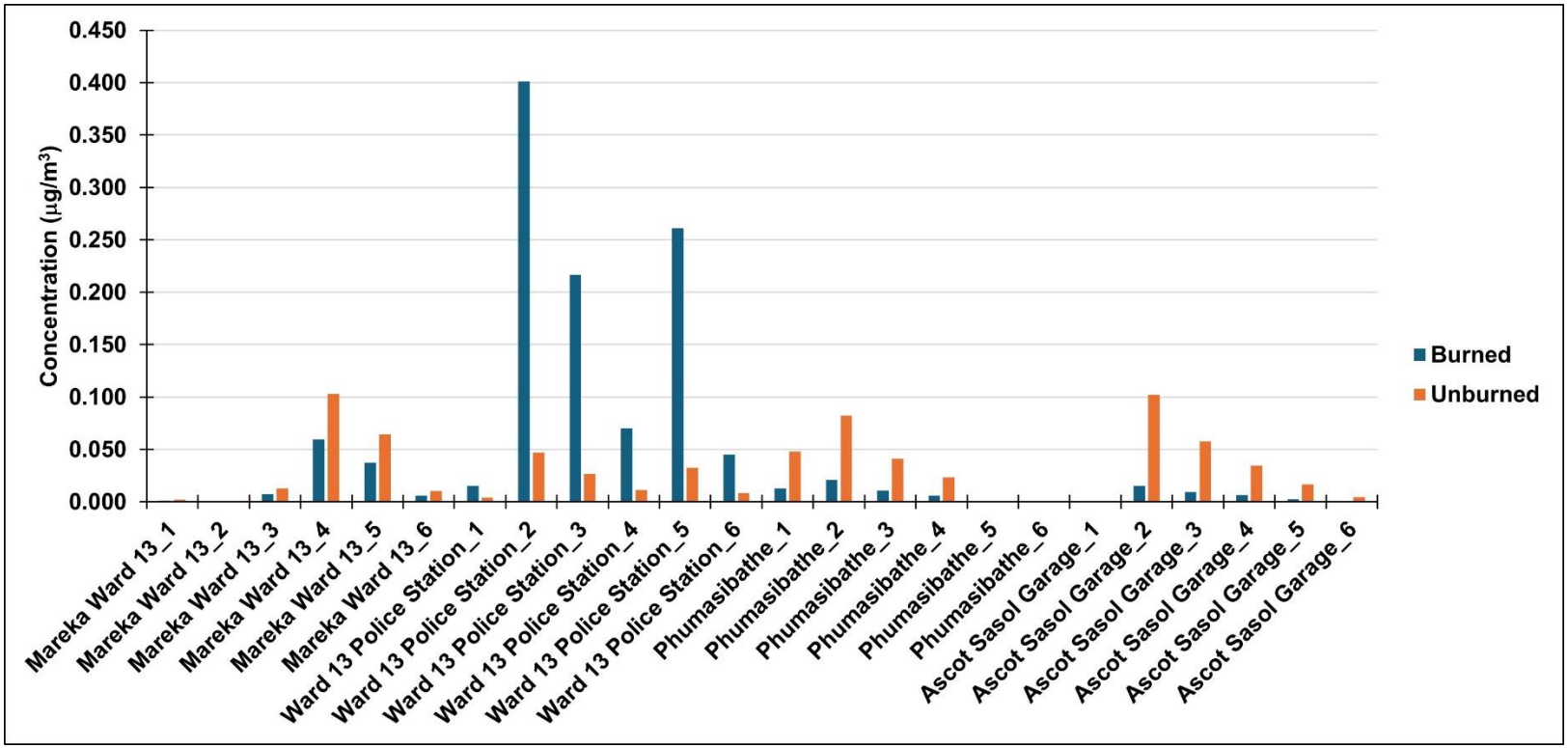


Figure 4-27: Simulated 5-day mean ambient NO_2 concentrations at the sensitive receptors for Campaign 1 (1-hour averages).

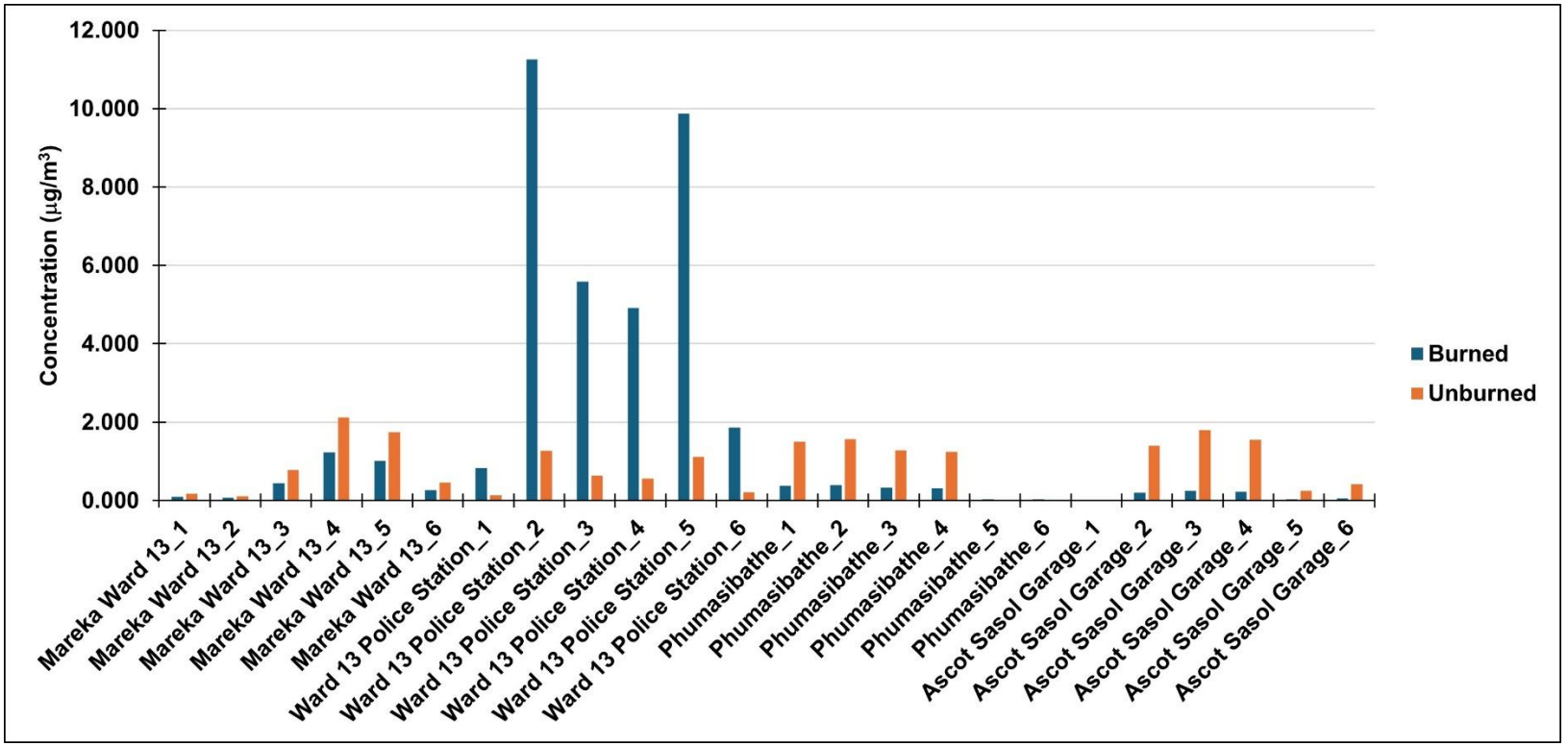


Figure 4-28: Simulated maximum 1-Hour ambient NO_2 concentrations at the sensitive receptors for Campaign 1 (5-days).

4.2.2 CAMPAIGN 2

Figure 4-29 is a map detailing the five waste collection sites during campaign 2, whilst Figure 4-30 is indicative of the three sites where waste burning practices were conducted.

Figure 4-29: Location of the waste collection sites during Campaign 2.

Figure 4-30: Location of the waste burning sites during Campaign 2.

Figures 4-31 to 4-33 are detailed maps of the sites where waste burning practices were conducted, as well as the location of sensitive receptors around the burning sites.

Figure 3-31: Mareka Ward 13 waste burning site and sensitive receptors near the site.

Figure 3-32: Ward 12/13 Police Station waste burning site and sensitive receptors near the site.

Figure 3-33: Ascot Sasol Garage waste burning site and sensitive receptors near the site.

4.2.2.1 Particulate Matter (PM_{10})

Figure 4-34 illustrates the simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 2 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 9.90 $\mu g/m^3$ and 1.20 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-35 illustrates the simulated maximum 24-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 2. Maximum 24-hour concentrations of 30.40 $\mu g/m^3$ and 4.40 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for a 24-hour time average is 75 $\mu g/m^3$.

Figure 4-36 illustrates the simulated maximum 1-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 2. Maximum 1-hour concentrations of 305.00 $\mu g/m^3$

and 33.90 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No PM_{10} NAAQS standard exist for a 1-hour time average.

Table 4-5 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-37 to 4-39 is a graphical representation of Table 4-5.

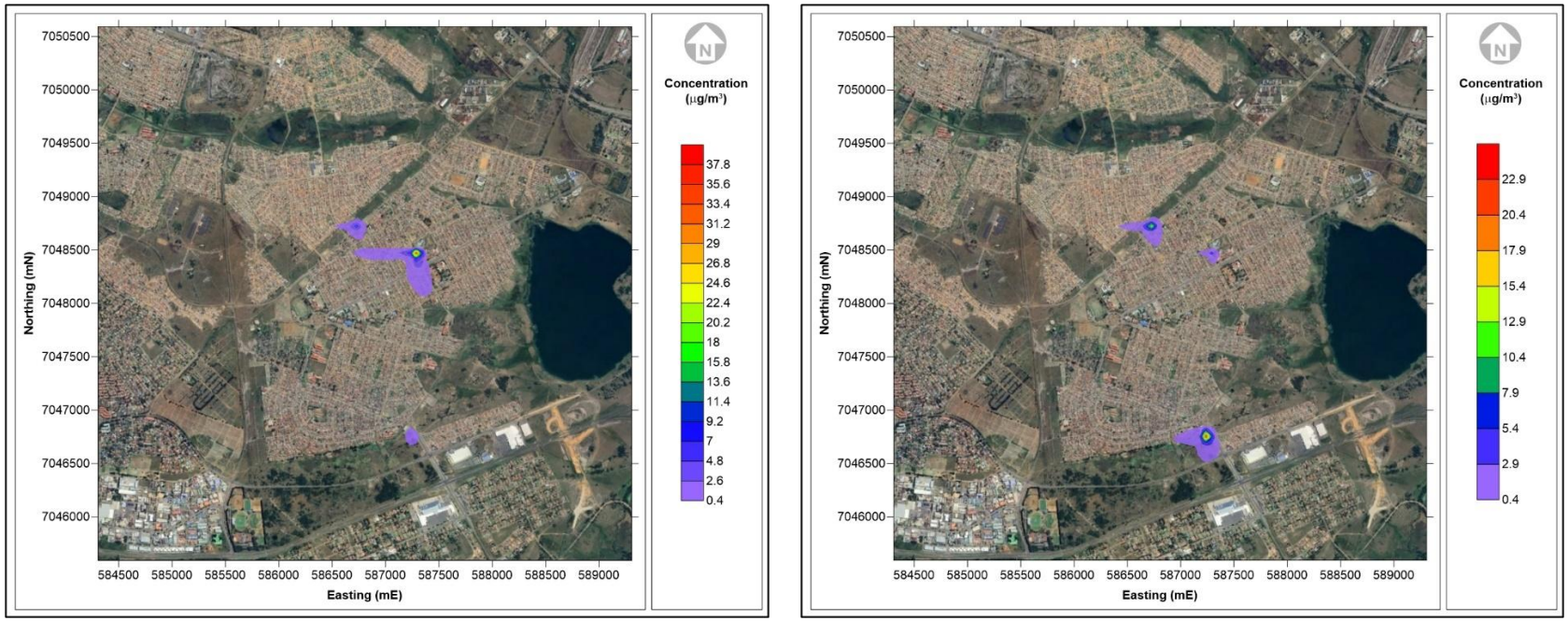


Figure 4-34: Simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 2 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

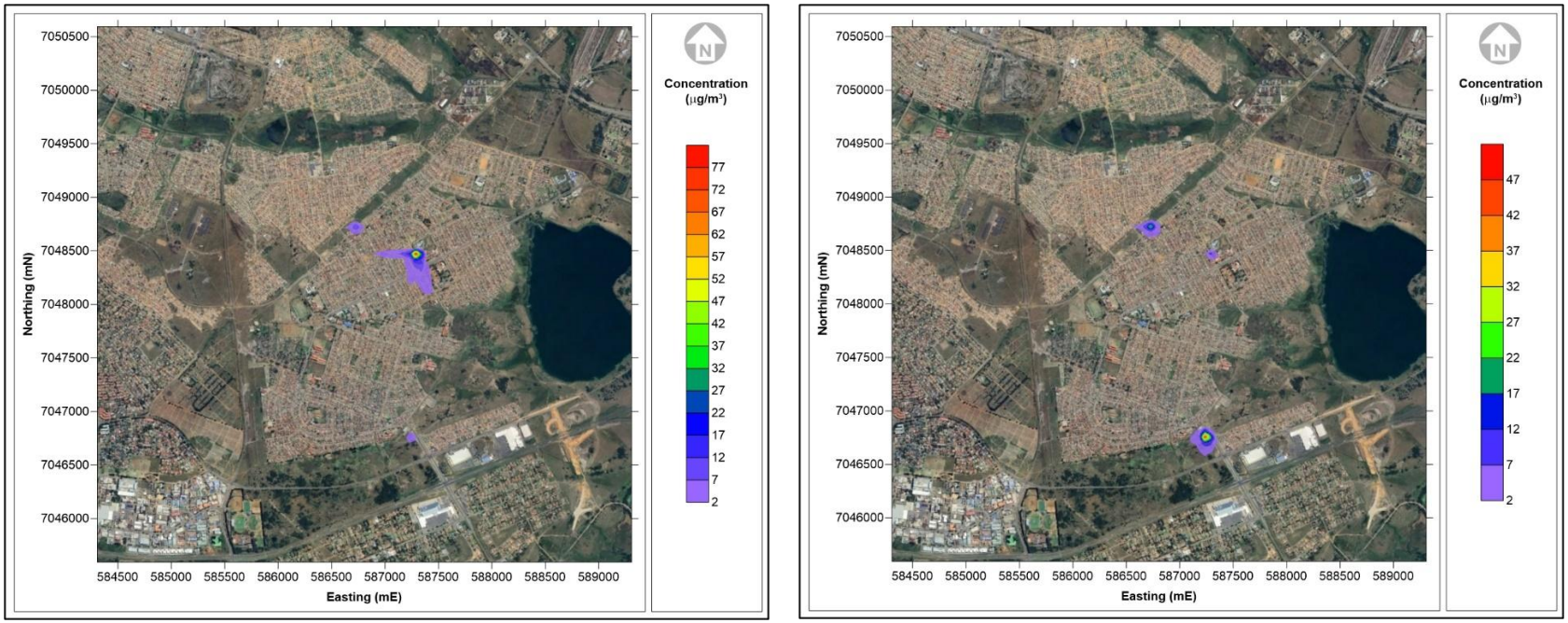


Figure 4-35: Simulated maximum 24-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

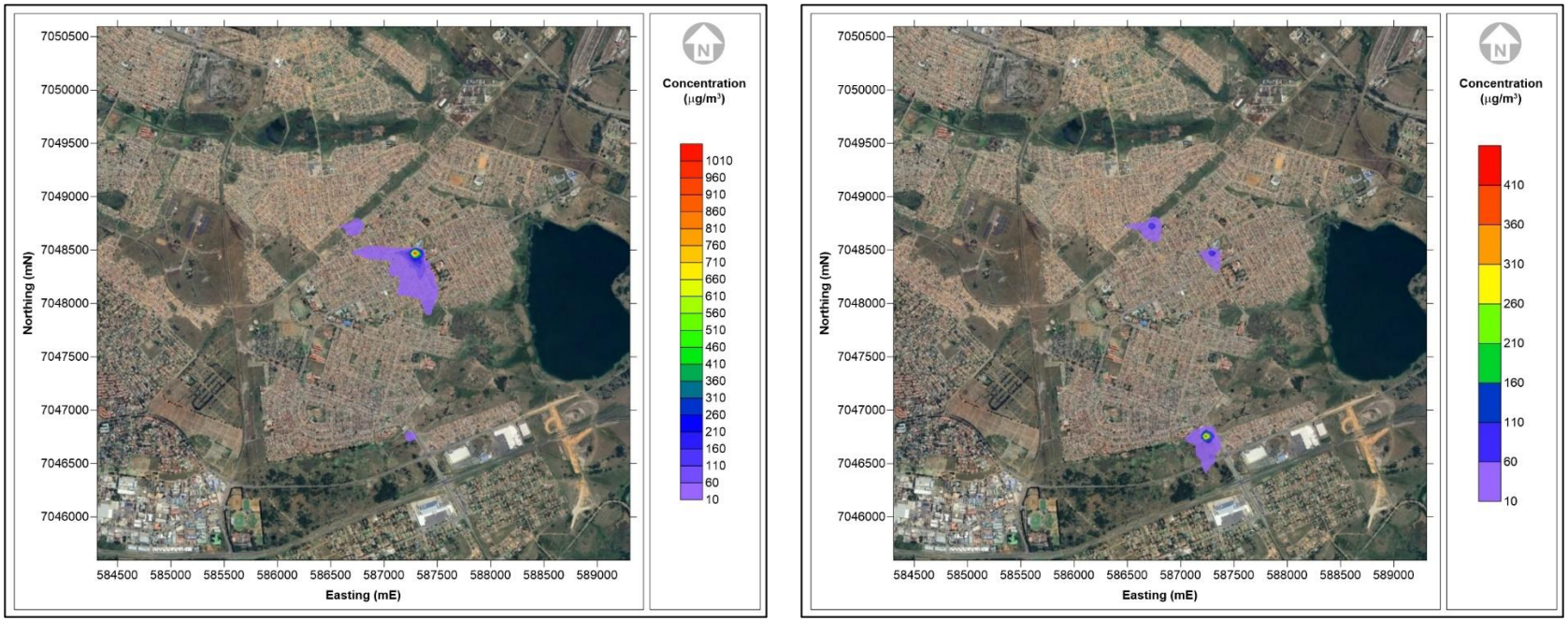


Figure 4-36: Simulated maximum 1-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-5: Simulated ambient PM_{10} concentrations at the sensitive receptors for Campaign 2.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.01	0.02	0.04	0.08	0.78	1.45
Mareka Ward 13_2	0.03	0.05	0.06	0.11	0.63	1.18
Mareka Ward 13_3	0.83	1.53	1.64	3.04	12.26	22.79
Mareka Ward 13_4	0.45	0.83	1.45	2.70	8.03	14.92
Mareka Ward 13_5	1.06	1.97	2.38	4.41	17.37	32.28
Mareka Ward 13_6	0.53	0.98	1.14	2.11	8.42	15.64
Ward 13 Police Station_1	1.71	0.20	8.20	0.97	105.50	11.78
Ward 13 Police Station_2	6.60	0.75	21.15	2.41	305.08	33.96
Ward 13 Police Station_3	9.92	1.12	30.41	3.45	288.28	32.15
Ward 13 Police Station_4	5.04	0.58	14.29	1.61	140.53	15.62
Ward 13 Police Station_5	6.17	0.70	13.73	1.54	124.31	13.82
Ward 13 Police Station_6	2.16	0.26	8.15	0.98	187.01	20.80
Ascot Sasol Garage_1	0.02	0.01	0.09	0.04	1.62	1.03
Ascot Sasol Garage_2	0.08	0.48	0.35	2.64	1.75	15.75
Ascot Sasol Garage_3	0.07	0.44	0.27	1.89	1.48	13.28
Ascot Sasol Garage_4	0.06	0.28	0.17	0.90	1.20	10.81
Ascot Sasol Garage_5	0.04	0.25	0.08	0.55	1.27	7.34
Ascot Sasol Garage_6	0.08	0.56	0.13	1.15	1.54	8.00

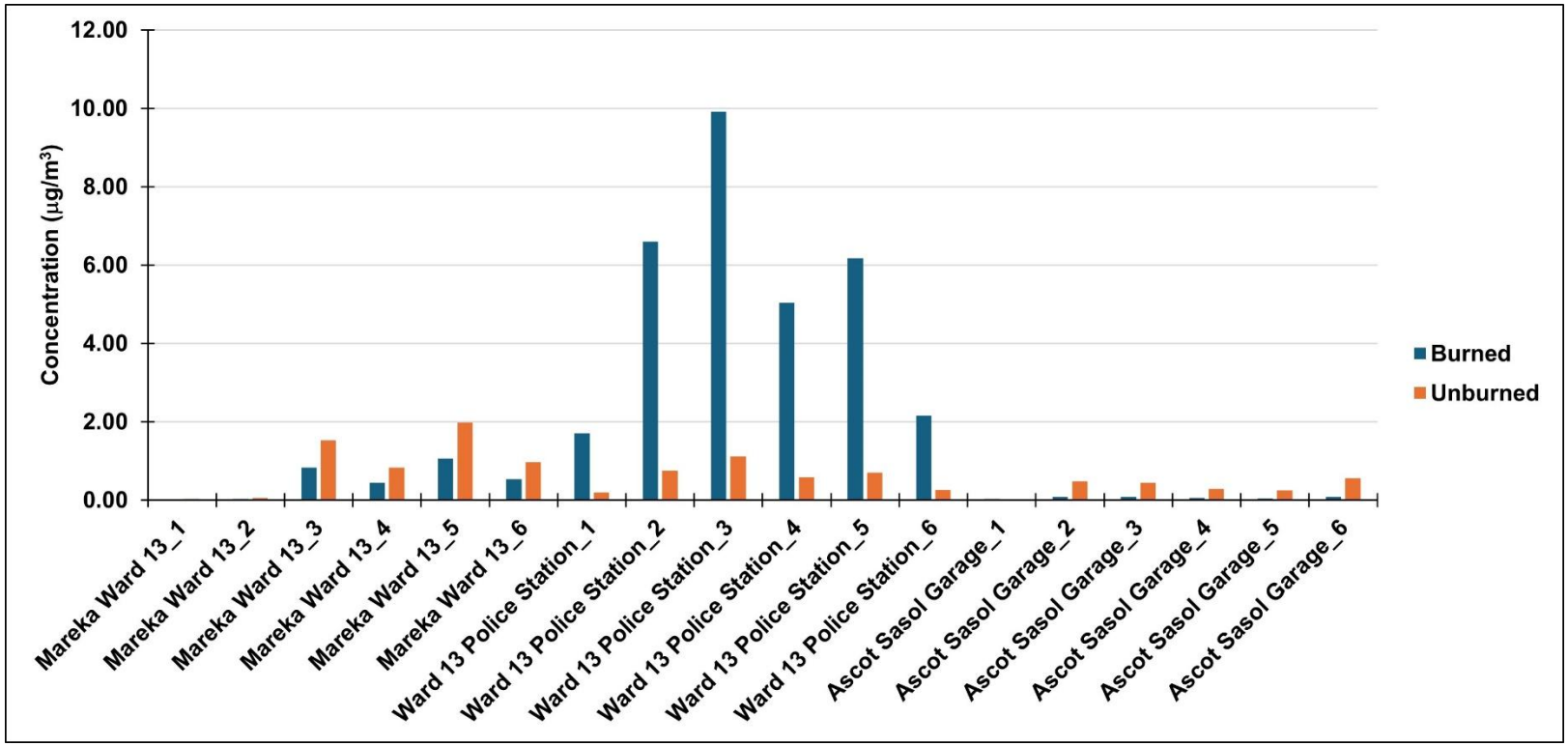


Figure 4-37: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 2 (1-hour averages).

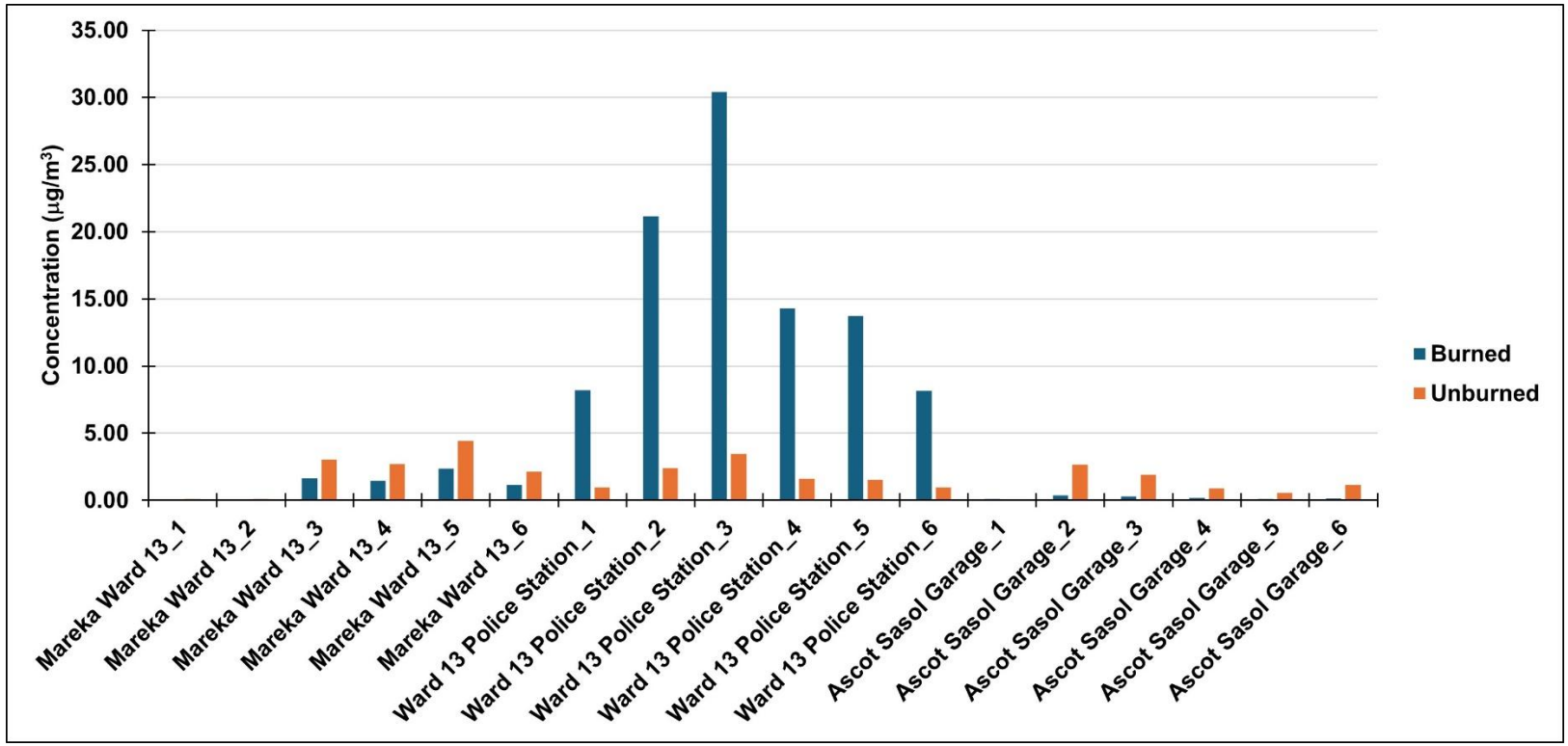


Figure 4-38: Simulated maximum 24-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 2 (5-days).

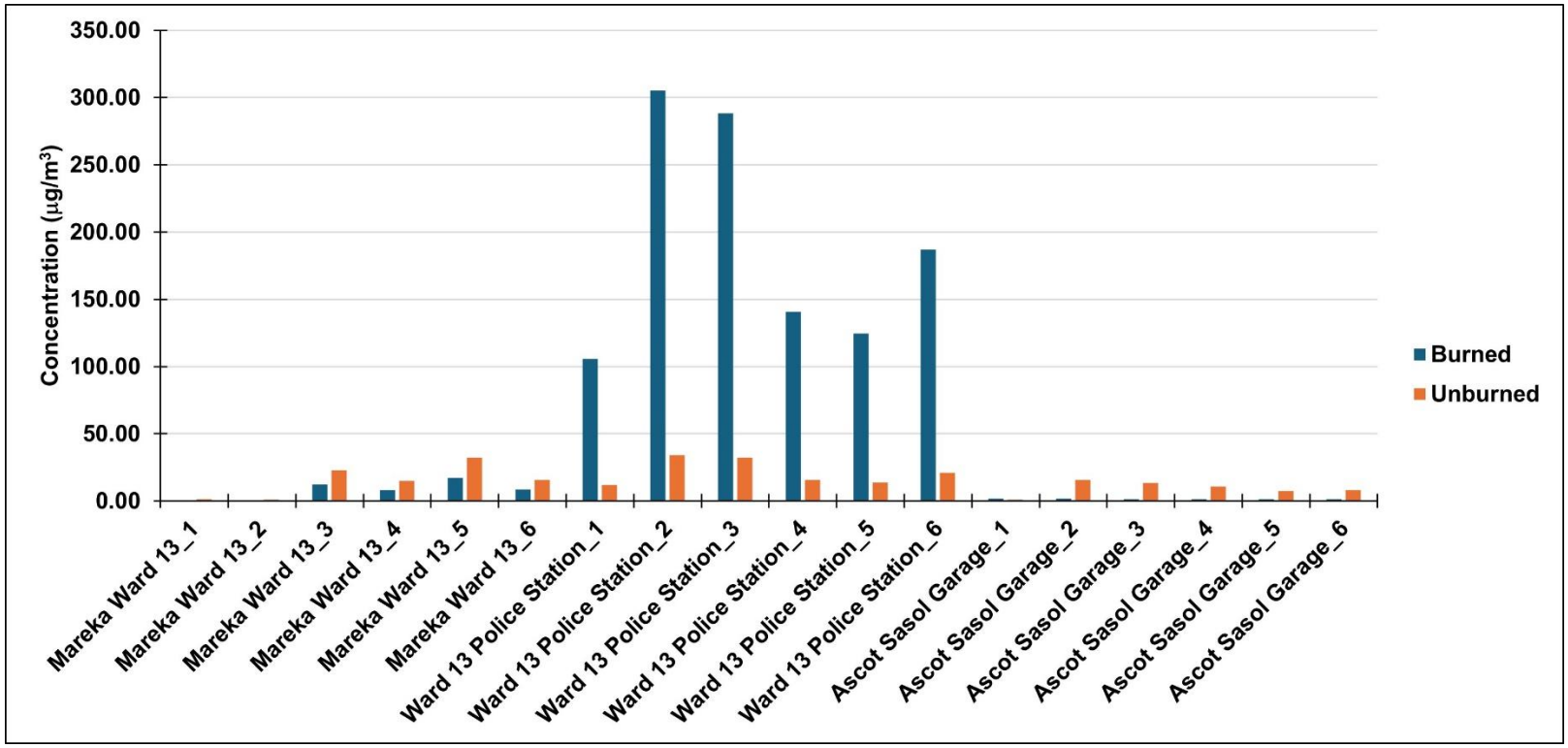


Figure 4-39: Simulated maximum 1-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 2 (5-days).

4.2.2.2 Particulate Matter ($PM_{2.5}$)

Figure 4-40 illustrates the simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 2 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 9.80 $\mu g/m^3$ and 1.90 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for an annual time average is 20 $\mu g/m^3$.

Figure 4-41 illustrates the simulated maximum 24-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 2. Maximum 24-hour concentrations of 30.20 $\mu g/m^3$ and 4.40 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for a 24-hour time average is 40 $\mu g/m^3$.

Figure 4-42 illustrates the simulated maximum 1-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 2. Maximum 1-hour concentrations of 303.00 $\mu g/m^3$ and 33.80 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No $PM_{2.5}$ NAAQS standard exist for a 1-hour time average.

Table 4-6 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-43 to 4-45 is a graphical representation of Table 4-6.

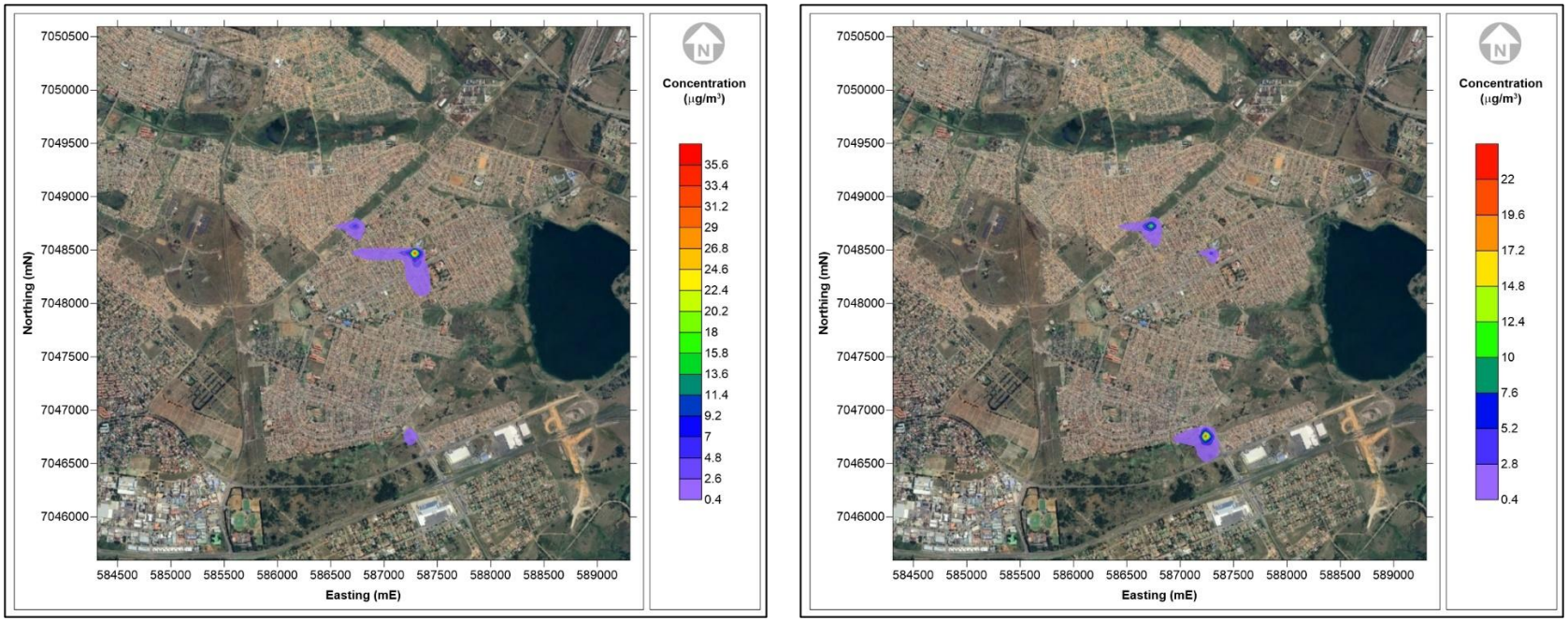


Figure 4-40 Simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 2 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

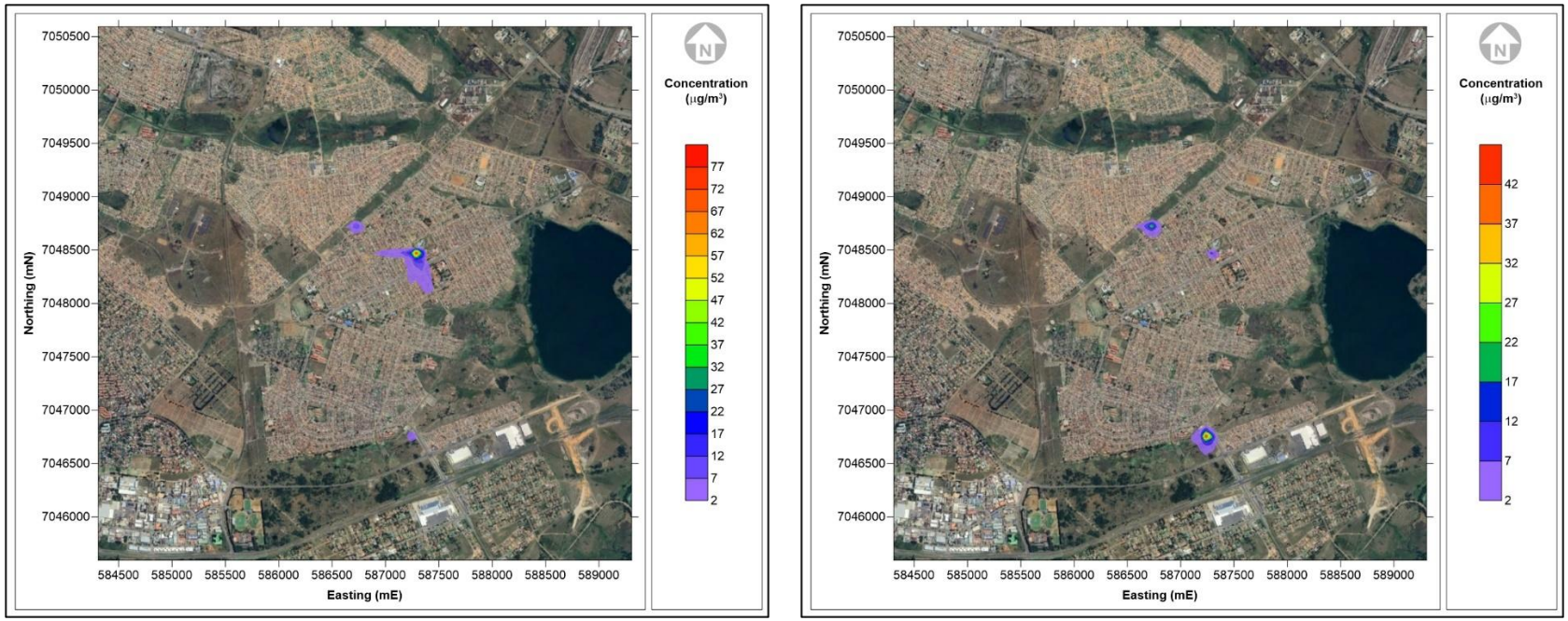


Figure 4-41: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

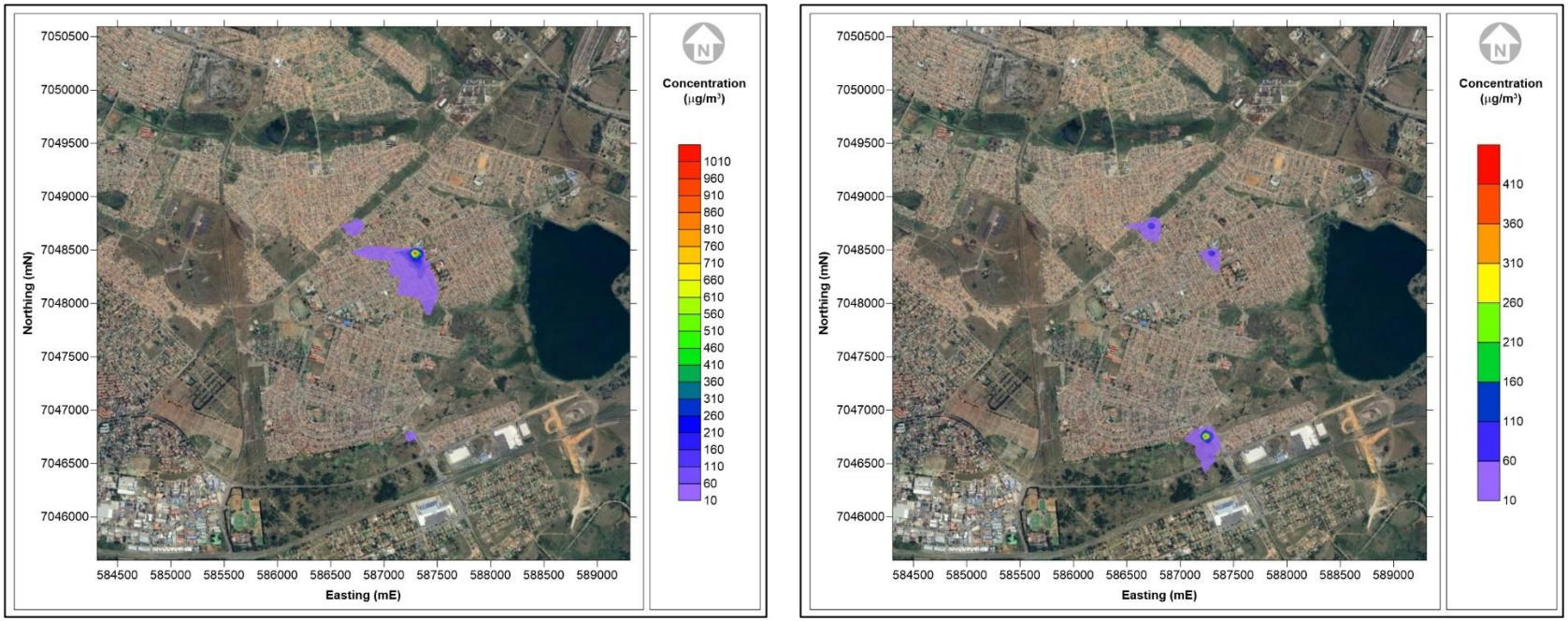


Figure 4-42: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-6: Simulated ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 2.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.01	0.02	0.04	0.08	0.78	1.44
Mareka Ward 13_2	0.03	0.05	0.06	0.11	0.63	1.17
Mareka Ward 13_3	0.82	1.53	1.63	3.03	12.23	22.70
Mareka Ward 13_4	0.44	0.82	1.45	2.68	8.00	14.86
Mareka Ward 13_5	1.06	1.96	2.37	4.40	17.32	32.15
Mareka Ward 13_6	0.53	0.97	1.13	2.11	8.39	15.58
Ward 13 Police Station_1	1.70	0.20	8.17	0.97	105.08	11.74
Ward 13 Police Station_2	6.58	0.74	21.07	2.40	303.88	33.85
Ward 13 Police Station_3	9.88	1.11	30.29	3.44	287.14	32.04
Ward 13 Police Station_4	5.02	0.58	14.23	1.60	139.98	15.57
Ward 13 Police Station_5	6.14	0.70	13.68	1.54	123.82	13.77
Ward 13 Police Station_6	2.15	0.25	8.12	0.97	186.27	20.73
Ascot Sasol Garage_1	0.02	0.01	0.09	0.04	1.61	1.03
Ascot Sasol Garage_2	0.08	0.48	0.35	2.63	1.75	15.68
Ascot Sasol Garage_3	0.07	0.43	0.27	1.88	1.47	13.23
Ascot Sasol Garage_4	0.06	0.28	0.17	0.90	1.20	10.77
Ascot Sasol Garage_5	0.04	0.25	0.08	0.55	1.26	7.31
Ascot Sasol Garage_6	0.08	0.56	0.13	1.15	1.53	7.97

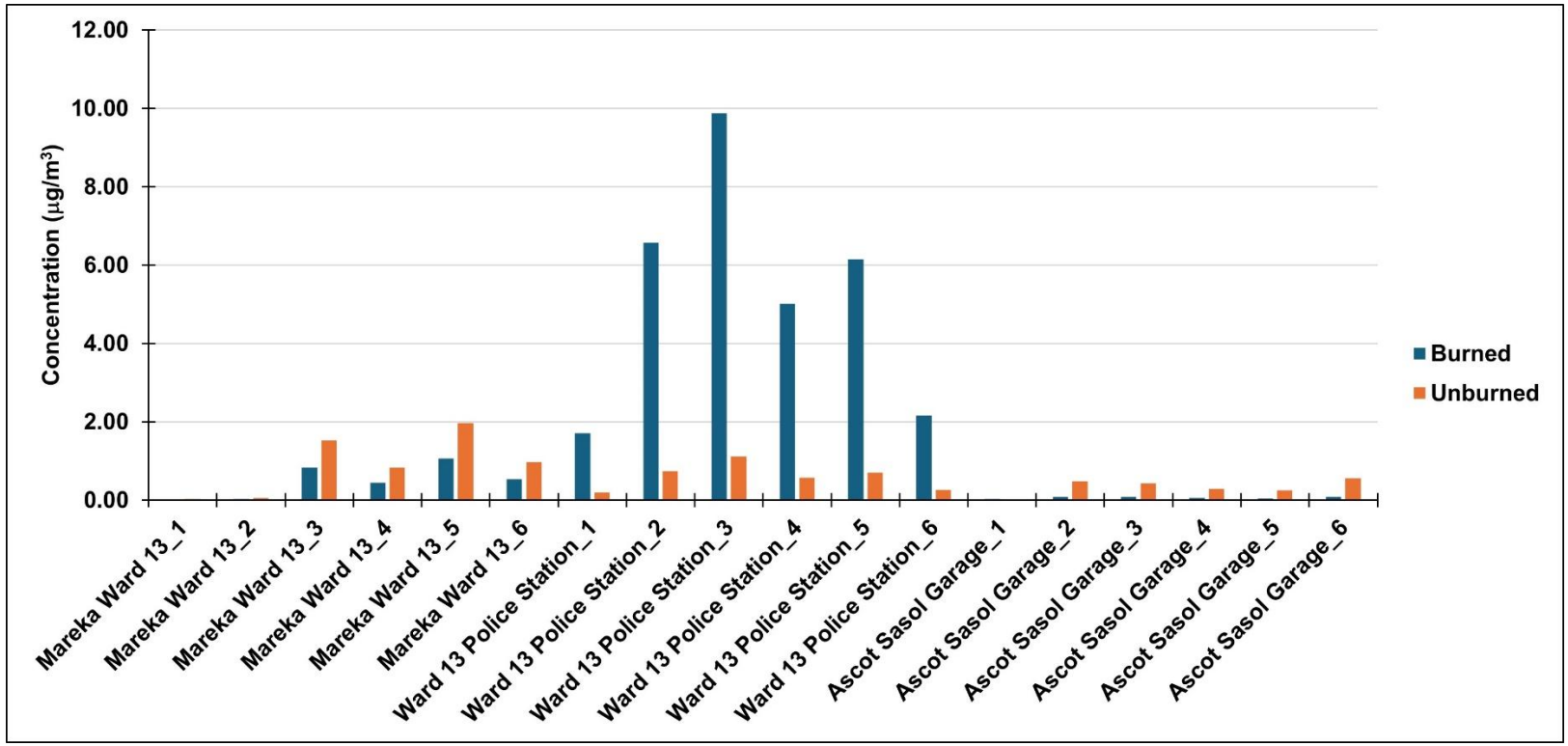


Figure 4-43: Simulated 5-day mean ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 2 (1-hour averages).

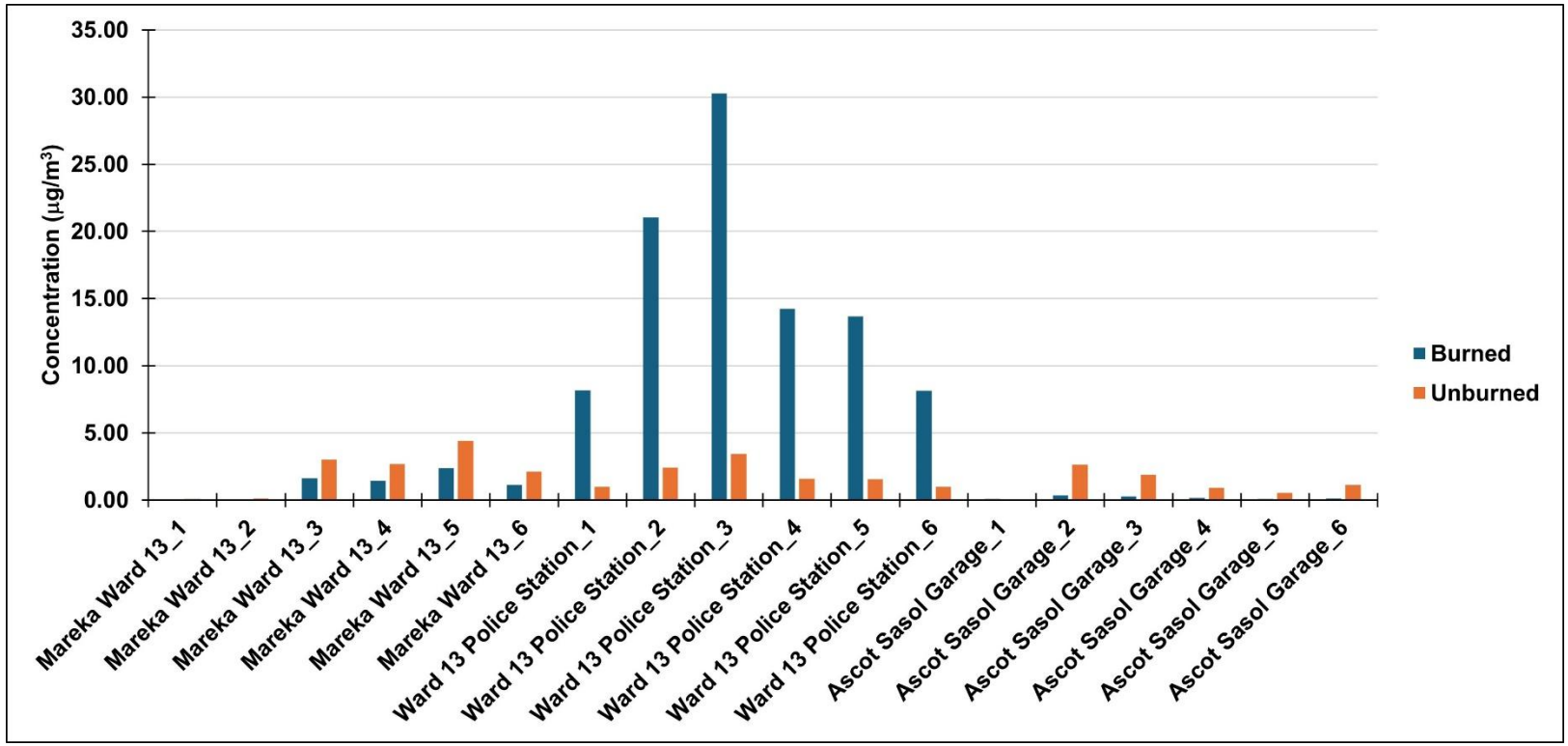


Figure 4-44: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 2 (5-days).

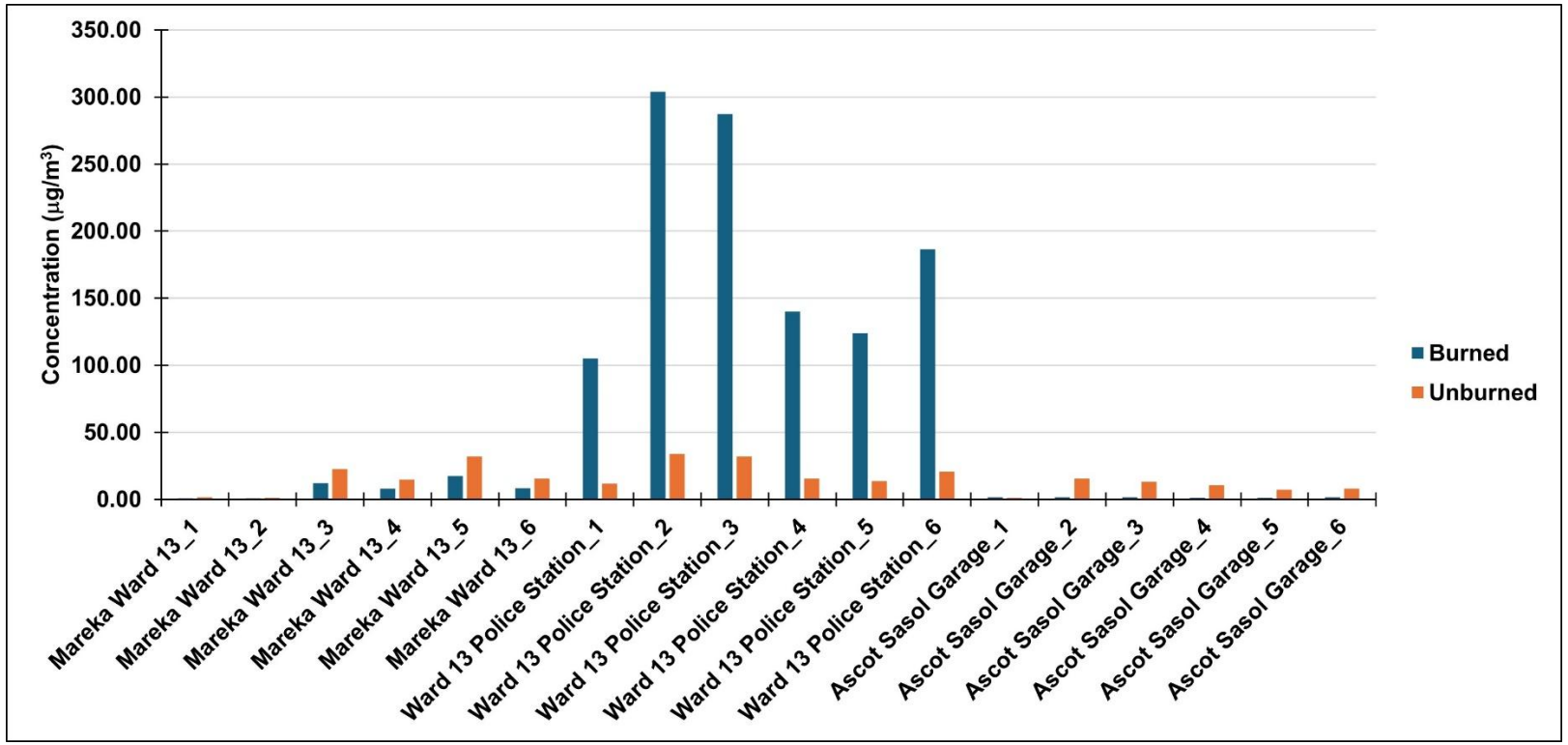


Figure 4-45: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 2 (5-days).

4.2.2.3 Sulphur Dioxide (SO_2)

Figure 4-46 illustrates the simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 2 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.20 $\mu g/m^3$ and 0.02 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for an annual time average is 50 $\mu g/m^3$.

Figure 4-47 illustrates the simulated maximum 24-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 2. Maximum 24-hour concentrations of 0.60 $\mu g/m^3$ and 0.09 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 24-hour time average is 125 $\mu g/m^3$.

Figure 4-48 illustrates the simulated maximum 1-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 2. Maximum 1-hour concentrations of 6.10 $\mu g/m^3$ and 0.60 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Table 4-7 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-49 to 4-51 is a graphical representation of Table 4-7.

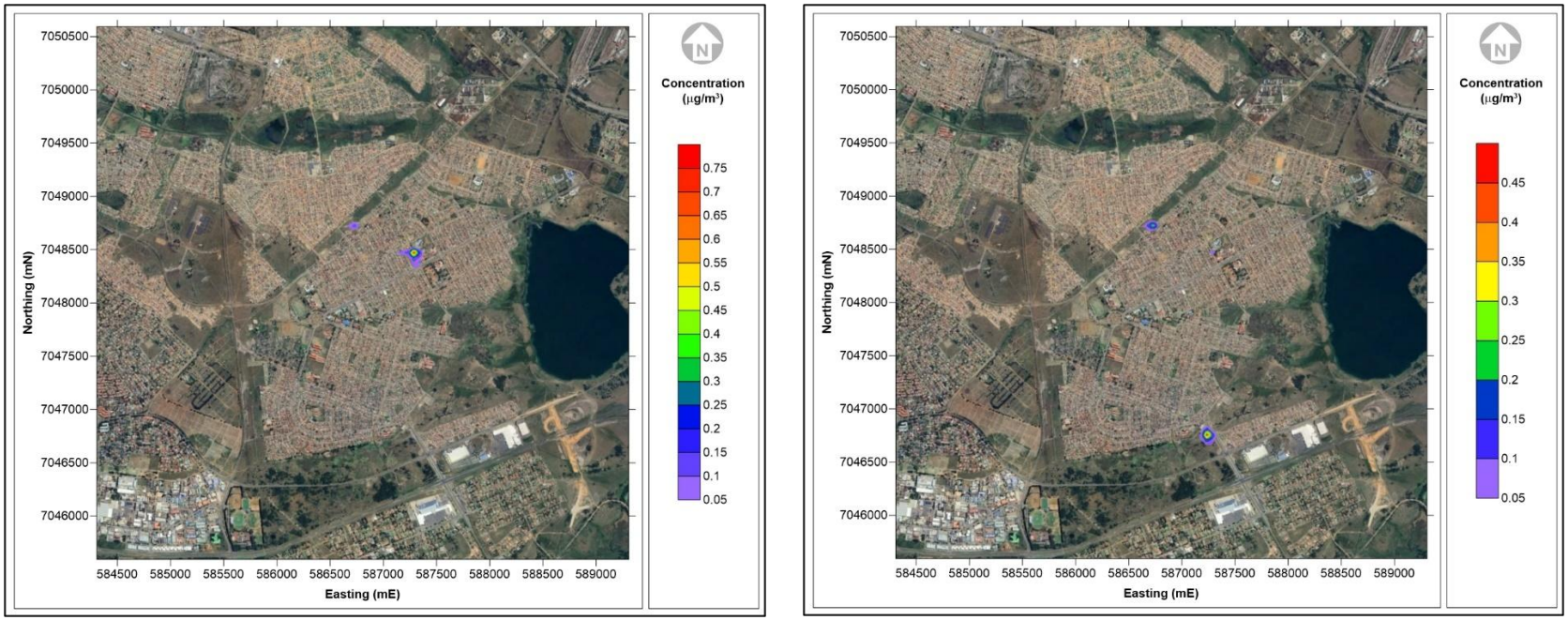


Figure 4-46 Simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 2 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

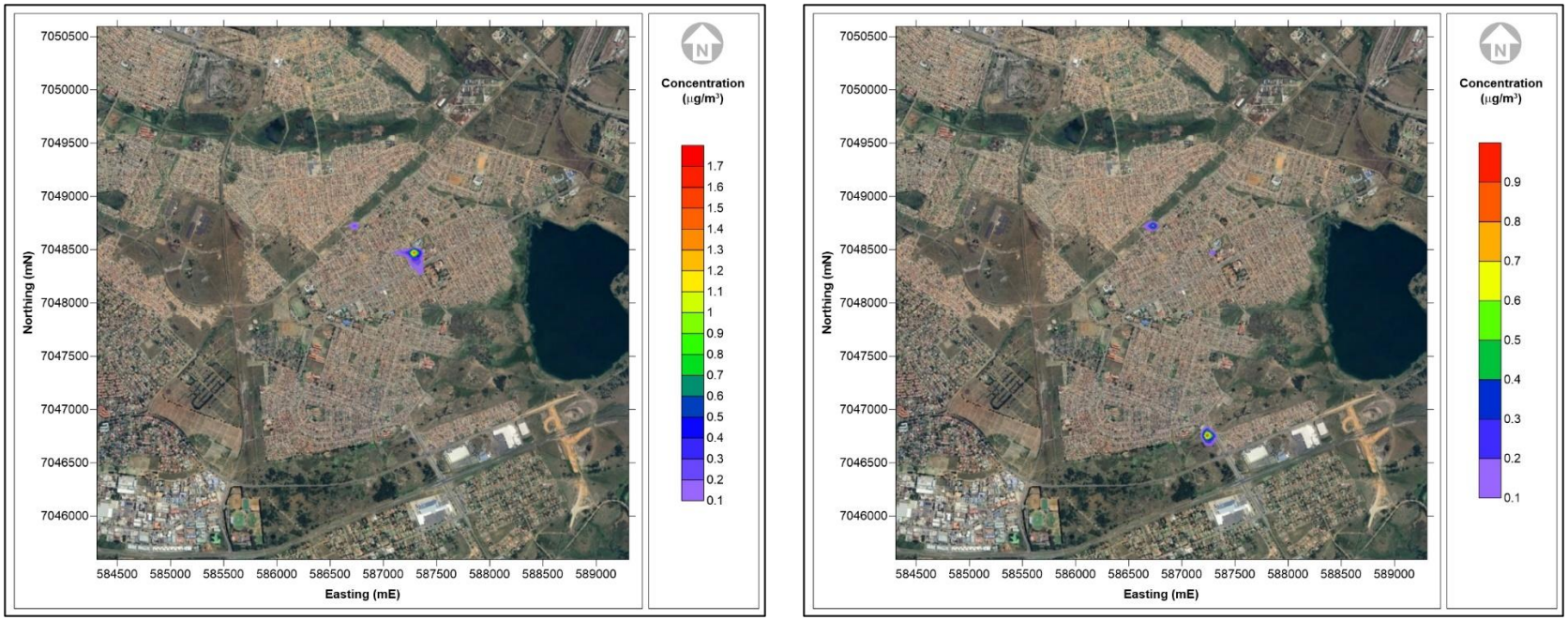


Figure 4-47: Simulated maximum 24-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

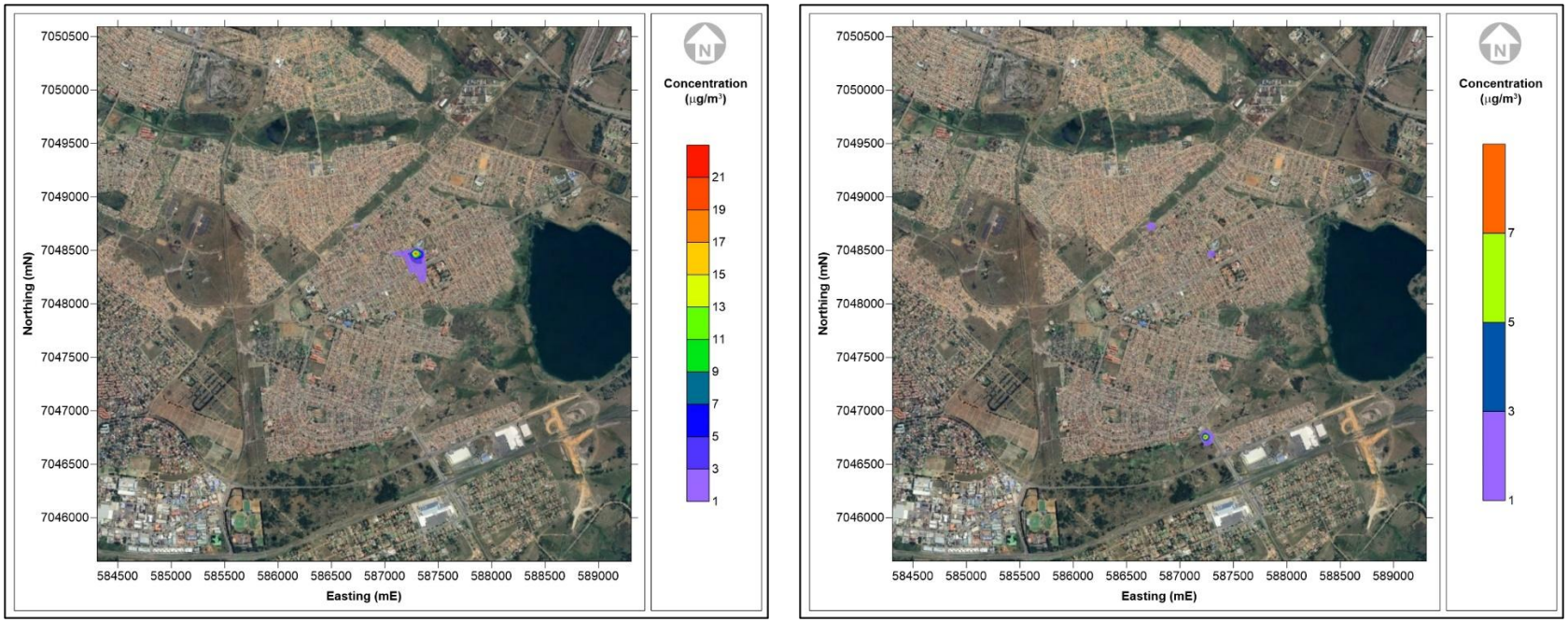


Figure 4-48: Simulated maximum 1-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-7: Simulated ambient SO_2 concentrations at the sensitive receptors for Campaign 2.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.0003	0.0005	0.0009	0.0017	0.0160	0.0296
Mareka Ward 13_2	0.0006	0.0010	0.0012	0.0022	0.0131	0.0242
Mareka Ward 13_3	0.0170	0.0314	0.0337	0.0624	0.2526	0.4673
Mareka Ward 13_4	0.0092	0.0170	0.0299	0.0553	0.1654	0.3060
Mareka Ward 13_5	0.0219	0.0404	0.0489	0.0905	0.3578	0.6620
Mareka Ward 13_6	0.0109	0.0200	0.0234	0.0434	0.1734	0.3207
Ward 13 Police Station_1	0.0347	0.0041	0.1662	0.0199	2.1376	0.2414
Ward 13 Police Station_2	0.1338	0.0153	0.4285	0.0494	6.1814	0.6961
Ward 13 Police Station_3	0.2009	0.0229	0.6162	0.0706	5.8410	0.6589
Ward 13 Police Station_4	0.1020	0.0118	0.2895	0.0329	2.8474	0.3201
Ward 13 Police Station_5	0.1250	0.0144	0.2783	0.0317	2.5187	0.2832
Ward 13 Police Station_6	0.0438	0.0052	0.1652	0.0200	3.7891	0.4262
Ascot Sasol Garage_1	0.0005	0.0003	0.0018	0.0009	0.0328	0.0211
Ascot Sasol Garage_2	0.0017	0.0098	0.0075	0.0540	0.0378	0.3216
Ascot Sasol Garage_3	0.0016	0.0089	0.0058	0.0386	0.0319	0.2713
Ascot Sasol Garage_4	0.0012	0.0057	0.0035	0.0184	0.0260	0.2208
Ascot Sasol Garage_5	0.0009	0.0051	0.0018	0.0112	0.0257	0.1499
Ascot Sasol Garage_6	0.0017	0.0114	0.0028	0.0235	0.0312	0.1634

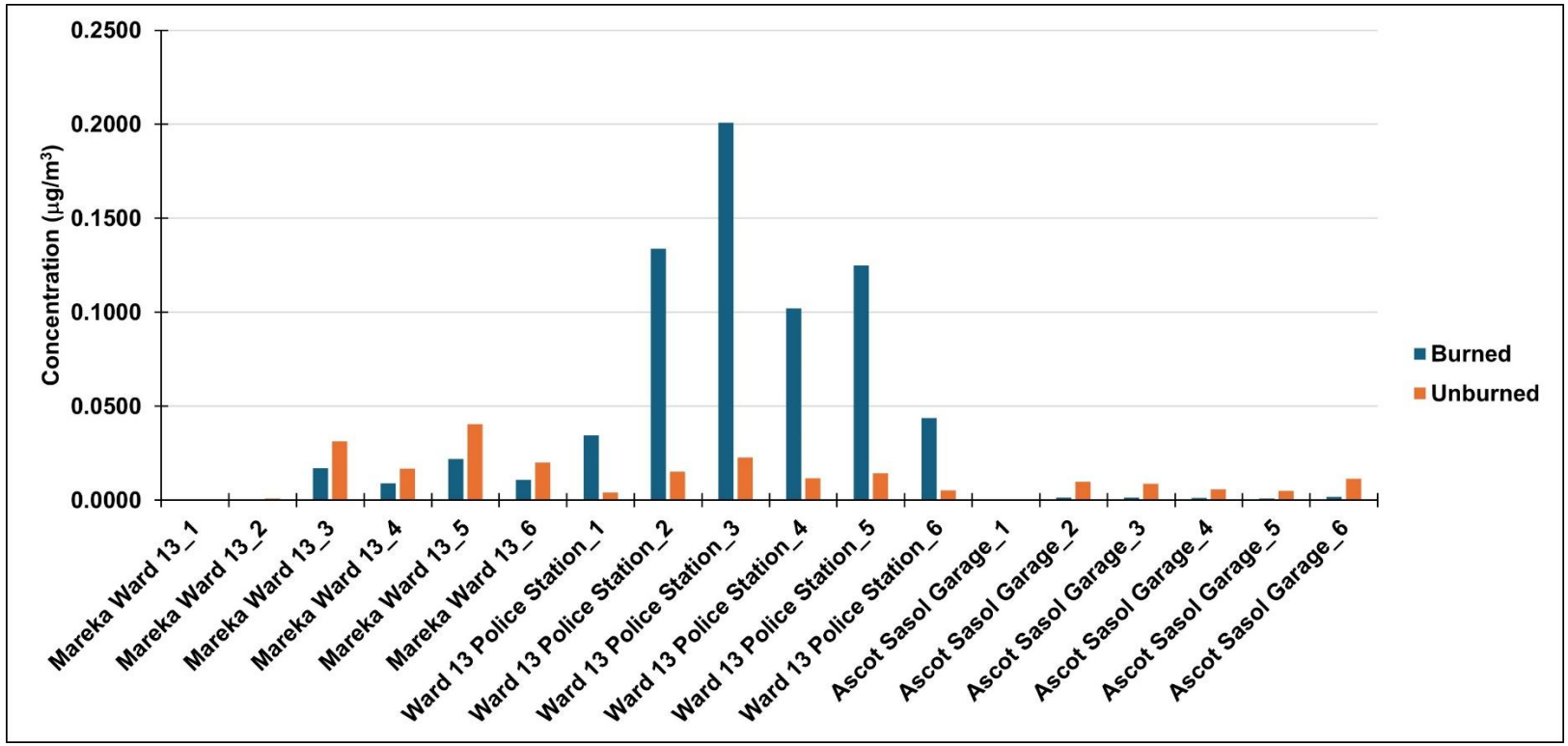


Figure 4-49: Simulated 5-day mean ambient SO_2 concentrations at the sensitive receptors for Campaign 2 (1-hour averages).

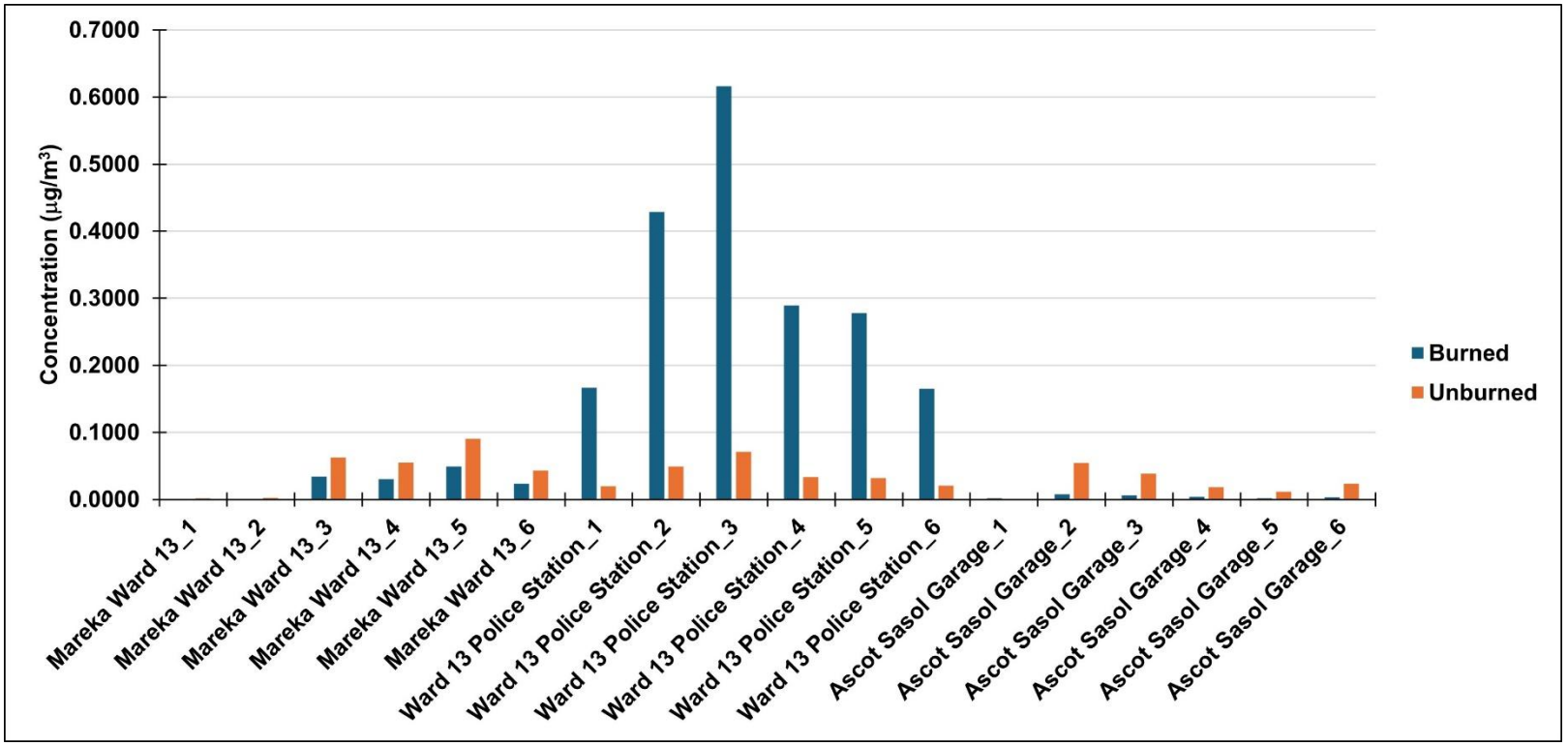


Figure 4-50: Simulated maximum 24-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 2 (5-days).

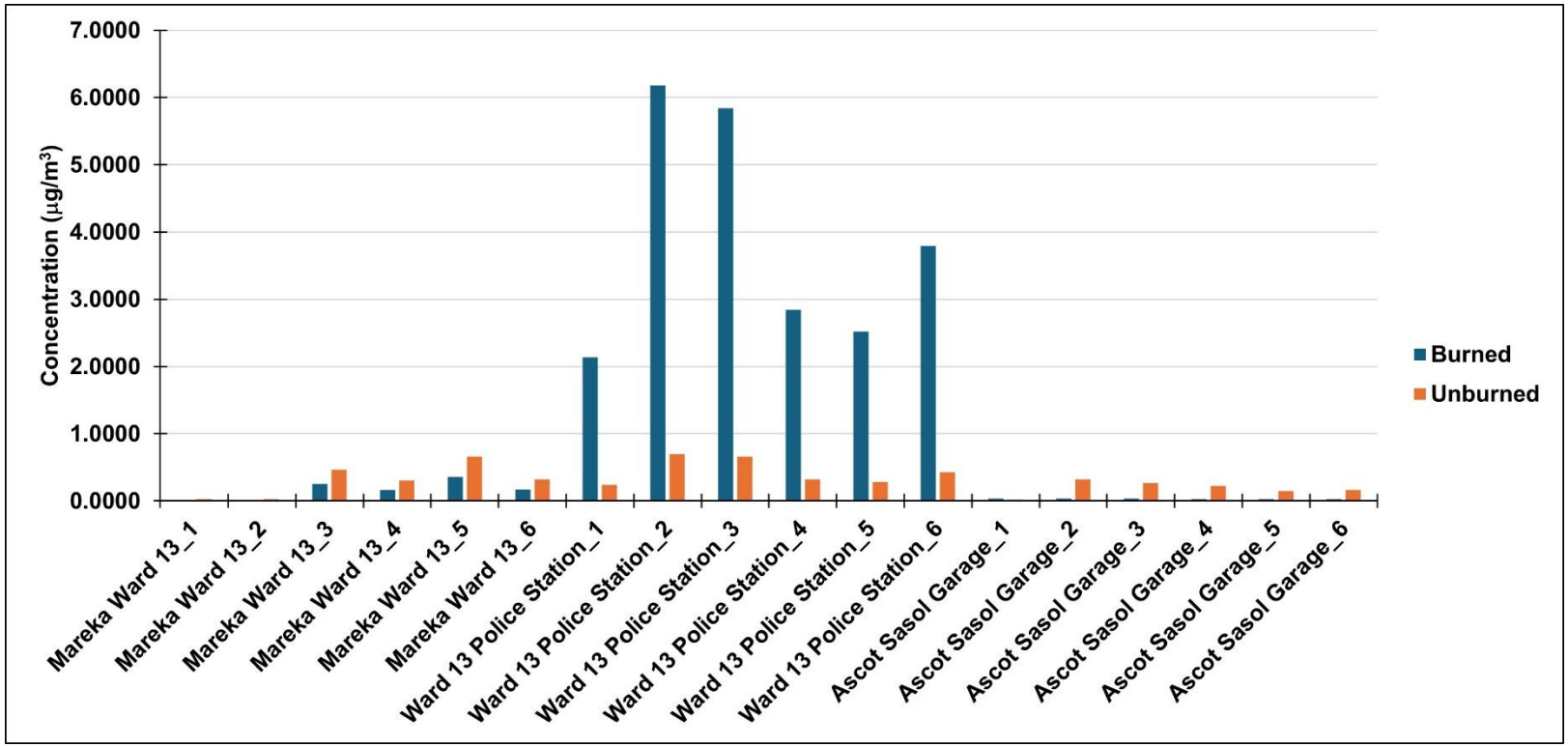


Figure 4-51: Simulated maximum 1-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 2 (5-days).

4.2.2.4 Nitrogen Dioxide (NO_2)

Figure 4-52 illustrates the simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 2 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 1.00 $\mu g/m^3$ and 0.20 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-53 illustrates the simulated maximum 1-hour ambient NO_2 concentrations over the Sharpeville region for Campaign 2. Maximum 1-hour concentrations of 31.0 $\mu g/m^3$ and 3.50 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for a 1-hour time average is 200 $\mu g/m^3$.

Table 4-8 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-54 and 4-55 is a graphical representation of Table 4-8.

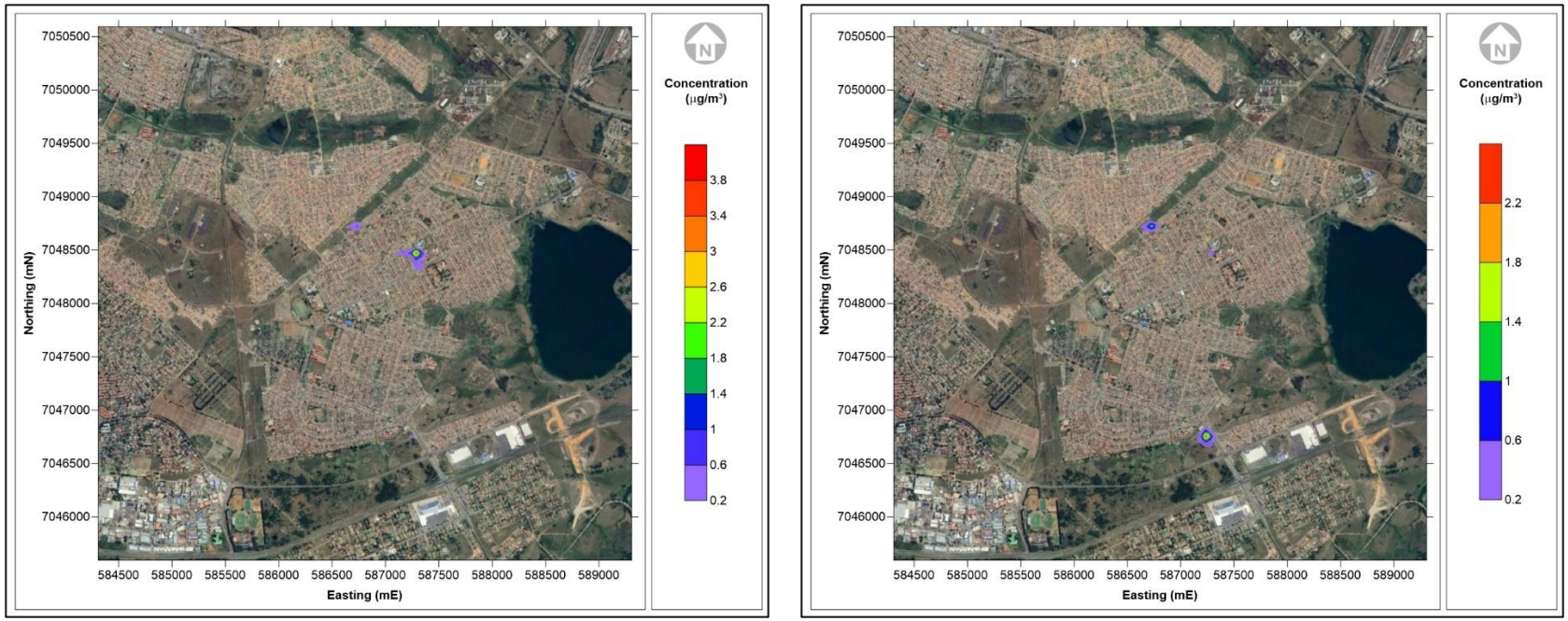


Figure 4-52 Simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 2 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

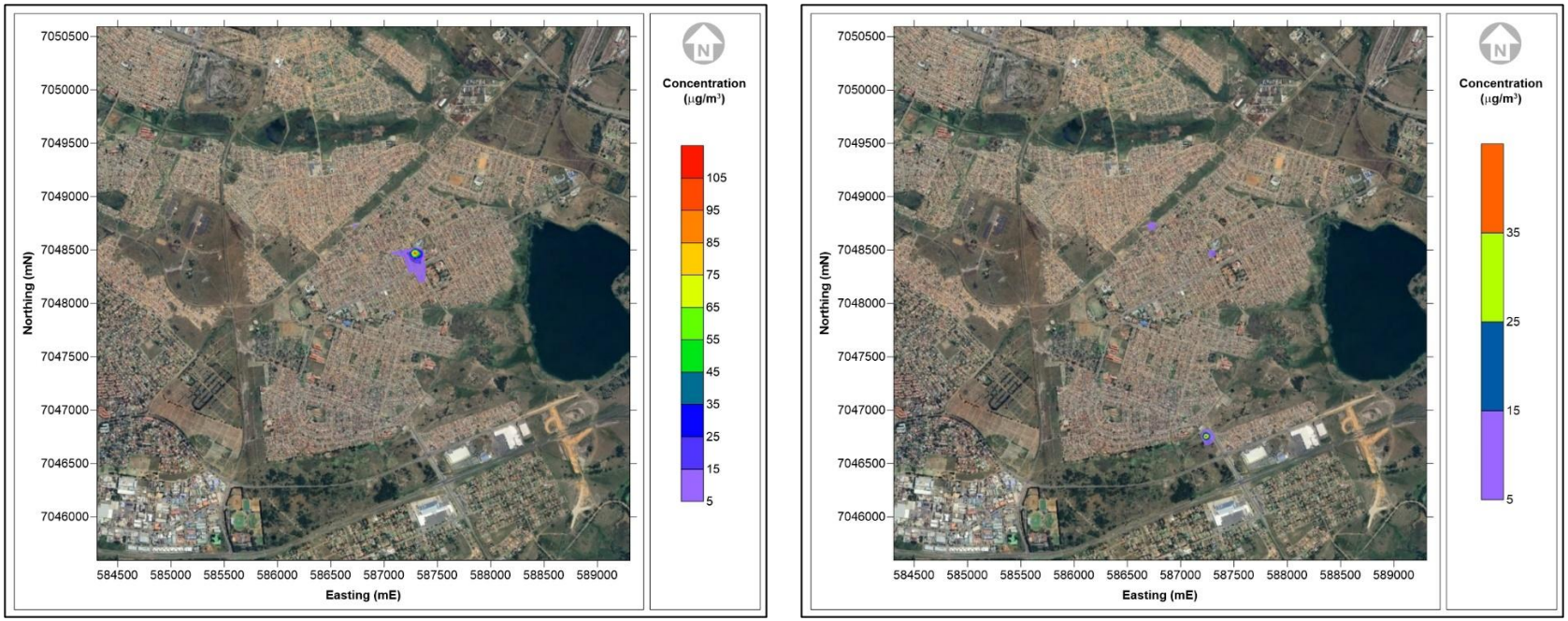


Figure 4-53: Simulated maximum 1-Hour ambient NO_2 concentrations over the Sharpeville region for Campaign 2 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-8: Simulated ambient NO_2 concentrations at the sensitive receptors for Campaign 2.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Mareka Ward 13_1	0.001	0.003	0.080	0.149
Mareka Ward 13_2	0.003	0.005	0.065	0.122
Mareka Ward 13_3	0.085	0.158	1.263	2.349
Mareka Ward 13_4	0.046	0.085	0.827	1.538
Mareka Ward 13_5	0.109	0.203	1.789	3.328
Mareka Ward 13_6	0.055	0.101	0.867	1.612
Ward 13 Police Station_1	0.176	0.021	10.852	1.220
Ward 13 Police Station_2	0.679	0.077	31.382	3.517
Ward 13 Police Station_3	1.020	0.116	29.654	3.329
Ward 13 Police Station_4	0.518	0.060	14.456	1.617
Ward 13 Police Station_5	0.635	0.073	12.787	1.431
Ward 13 Police Station_6	0.223	0.026	19.237	2.154
Ascot Sasol Garage_1	0.002	0.001	0.167	0.106
Ascot Sasol Garage_2	0.008	0.049	0.183	1.621
Ascot Sasol Garage_3	0.008	0.045	0.154	1.367
Ascot Sasol Garage_4	0.006	0.029	0.126	1.112
Ascot Sasol Garage_5	0.005	0.026	0.131	0.755
Ascot Sasol Garage_6	0.008	0.058	0.158	0.823

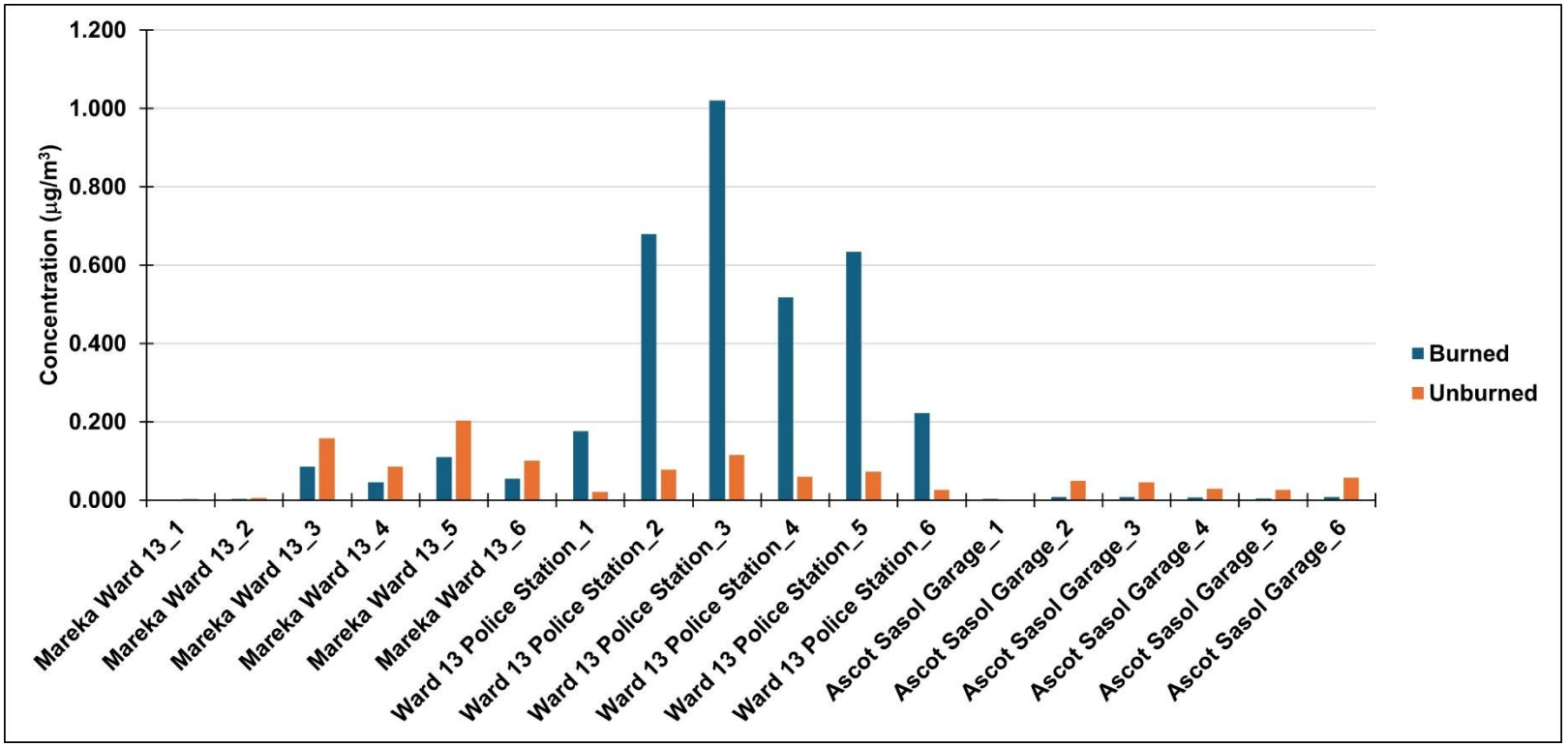


Figure 4-54: Simulated 5-day mean ambient NO_2 concentrations at the sensitive receptors for Campaign 2 (1-hour averages).

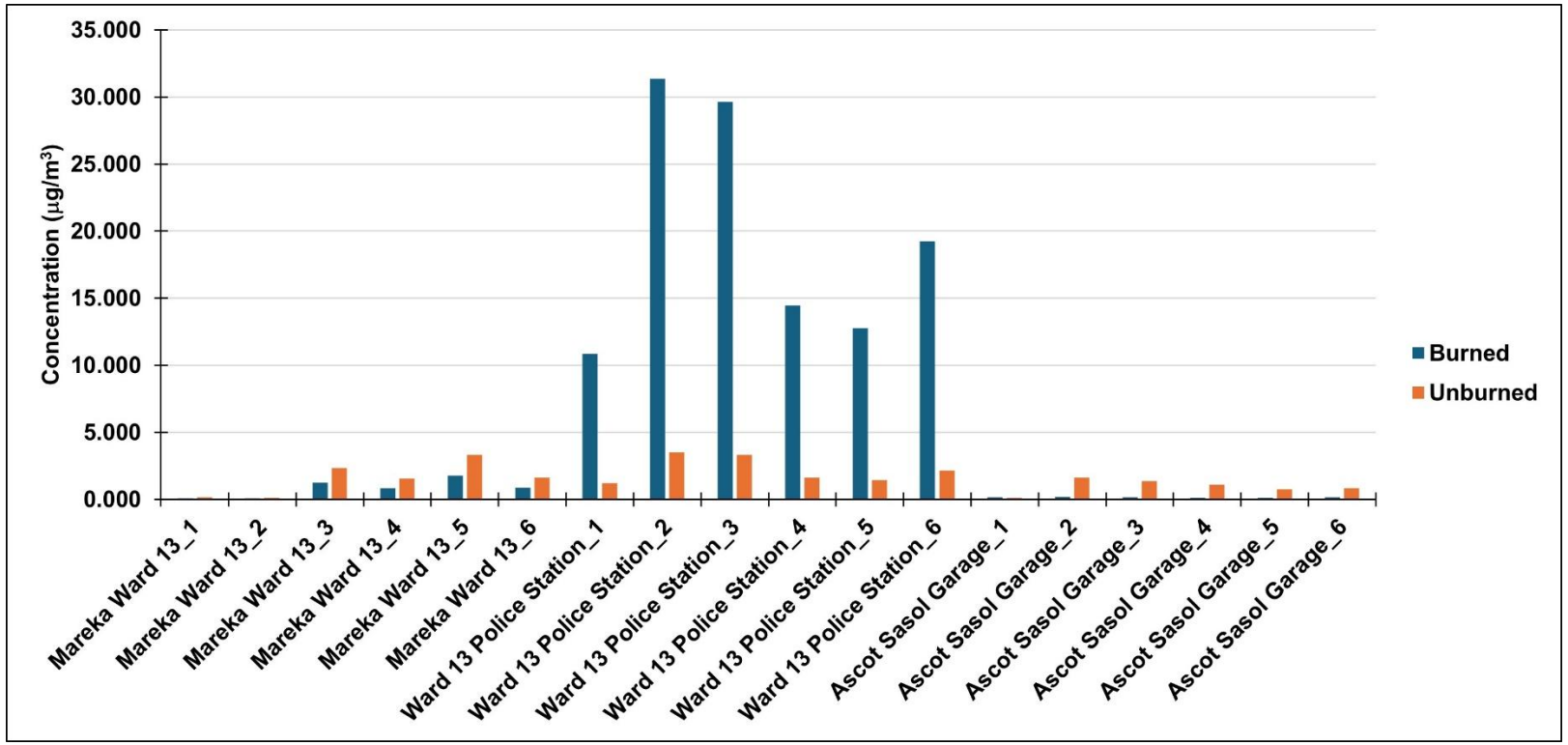


Figure 4-55: Simulated maximum 1-Hour ambient NO_2 concentrations at the sensitive receptors for Campaign 2 (5-days).

4.2.3 CAMPAIGN 3

Figure 4-56 is a map detailing the eight waste collection sites during campaign 3, whilst Figure 4-57 is indicative of the three sites where waste burning practices were conducted.

Figure 4-56: Location of the waste collection sites during Campaign 3.

Figure 57: Location of the waste burning sites during Campaign 3.

Figures 4-58 to 4-60 are detailed maps of the sites where waste burning practices were conducted, as well as the location of sensitive receptors around the burning sites.

Figure 4-58: Ward 12/13 Police Station waste burning site and sensitive receptors near the site.

Figure 4-59: Ascot Sasol Garage waste burning site and sensitive receptors near the site.

Figure 4-60: Kgomocho Primary School waste burning site and sensitive receptors near the site.

4.2.3.1 Particulate Matter (PM_{10})

Figure 4-61 illustrates the simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 14.76 $\mu g/m^3$ and 11.46 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-62 illustrates the simulated maximum 24-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3. Maximum 24-hour concentrations of 22.50 $\mu g/m^3$ and 28.87 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for a 24-hour time average is 75 $\mu g/m^3$.

Figure 4-63 illustrates the simulated maximum 1-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3. Maximum 1-hour concentrations of 236.00 $\mu g/m^3$

and 278.00 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No PM_{10} NAAQS standard exist for a 1-hour time average.

Table 4-9 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-64 to 4-66 is a graphical representation of Table 4-9.

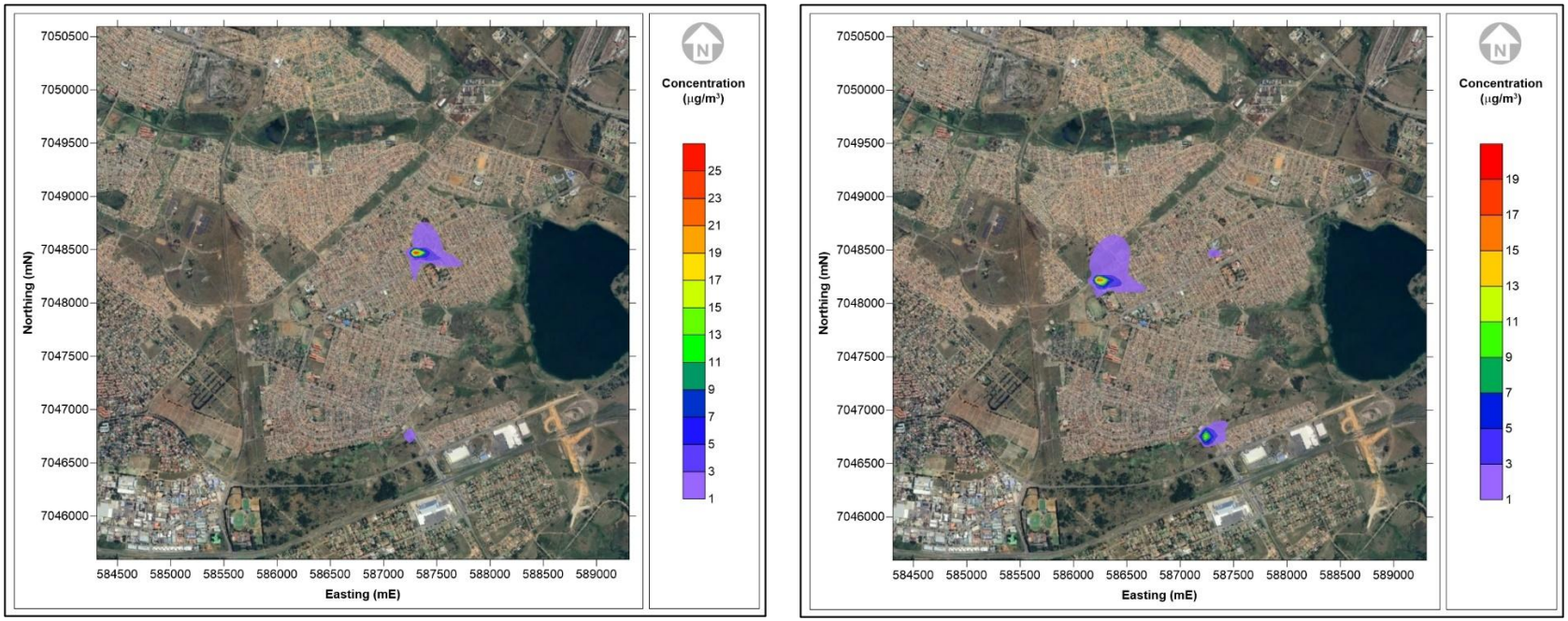


Figure 4-61: Simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

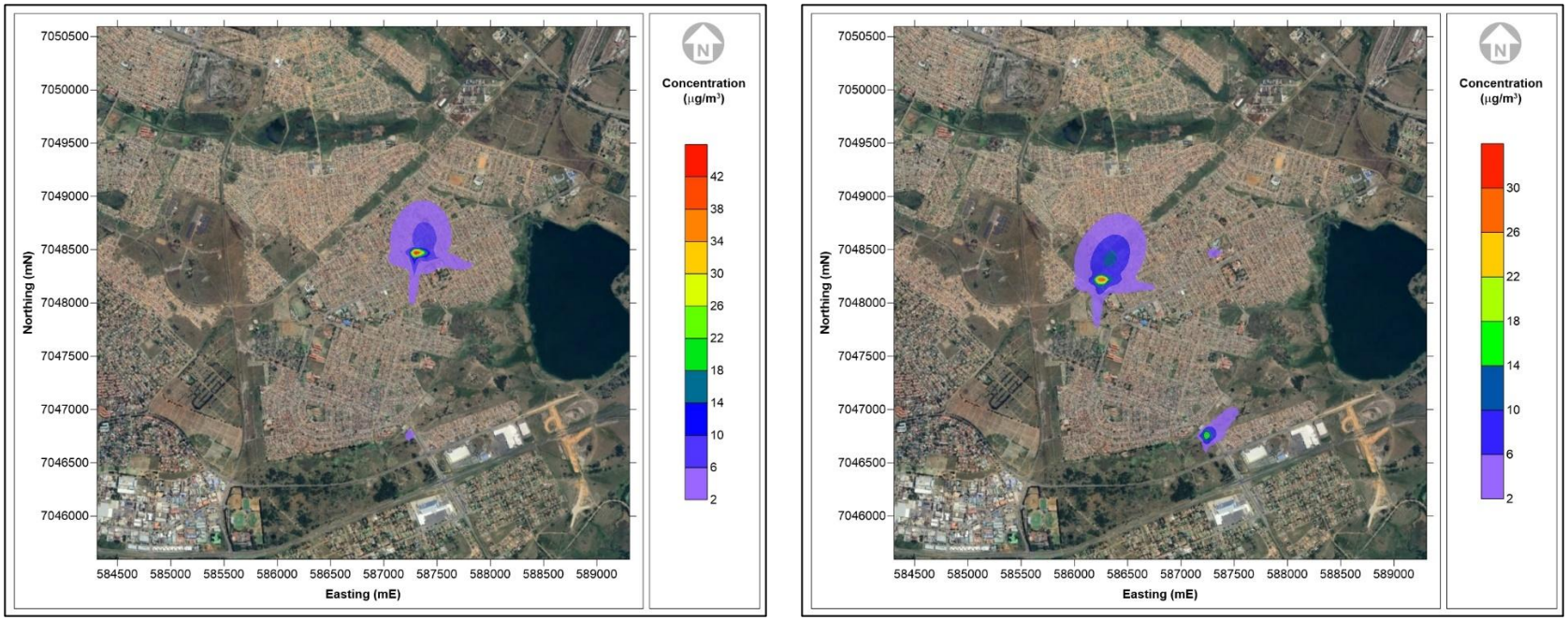


Figure 4-62: Simulated maximum 24-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

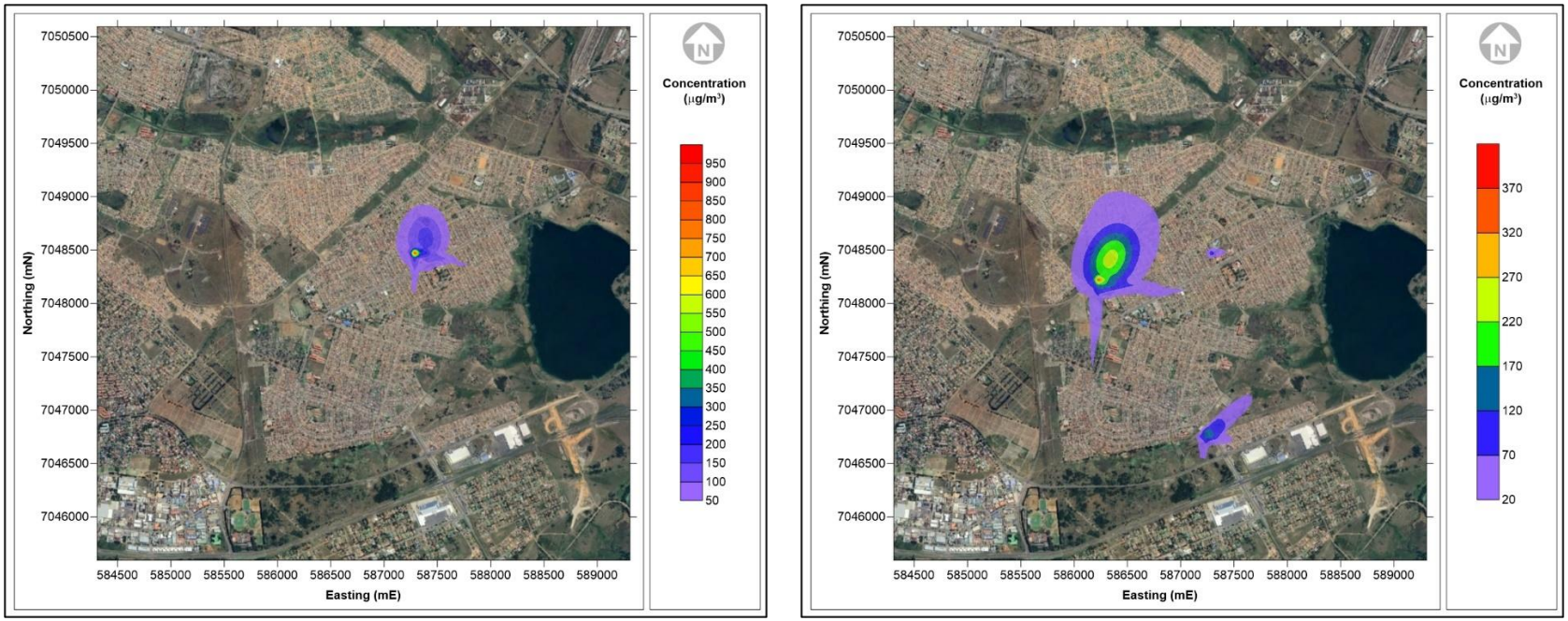


Figure 4-63: Simulated maximum 1-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-9: Simulated ambient PM_{10} concentrations at the sensitive receptors for Campaign 3.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Kgomocho Primary_1	0.12	3.22	0.30	9.35	4.54	136.12
Kgomocho Primary_2	0.21	6.14	0.52	16.10	4.24	126.69
Kgomocho Primary_3	0.37	11.12	0.93	28.87	7.94	245.21
Kgomocho Primary_4	0.38	11.46	0.58	16.38	9.82	278.55
Kgomocho Primary_5	0.04	0.85	0.22	5.10	2.23	60.90
Kgomocho Primary_6	0.03	0.62	0.16	3.69	1.89	40.40
Ward 13 Police Station_1	0.91	0.13	5.17	0.64	105.77	12.68
Ward 13 Police Station_2	14.76	1.67	22.56	2.55	236.20	26.26
Ward 13 Police Station_3	3.93	0.47	13.43	1.49	142.54	15.85
Ward 13 Police Station_4	0.73	0.11	4.38	0.57	69.92	8.99
Ward 13 Police Station_5	1.96	0.25	11.78	1.39	197.47	21.95
Ward 13 Police Station_6	1.08	0.15	6.43	0.79	72.07	8.45
Ascot Sasol Garage_1	0.08	0.03	0.43	0.16	8.12	2.70
Ascot Sasol Garage_2	0.74	3.98	1.02	5.63	18.49	101.99
Ascot Sasol Garage_3	0.24	1.23	0.34	1.86	4.88	26.92
Ascot Sasol Garage_4	0.05	0.18	0.16	0.42	0.98	4.12
Ascot Sasol Garage_5	0.07	0.11	0.33	0.62	6.20	6.27
Ascot Sasol Garage_6	0.03	0.04	0.15	0.20	2.33	1.97

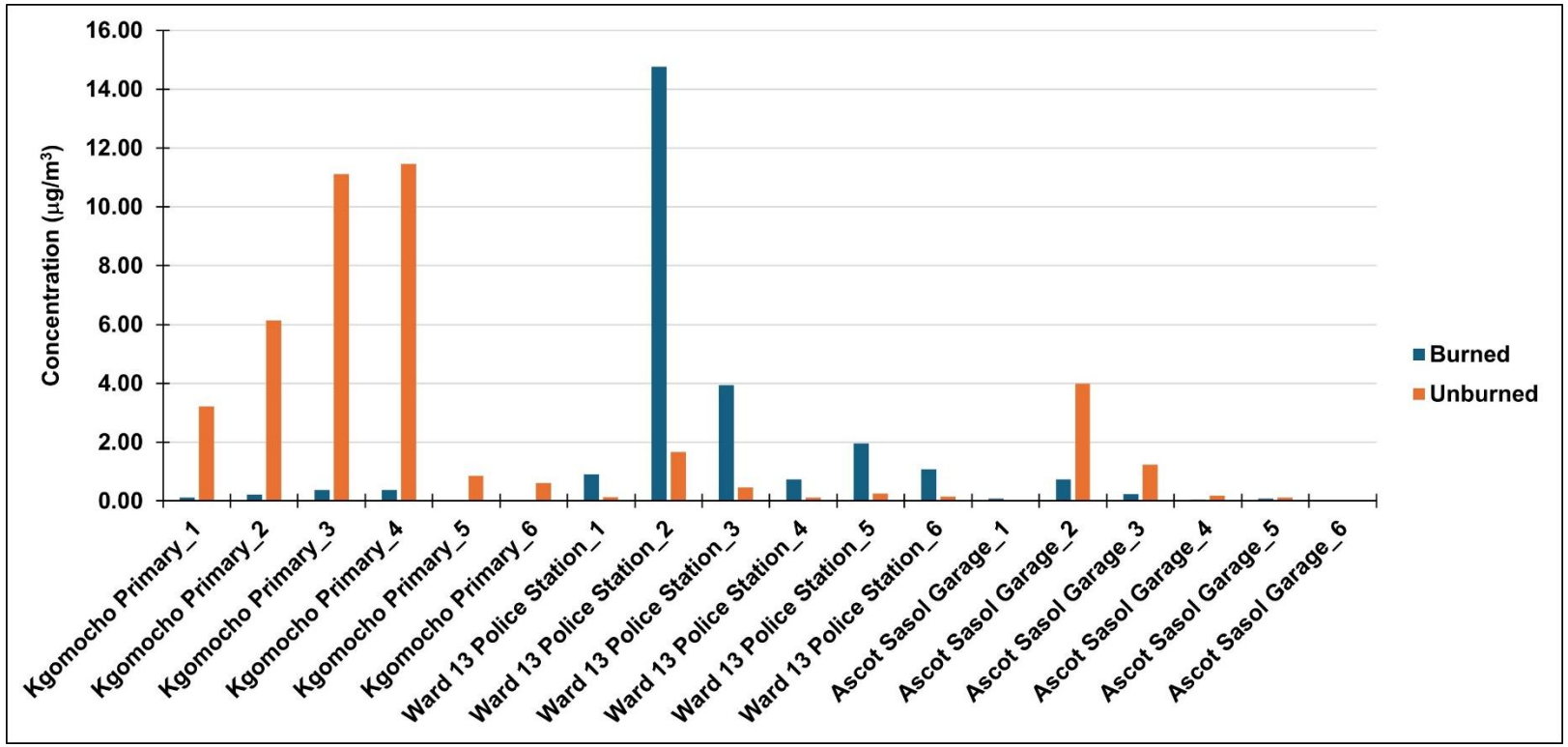


Figure 4-64: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (1-hour averages).

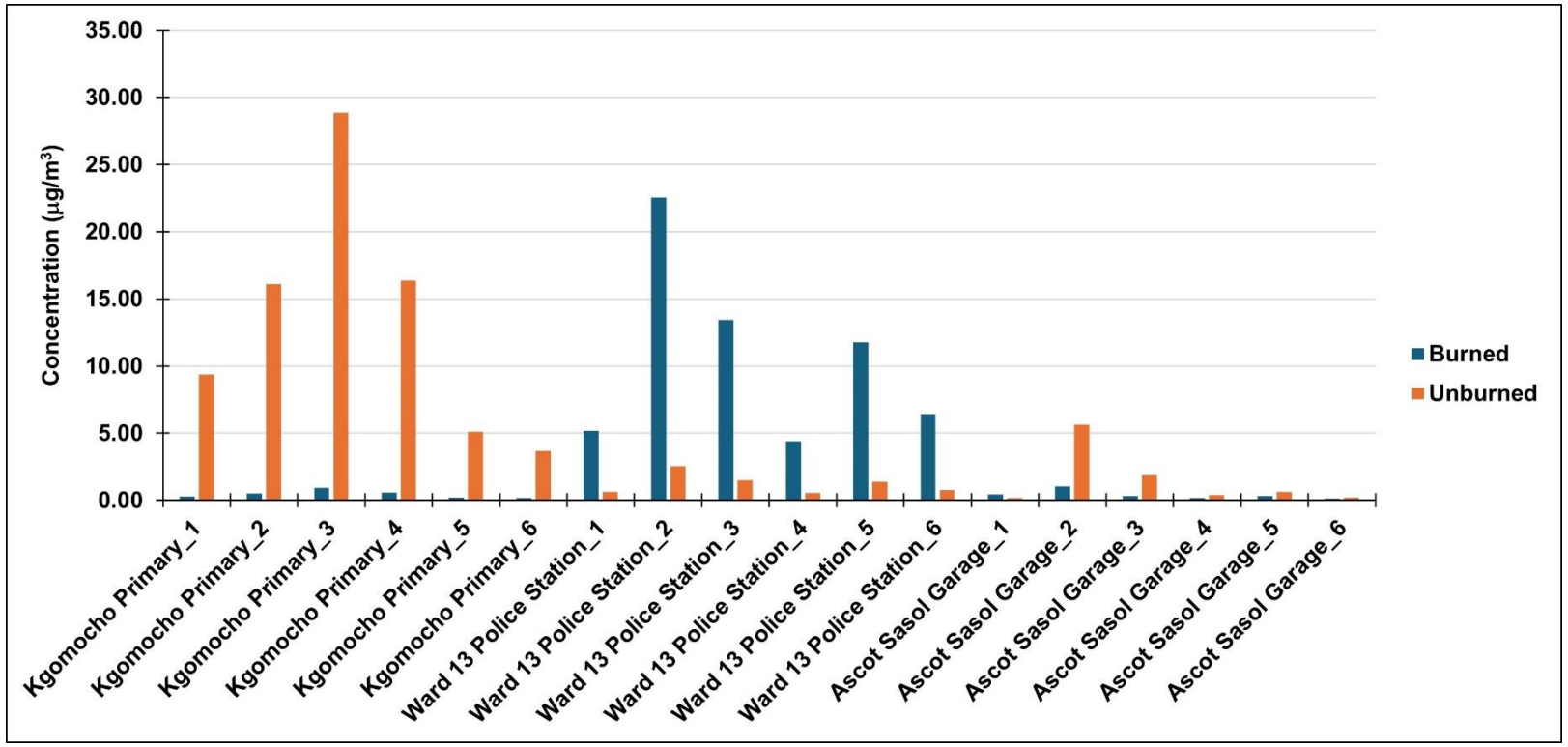


Figure 4-65: Simulated maximum 24-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (5-days).

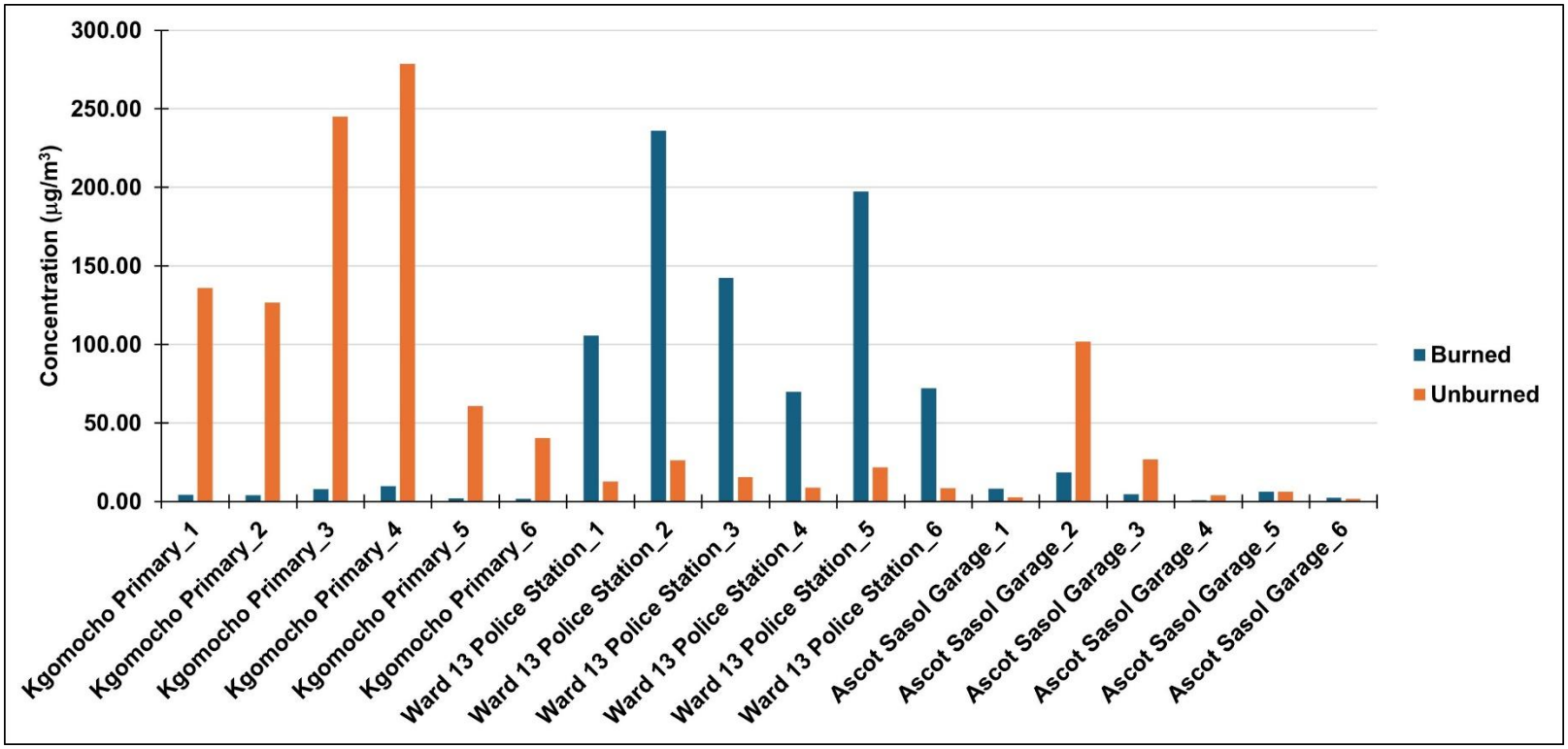


Figure 4-66: Simulated maximum 1-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (5-days).

4.2.3.2 Particulate Matter ($PM_{2.5}$)

Figure 4-67 illustrates the simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 3 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 14.70 $\mu g/m^3$ and 11.40 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for an annual time average is 20 $\mu g/m^3$.

Figure 4-68 illustrates the simulated maximum 24-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 3. Maximum 24-hour concentrations of 22.40 $\mu g/m^3$ and 28.70 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for a 24-hour time average is 40 $\mu g/m^3$.

Figure 4-69 illustrates the simulated maximum 1-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 3. Maximum 1-hour concentrations of 235.27 $\mu g/m^3$ and 277.45 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No $PM_{2.5}$ NAAQS standard exist for a 1-hour time average.

Table 4-10 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-70 to 4-72 is a graphical representation of Table 4-10.

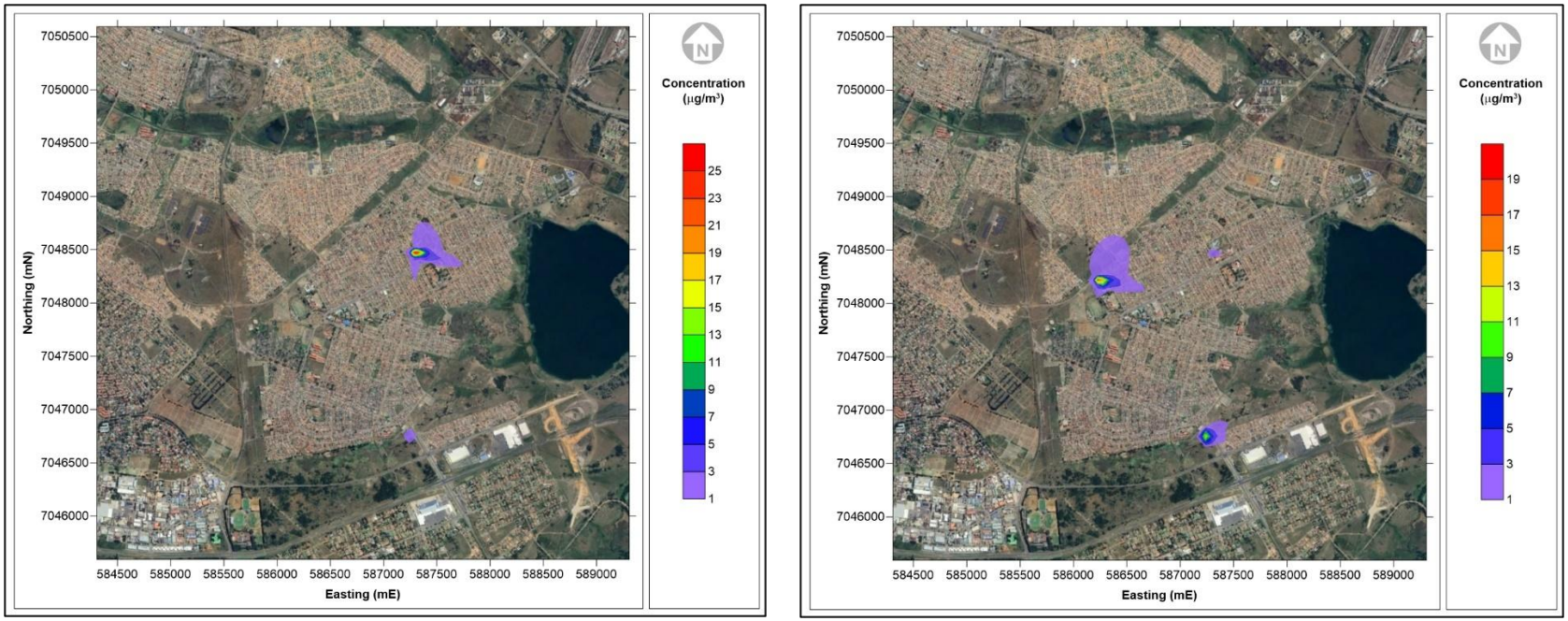


Figure 4-67 Simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 3 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

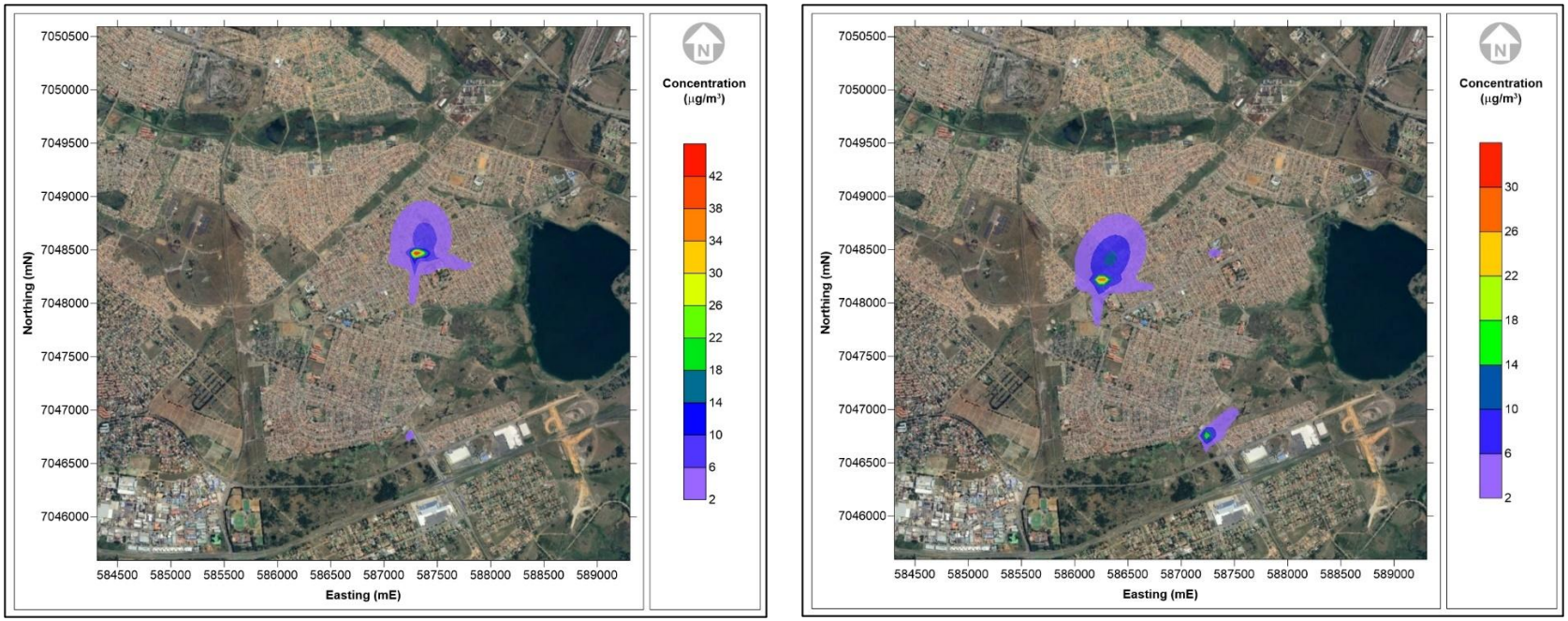


Figure 4-68: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

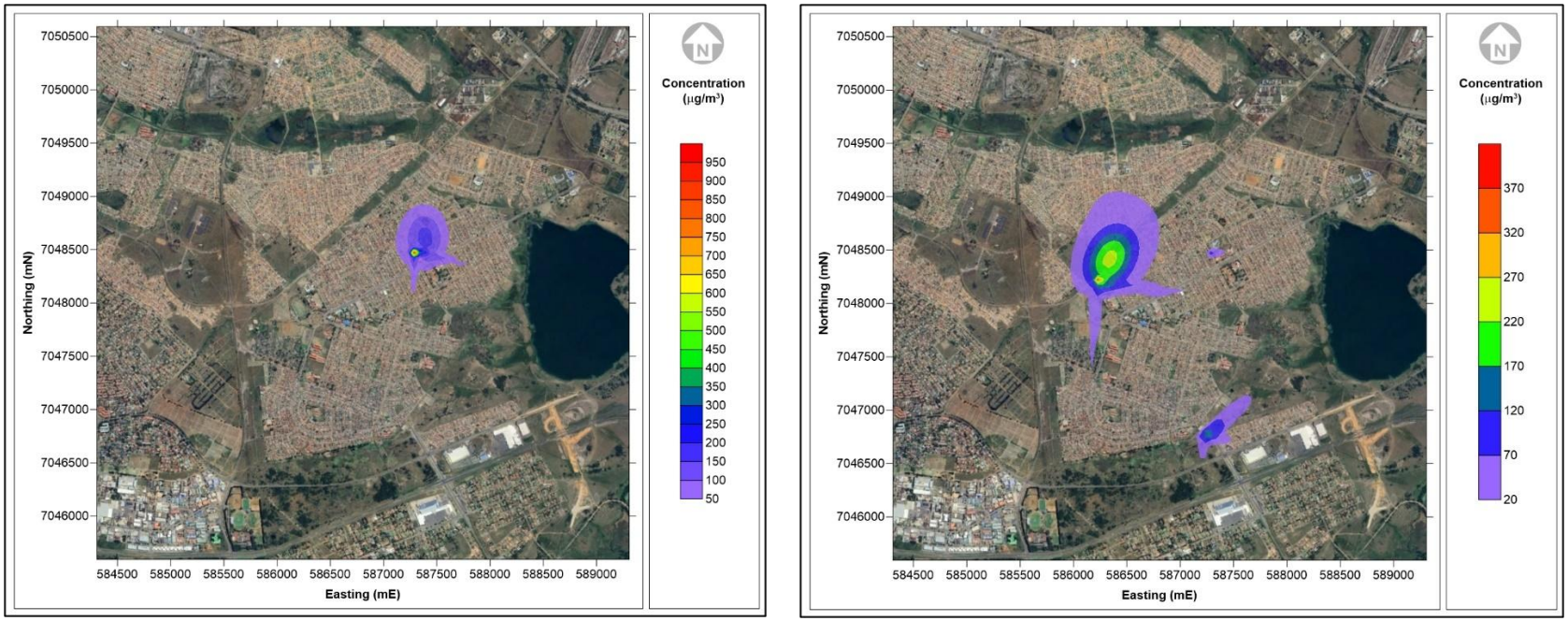


Figure 4-69: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-10: Simulated ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 3.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Kgomocho Primary_1	0.12	3.21	0.30	9.32	4.52	135.59
Kgomocho Primary_2	0.21	6.12	0.52	16.04	4.22	126.19
Kgomocho Primary_3	0.37	11.07	0.93	28.75	7.89	244.25
Kgomocho Primary_4	0.38	11.42	0.58	16.32	9.76	277.45
Kgomocho Primary_5	0.04	0.85	0.22	5.08	2.22	60.67
Kgomocho Primary_6	0.03	0.61	0.16	3.68	1.88	40.24
Ward 13 Police Station_1	0.91	0.13	5.15	0.64	105.35	12.63
Ward 13 Police Station_2	14.70	1.66	22.47	2.54	235.27	26.15
Ward 13 Police Station_3	3.92	0.46	13.37	1.49	141.98	15.78
Ward 13 Police Station_4	0.73	0.11	4.36	0.56	69.65	8.95
Ward 13 Police Station_5	1.96	0.25	11.73	1.38	196.69	21.86
Ward 13 Police Station_6	1.08	0.15	6.40	0.78	71.79	8.42
Ascot Sasol Garage_1	0.08	0.03	0.43	0.16	8.09	2.69
Ascot Sasol Garage_2	0.74	3.97	1.02	5.61	18.43	101.60
Ascot Sasol Garage_3	0.24	1.23	0.34	1.85	4.86	26.81
Ascot Sasol Garage_4	0.05	0.18	0.16	0.42	0.98	4.11
Ascot Sasol Garage_5	0.07	0.11	0.33	0.62	6.17	6.25
Ascot Sasol Garage_6	0.03	0.04	0.15	0.20	2.33	1.96

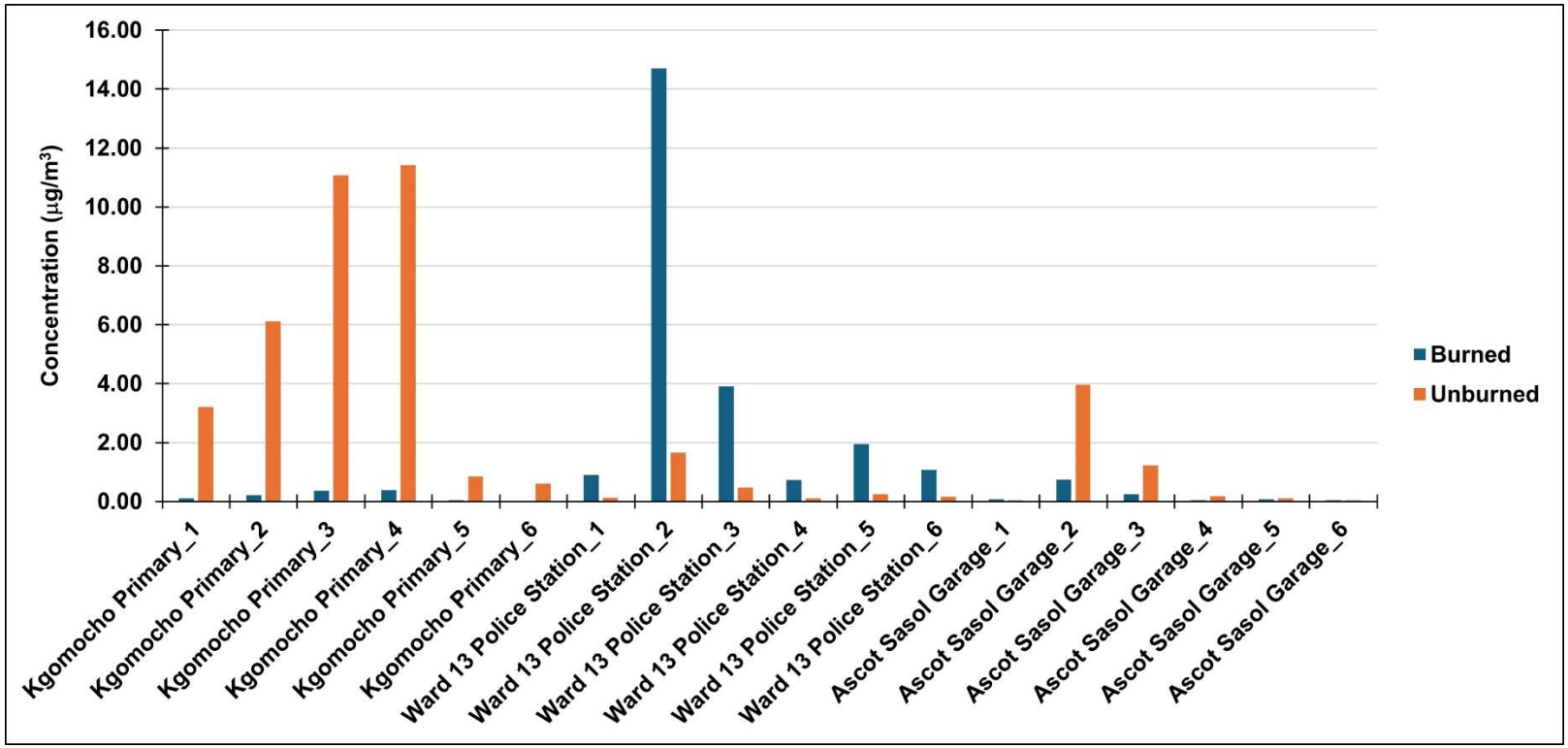


Figure 4-70: Simulated 5-day mean ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 3 (1-hour averages).

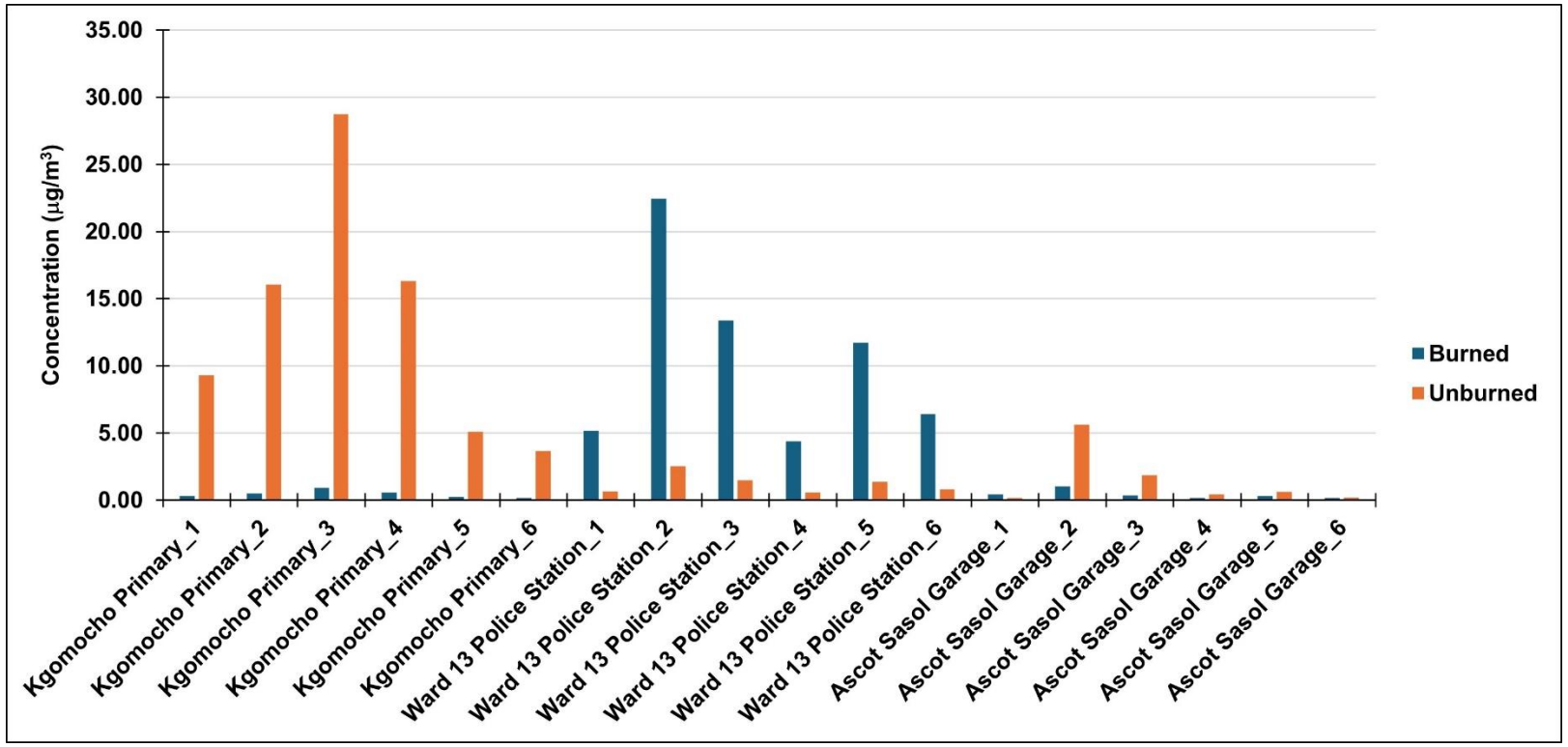


Figure 4-71: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 3 (5-days).

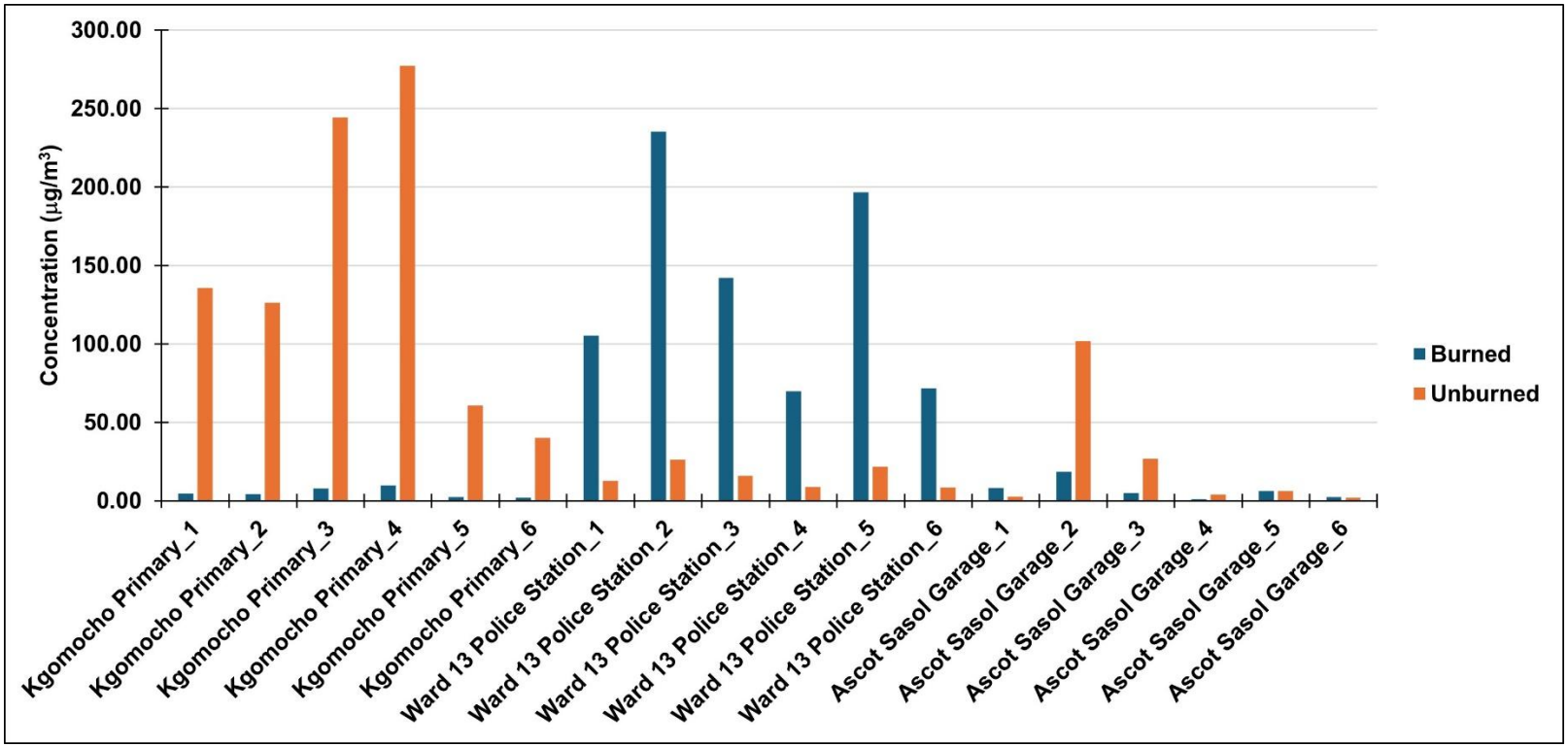


Figure 4-72: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 3 (5-days).

4.2.3.3 Sulphur Dioxide (SO_2)

Figure 4-73 illustrates the simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 3 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.30 $\mu g/m^3$ and 0.20 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for an annual time average is 50 $\mu g/m^3$.

Figure 4-74 illustrates the simulated maximum 24-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 3. Maximum 24-hour concentrations of 0.45 $\mu g/m^3$ and 0.58 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 24-hour time average is 125 $\mu g/m^3$.

Figure 4-75 illustrates the simulated maximum 1-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 3. Maximum 1-hour concentrations of 4.80 $\mu g/m^3$ and 5.60 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Table 4-11 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-76 to 4-78 is a graphical representation of Table 4-11.

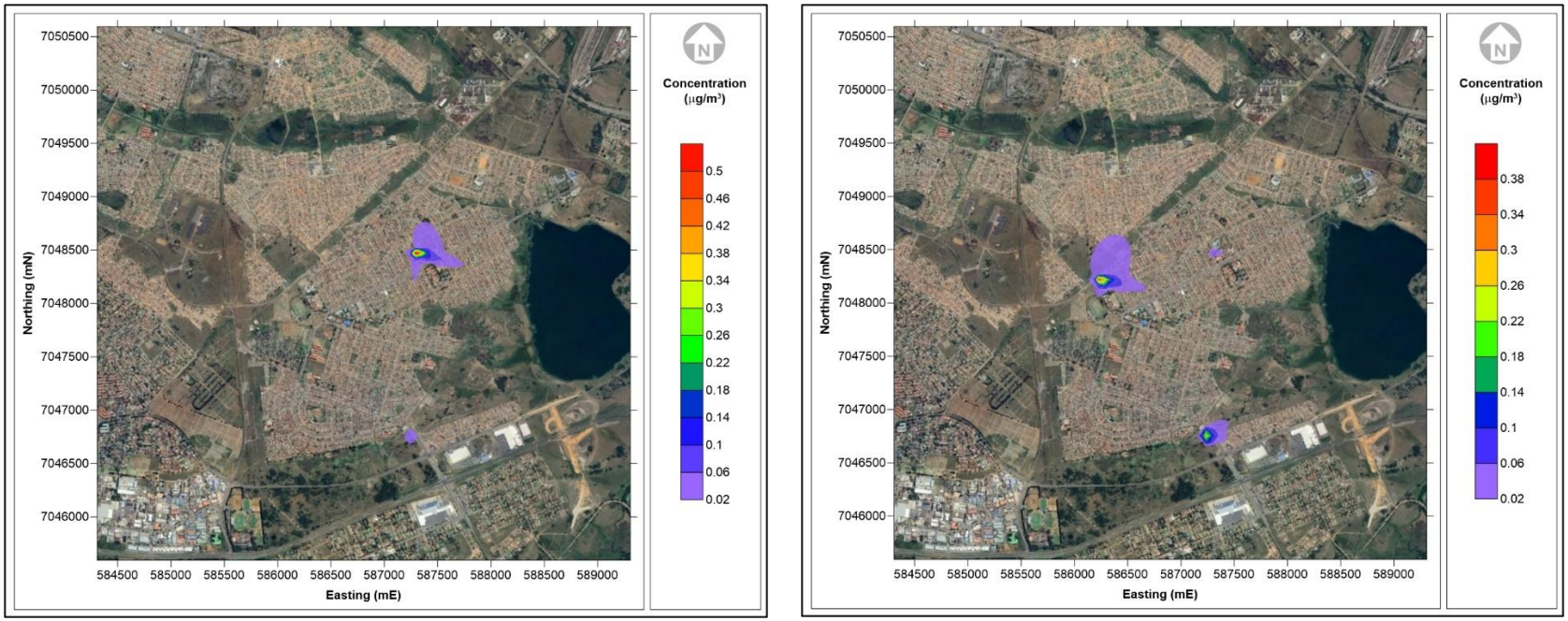


Figure 4-73 Simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 3 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

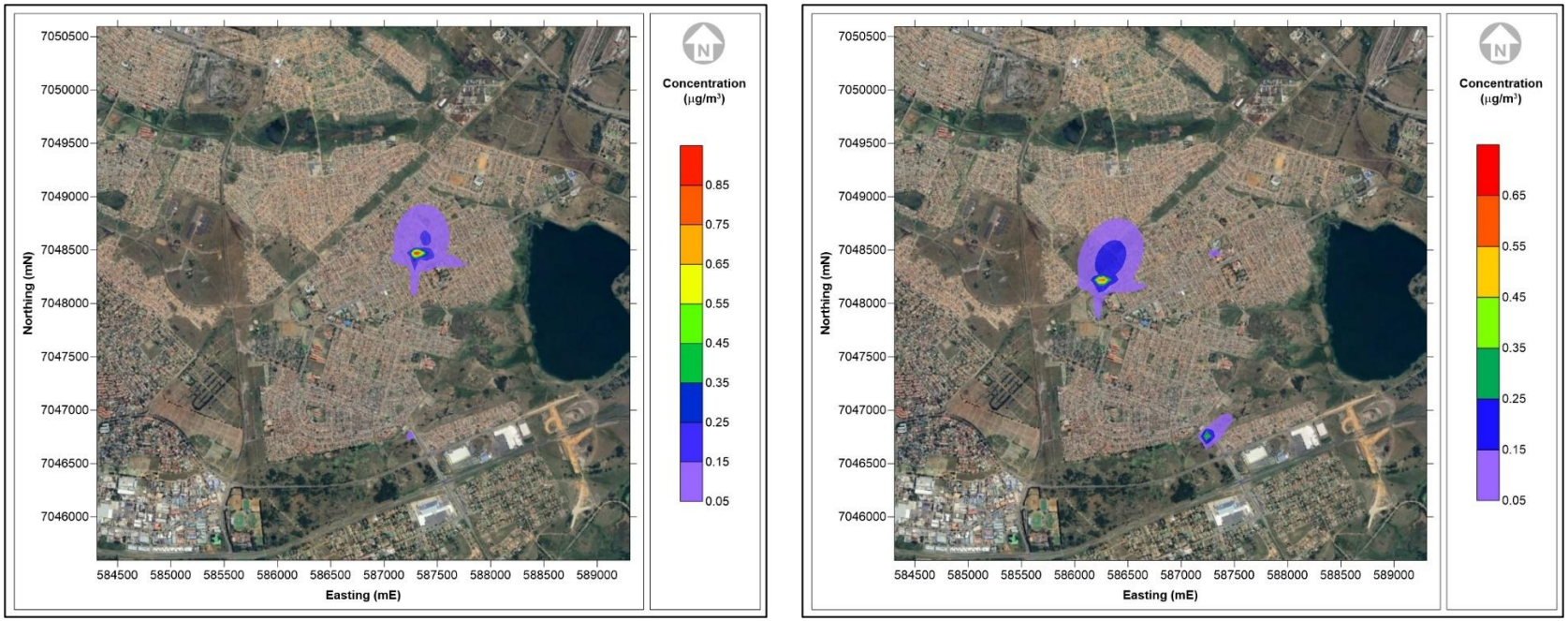


Figure 4-74: Simulated maximum 24-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

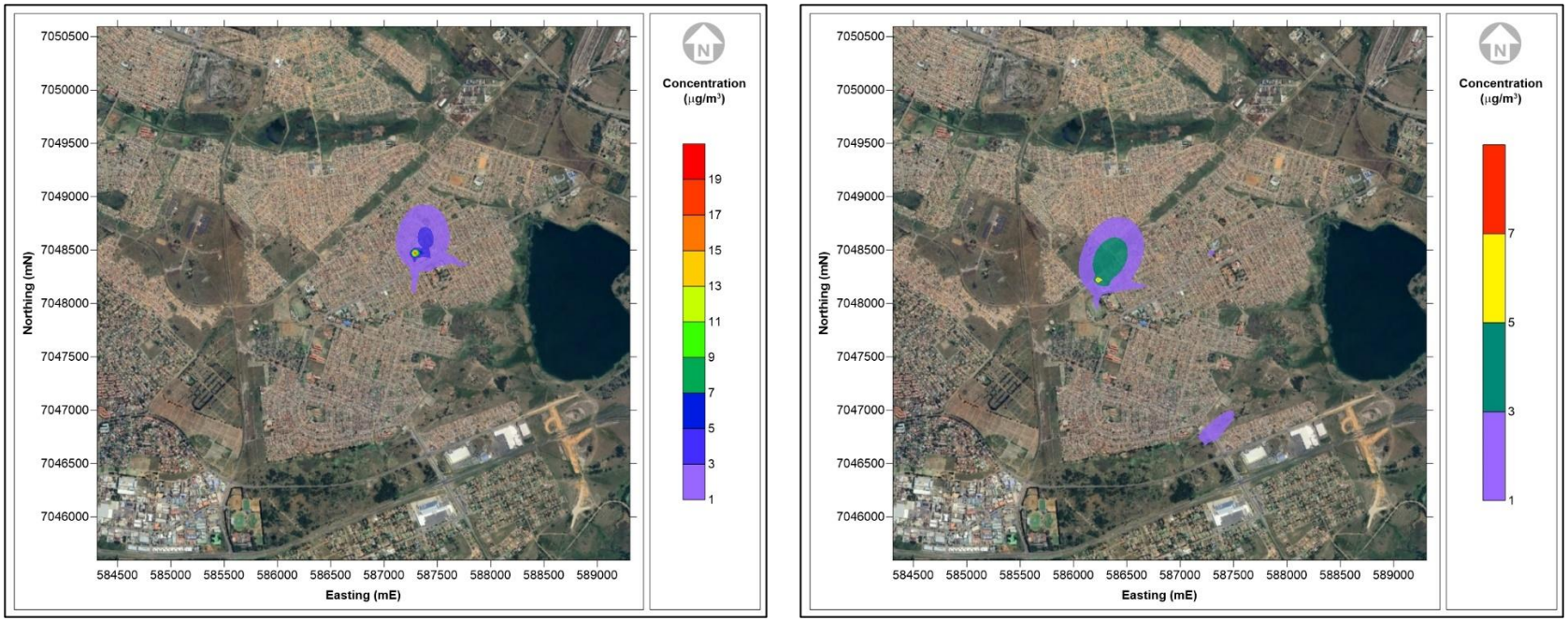


Figure 4-75: Simulated maximum 1-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-11: Simulated ambient SO_2 concentrations at the sensitive receptors for Campaign 3.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Kgomocho Primary_1	0.002	0.065	0.006	0.190	0.092	2.764
Kgomocho Primary_2	0.004	0.125	0.011	0.327	0.086	2.572
Kgomocho Primary_3	0.008	0.226	0.019	0.586	0.161	4.978
Kgomocho Primary_4	0.008	0.233	0.012	0.333	0.199	5.655
Kgomocho Primary_5	0.001	0.017	0.004	0.103	0.045	1.236
Kgomocho Primary_6	0.001	0.012	0.003	0.075	0.038	0.820
Ward 13 Police Station_1	0.018	0.003	0.105	0.013	2.150	0.263
Ward 13 Police Station_2	0.300	0.035	0.458	0.053	4.801	0.546
Ward 13 Police Station_3	0.080	0.010	0.273	0.031	2.898	0.330
Ward 13 Police Station_4	0.015	0.002	0.089	0.012	1.421	0.186
Ward 13 Police Station_5	0.040	0.005	0.239	0.029	4.014	0.457
Ward 13 Police Station_6	0.022	0.003	0.131	0.016	1.465	0.175
Ascot Sasol Garage_1	0.002	0.001	0.009	0.003	0.165	0.055
Ascot Sasol Garage_2	0.016	0.081	0.022	0.114	0.394	2.068
Ascot Sasol Garage_3	0.005	0.025	0.007	0.038	0.104	0.546
Ascot Sasol Garage_4	0.001	0.004	0.003	0.009	0.020	0.084
Ascot Sasol Garage_5	0.002	0.002	0.007	0.013	0.126	0.127
Ascot Sasol Garage_6	0.001	0.001	0.003	0.004	0.047	0.040

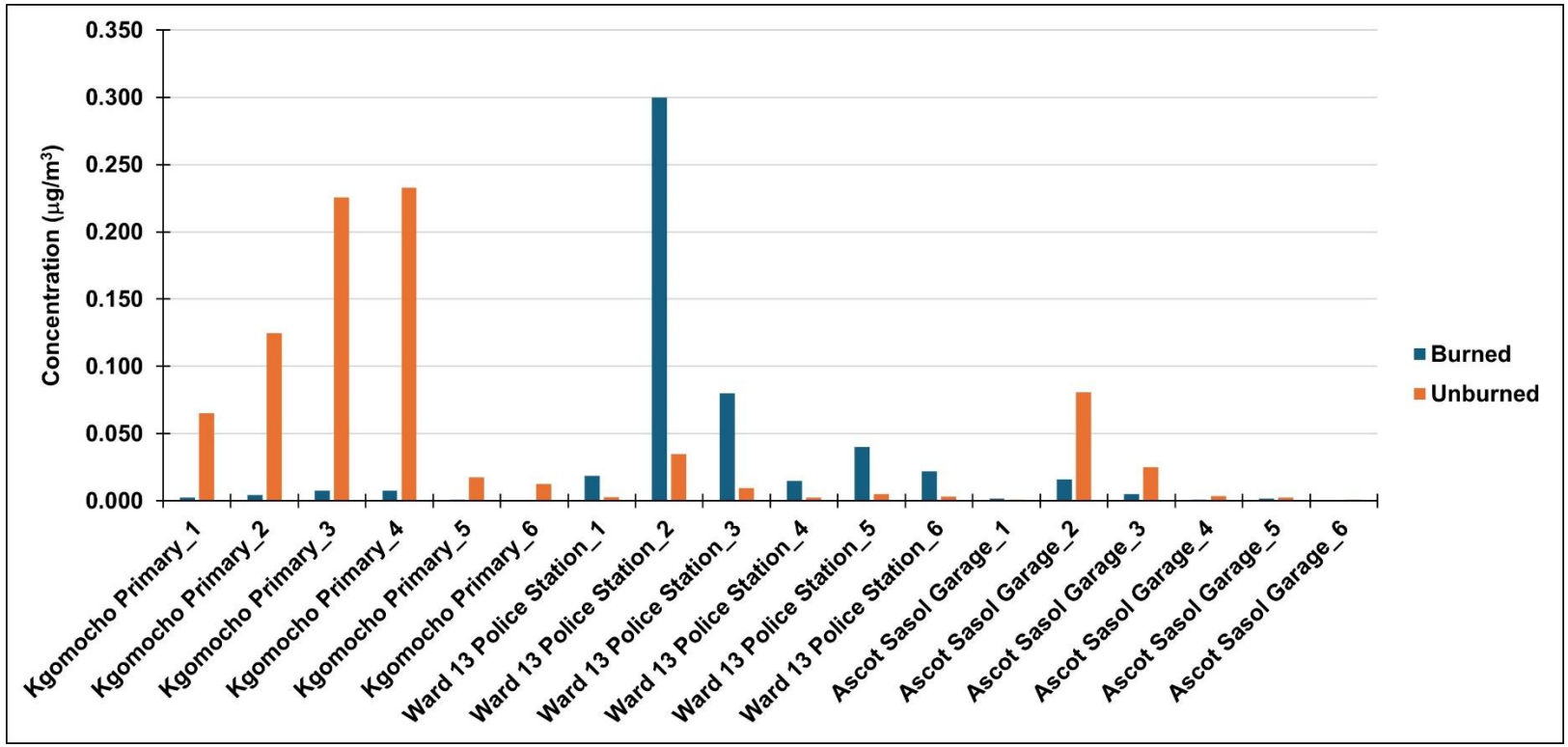


Figure 4-76: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (1-hour averages).

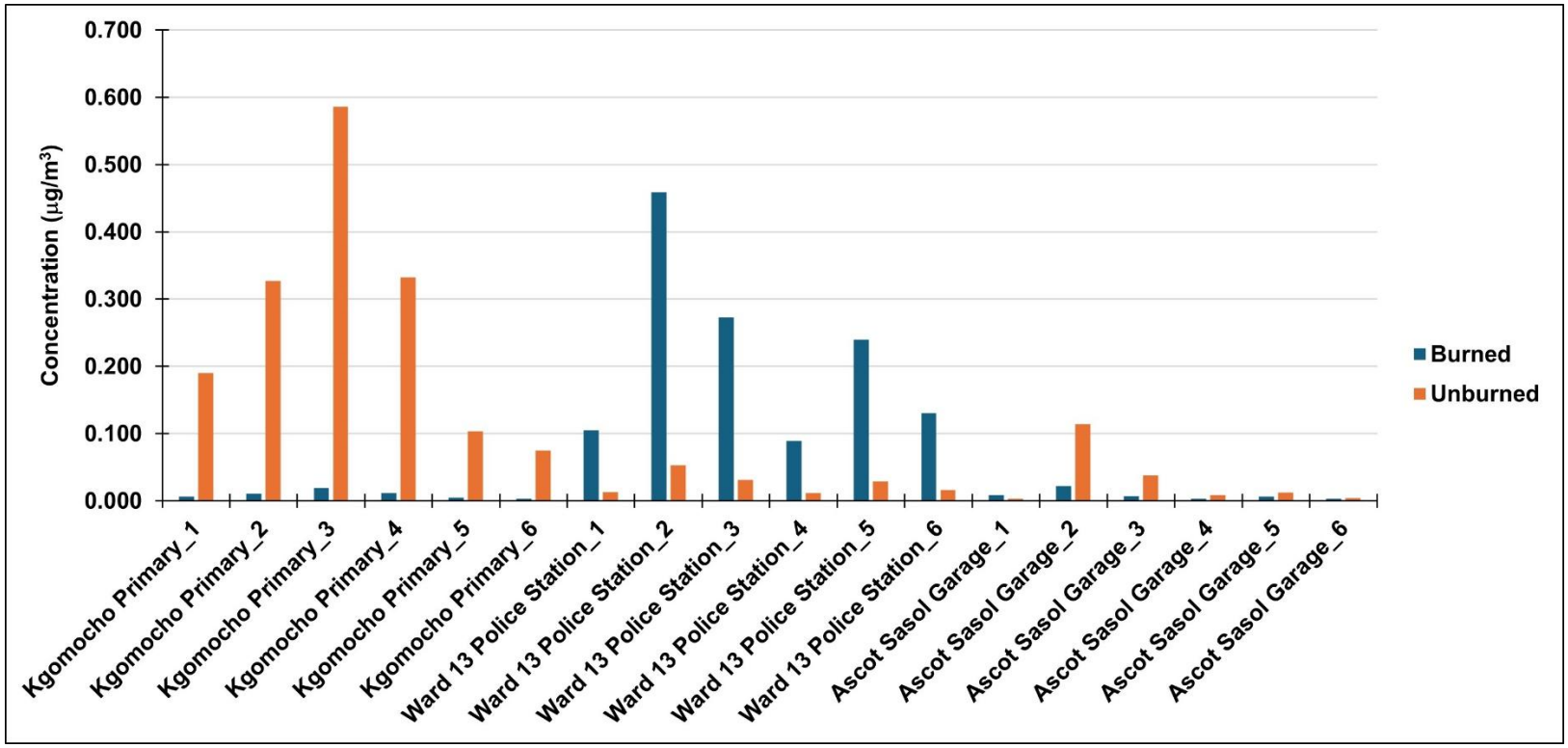


Figure 4-77: Simulated maximum 24-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 3 (5-days).

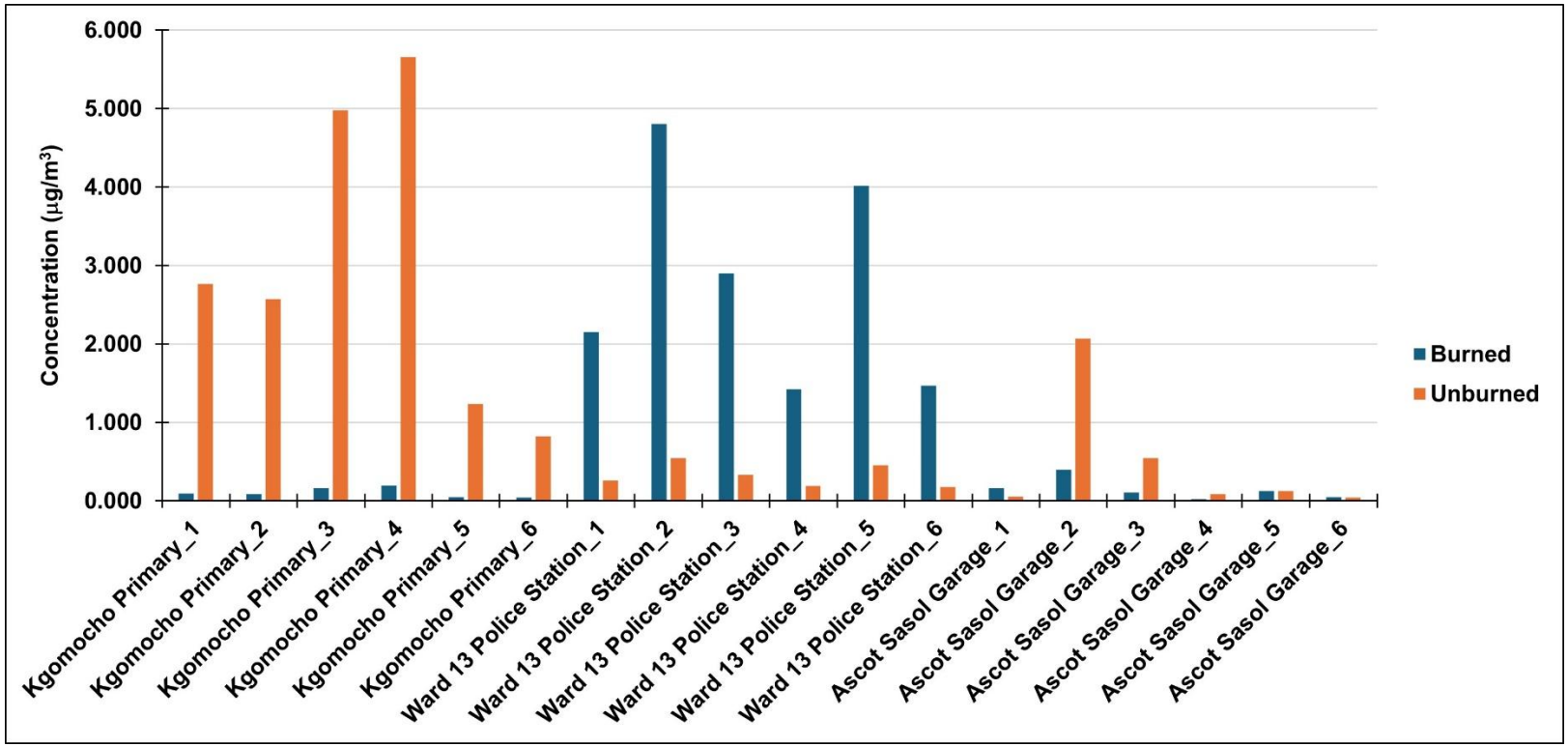


Figure 4-78: Simulated maximum 1-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 3 (5-days).

4.2.3.4 Nitrogen Dioxide (NO_2)

Figure 4-79 illustrates the simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 3 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 1.50 $\mu g/m^3$ and 1.10 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-80 illustrates the simulated maximum 1-hour ambient NO_2 concentrations over the Sharpeville region for Campaign 3. Maximum 1-hour concentrations of 24.20 $\mu g/m^3$ and 28.60 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for a 1-hour time average is 200 $\mu g/m^3$.

Table 4-12 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-81 and 4-82 is a graphical representation of Table 4-12.

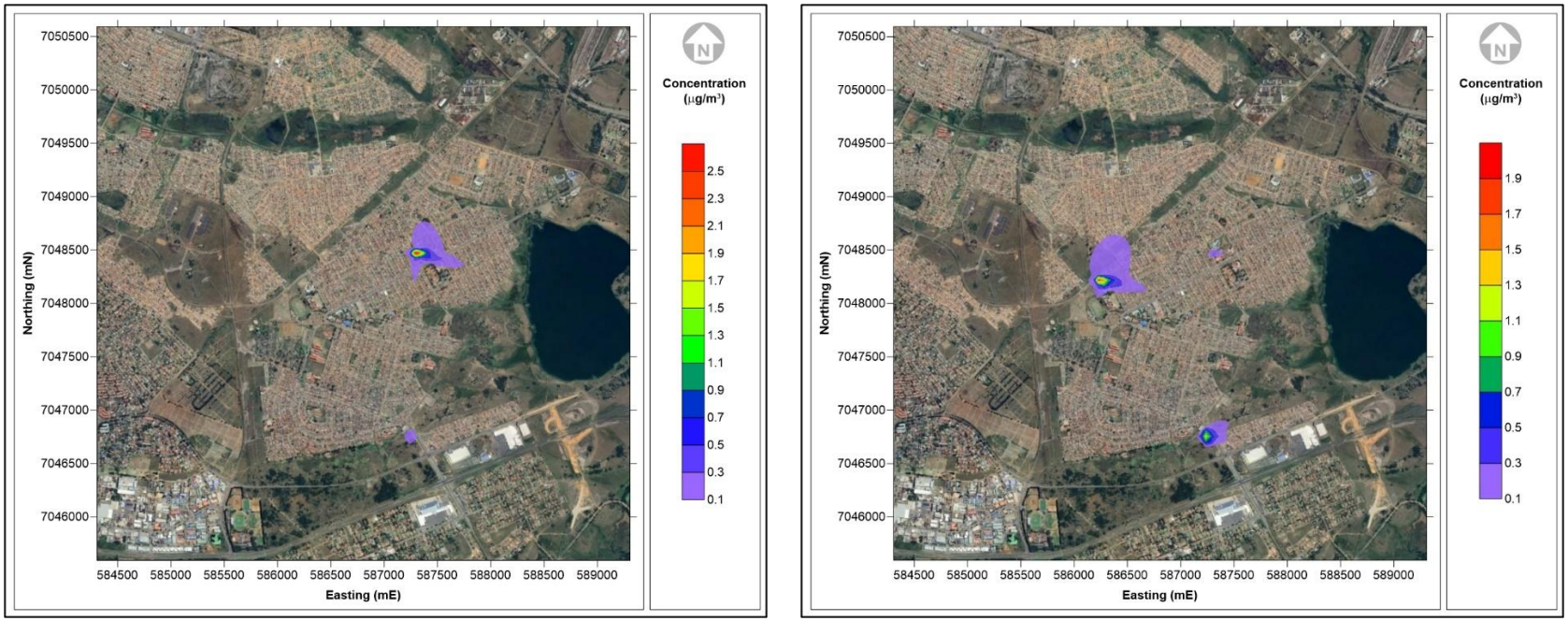


Figure 4-79 Simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 3 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

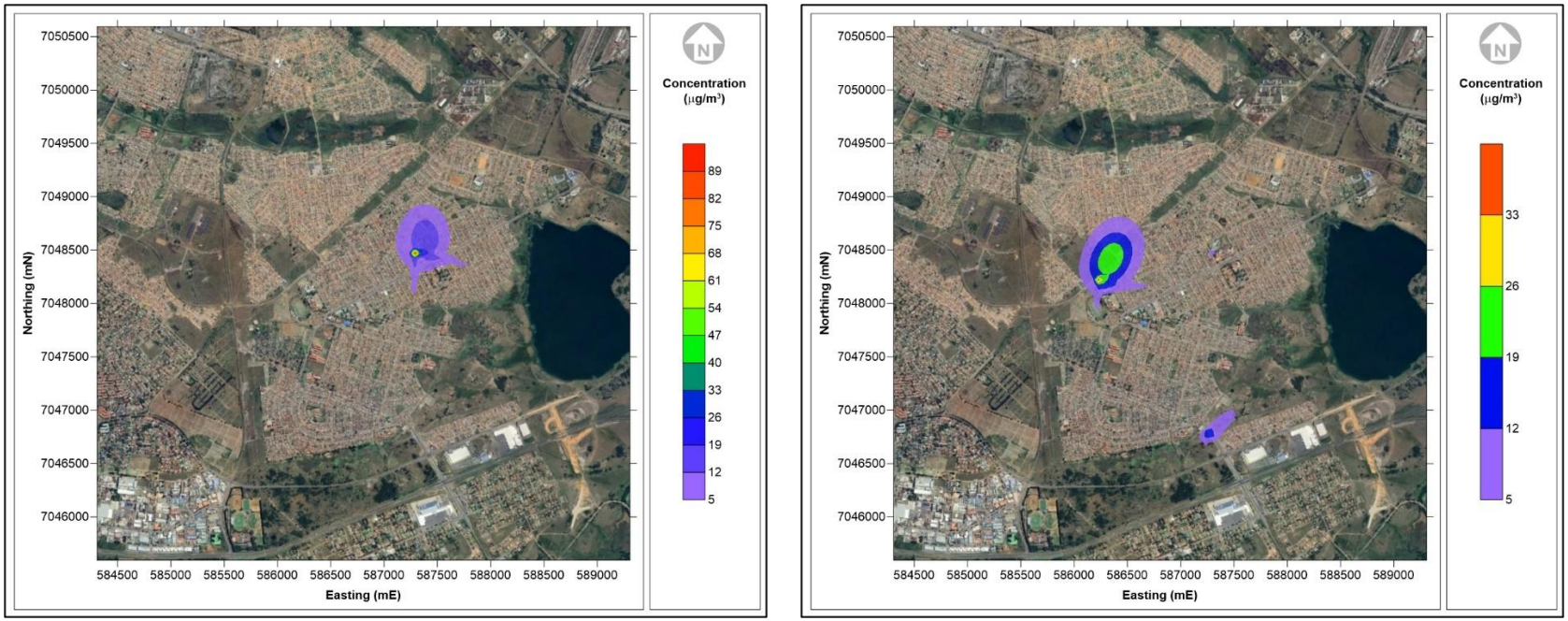


Figure 4-80: Simulated maximum 1-Hour ambient NO_2 concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-12: Simulated ambient NO_2 concentrations at the sensitive receptors for Campaign 3.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Kgomocho Primary_1	0.012	0.331	0.472	13.996
Kgomocho Primary_2	0.022	0.631	0.441	13.026
Kgomocho Primary_3	0.039	1.143	0.826	25.212
Kgomocho Primary_4	0.040	1.179	1.021	28.639
Kgomocho Primary_5	0.004	0.088	0.231	6.262
Kgomocho Primary_6	0.003	0.063	0.196	4.154
Ward 13 Police Station_1	0.093	0.013	10.872	1.307
Ward 13 Police Station_2	1.517	0.172	24.280	2.708
Ward 13 Police Station_3	0.404	0.048	14.653	1.634
Ward 13 Police Station_4	0.075	0.012	7.188	0.926
Ward 13 Police Station_5	0.202	0.026	20.298	2.264
Ward 13 Police Station_6	0.111	0.016	7.409	0.871
Ascot Sasol Garage_1	0.008	0.004	0.835	0.278
Ascot Sasol Garage_2	0.076	0.410	1.905	10.504
Ascot Sasol Garage_3	0.025	0.127	0.502	2.772
Ascot Sasol Garage_4	0.005	0.018	0.101	0.425
Ascot Sasol Garage_5	0.008	0.011	0.637	0.646
Ascot Sasol Garage_6	0.003	0.004	0.240	0.203

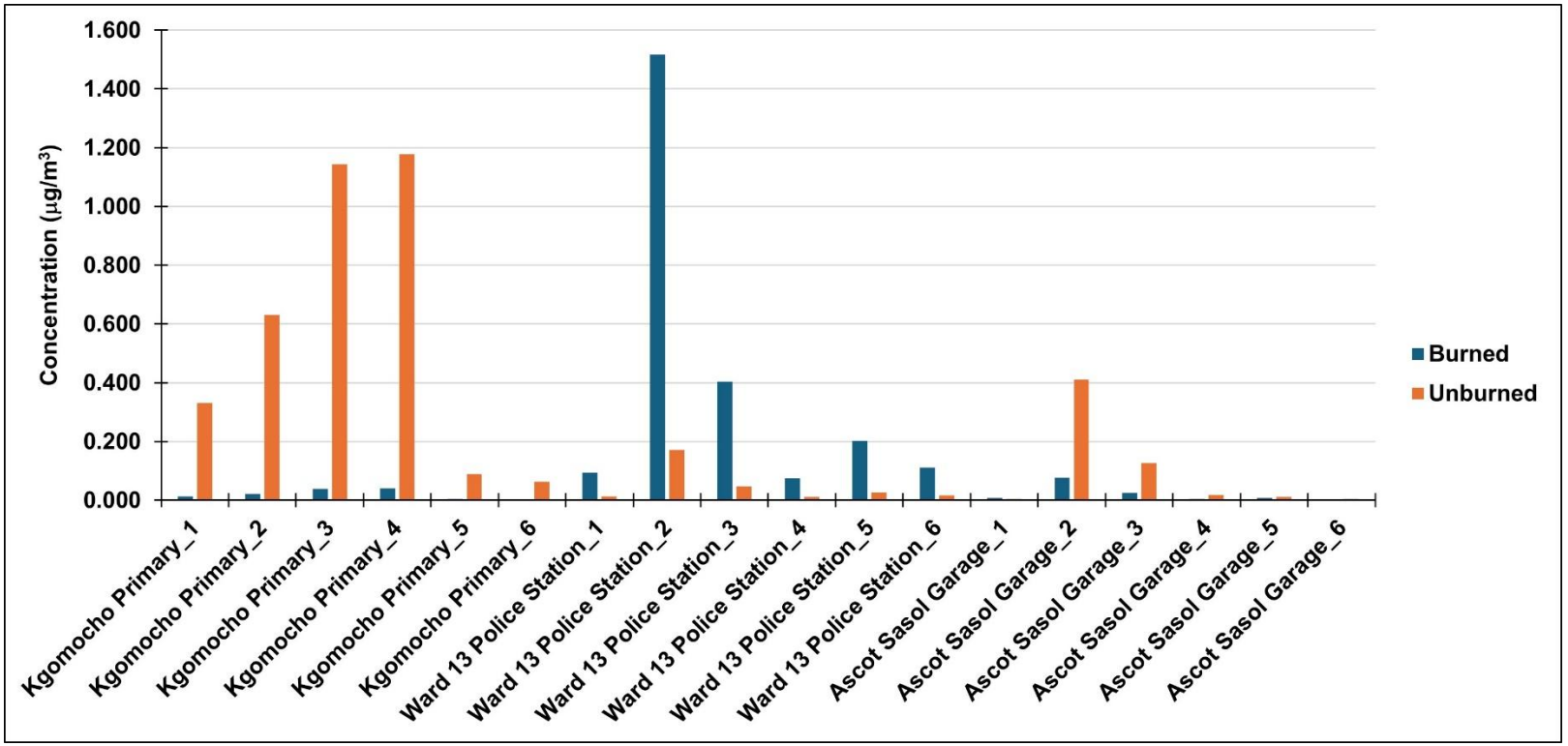


Figure 4-81: Simulated 5-day mean ambient NO_2 concentrations at the sensitive receptors for Campaign 3 (1-hour averages).

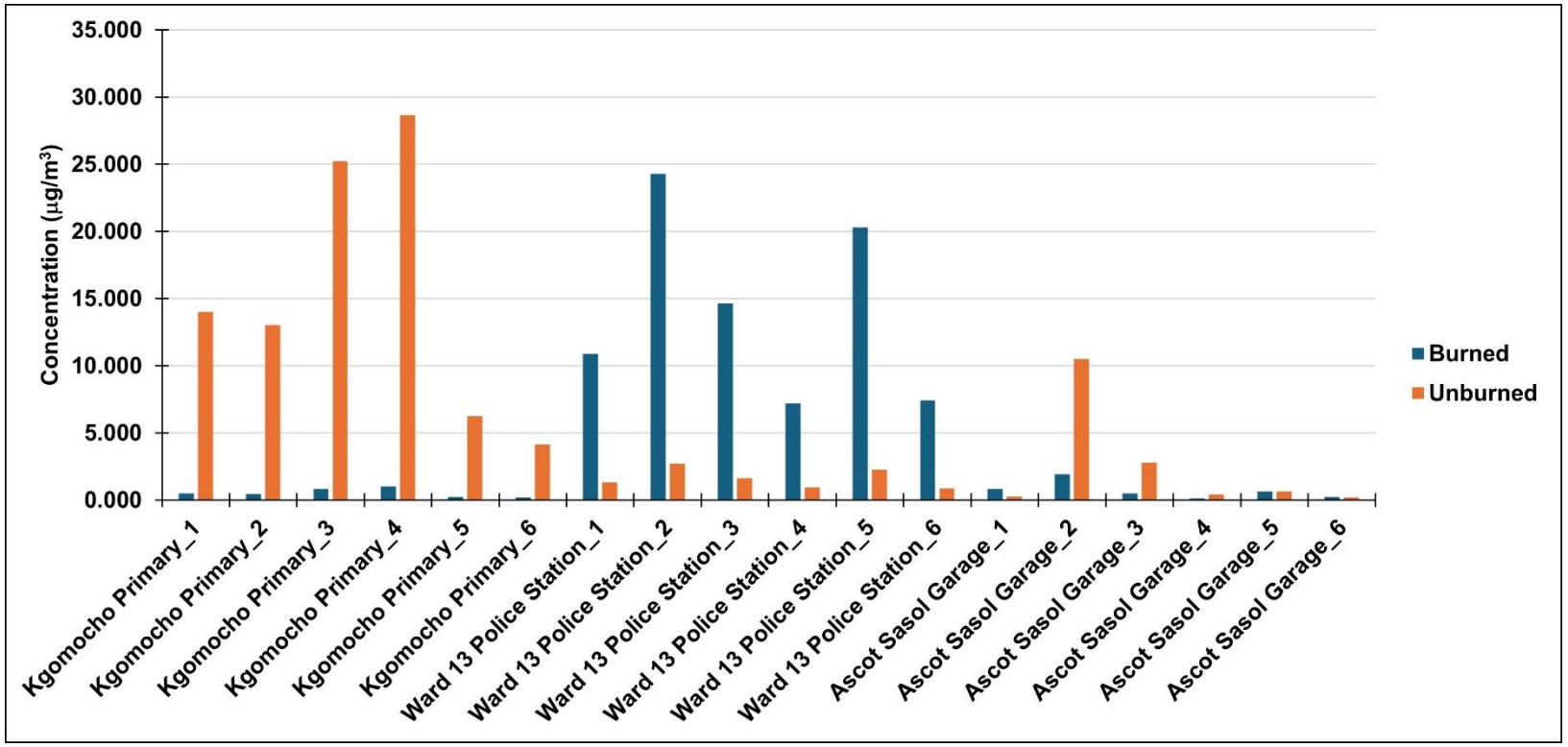


Figure 4-82: Simulated maximum 1-Hour ambient NO_2 concentrations at the sensitive receptors for Campaign 3 (5-days).

4.2.4 CAMPAIGN 4

Figure 4-83 is a map detailing the two waste collection sites during campaign 4, whilst Figure 4-84 is indicative of the two sites where waste burning practices were conducted.

Figure 4-83: Location of the waste collection sites during Campaign 4.

Figure 4-84: Location of the waste burning sites during Campaign 4.

Figures 4-85 and 4-86 are detailed maps of the sites where waste burning practices were conducted, as well as the location of sensitive receptors around the burning sites.

Figure 4-85: Vuka Cemetery Ward 14 waste burning site and sensitive receptors near the site.

Figure 4-86: Phumasibathe waste burning site and sensitive receptors near the site.

4.2.4.1 Particulate Matter (PM_{10})

Figure 4-87 illustrates the simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 4 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 2.06 $\mu g/m^3$ and 0.86 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-88 illustrates the simulated maximum 24-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 4. Maximum 24-hour concentrations of 3.95 $\mu g/m^3$ and 1.57 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for a 24-hour time average is 75 $\mu g/m^3$.

Figure 4-89 illustrates the simulated maximum 1-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 4. Maximum 1-hour concentrations of 44.10 $\mu g/m^3$ and 12.99 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No PM_{10} NAAQS standard exist for a 1-hour time average.

Table 4-13 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-90 to 4-92 is a graphical representation of Table 4-13.

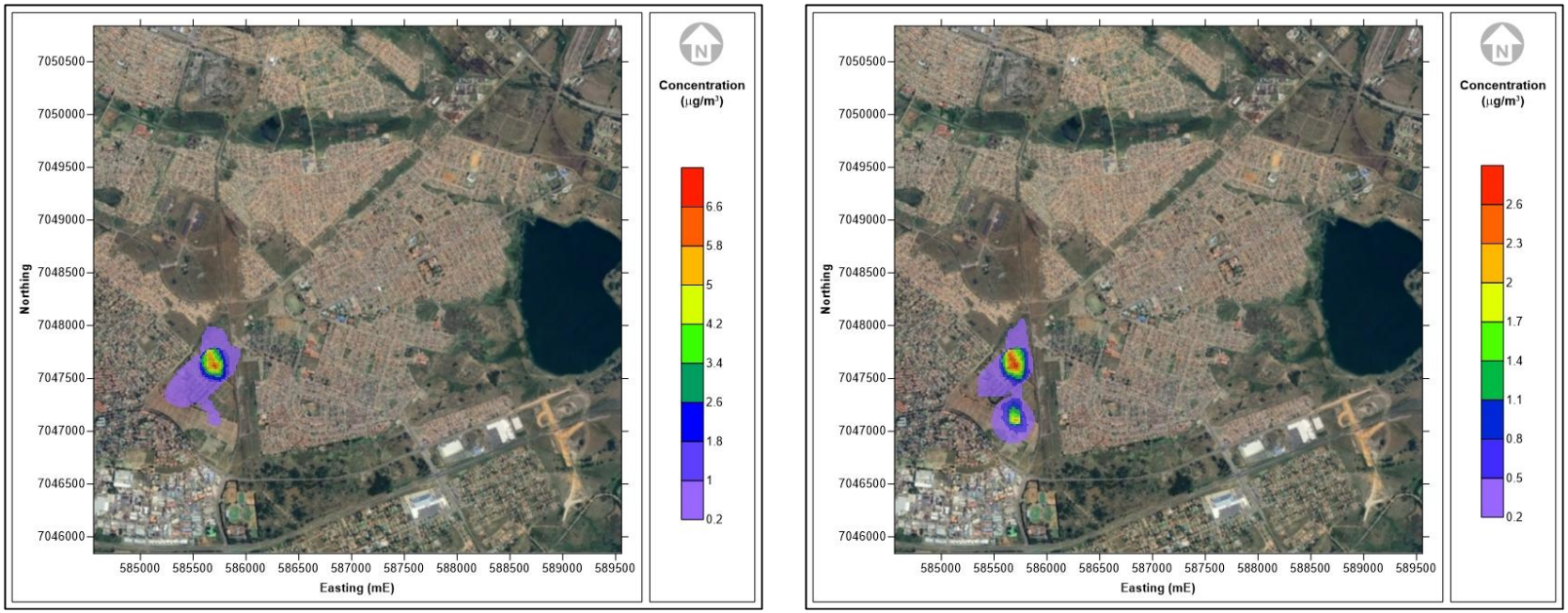


Figure 4-87: Simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 4 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

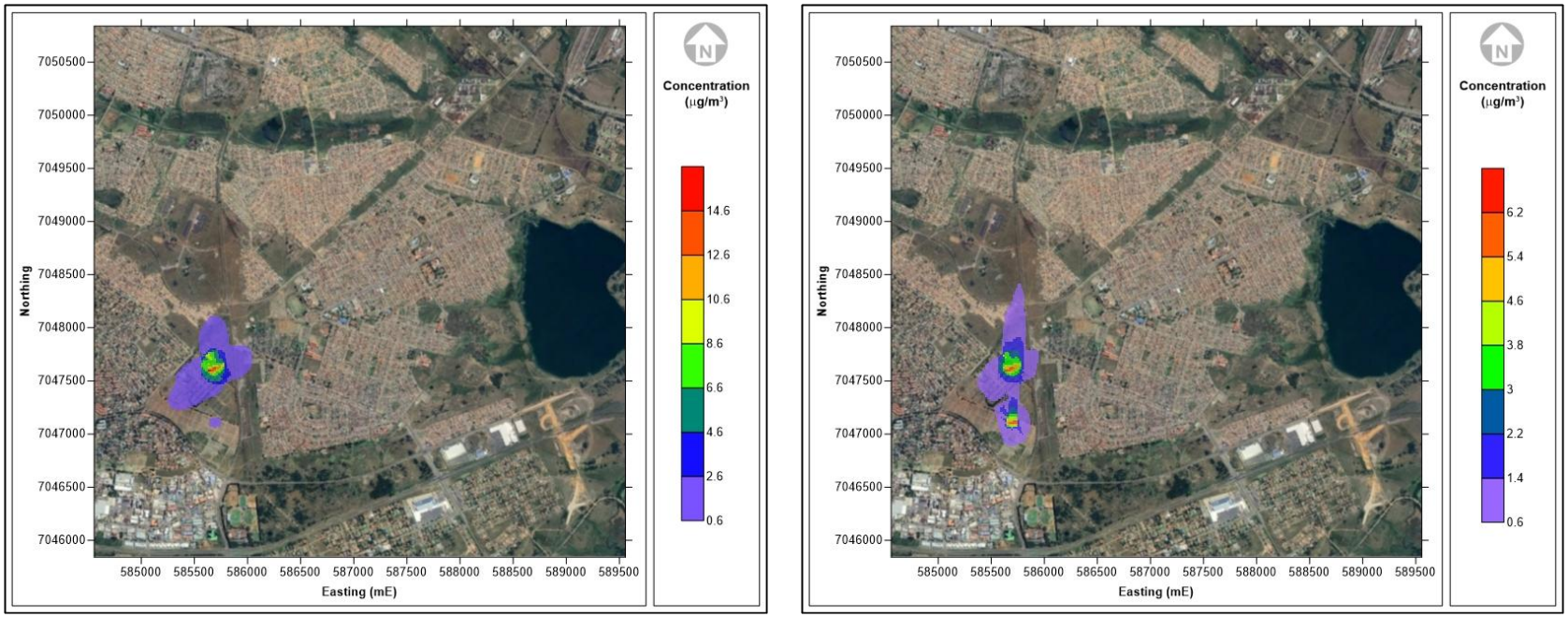


Figure 4-88: Simulated maximum 24-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

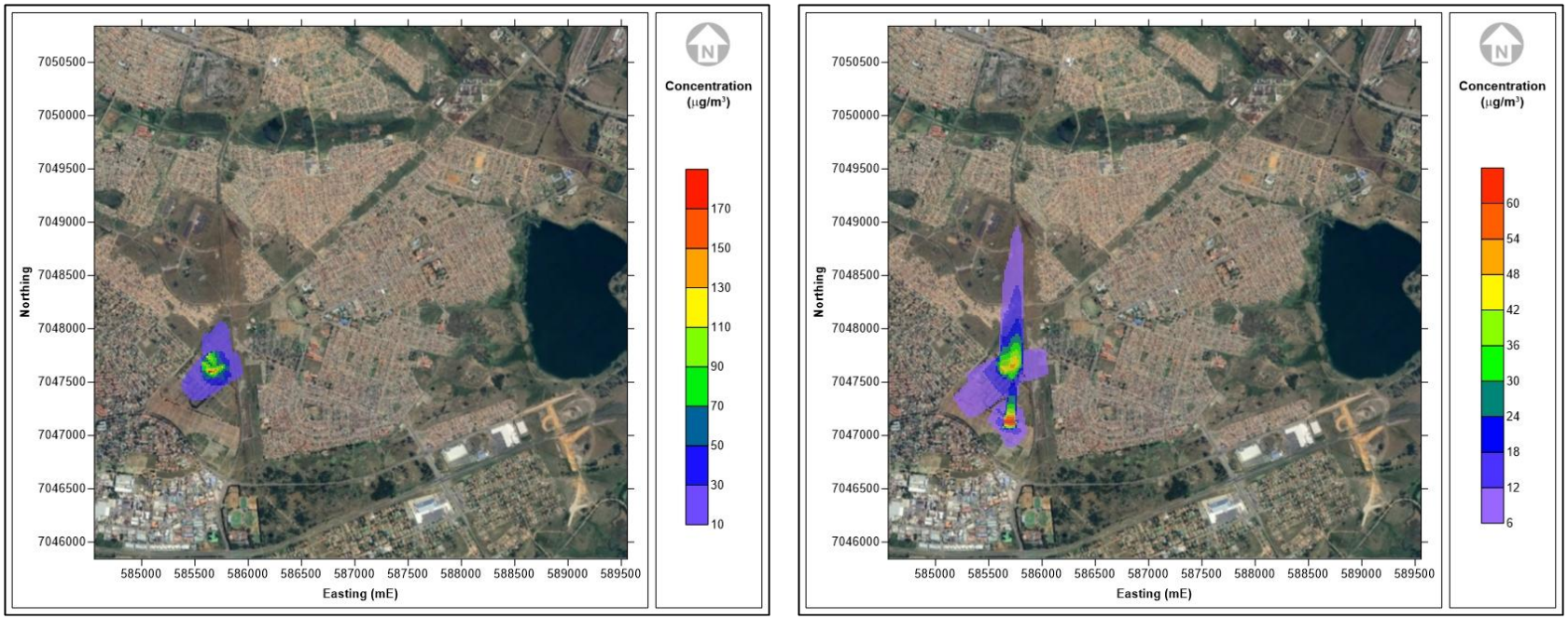


Figure 4-89: Simulated maximum 1-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-13: Simulated ambient PM_{10} concentrations at the sensitive receptors for Campaign 4.

Receptor	Burned 5-Day Average ($mg.m^{-3}$)	Unburned 5-Day Average ($mg.m^{-3}$)	Burned 24-Hr Maximum ($mg.m^{-3}$)	Unburned 24-Hr Maximum ($mg.m^{-3}$)	Burned 1-Hr Maximum ($mg.m^{-3}$)	Unburned 1-Hr Maximum ($mg.m^{-3}$)
Vuka Cemetery_1	0.61	0.38	1.54	0.94	18.05	12.68
Vuka Cemetery_2	0.64	0.36	2.07	1.00	24.20	10.13
Vuka Cemetery_3	0.03	0.17	0.07	0.34	0.63	2.89
Vuka Cemetery_4	0.04	0.23	0.12	0.59	1.08	4.70
Vuka Cemetery_5	0.00	0.00	0.00	0.00	0.00	0.00
Vuka Cemetery_6	0.00	0.00	0.00	0.00	0.00	0.00
Vuka Cemetery_7	0.16	0.12	0.43	0.34	5.41	5.51
Phumasibathe_1	1.78	0.79	2.96	1.19	33.09	9.89
Phumasibathe_2	2.06	0.86	3.95	1.57	44.10	12.99
Phumasibathe_3	0.22	0.15	1.09	0.73	12.75	9.84
Phumasibathe_4	0.02	0.02	0.07	0.05	0.88	0.95
Phumasibathe_5	0.02	0.01	0.11	0.05	1.98	0.75
Phumasibathe_6	0.00	0.01	0.01	0.03	0.15	0.34

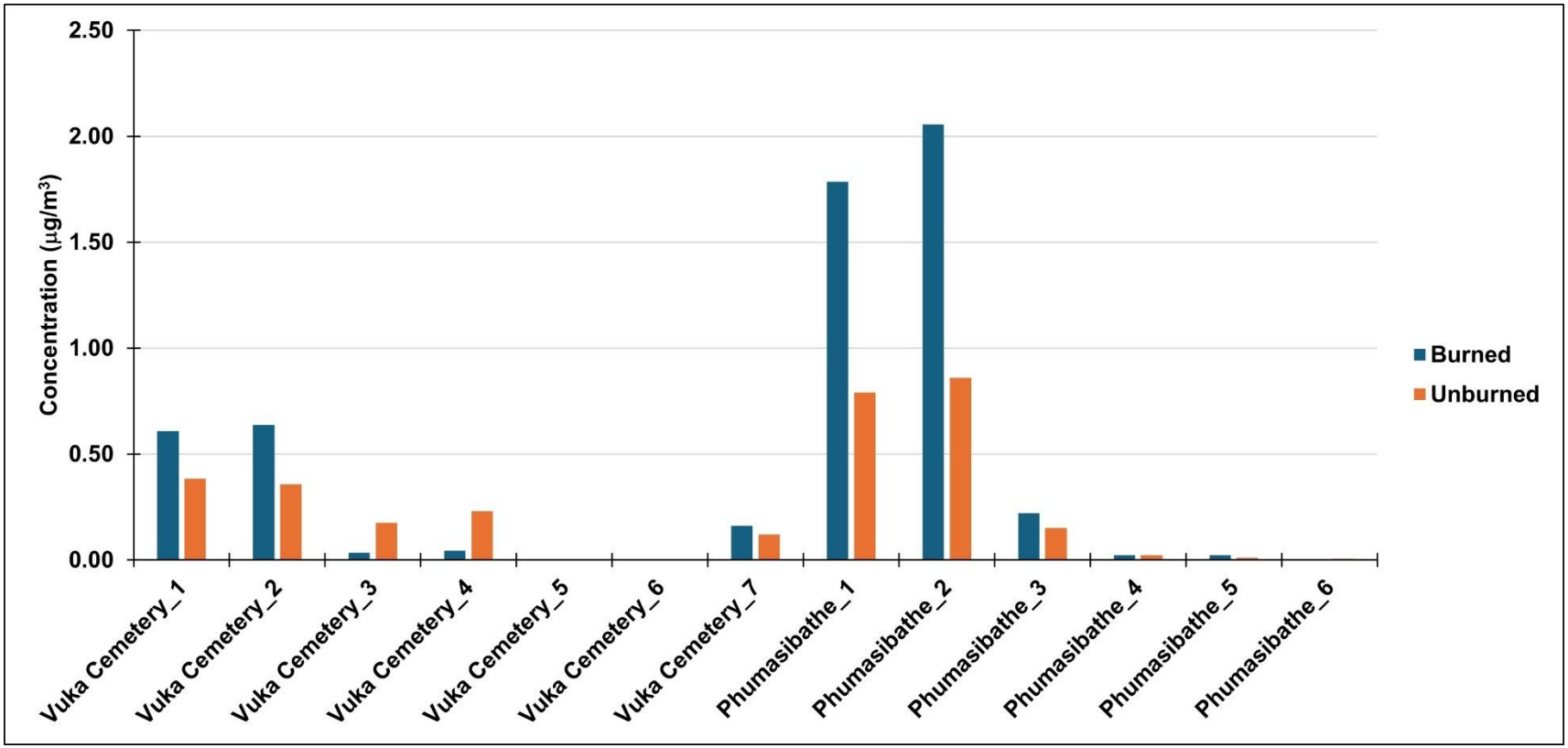


Figure 4-90: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (1-hour averages).

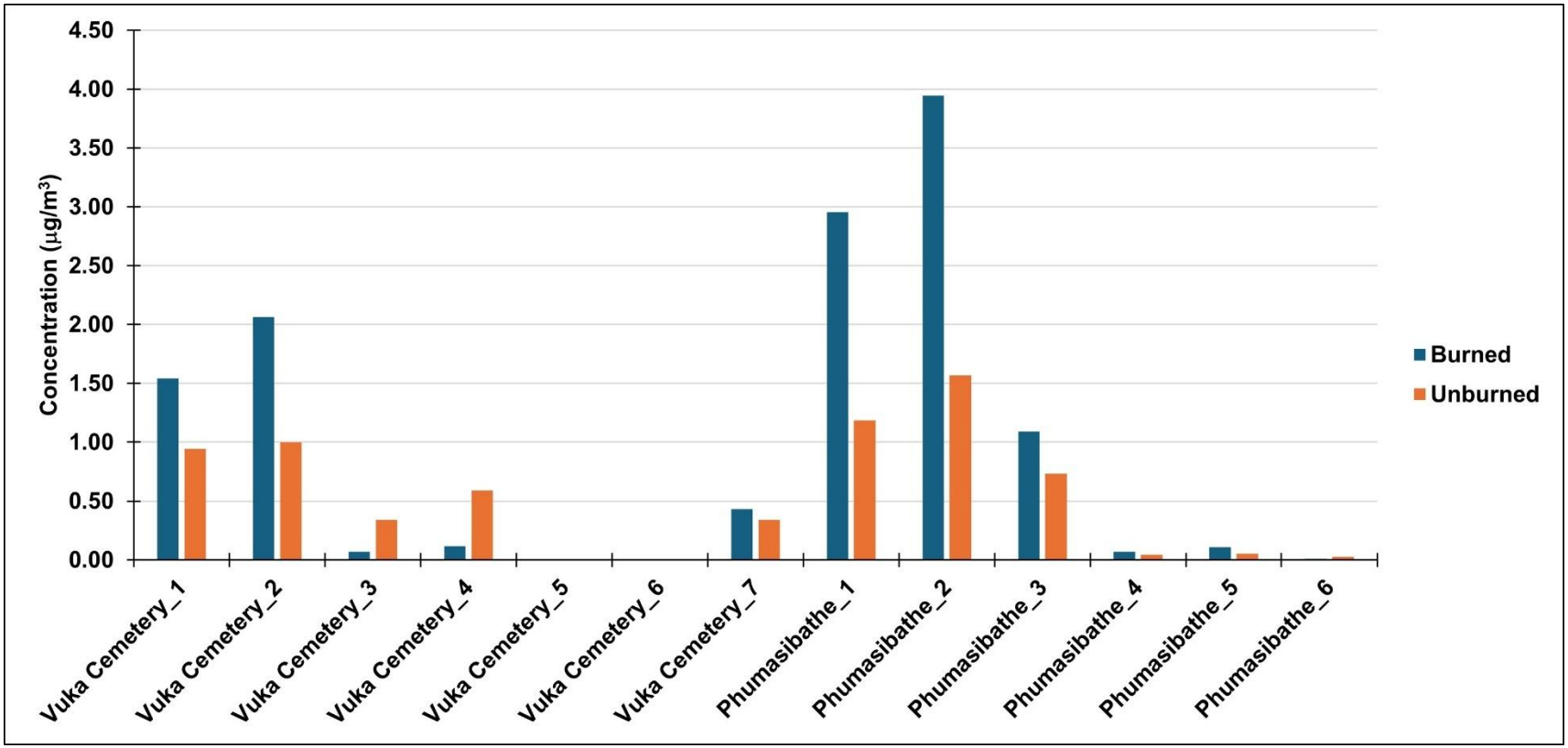


Figure 4-91: Simulated maximum 24-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (5-days).

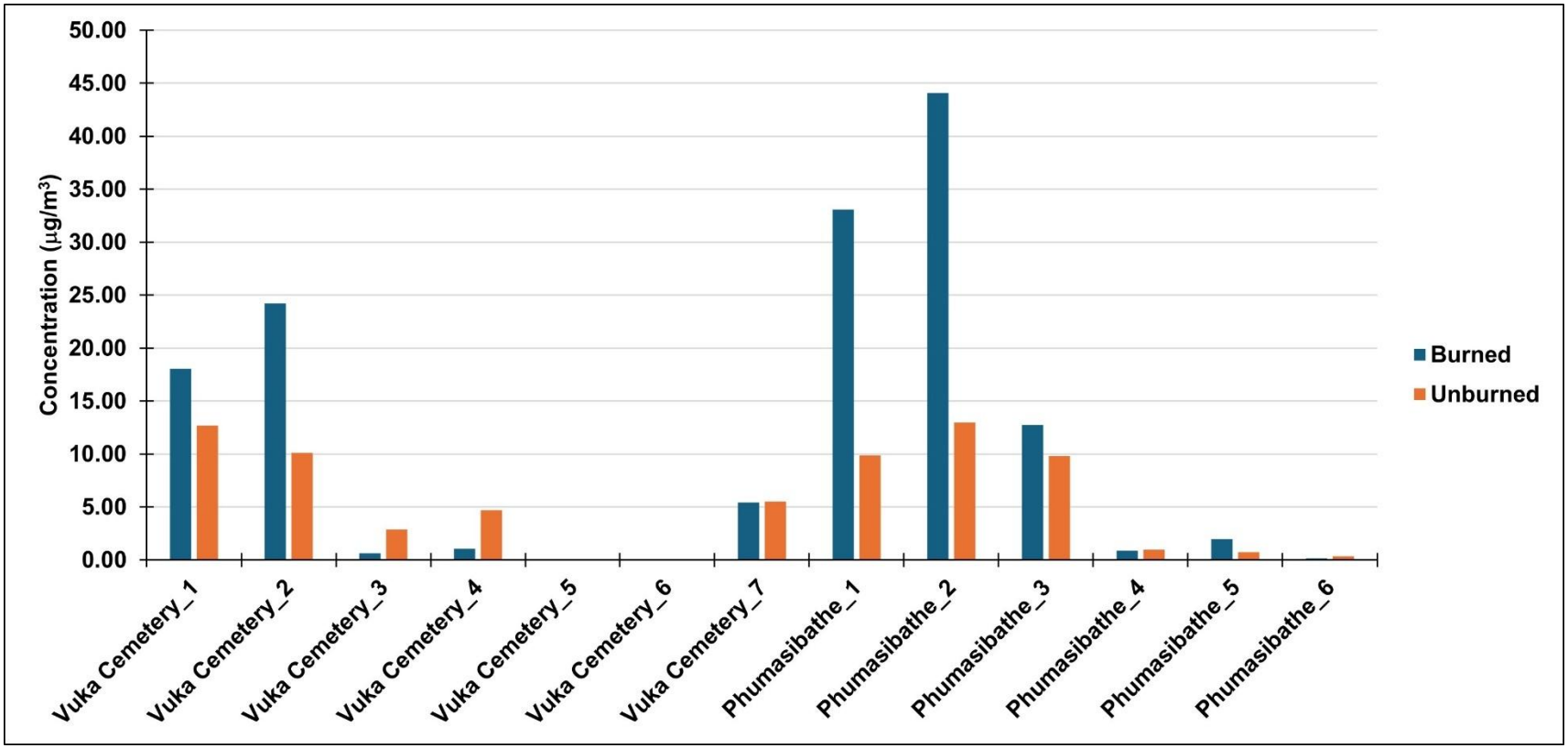


Figure 4-92: Simulated maximum 1-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 3 (5-days).

4.2.4.2 Particulate Matter ($PM_{2.5}$)

Figure 4-93 illustrates the simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 4 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 2.05 $\mu g/m^3$ and 0.86 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for an annual time average is 20 $\mu g/m^3$.

Figure 4-94 illustrates the simulated maximum 24-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 4. Maximum 24-hour concentrations of 3.93 $\mu g/m^3$ and 1.56 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for a 24-hour time average is 40 $\mu g/m^3$.

Figure 4-95 illustrates the simulated maximum 1-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 4. Maximum 1-hour concentrations of 43.93 $\mu g/m^3$ and 12.95 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No $PM_{2.5}$ NAAQS standard exist for a 1-hour time average.

Table 4-14 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-94 to 4-96 is a graphical representation of Table 4-14.

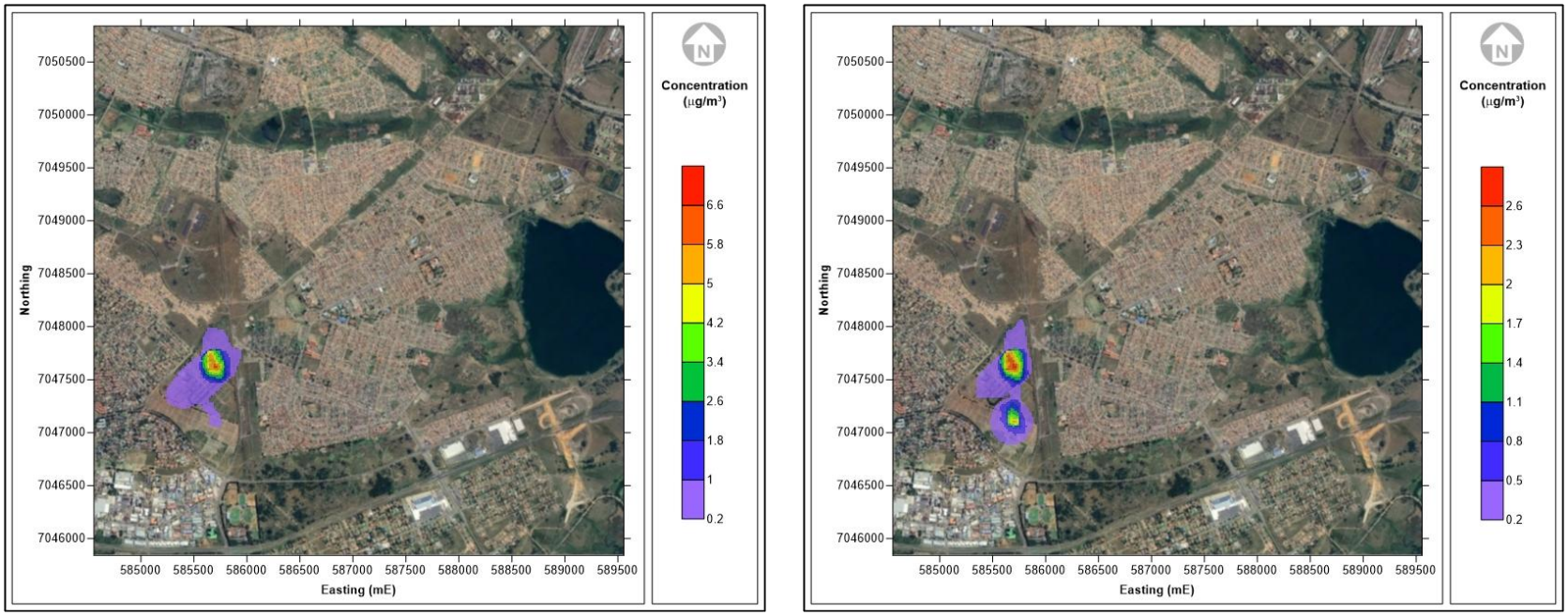


Figure 4-93 Simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 4 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

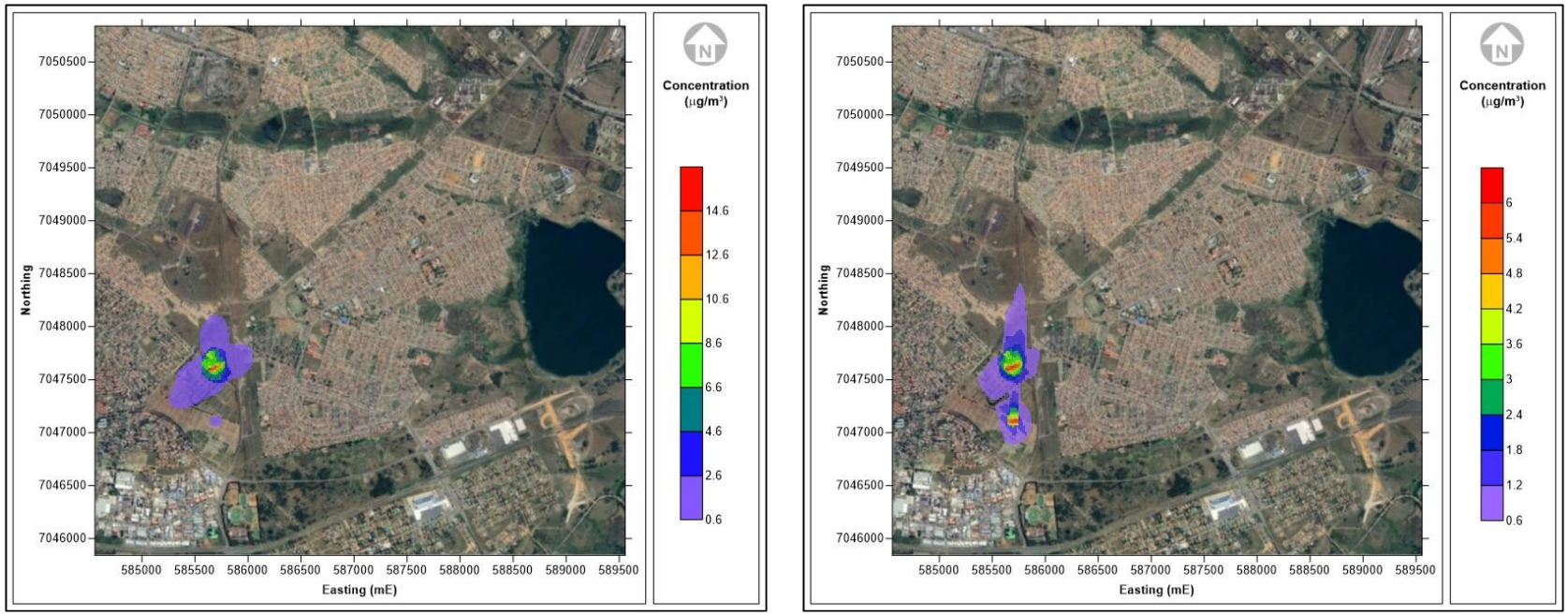


Figure 4-94: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 4 (5-days). Impact of burned waste (left), and unburnt waste (right).

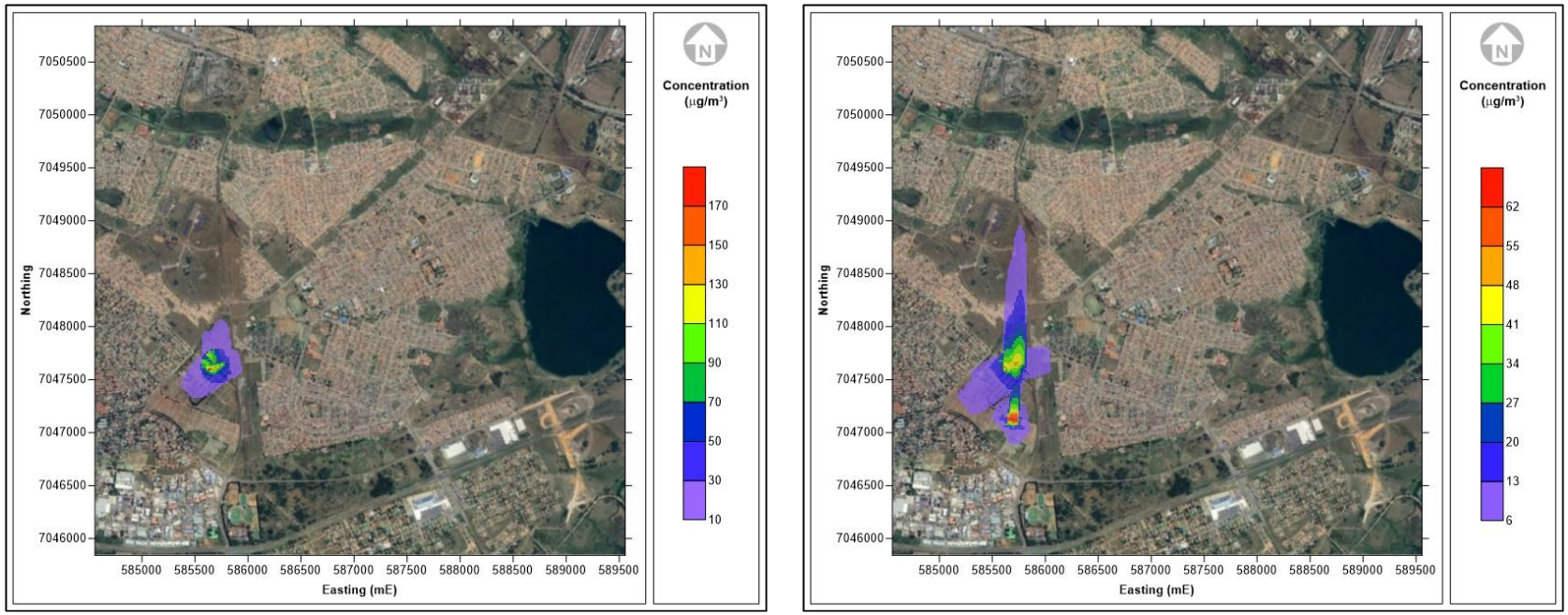


Figure 4-95: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 4 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-14: Simulated ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 4.

Receptor	Burned 5-Day Average ($mg.m^{-3}$)	Unburned 5-Day Average ($mg.m^{-3}$)	Burned 24-Hr Maximum ($mg.m^{-3}$)	Unburned 24-Hr Maximum ($mg.m^{-3}$)	Burned 1-Hr Maximum ($mg.m^{-3}$)	Unburned 1-Hr Maximum ($mg.m^{-3}$)
Vuka Cemetery_1	0.61	0.38	1.54	0.94	17.98	12.65
Vuka Cemetery_2	0.64	0.36	2.06	1.00	24.11	10.10
Vuka Cemetery_3	0.03	0.17	0.07	0.34	0.62	2.88
Vuka Cemetery_4	0.04	0.23	0.12	0.59	1.07	4.68
Vuka Cemetery_5	0.00	0.00	0.00	0.00	0.00	0.00
Vuka Cemetery_6	0.00	0.00	0.00	0.00	0.00	0.00
Vuka Cemetery_7	0.16	0.12	0.43	0.34	5.39	5.49
Phumasibathe_1	1.78	0.79	2.94	1.18	32.96	9.86
Phumasibathe_2	2.05	0.86	3.93	1.56	43.93	12.95
Phumasibathe_3	0.22	0.15	1.09	0.73	12.70	9.81
Phumasibathe_4	0.02	0.02	0.07	0.05	0.88	0.95
Phumasibathe_5	0.02	0.01	0.11	0.05	1.97	0.75
Phumasibathe_6	0.00	0.01	0.01	0.03	0.15	0.33

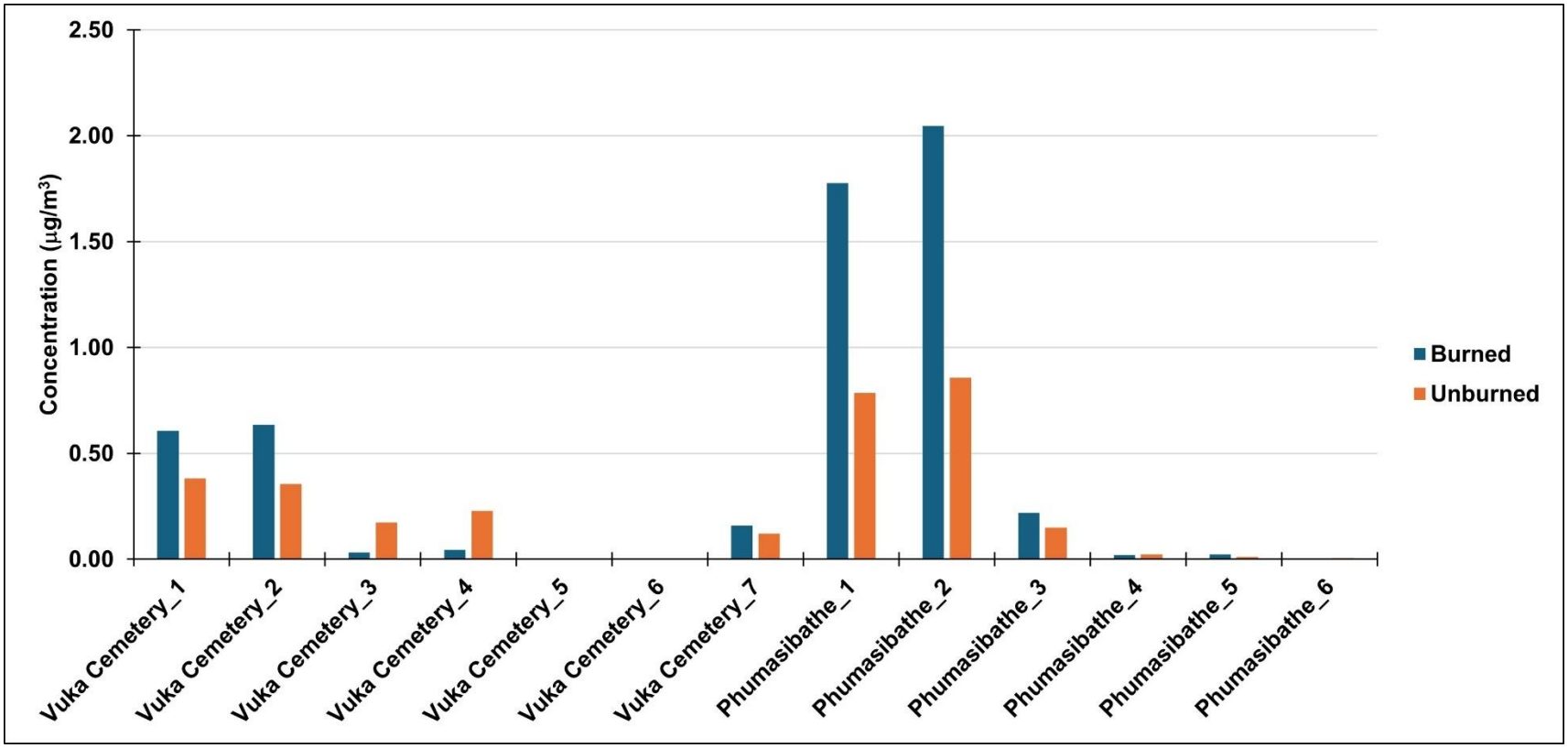


Figure 4-96: Simulated 5-day mean ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 4 (1-hour averages).

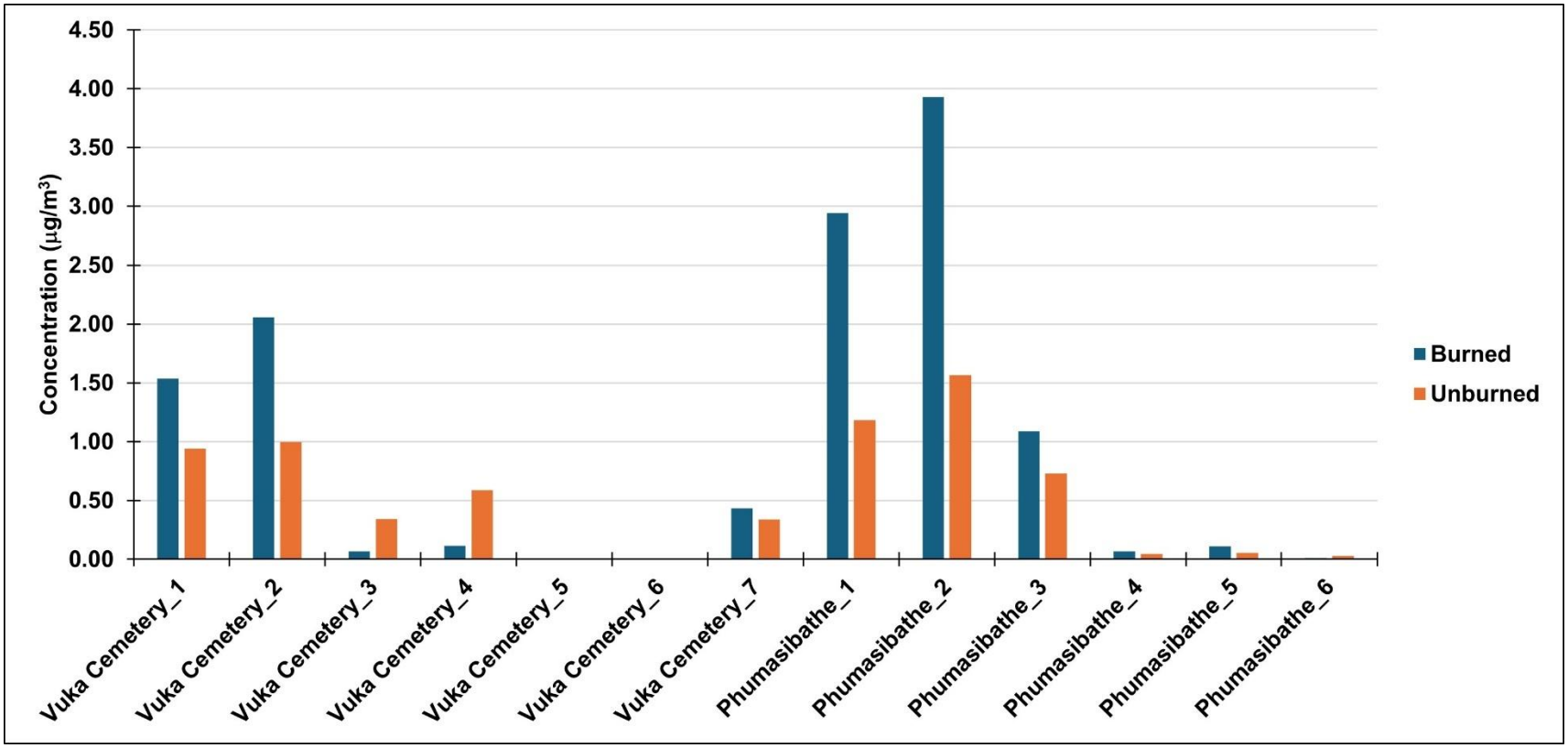


Figure 4-97: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 4 (5-days).

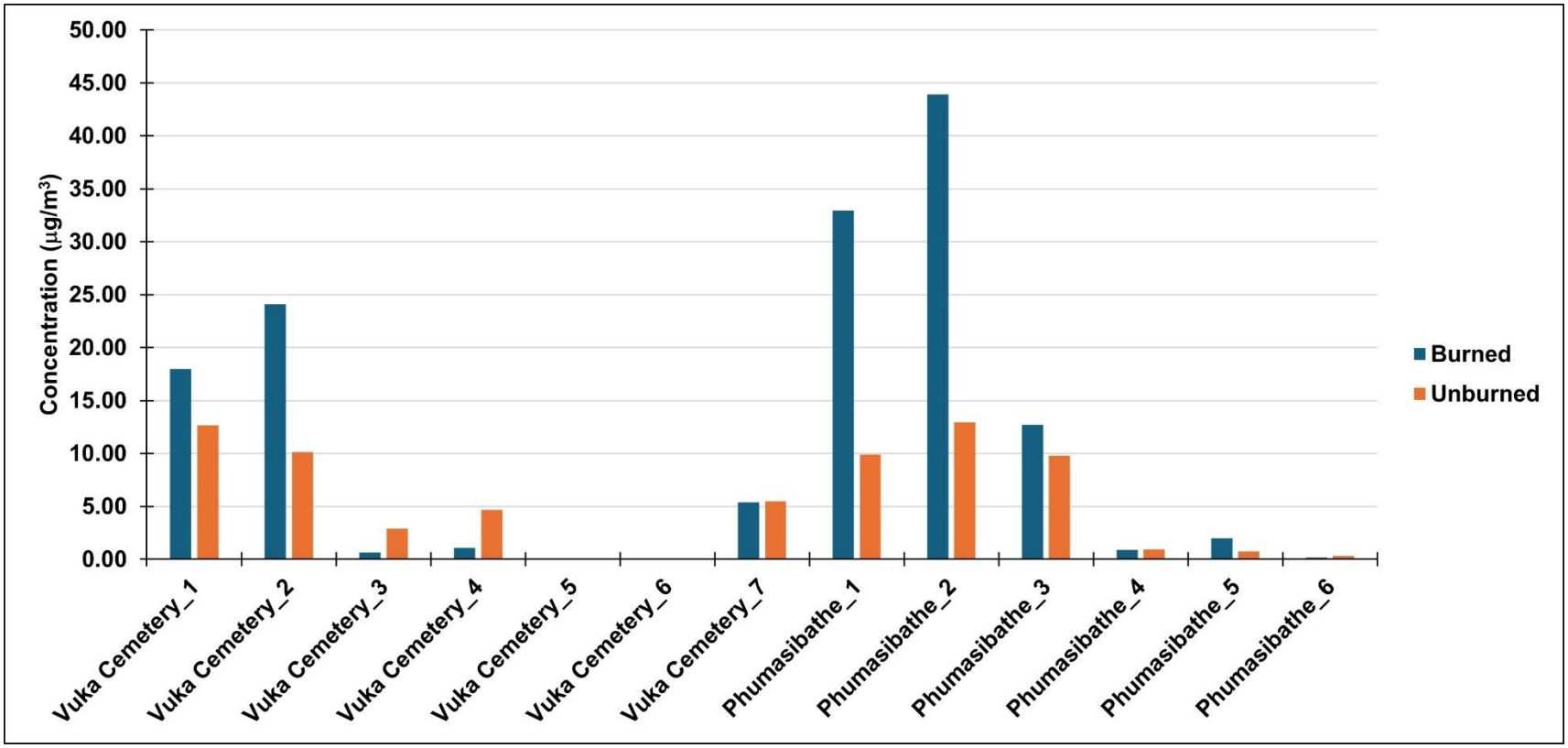


Figure 4-98: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 4 (5-days).

4.2.4.3 Sulphur Dioxide (SO_2)

Figure 4-99 illustrates the simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 4 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.04 $\mu g/m^3$ and 0.02 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for an annual time average is 50 $\mu g/m^3$.

Figure 4-100 illustrates the simulated maximum 24-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 4. Maximum 24-hour concentrations of 0.08 $\mu g/m^3$ and 0.03 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 24-hour time average is 125 $\mu g/m^3$.

Figure 4-101 illustrates the simulated maximum 1-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 4. Maximum 1-hour concentrations of 0.90 $\mu g/m^3$ and 0.27 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Table 4-15 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-102 to 4-104 is a graphical representation of Table 4-15.

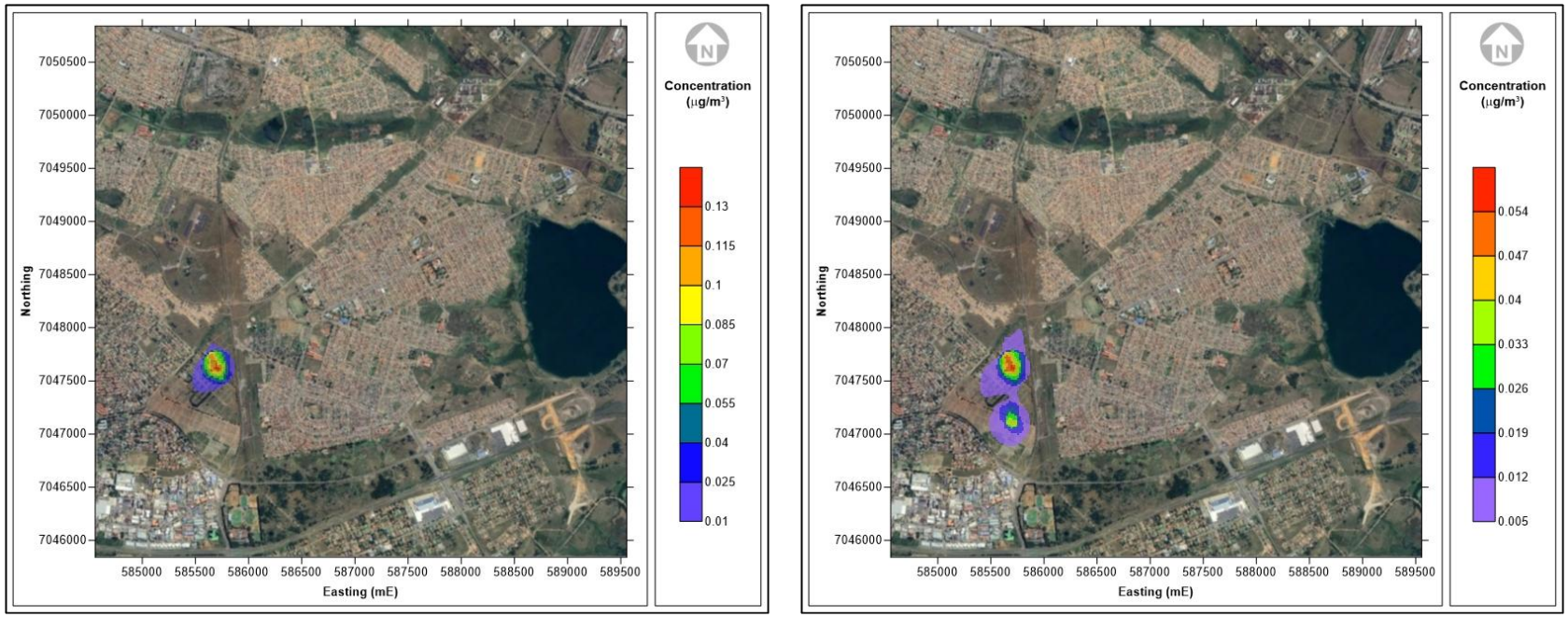


Figure 4-99: Simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 4 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

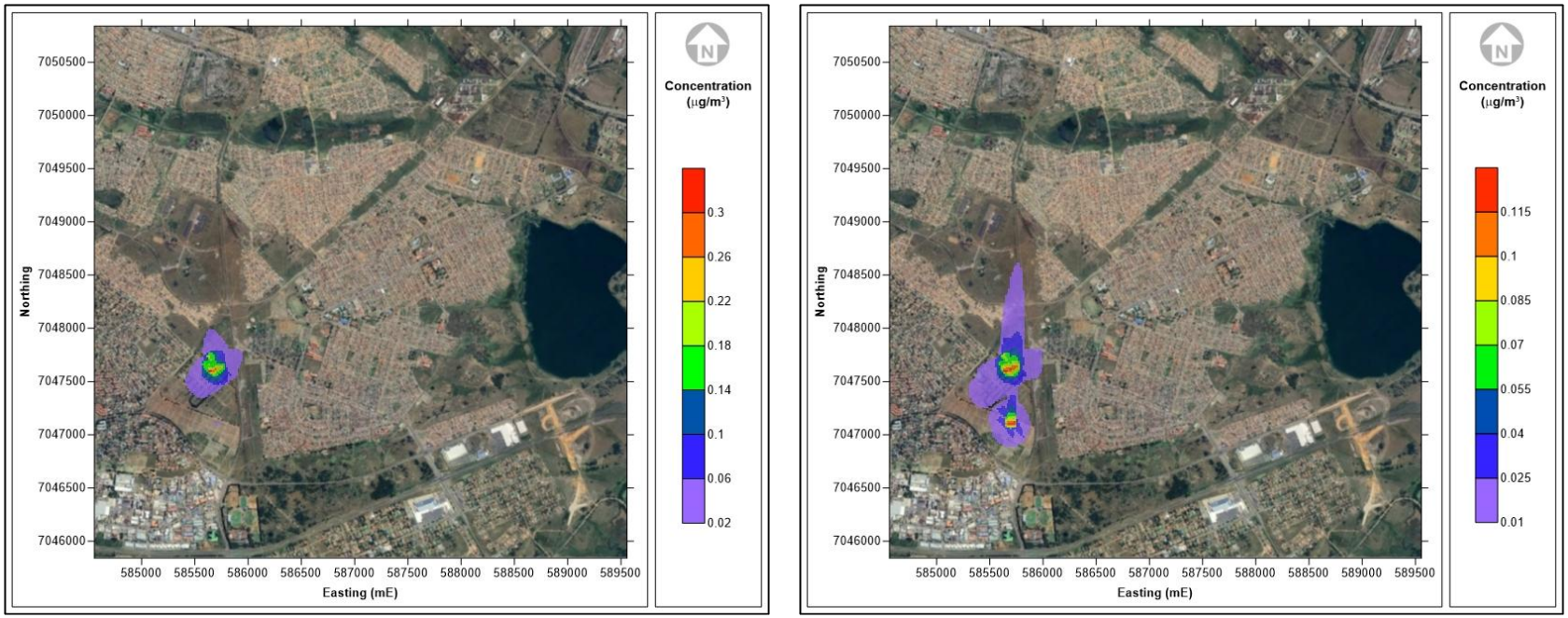


Figure 4-100: Simulated maximum 24-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 4 (5-days). Impact of burned waste (left), and unburnt waste (right).

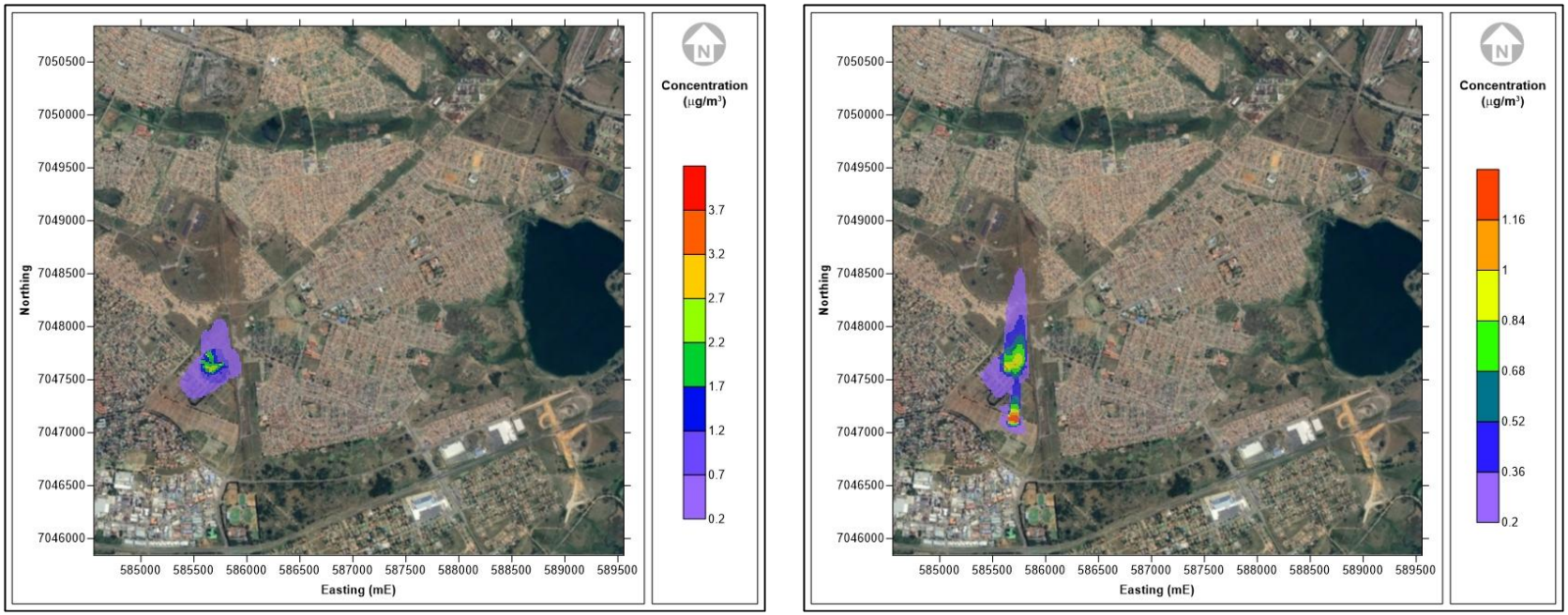


Figure 4-101: Simulated maximum 1-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 4 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-15: Simulated ambient SO_2 concentrations at the sensitive receptors for Campaign 4.

Receptor	Burned 5-Day Average ($mg.m^{-3}$)	Unburned 5-Day Average ($mg.m^{-3}$)	Burned 24-Hr Maximum ($mg.m^{-3}$)	Unburned 24-Hr Maximum ($mg.m^{-3}$)	Burned 1-Hr Maximum ($mg.m^{-3}$)	Unburned 1-Hr Maximum ($mg.m^{-3}$)
Vuka Cemetery_1	0.012	0.008	0.031	0.019	0.367	0.261
Vuka Cemetery_2	0.013	0.007	0.042	0.021	0.492	0.208
Vuka Cemetery_3	0.001	0.004	0.001	0.007	0.013	0.059
Vuka Cemetery_4	0.001	0.005	0.002	0.012	0.022	0.095
Vuka Cemetery_5	0.000	0.000	0.000	0.000	0.000	0.000
Vuka Cemetery_6	0.000	0.000	0.000	0.000	0.000	0.000
Vuka Cemetery_7	0.003	0.002	0.009	0.007	0.110	0.113
Phumasibathe_1	0.036	0.016	0.060	0.024	0.673	0.203
Phumasibathe_2	0.042	0.018	0.080	0.032	0.896	0.267
Phumasibathe_3	0.004	0.003	0.022	0.015	0.259	0.202
Phumasibathe_4	0.000	0.000	0.001	0.001	0.018	0.019
Phumasibathe_5	0.000	0.000	0.002	0.001	0.040	0.015
Phumasibathe_6	0.000	0.000	0.000	0.001	0.003	0.007

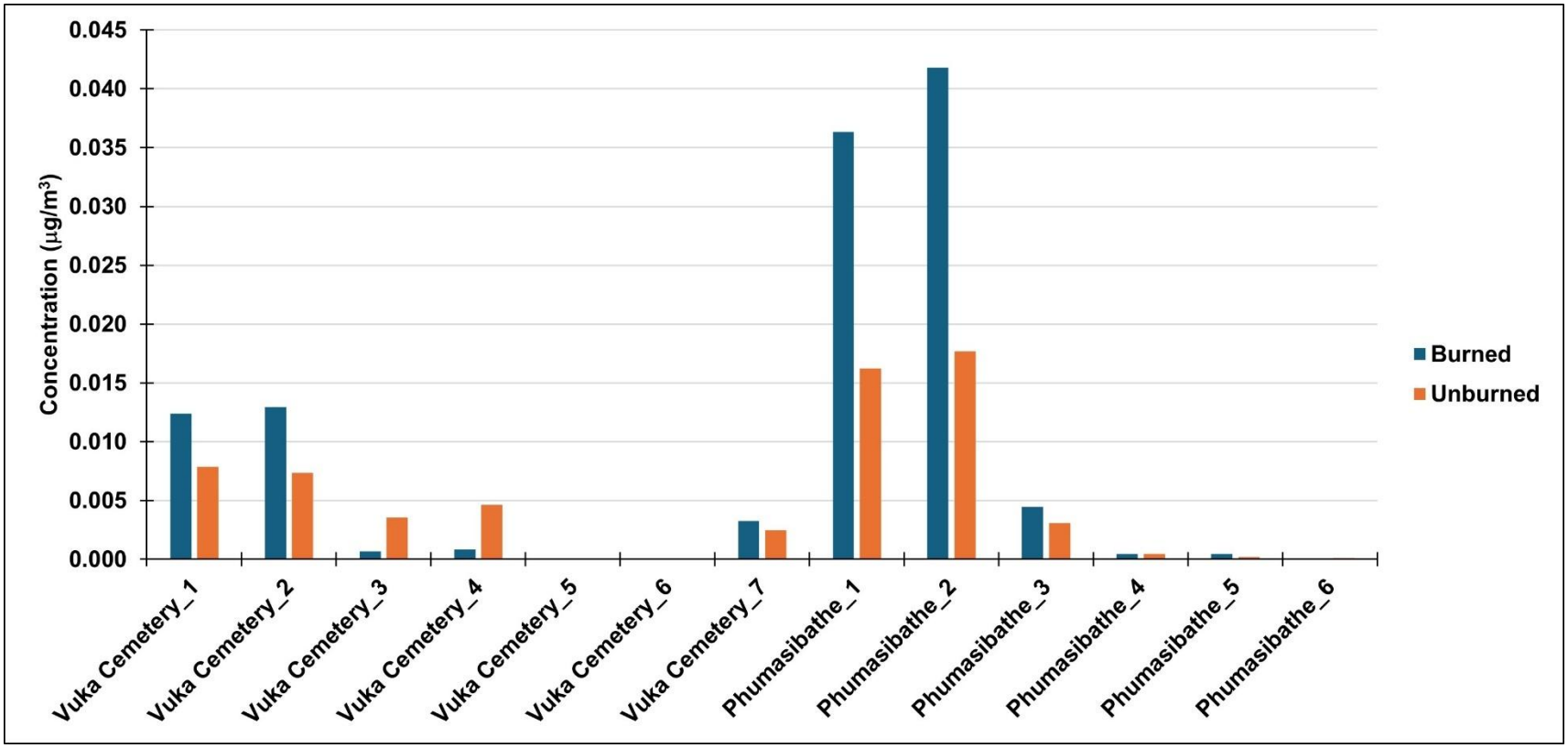


Figure 4-102: Simulated 5-day mean ambient SO_2 concentrations at the sensitive receptors for Campaign 4 (1-hour averages).

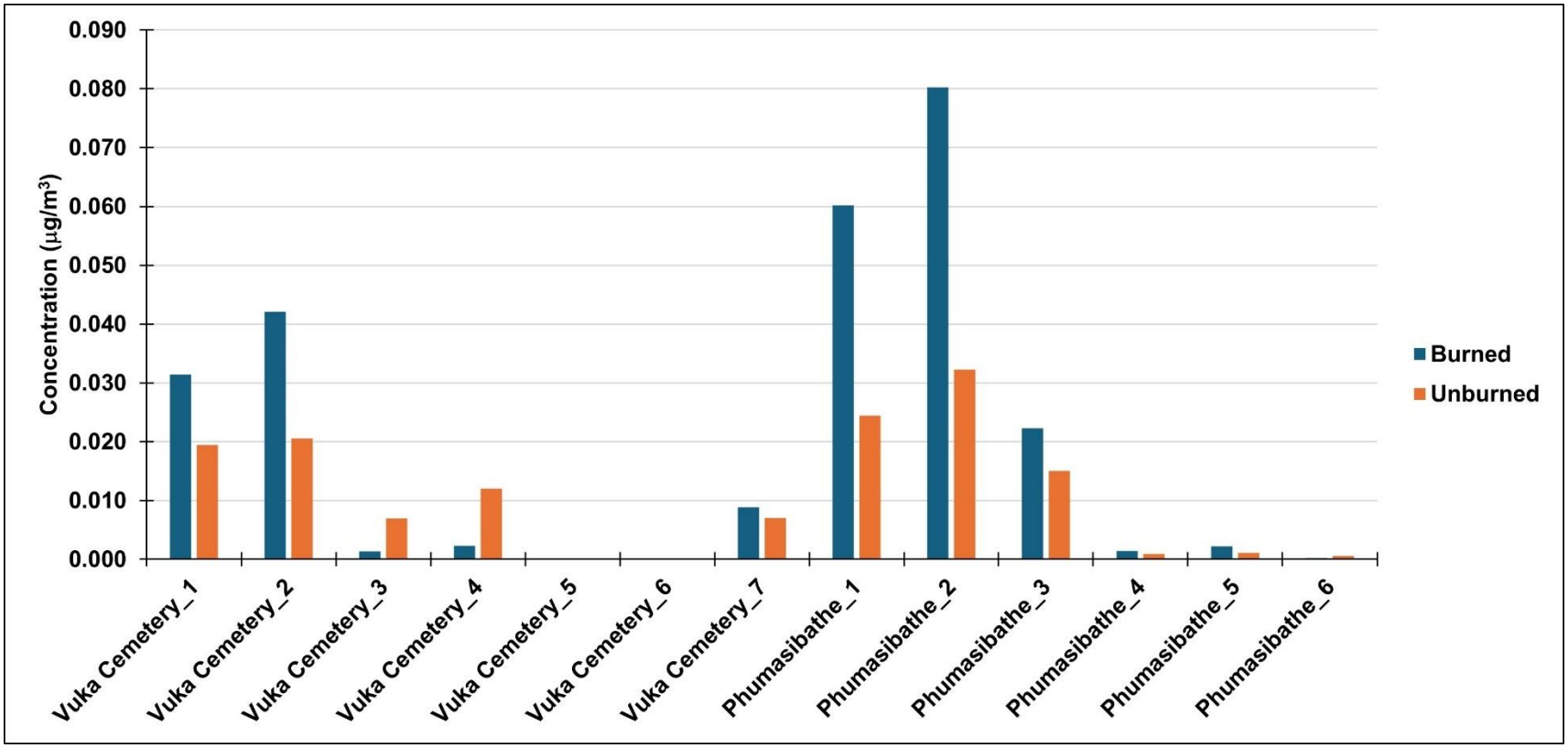


Figure 4-103: Simulated maximum 24-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 4 (5-days).

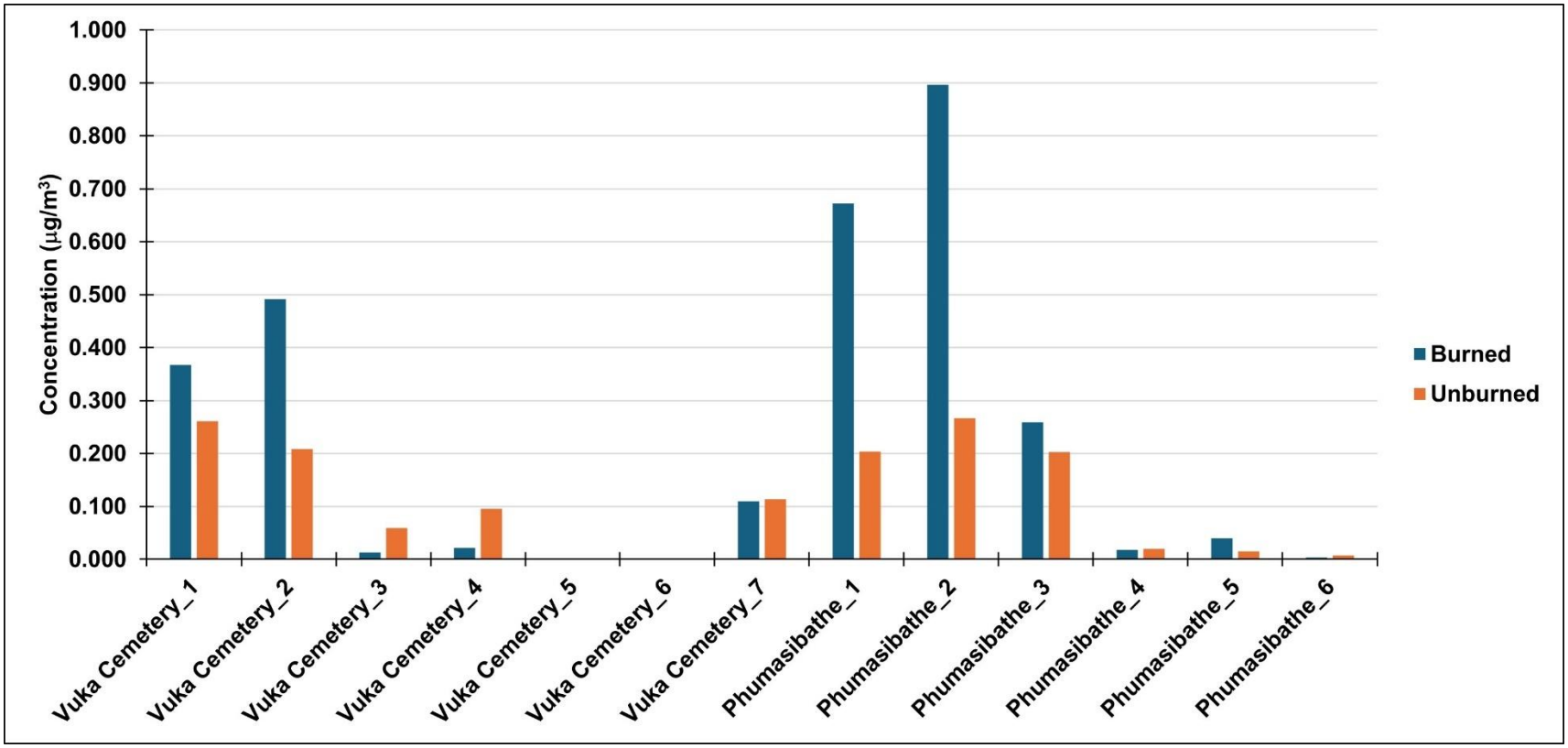


Figure 4-104: Simulated maximum 1-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 4 (5-days).

4.2.4.4 Nitrogen Dioxide (NO_2)

Figure 4-105 illustrates the simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 4 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.21 $\mu g/m^3$ and 0.09 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-106 illustrates the simulated maximum 1-hour ambient NO_2 concentrations over the Sharpeville region for Campaign 4. Maximum 1-hour concentrations of 4.53 $\mu g/m^3$ and 1.35 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for a 1-hour time average is 200 $\mu g/m^3$.

Table 4-16 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-107 and 4-108 is a graphical representation of Table 4-16.

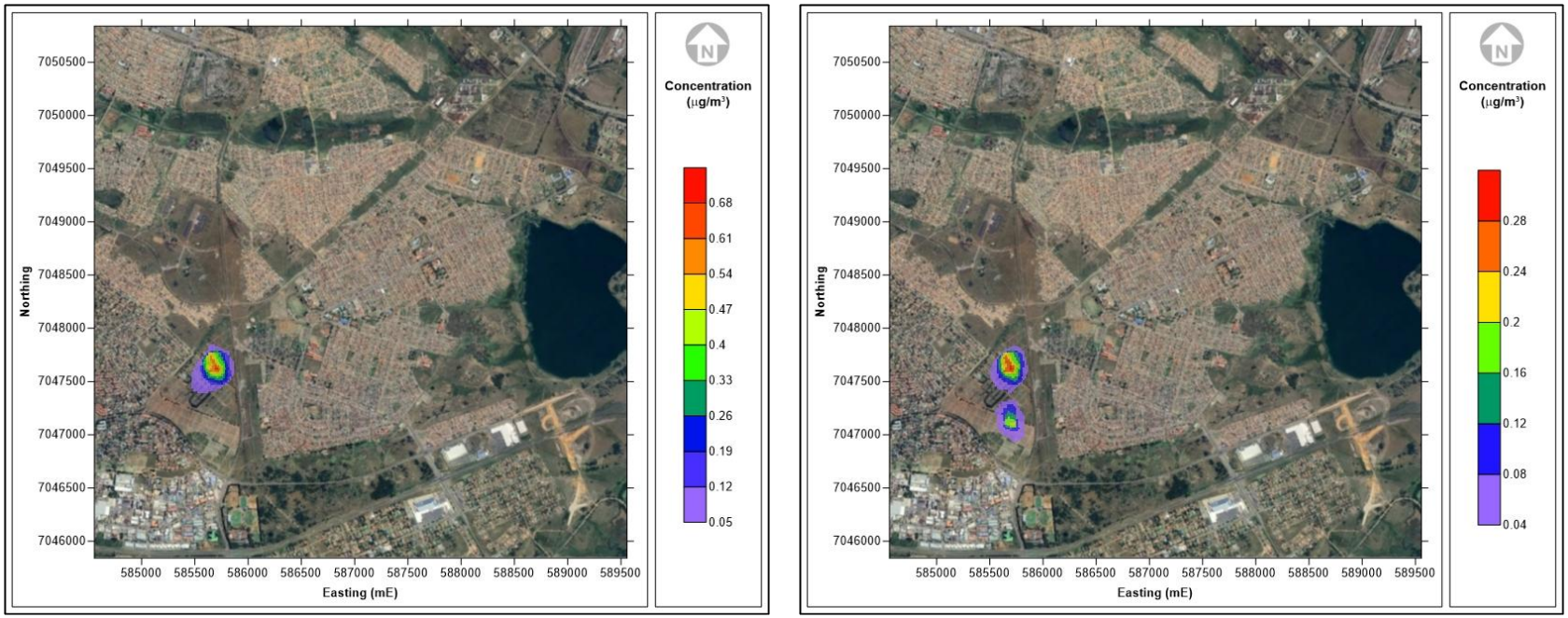


Figure 4-105: Simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 4 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

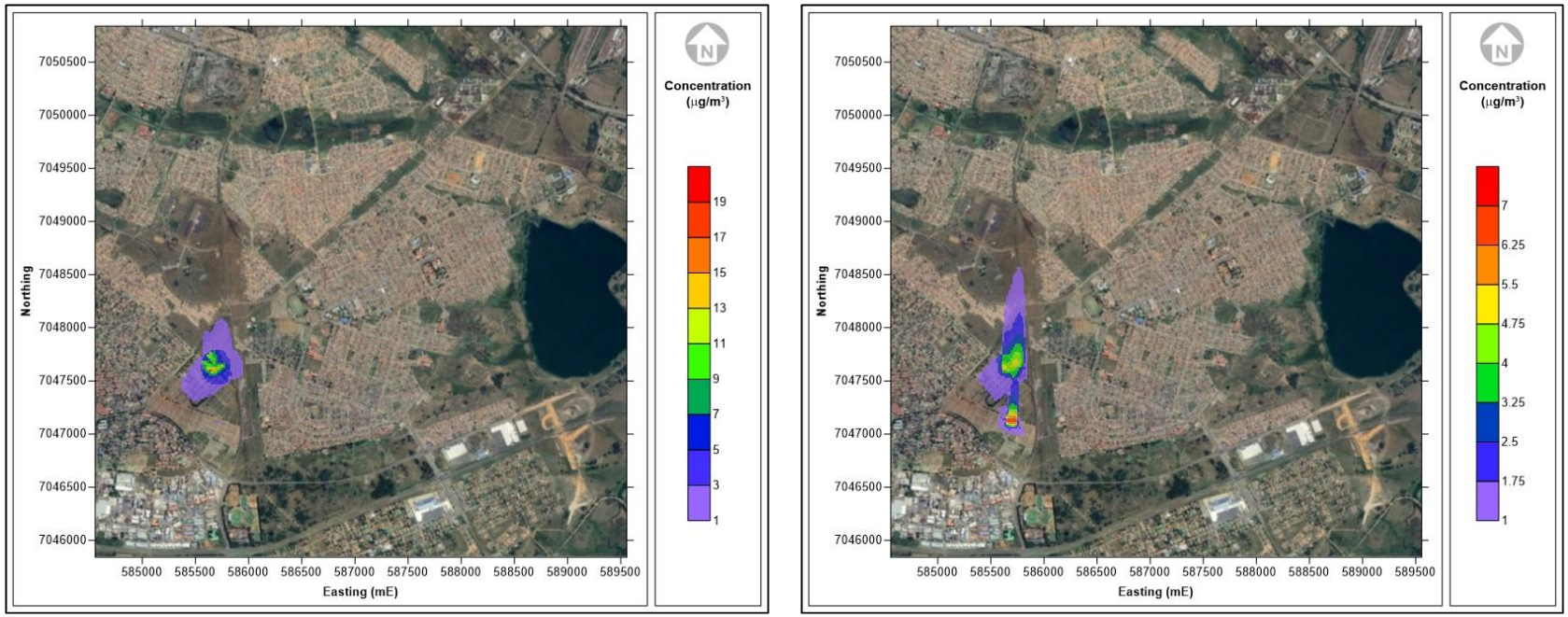


Figure 4-106: Simulated maximum 1-Hour ambient NO_2 concentrations over the Sharpeville region for Campaign 4 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-16: Simulated ambient NO_2 concentrations at the sensitive receptors for Campaign 3.

Receptor	Burned 5-Day Average ($mg.m^{-3}$)	Unburned 5-Day Average ($mg.m^{-3}$)	Burned 1-Hr Maximum ($mg.m^{-3}$)	Unburned 1-Hr Maximum ($mg.m^{-3}$)
Vuka Cemetery_1	0.063	0.040	1.856	1.320
Vuka Cemetery_2	0.066	0.037	2.488	1.055
Vuka Cemetery_3	0.003	0.018	0.065	0.297
Vuka Cemetery_4	0.005	0.024	0.112	0.483
Vuka Cemetery_5	0.000	0.000	0.000	0.000
Vuka Cemetery_6	0.000	0.000	0.000	0.000
Vuka Cemetery_7	0.017	0.013	0.556	0.574
Phumasibathe_1	0.184	0.082	3.402	1.029
Phumasibathe_2	0.211	0.089	4.533	1.352
Phumasibathe_3	0.023	0.016	1.311	1.024
Phumasibathe_4	0.002	0.002	0.090	0.098
Phumasibathe_5	0.002	0.001	0.204	0.078
Phumasibathe_6	0.000	0.001	0.015	0.035

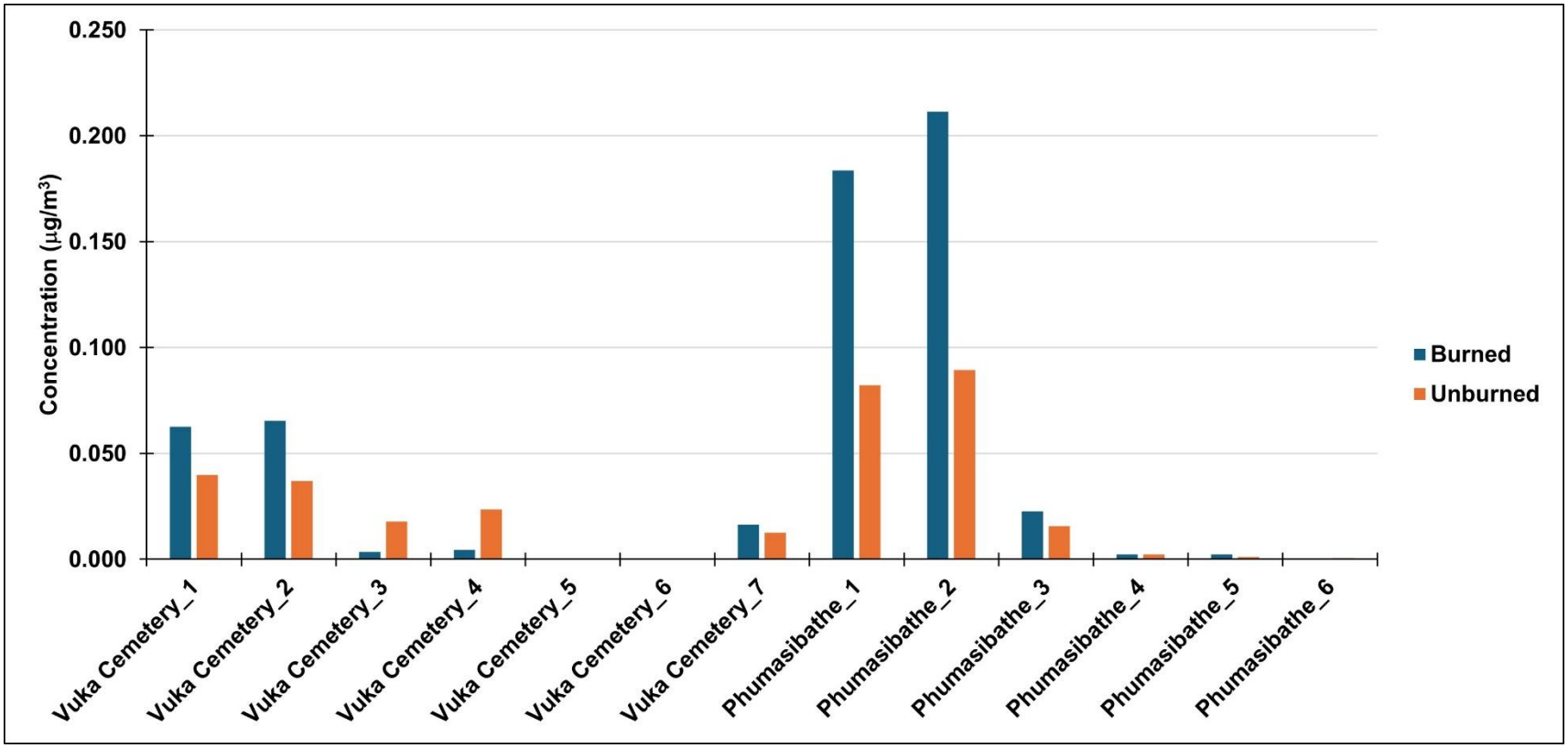


Figure 4-107: Simulated 5-day mean ambient NO_2 concentrations at the sensitive receptors for Campaign 4 (1-hour averages).

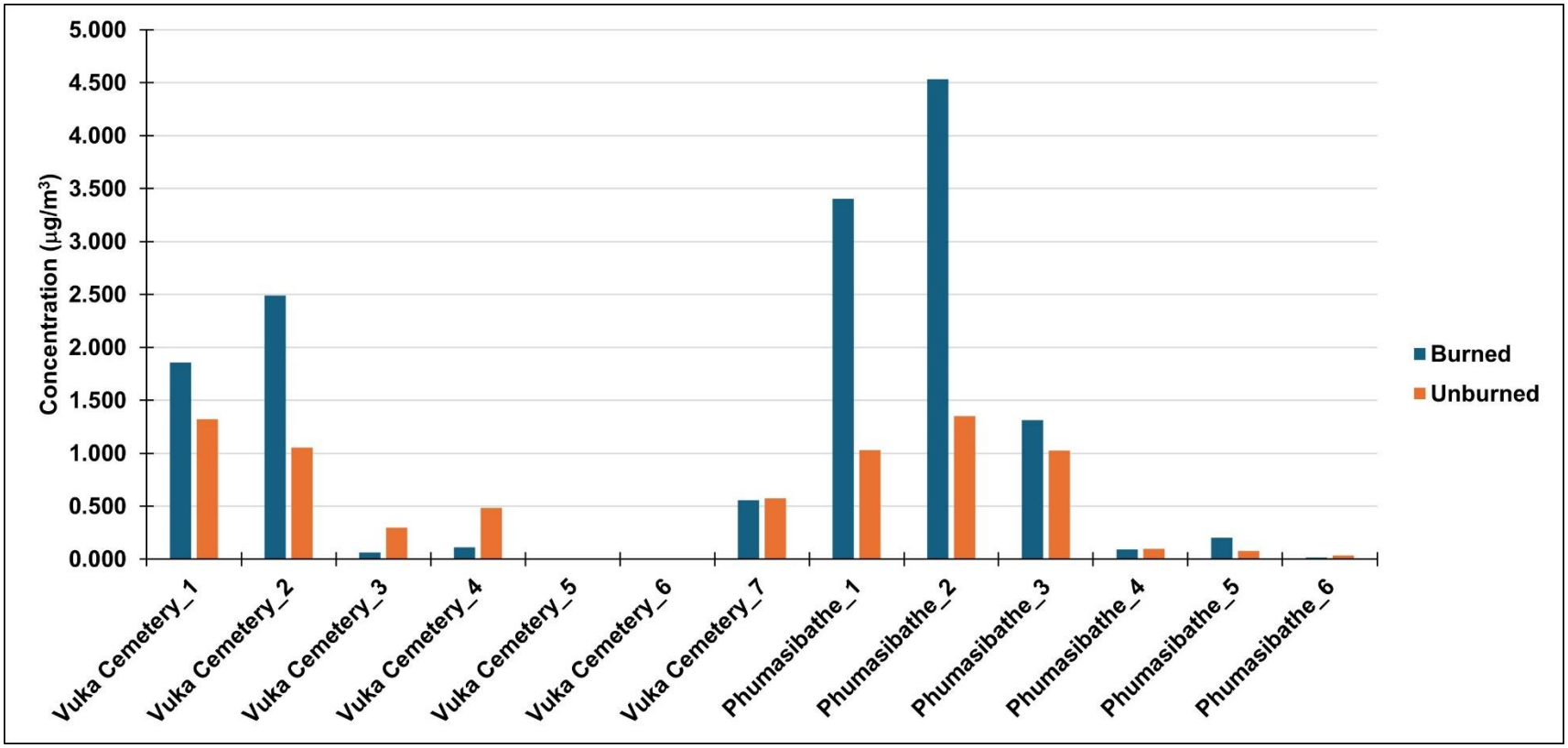


Figure 4-108: Simulated maximum 1-Hour ambient NO_2 concentrations at the sensitive receptors for Campaign 4 (5-days).

4.2.5 CAMPAIGN 5

Figure 4-109 is a map detailing the six waste collection sites during campaign 5, whilst Figure 4-110 is indicative of the five sites where waste burning practices were conducted.

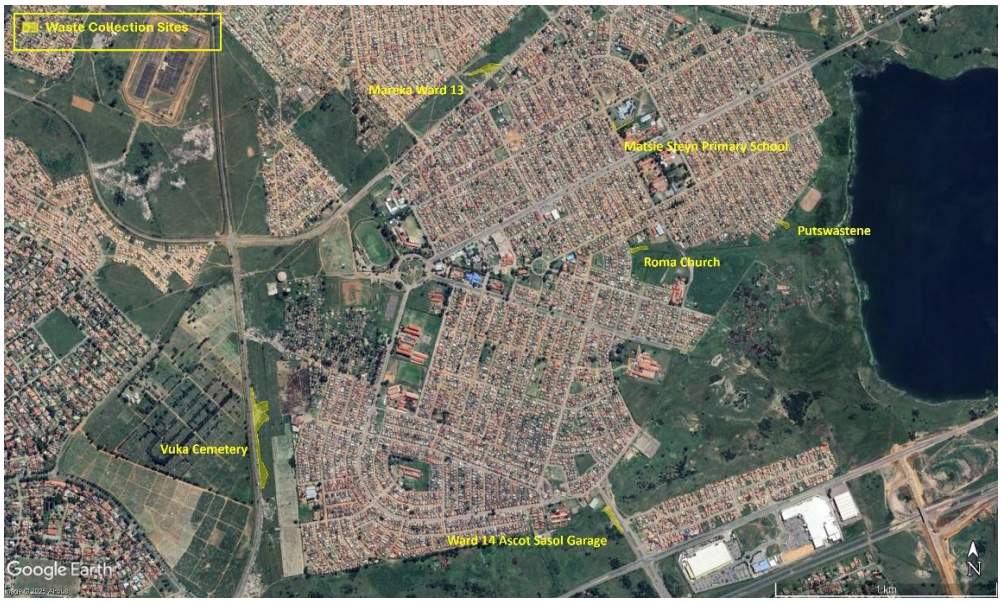


Figure 4-109: Location of the waste collection sites during Campaign 5.

Figure 4-110: Location of the waste burning sites during Campaign 5.

Figures 4-111 to 4-116 are detailed maps of the sites where waste burning practices were conducted, as well as the location of sensitive receptors around the burning sites.

Figure 4-111: Ascot Sasol Garage waste burning site and sensitive receptors near the site.

Figure 4-112: Vuka Cemetery Ward 14 waste burning site and sensitive receptors near the site.

Figure 4-113: Matsie Steyn Primary School waste burning site and sensitive receptors near the site.

Figure 4-114: Mareka Ward 13 waste burning site and sensitive receptors near the site.

Figure 4-114: Putswatsene waste burning site and sensitive receptors near the site.

4.2.5.1 Particulate Matter (PM_{10})

Figure 4-115 illustrates the simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 5 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 2.76 $\mu g/m^3$ and 1.36 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-116 illustrates the simulated maximum 24-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 5. Maximum 24-hour concentrations of 3.94 $\mu g/m^3$ and 4.01 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for a 24-hour time average is 75 $\mu g/m^3$.

Figure 4-117 illustrates the simulated maximum 1-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 5. Maximum 1-hour concentrations of 56.33 $\mu g/m^3$

and 78.69 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No PM_{10} NAAQS standard exist for a 1-hour time average.

Table 4-17 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-118 to 4-120 is a graphical representation of Table 4-17.

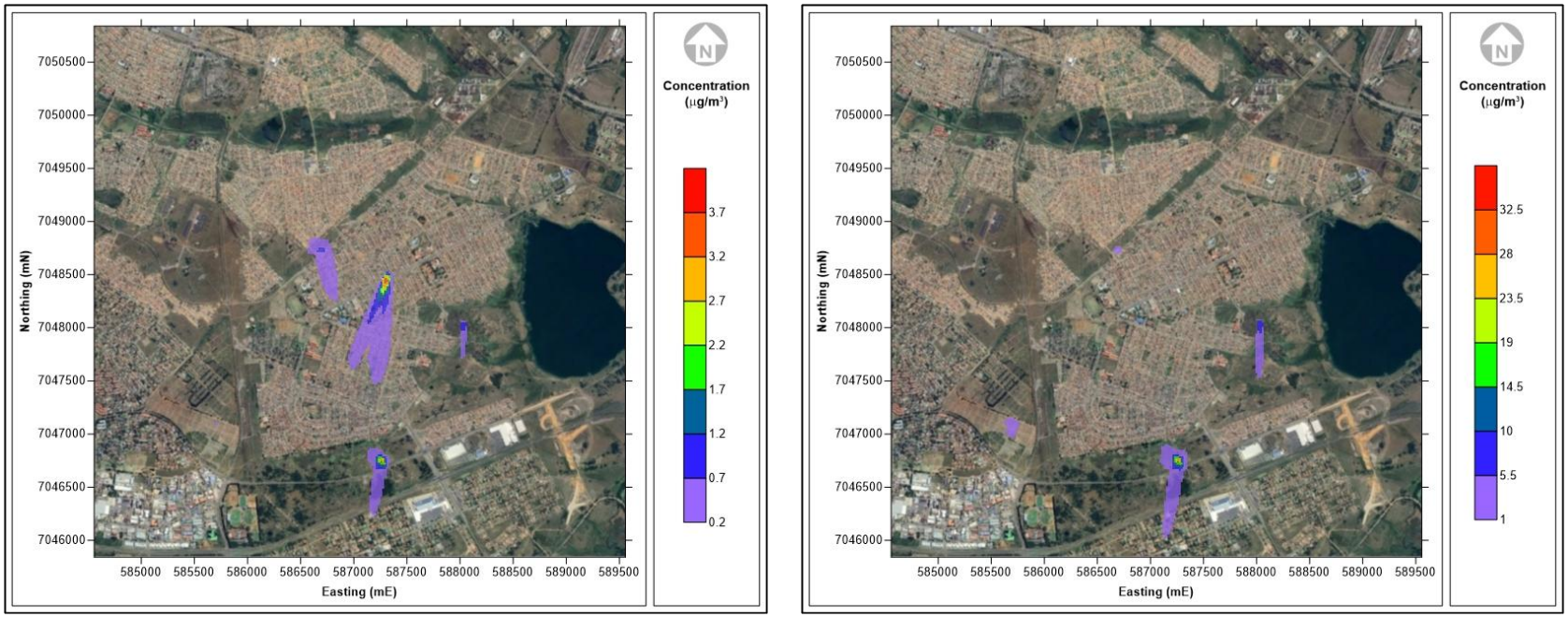


Figure 4-115: Simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 5 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

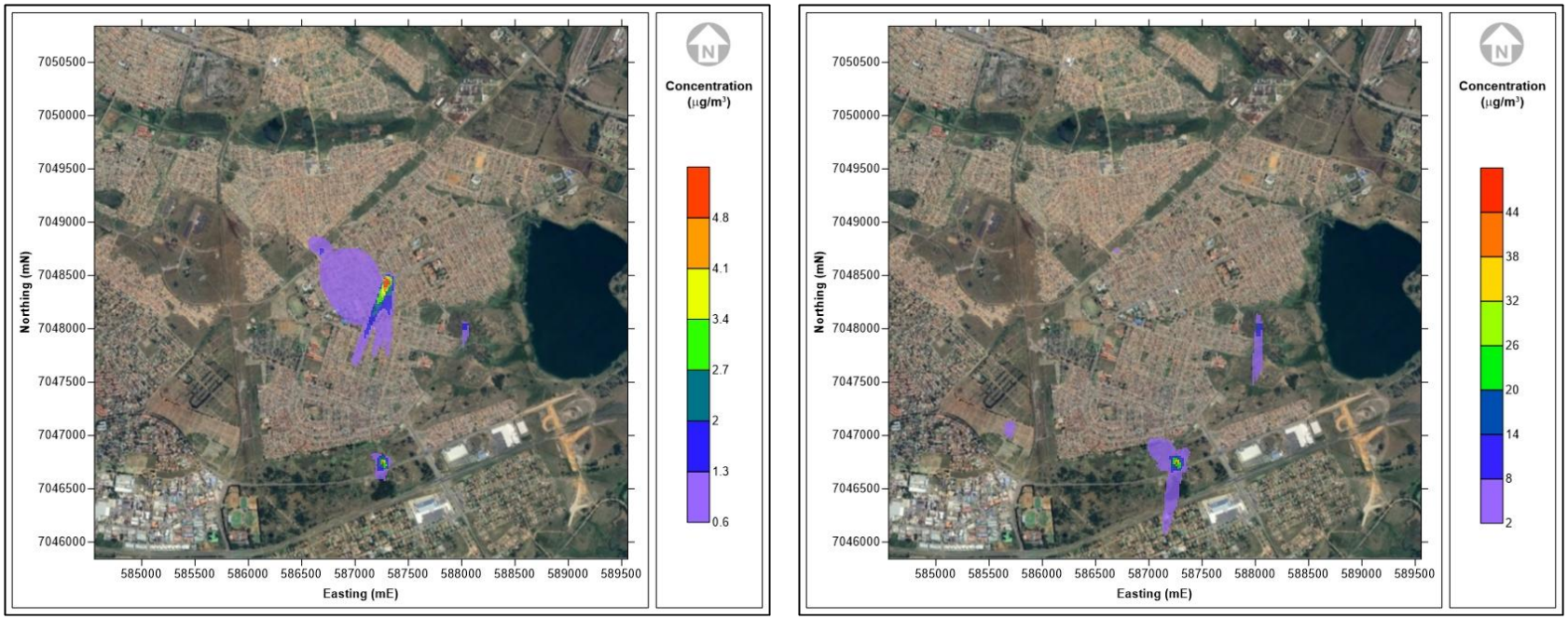


Figure 4-116: Simulated maximum 24-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 3 (5-days). Impact of burned waste (left), and unburnt waste (right).

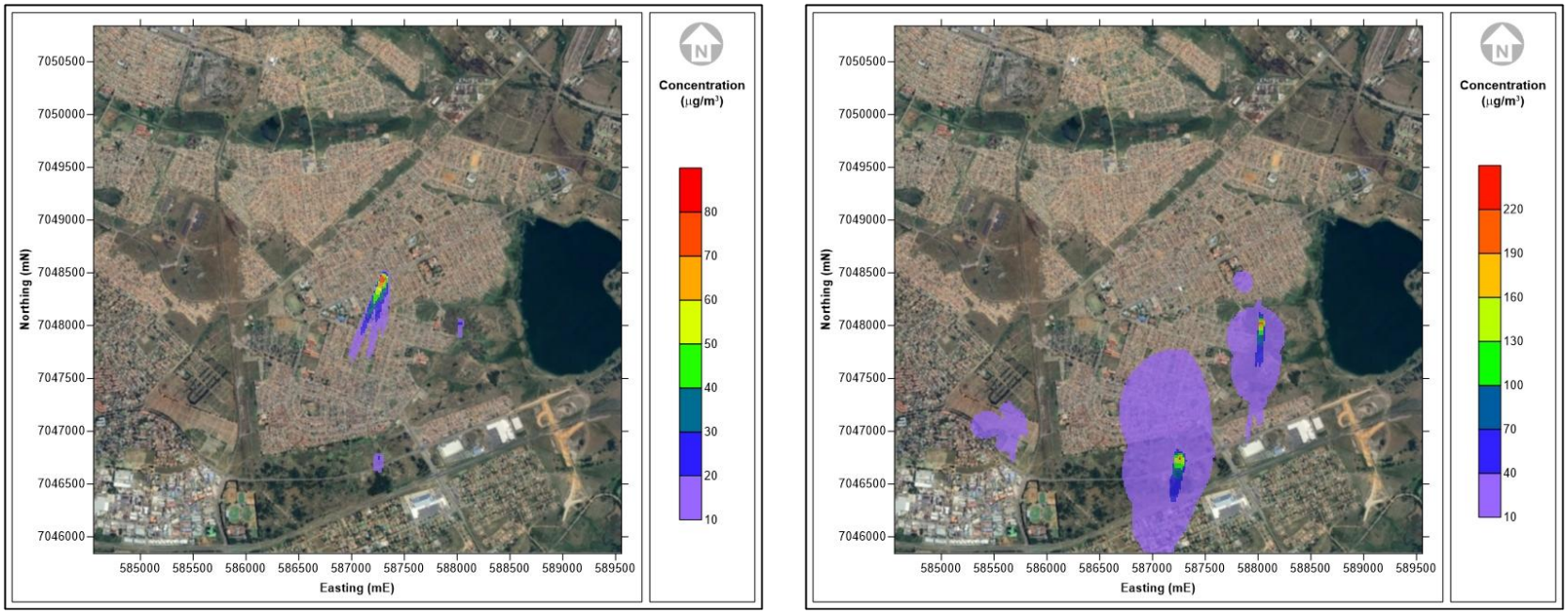


Figure 4-117: Simulated maximum 1-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 5 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-17: Simulated ambient PM_{10} concentrations at the sensitive receptors for Campaign 5.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.16	0.91	0.34	2.38	2.34	15.27
Ascot Sasol Garage_2	0.20	1.36	0.47	2.66	2.53	22.79
Ascot Sasol Garage_3	0.12	0.76	0.22	1.93	1.90	17.06
Ascot Sasol Garage_4	0.09	0.58	0.14	1.21	1.68	14.80
Ascot Sasol Garage_5	0.12	0.71	0.15	1.25	2.45	18.42
Ascot Sasol Garage_6	0.15	0.88	0.27	2.26	3.03	16.64
MatsieSteyn_1	0.02	0.10	0.06	0.39	0.66	4.05
MatsieSteyn_2	0.02	0.08	0.05	0.30	0.55	3.11
MatsieSteyn_3	0.03	0.18	0.06	0.46	0.75	4.79
MatsieSteyn_4	0.03	0.24	0.06	0.47	0.75	5.08
MatsieSteyn_5	0.02	0.11	0.05	0.37	0.60	4.59
MatsieSteyn_6	0.01	0.07	0.03	0.22	0.39	2.99
MatsieSteyn_7	0.02	0.10	0.05	0.41	0.72	5.07
Ward 13 Police Station_1	0.10	0.07	0.38	0.29	4.20	5.09
Ward 13 Police Station_2	0.88	0.16	1.77	0.32	18.10	5.41
Ward 13 Police Station_3	2.76	0.37	3.94	0.46	56.33	6.34
Ward 13 Police Station_4	0.13	0.06	0.50	0.26	5.50	4.38
Ward 13 Police Station_5	0.14	0.07	0.50	0.27	5.36	4.57
Ward 13 Police Station_6	0.59	0.12	1.08	0.28	16.69	4.67
Mareka Ward 13_1	0.19	0.22	0.63	0.59	7.50	3.61
Mareka Ward 13_2	0.26	0.35	0.85	0.98	7.72	3.70
Mareka Ward 13_3	0.19	0.23	0.52	0.59	7.57	3.58
Mareka Ward 13_4	0.21	0.21	0.54	0.31	8.17	3.13
Mareka Ward 13_5	0.49	0.74	0.92	1.06	8.34	5.61
Mareka Ward 13_6	0.27	0.34	0.54	0.50	8.27	6.34
Putswastene_1	0.05	0.47	0.22	1.93	3.22	28.98

Putswastene_2	0.10	0.89	0.45	4.01	8.74	78.69
Putswastene_3	0.05	0.44	0.21	1.78	2.77	24.92
Putswastene_4	0.06	0.53	0.16	1.39	3.60	32.37
Putswastene_5	0.04	0.35	0.09	0.73	1.43	12.84
Putswastene_6	0.03	0.23	0.08	0.69	1.12	10.07

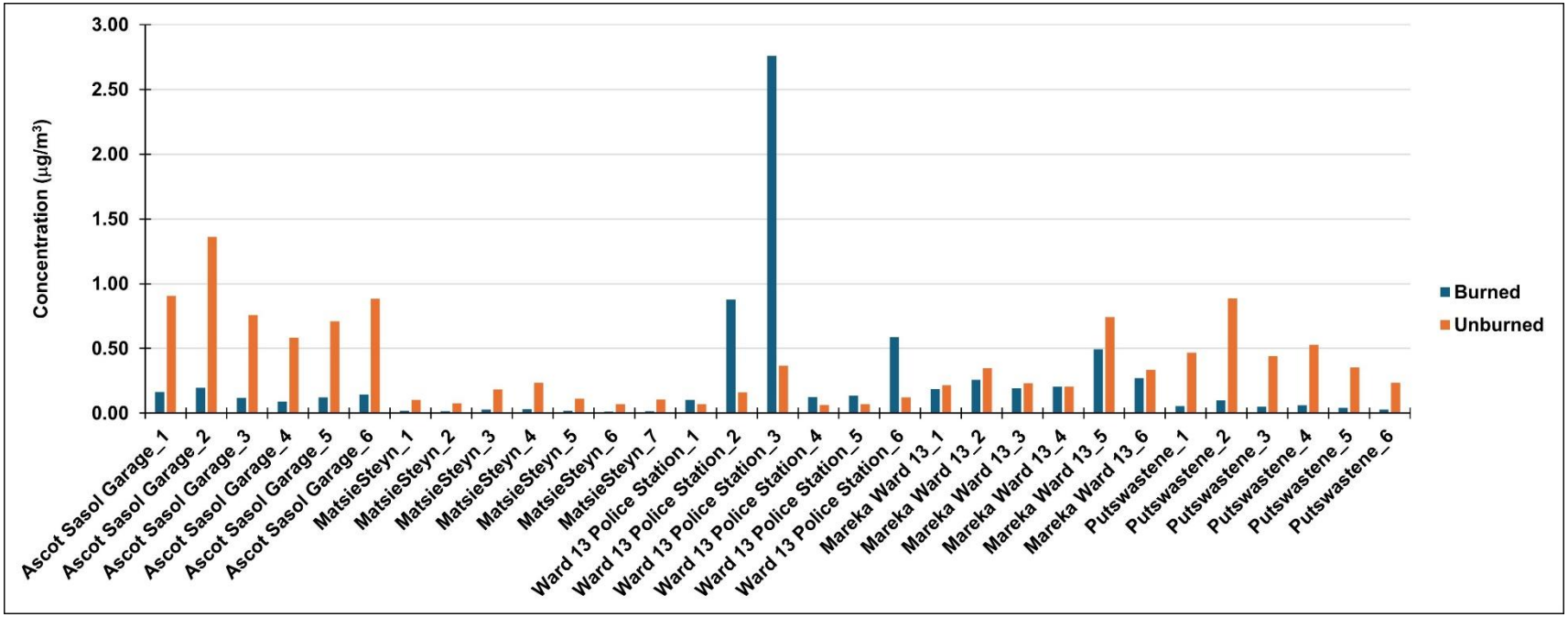


Figure 4-118: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 5 (1-hour averages).

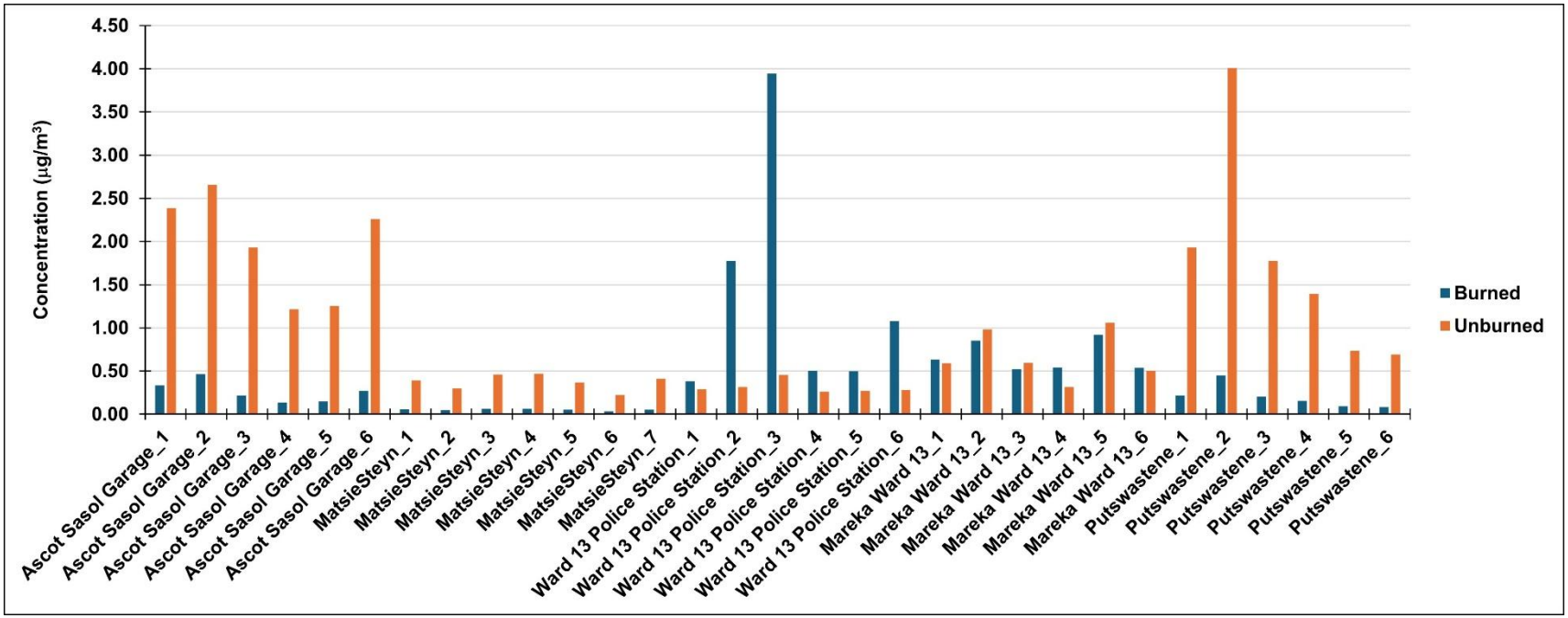


Figure 4-119: Simulated maximum 24-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 5 (5-days).

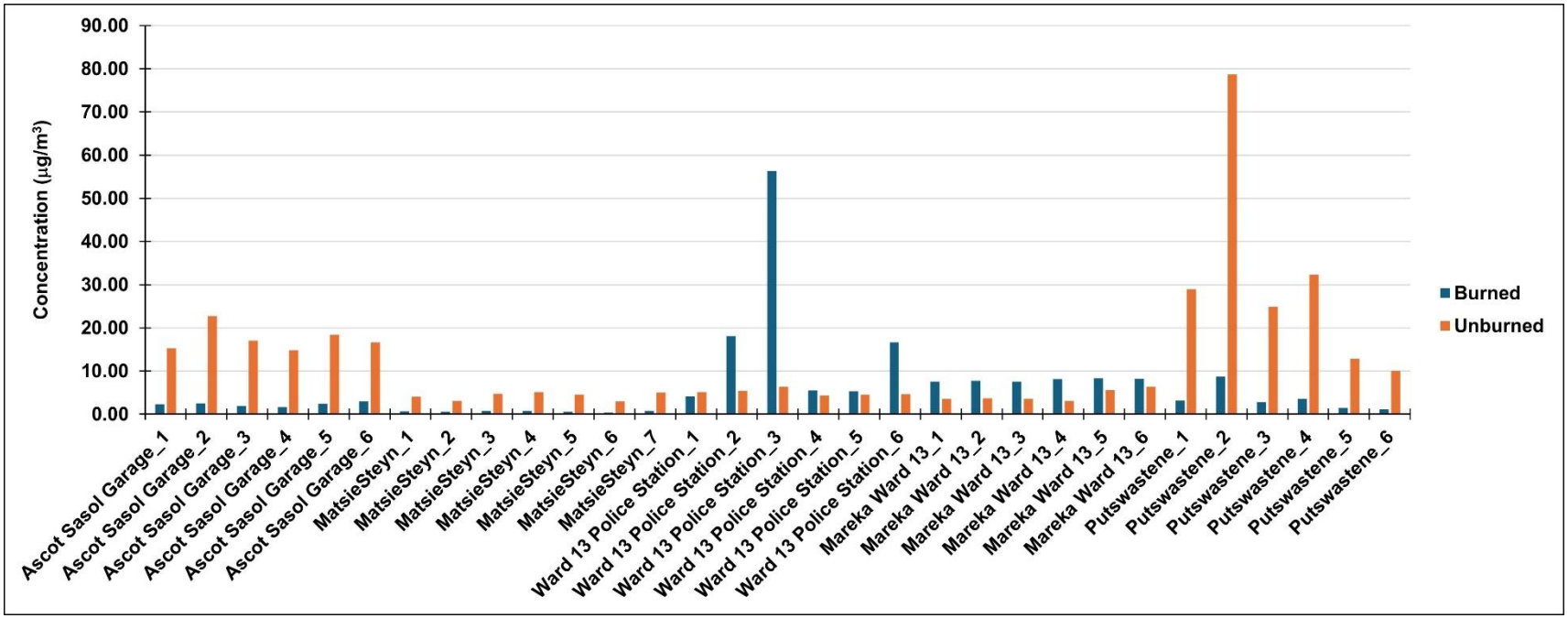


Figure 4-120: Simulated maximum 1-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 5 (5-days).

4.2.5.2 Particulate Matter ($PM_{2.5}$)

Figure 4-121 illustrates the simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 5 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 2.75 $\mu g/m^3$ and 1.36 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for an annual time average is 20 $\mu g/m^3$.

Figure 4-122 illustrates the simulated maximum 24-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 5. Maximum 24-hour concentrations of 3.93 $\mu g/m^3$ and 3.99 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for a 24-hour time average is 40 $\mu g/m^3$.

Figure 4-123 illustrates the simulated maximum 1-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 5. Maximum 1-hour concentrations of 56.11 $\mu g/m^3$ and 78.38 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No $PM_{2.5}$ NAAQS standard exist for a 1-hour time average.

Table 4-18 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-124 to 4-126 is a graphical representation of Table 4-18.

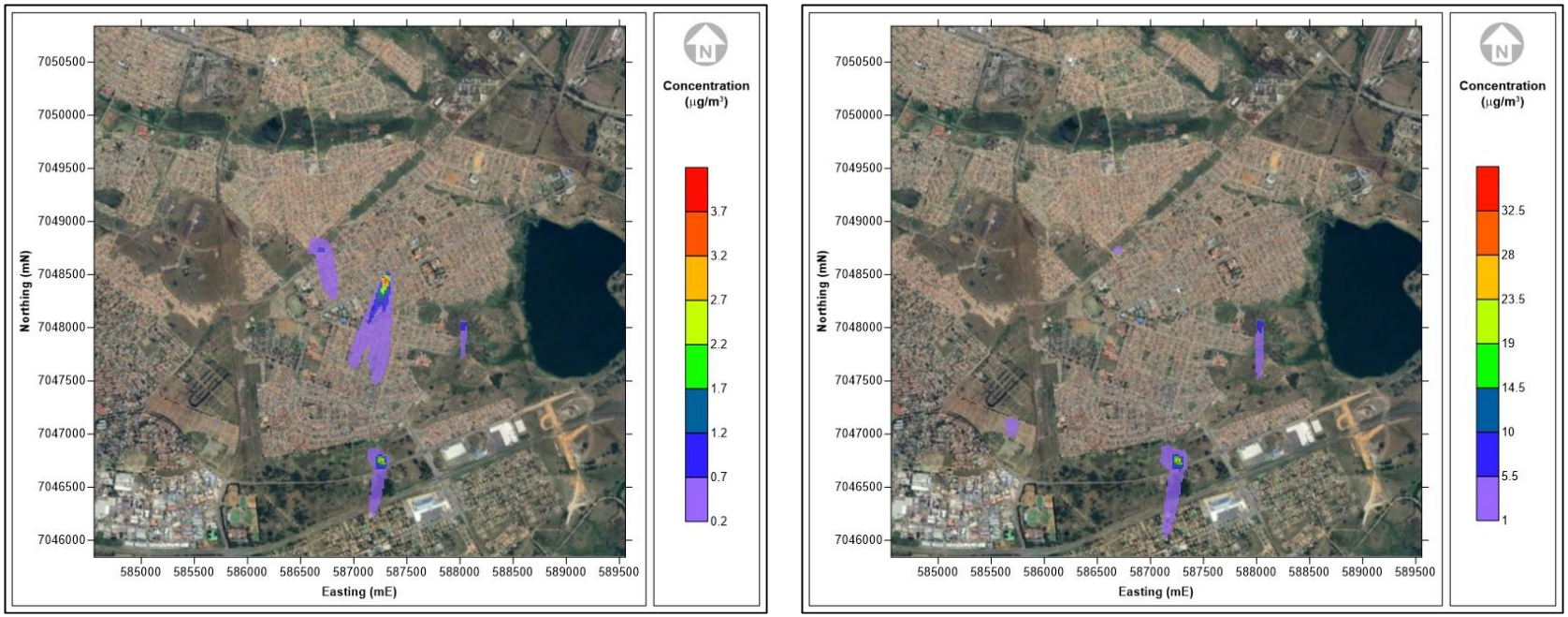


Figure 4-121 Simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 5 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

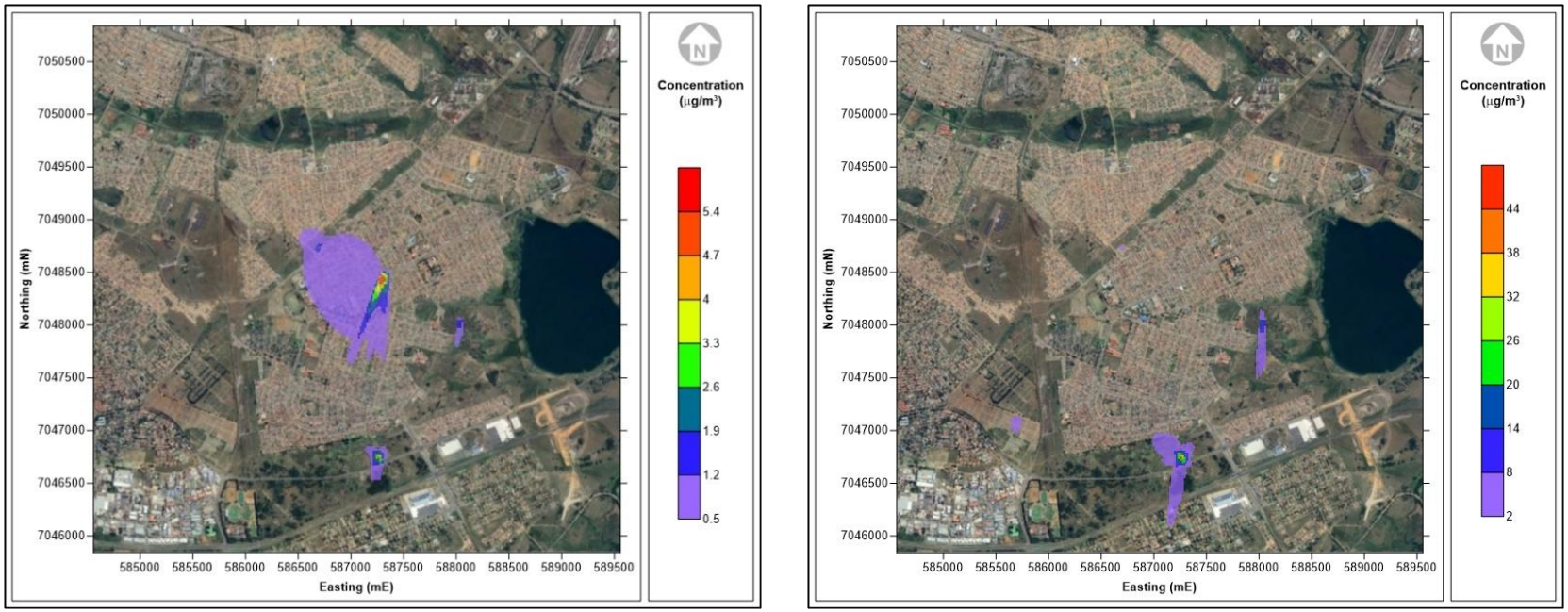


Figure 4-122: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 5 (5-days). Impact of burned waste (left), and unburnt waste (right).

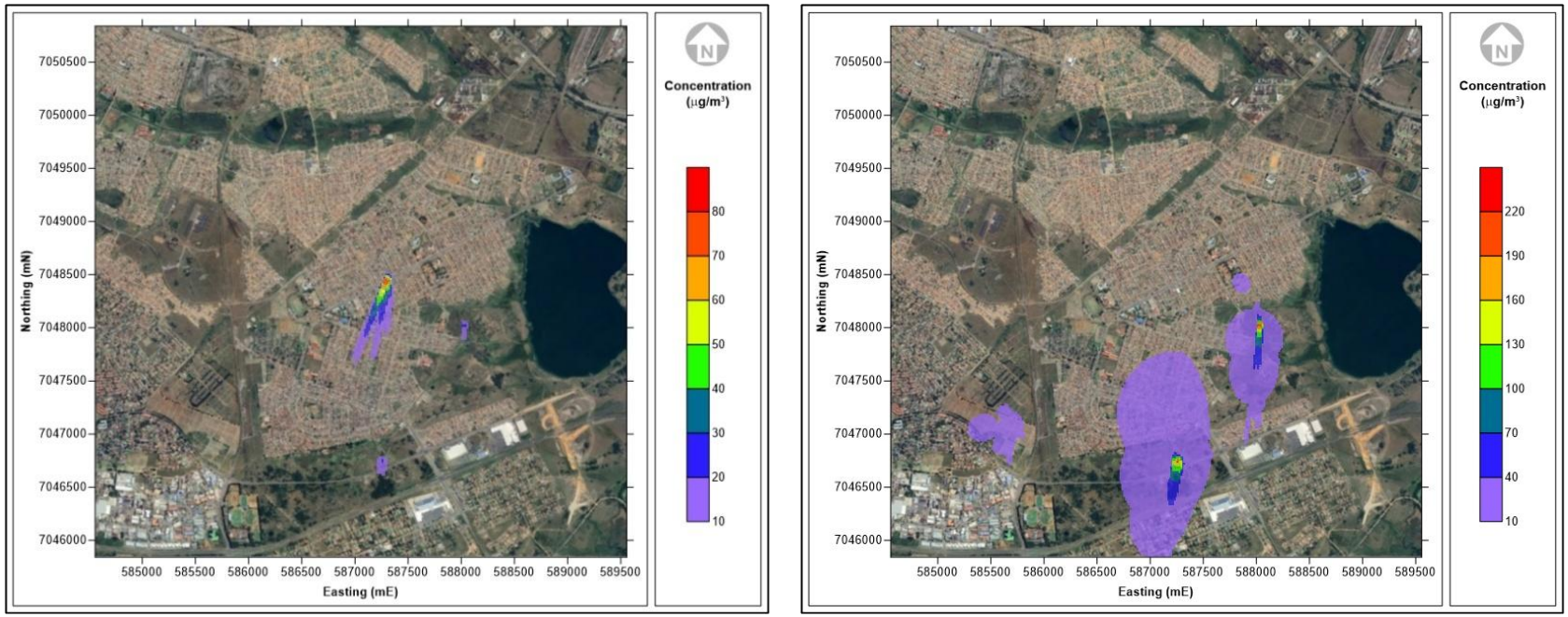


Figure 4-123: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 5 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-18: Simulated ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 5.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.16	0.90	0.33	2.38	2.33	15.21
Ascot Sasol Garage_2	0.19	1.36	0.46	2.65	2.52	22.70
Ascot Sasol Garage_3	0.12	0.76	0.22	1.93	1.89	16.99
Ascot Sasol Garage_4	0.09	0.58	0.14	1.21	1.67	14.74
Ascot Sasol Garage_5	0.12	0.71	0.15	1.25	2.44	18.35
Ascot Sasol Garage_6	0.14	0.88	0.27	2.25	3.02	16.58
MatsieSteyn_1	0.02	0.10	0.06	0.39	0.66	4.03
MatsieSteyn_2	0.02	0.08	0.05	0.30	0.54	3.10
MatsieSteyn_3	0.03	0.18	0.06	0.46	0.74	4.77
MatsieSteyn_4	0.03	0.24	0.06	0.47	0.75	5.06
MatsieSteyn_5	0.02	0.11	0.05	0.37	0.60	4.57
MatsieSteyn_6	0.01	0.07	0.03	0.22	0.39	2.97
MatsieSteyn_7	0.02	0.10	0.05	0.41	0.72	5.05
Ward 13 Police Station_1	0.10	0.07	0.38	0.29	4.19	5.07
Ward 13 Police Station_2	0.87	0.16	1.77	0.32	18.03	5.39
Ward 13 Police Station_3	2.75	0.37	3.93	0.45	56.11	6.31
Ward 13 Police Station_4	0.13	0.06	0.50	0.26	5.48	4.36
Ward 13 Police Station_5	0.13	0.07	0.50	0.27	5.33	4.55
Ward 13 Police Station_6	0.59	0.12	1.08	0.28	16.62	4.66
Mareka Ward 13_1	0.19	0.22	0.63	0.59	7.47	3.60
Mareka Ward 13_2	0.26	0.35	0.85	0.98	7.69	3.68
Mareka Ward 13_3	0.19	0.23	0.52	0.59	7.54	3.56
Mareka Ward 13_4	0.20	0.21	0.54	0.31	8.14	3.12
Mareka Ward 13_5	0.49	0.74	0.92	1.05	8.31	5.59
Mareka Ward 13_6	0.27	0.33	0.53	0.50	8.24	6.31
Putswastene_1	0.05	0.47	0.22	1.92	3.21	28.86

Putswastene_2	0.10	0.88	0.45	3.99	8.71	78.38
Putswastene_3	0.05	0.44	0.20	1.77	2.76	24.82
Putswastene_4	0.06	0.53	0.16	1.39	3.58	32.24
Putswastene_5	0.04	0.35	0.09	0.73	1.42	12.79
Putswastene_6	0.03	0.23	0.08	0.69	1.12	10.03

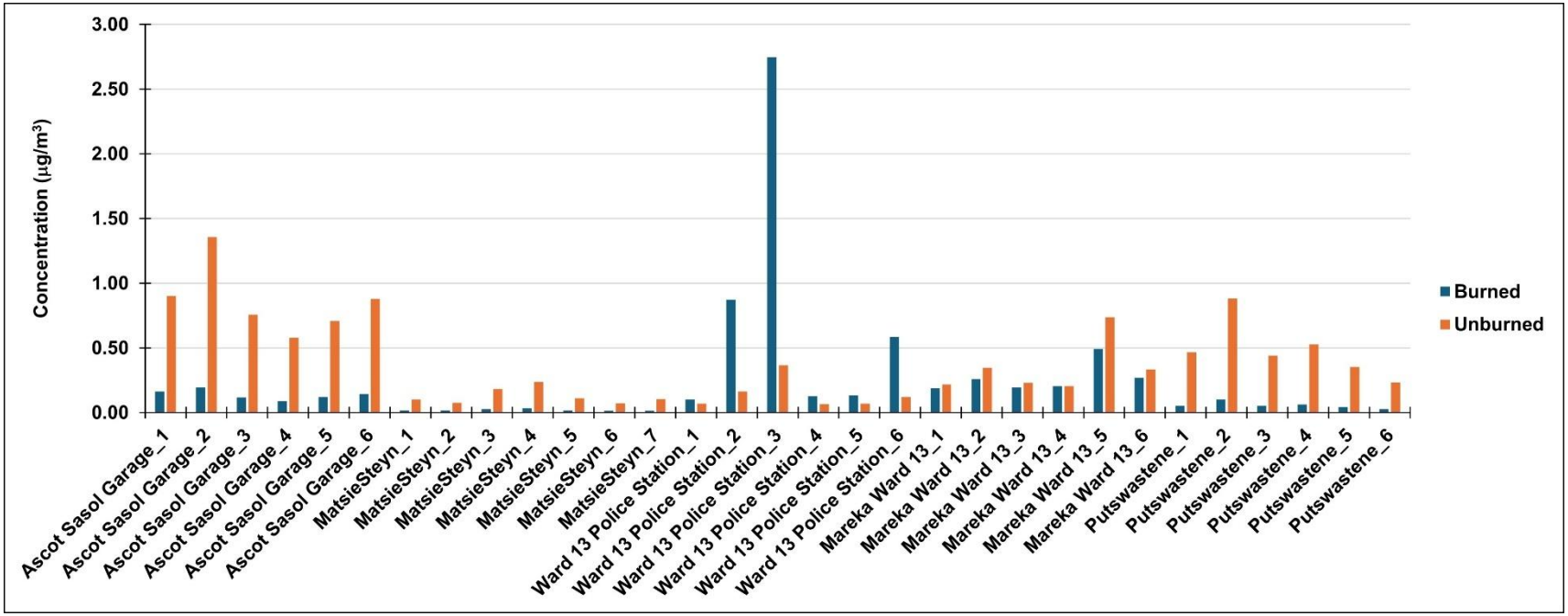


Figure 4-124: Simulated 5-day mean ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 5 (1-hour averages).

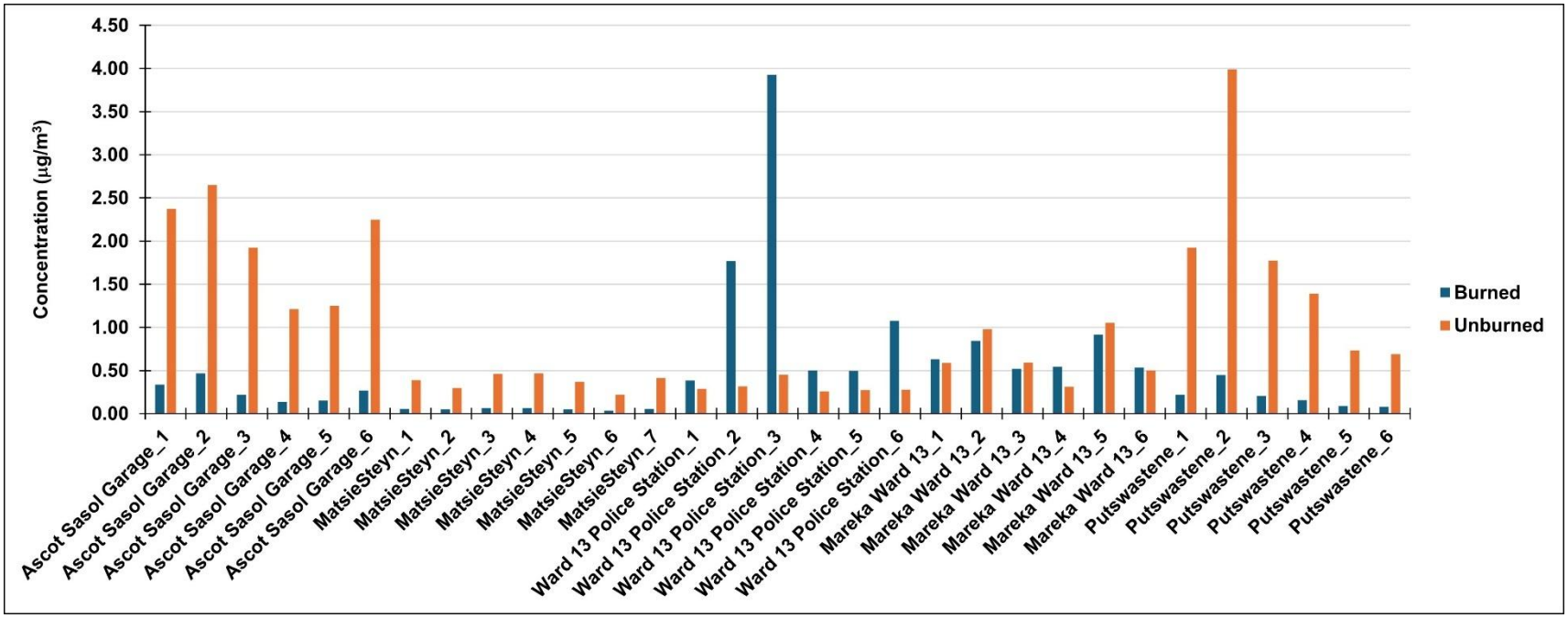


Figure 4-125: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 5 (5-days).

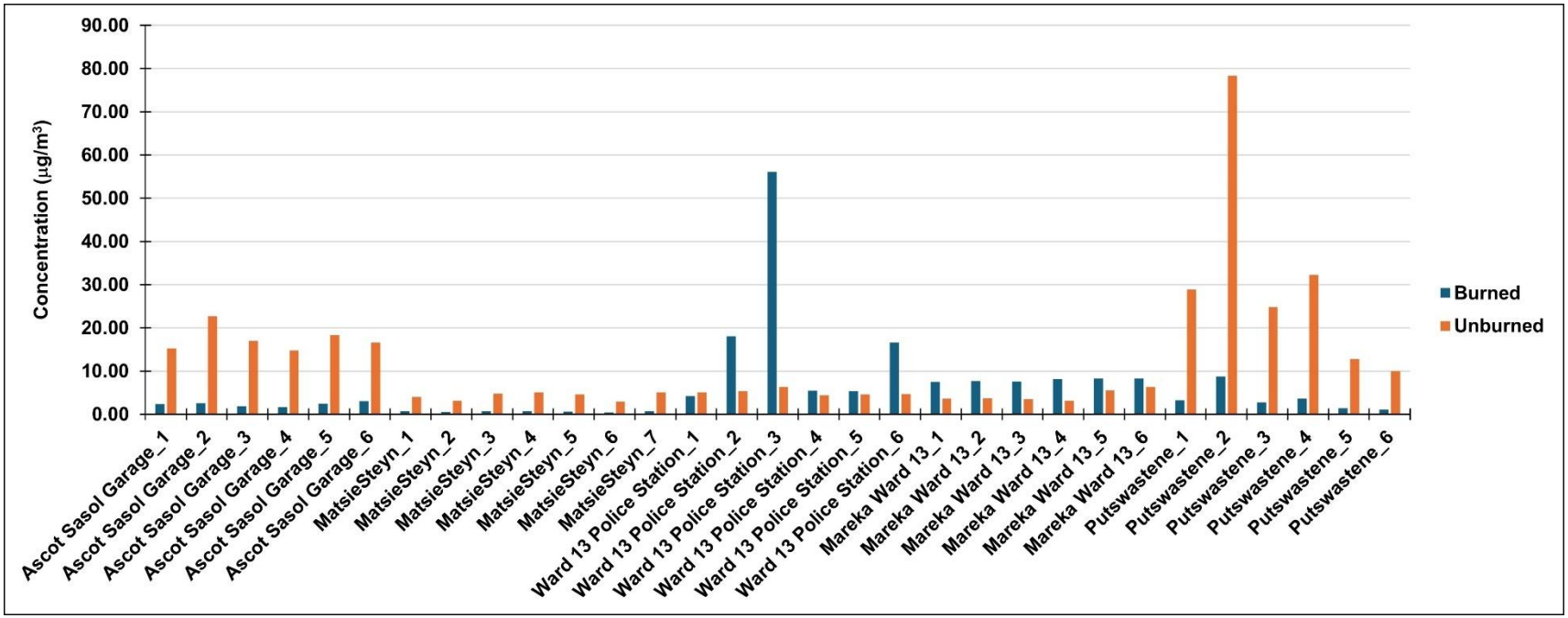


Figure 4-126: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 5 (5-days).

4.2.5.3 Sulphur Dioxide (SO_2)

Figure 4-127 illustrates the simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 5 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.06 $\mu g/m^3$ and 0.03 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for an annual time average is 50 $\mu g/m^3$.

Figure 4-128 illustrates the simulated maximum 24-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 5. Maximum 24-hour concentrations of 0.08 $\mu g/m^3$ were simulated for both the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 24-hour time average is 125 $\mu g/m^3$.

Figure 4-129 illustrates the simulated maximum 1-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 5. Maximum 1-hour concentrations of 1.14 $\mu g/m^3$ and 1.59 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Table 4-19 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-130 to 4-132 is a graphical representation of Table 4-19.

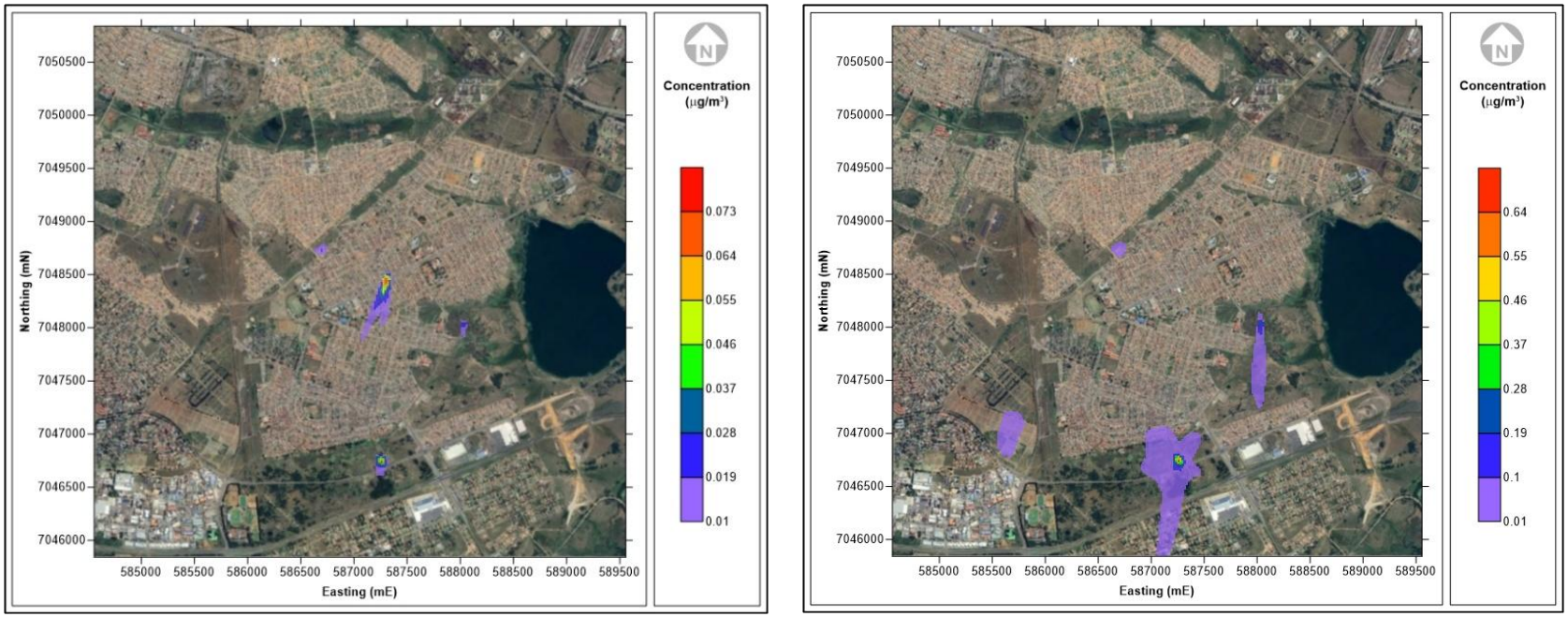


Figure 4-127 Simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 5 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

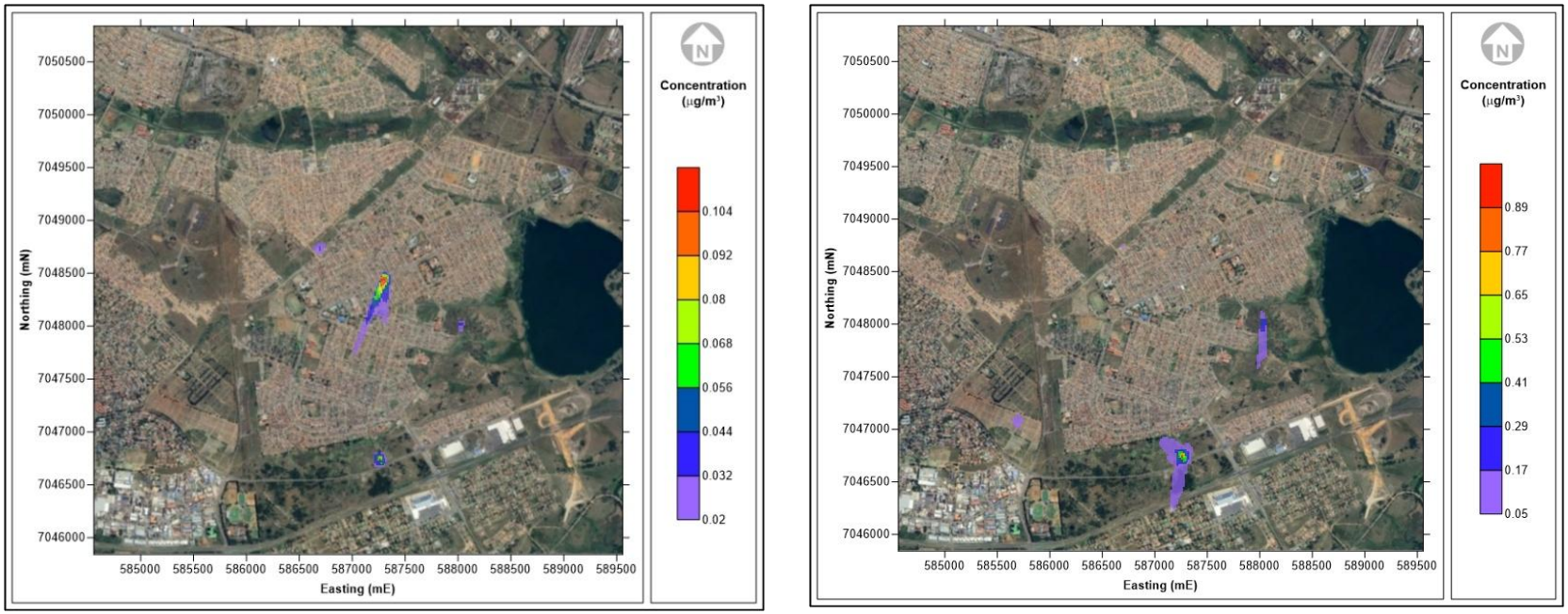


Figure 4-128: Simulated maximum 24-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 5 (5-days). Impact of burned waste (left), and unburnt waste (right).

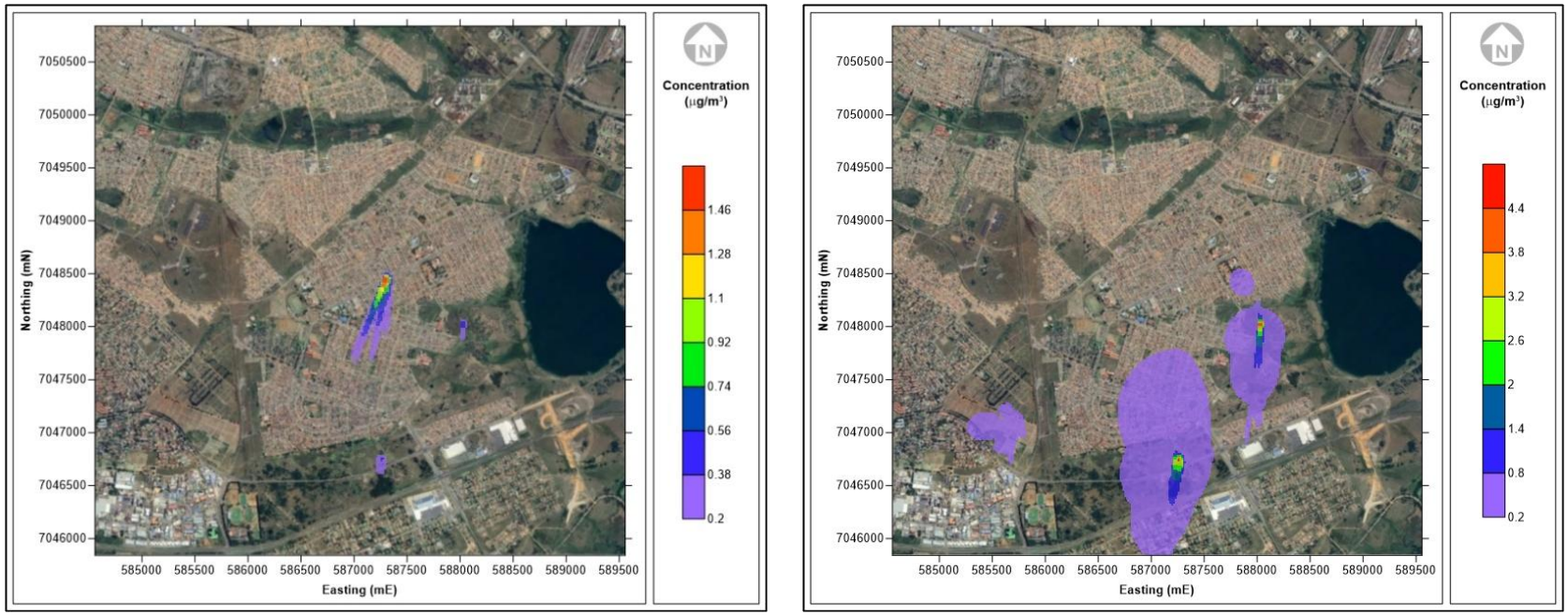


Figure 4-129: Simulated maximum 1-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 5 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-19: Simulated ambient SO_2 concentrations at the sensitive receptors for Campaign 5.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.003	0.018	0.007	0.048	0.047	0.309
Ascot Sasol Garage_2	0.004	0.028	0.009	0.054	0.051	0.462
Ascot Sasol Garage_3	0.002	0.015	0.004	0.039	0.038	0.346
Ascot Sasol Garage_4	0.002	0.012	0.003	0.025	0.034	0.300
Ascot Sasol Garage_5	0.002	0.014	0.003	0.025	0.050	0.373
Ascot Sasol Garage_6	0.003	0.018	0.005	0.046	0.061	0.337
MatsieSteyn_1	0.000	0.002	0.001	0.008	0.013	0.082
MatsieSteyn_2	0.000	0.002	0.001	0.006	0.011	0.063
MatsieSteyn_3	0.001	0.004	0.001	0.009	0.015	0.097
MatsieSteyn_4	0.001	0.005	0.001	0.009	0.015	0.103
MatsieSteyn_5	0.000	0.002	0.001	0.007	0.012	0.093
MatsieSteyn_6	0.000	0.001	0.001	0.004	0.008	0.060
MatsieSteyn_7	0.000	0.002	0.001	0.008	0.015	0.103
Ward 13 Police Station_1	0.002	0.001	0.008	0.006	0.085	0.103
Ward 13 Police Station_2	0.018	0.003	0.036	0.006	0.367	0.110
Ward 13 Police Station_3	0.056	0.007	0.080	0.009	1.141	0.128
Ward 13 Police Station_4	0.003	0.001	0.010	0.005	0.112	0.089
Ward 13 Police Station_5	0.003	0.001	0.010	0.006	0.109	0.093
Ward 13 Police Station_6	0.012	0.002	0.022	0.006	0.338	0.095
Mareka Ward 13_1	0.004	0.004	0.013	0.012	0.152	0.073
Mareka Ward 13_2	0.005	0.007	0.017	0.020	0.156	0.075
Mareka Ward 13_3	0.004	0.005	0.011	0.012	0.153	0.073
Mareka Ward 13_4	0.004	0.004	0.011	0.006	0.165	0.063
Mareka Ward 13_5	0.010	0.015	0.019	0.021	0.169	0.114
Mareka Ward 13_6	0.006	0.007	0.011	0.010	0.168	0.128
Putswastene_1	0.001	0.009	0.004	0.039	0.065	0.587

Putswastene_2	0.002	0.018	0.009	0.081	0.177	1.594
Putswastene_3	0.001	0.009	0.004	0.036	0.056	0.505
Putswastene_4	0.001	0.011	0.003	0.028	0.073	0.656
Putswastene_5	0.001	0.007	0.002	0.015	0.029	0.260
Putswastene_6	0.001	0.005	0.002	0.014	0.023	0.204

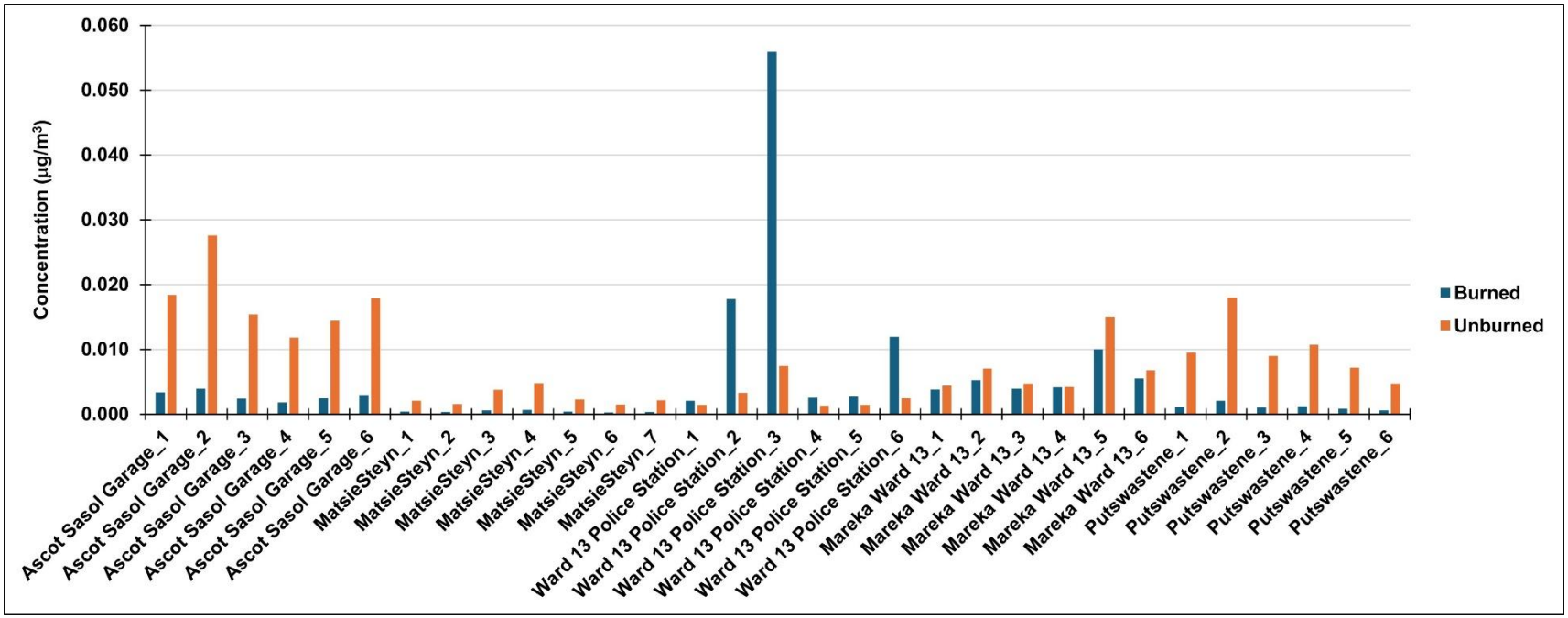


Figure 4-130: Simulated 5-day mean ambient SO_2 concentrations at the sensitive receptors for Campaign 5 (1-hour averages).

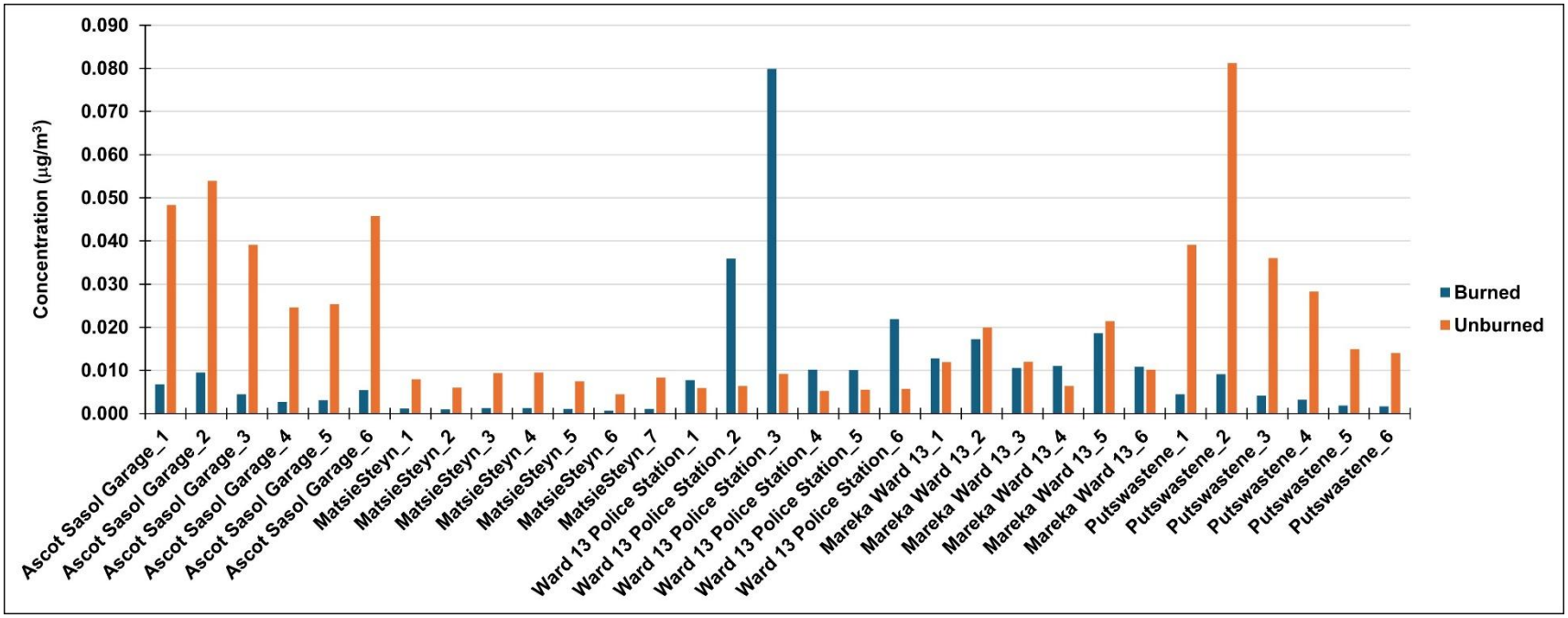


Figure 4-131: Simulated maximum 24-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 5 (5-days).

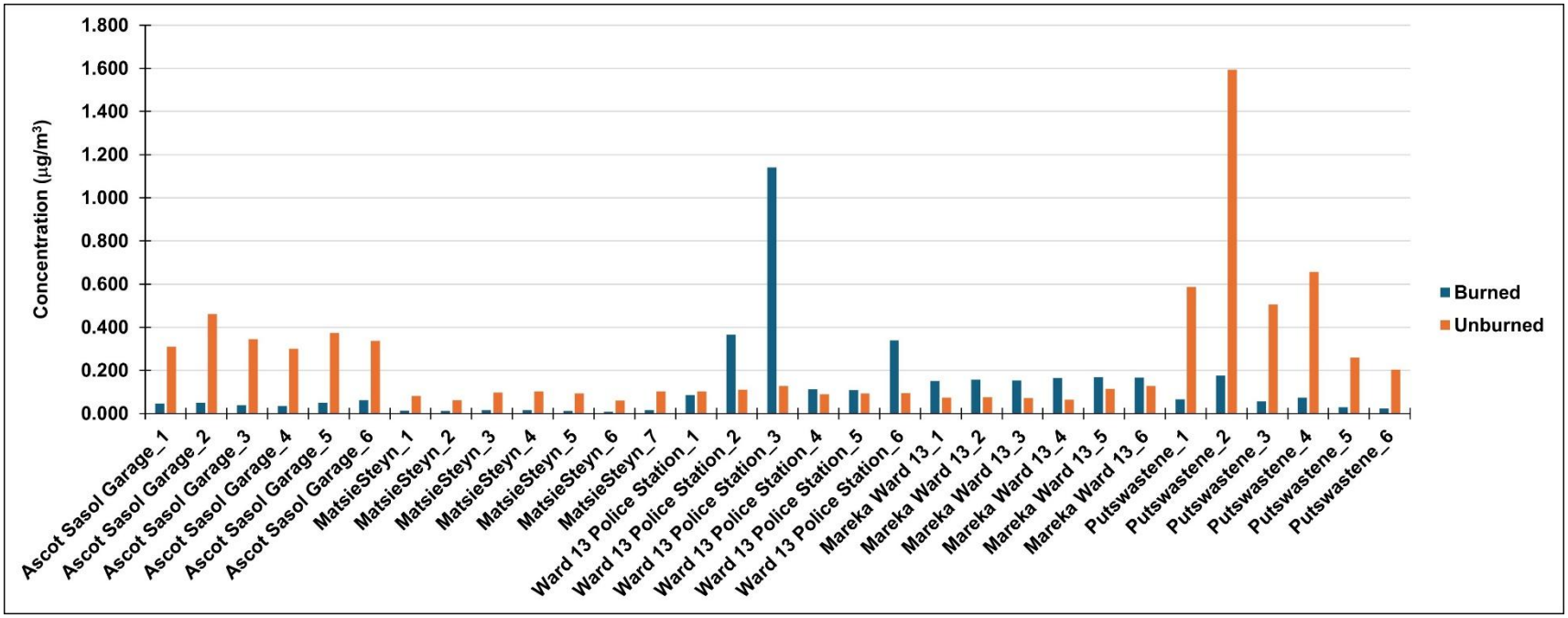


Figure 4-132: Simulated maximum 1-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 5 (5-days).

4.2.5.4 Nitrogen Dioxide (NO_2)

Figure 4-133 illustrates the simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 5 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.28 $\mu g/m^3$ and 0.14 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-134 illustrates the simulated maximum 1-hour ambient NO_2 concentrations over the Sharpeville region for Campaign 5. Maximum 1-hour concentrations of 5.79 $\mu g/m^3$ and 8.09 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for a 1-hour time average is 200 $\mu g/m^3$.

Table 4-20 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-135 and 4-136 is a graphical representation of Table 4-20.

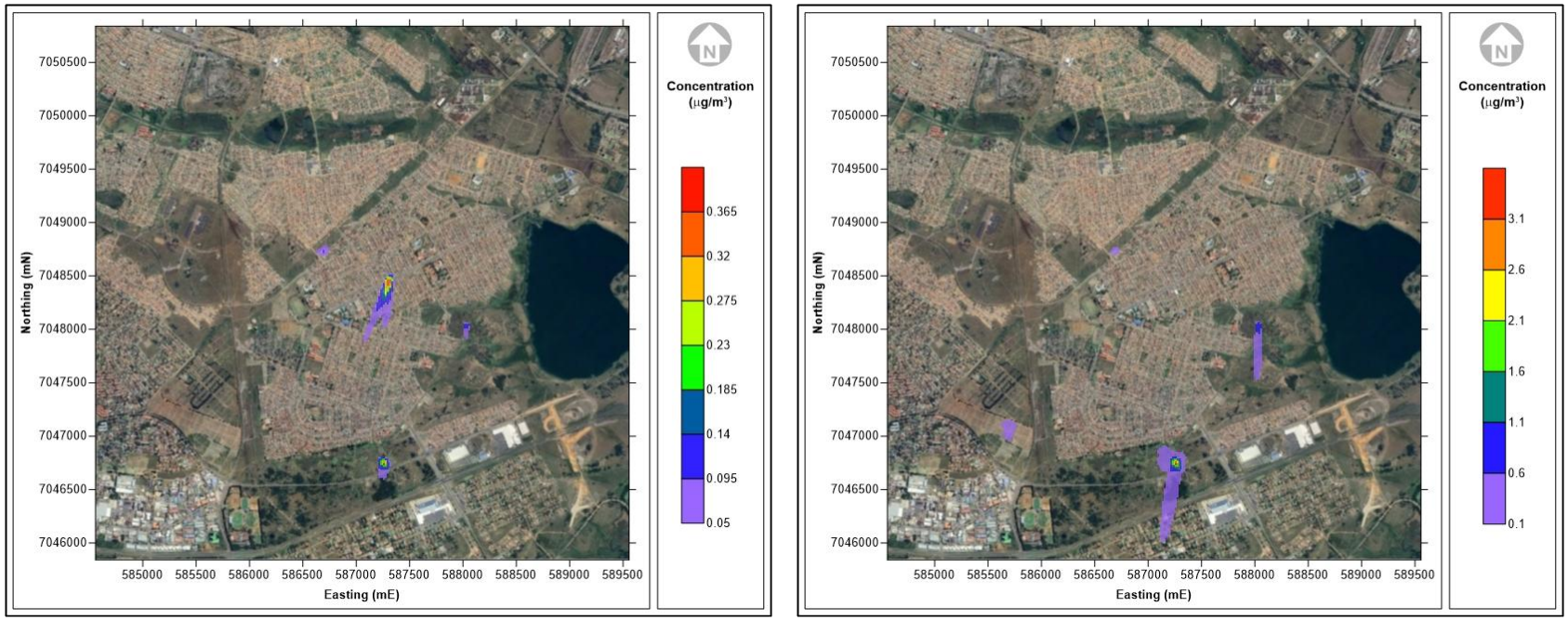


Figure 4-133: Simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 5 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

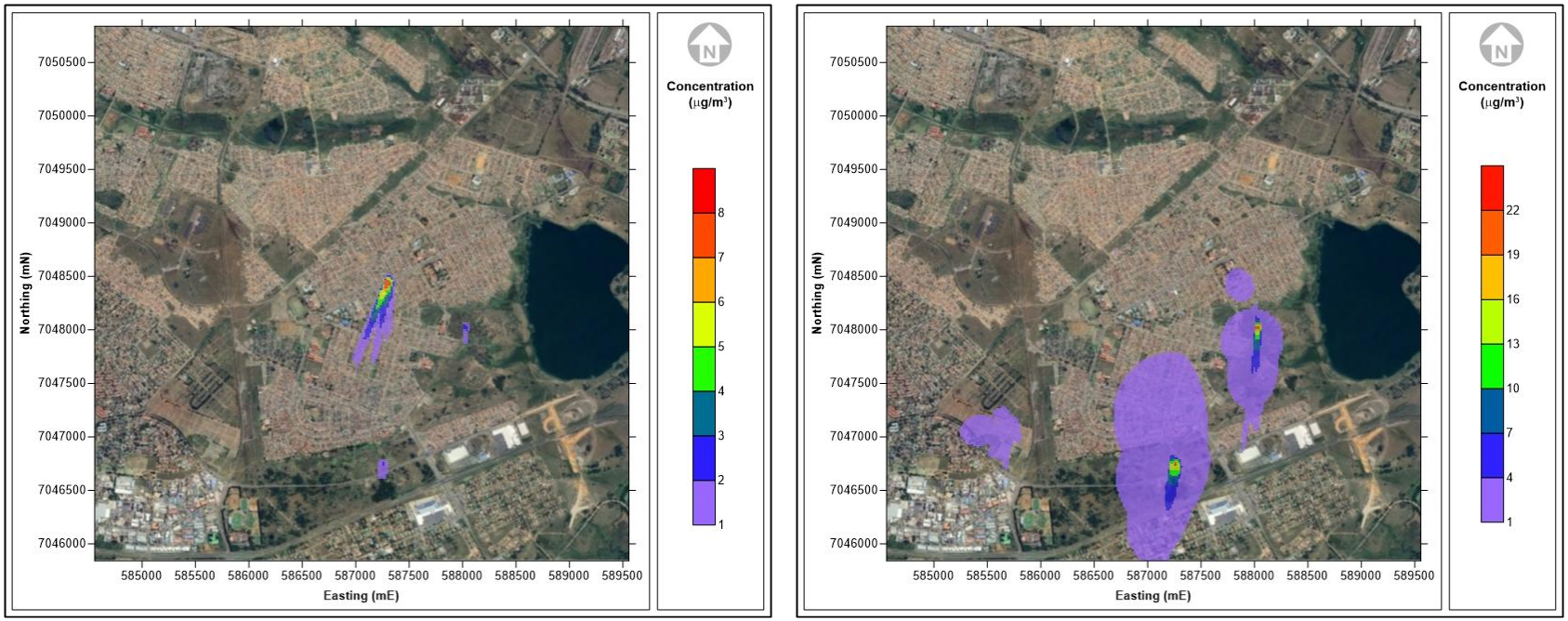


Figure 4-134: Simulated maximum 1-Hour ambient NO_2 concentrations over the Sharpeville region for Campaign 5 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-20: Simulated ambient NO_2 concentrations at the sensitive receptors for Campaign 5.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.017	0.093	0.240	1.569
Ascot Sasol Garage_2	0.020	0.140	0.260	2.343
Ascot Sasol Garage_3	0.012	0.078	0.195	1.753
Ascot Sasol Garage_4	0.009	0.060	0.172	1.521
Ascot Sasol Garage_5	0.012	0.073	0.251	1.893
Ascot Sasol Garage_6	0.015	0.091	0.312	1.710
MatsieSteyn_1	0.002	0.010	0.068	0.416
MatsieSteyn_2	0.002	0.008	0.056	0.319
MatsieSteyn_3	0.003	0.019	0.077	0.492
MatsieSteyn_4	0.003	0.024	0.077	0.522
MatsieSteyn_5	0.002	0.011	0.061	0.471
MatsieSteyn_6	0.001	0.007	0.040	0.307
MatsieSteyn_7	0.002	0.011	0.074	0.521
Ward 13 Police Station_1	0.011	0.007	0.432	0.523
Ward 13 Police Station_2	0.090	0.017	1.861	0.556
Ward 13 Police Station_3	0.284	0.038	5.790	0.651
Ward 13 Police Station_4	0.013	0.007	0.566	0.450
Ward 13 Police Station_5	0.014	0.007	0.550	0.469
Ward 13 Police Station_6	0.061	0.013	1.715	0.480
Mareka Ward 13_1	0.019	0.022	0.771	0.371
Mareka Ward 13_2	0.027	0.036	0.793	0.380
Mareka Ward 13_3	0.020	0.024	0.778	0.368
Mareka Ward 13_4	0.021	0.021	0.839	0.322
Mareka Ward 13_5	0.051	0.076	0.857	0.577
Mareka Ward 13_6	0.028	0.034	0.850	0.651
Putswastene_1	0.006	0.048	0.331	2.978

Putswastene_2	0.010	0.091	0.899	8.088
Putswastene_3	0.005	0.045	0.285	2.561
Putswastene_4	0.006	0.054	0.370	3.327
Putswastene_5	0.004	0.036	0.147	1.320
Putswastene_6	0.003	0.024	0.115	1.035

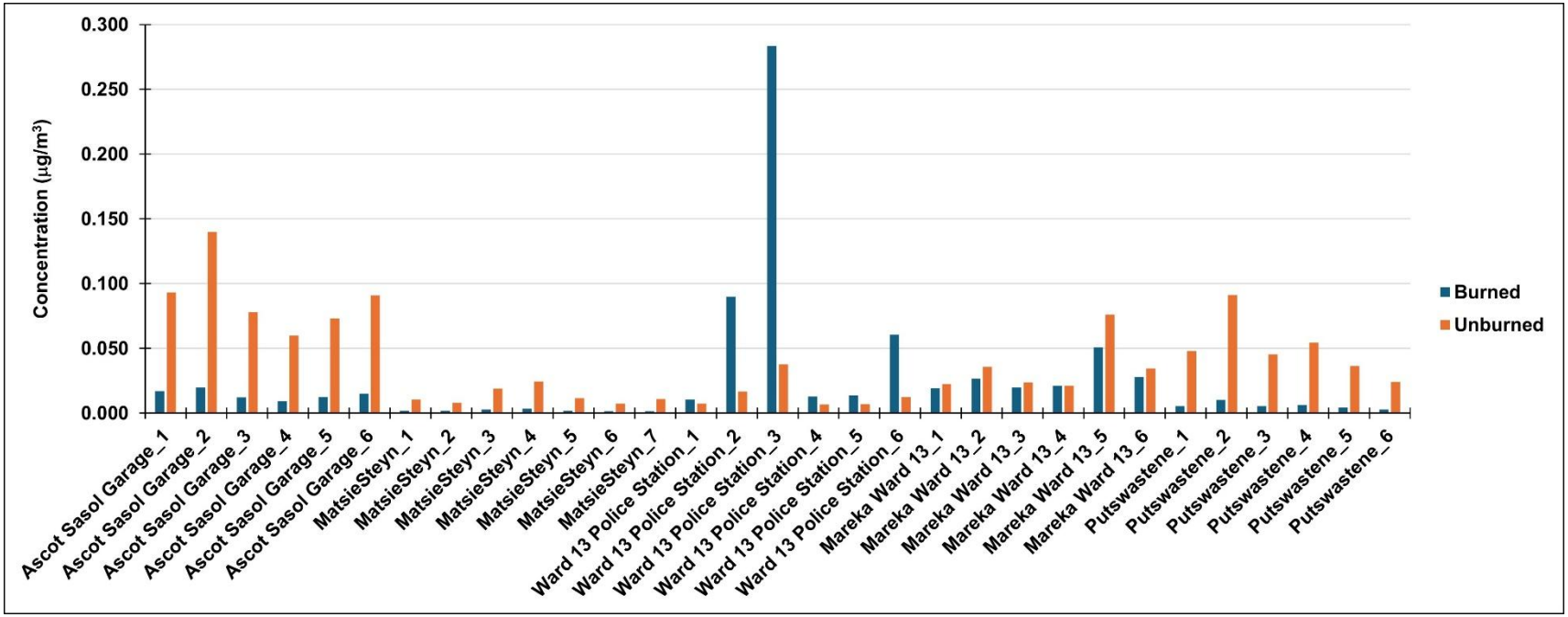


Figure 4-135: Simulated 5-day mean ambient NO_2 concentrations at the sensitive receptors for Campaign 5 (1-hour averages).

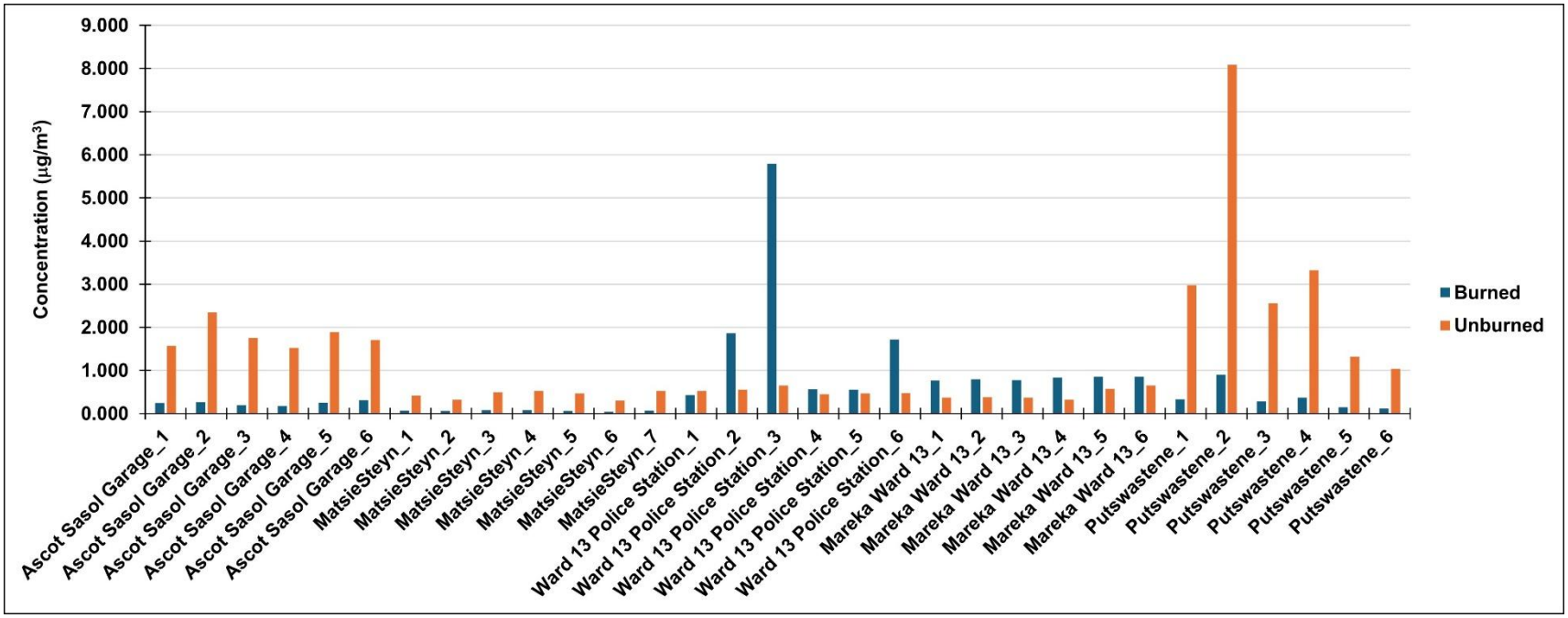


Figure 4-136: Simulated maximum 1-Hour ambient NO_2 concentrations at the sensitive receptors for Campaign 5 (5-days).

4.2.6 CAMPAIGN 6

Figure 4-137 is a map detailing the ten waste collection sites during campaign 6, whilst Figure 4-138 is indicative of the three sites where waste burning practices were conducted.

Figure 4-137: Location of the waste collection sites during Campaign 6.

Figure 138: Location of the waste burning sites during Campaign 6.

Figures 4-139 to 4-141 are detailed maps of the sites where waste burning practices were conducted, as well as the location of sensitive receptors around the burning sites.

Figure 4-139: Ascot Sasol Garage waste burning site and sensitive receptors near the site.

Figure 4-140: Matsie Steyn Primary School waste burning site and sensitive receptors near the site.

Figure 4-141: Mareka Ward 13 waste burning site and sensitive receptors near the site.

4.2.6.1 Particulate Matter (PM_{10})

Figure 4-141 illustrates the simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 6 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 0.28 $\mu g/m^3$ and 0.58 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-142 illustrates the simulated maximum 24-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 6. Maximum 24-hour concentrations of 1.30 $\mu g/m^3$ and 1.04 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the PM_{10} NAAQS for a 24-hour time average is 75 $\mu g/m^3$.

Figure 4-143 illustrates the simulated maximum 1-hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 6. Maximum 1-hour concentrations of 14.33 $\mu g/m^3$

and 10.52 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No PM_{10} NAAQS standard exist for a 1-hour time average.

Table 4-21 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-144 to 4-146 are graphical representations of Table 4-20.

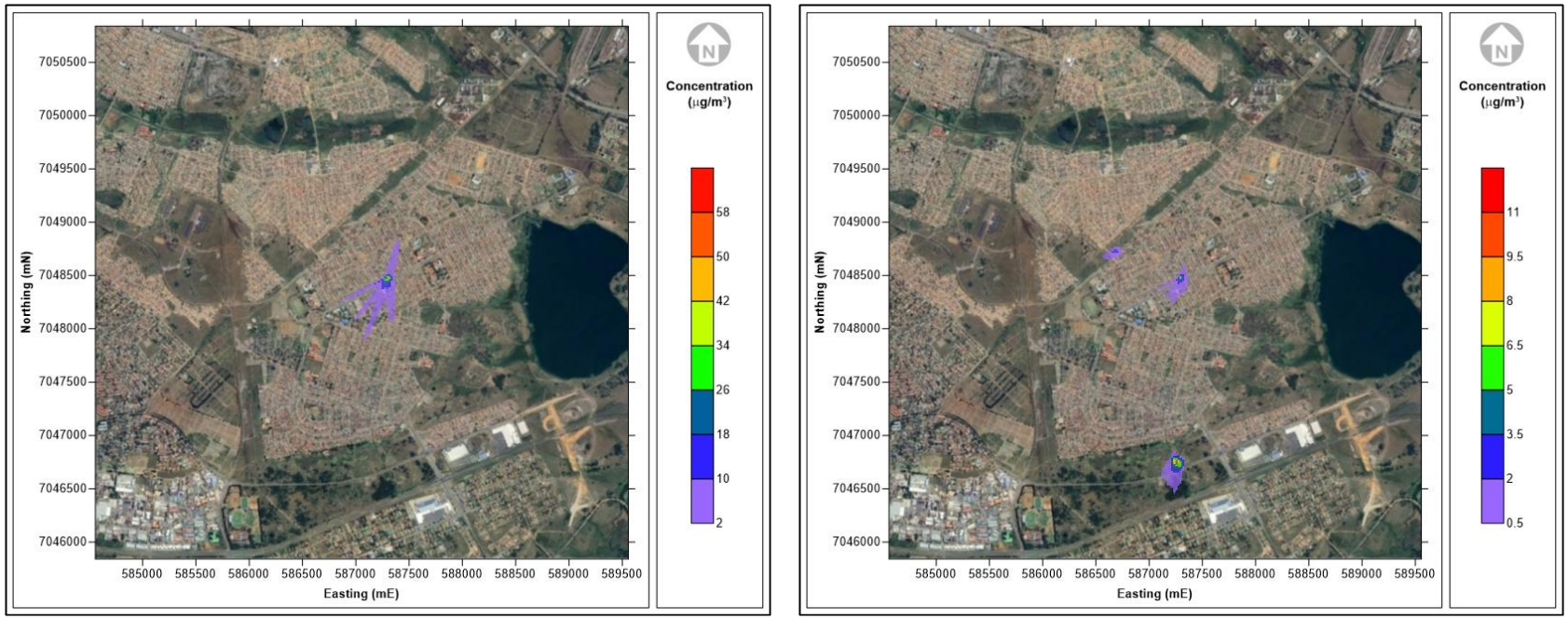


Figure 4-141: Simulated 5-day mean ambient PM_{10} concentrations over the Sharpeville region for Campaign 6 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

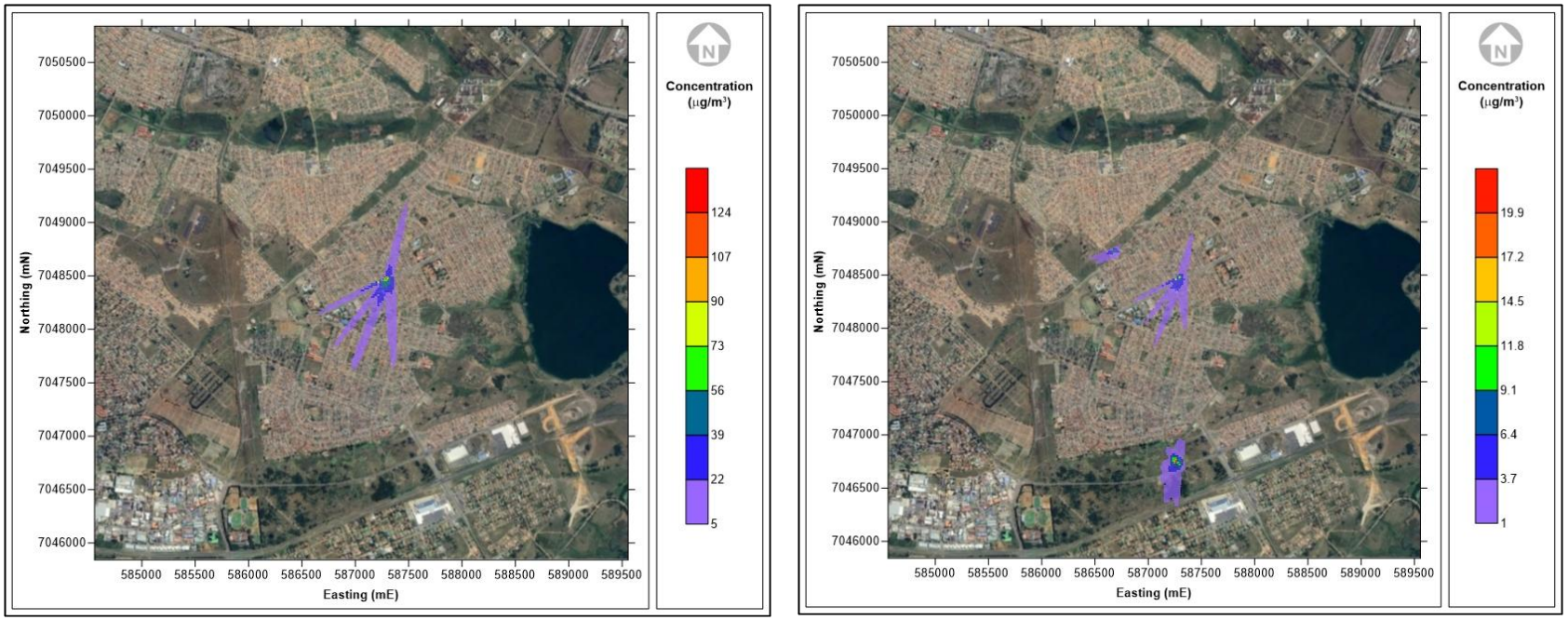


Figure 4-142: Simulated maximum 24-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

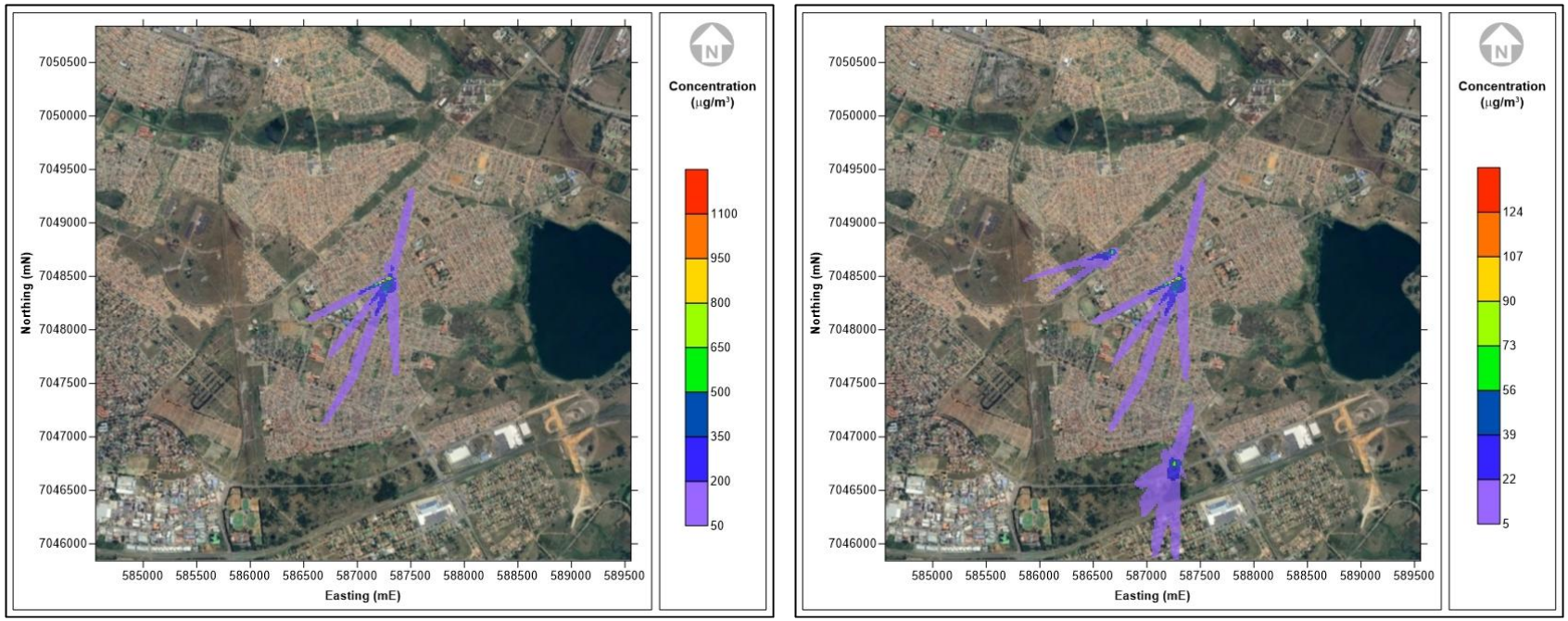


Figure 4-143: Simulated maximum 1-Hour ambient PM_{10} concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-20: Simulated ambient PM_{10} concentrations at the sensitive receptors for Campaign 6.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.02	0.16	0.09	0.77	0.47	4.19
Ascot Sasol Garage_2	0.15	0.20	0.75	1.01	8.45	4.23
Ascot Sasol Garage_3	0.22	0.17	1.11	0.87	12.76	3.21
Ascot Sasol Garage_4	0.26	0.11	1.30	0.55	14.33	2.15
Ascot Sasol Garage_5	0.07	0.58	0.12	1.04	1.17	10.52
Ascot Sasol Garage_6	0.00	0.01	0.01	0.05	0.13	1.18
MatsieSteyn_1	0.05	0.02	0.11	0.06	1.88	0.70
MatsieSteyn_2	0.05	0.01	0.14	0.04	2.18	0.48
MatsieSteyn_3	0.03	0.00	0.14	0.02	2.00	0.22
MatsieSteyn_4	0.03	0.00	0.13	0.01	2.12	0.24
MatsieSteyn_5	0.08	0.01	0.28	0.03	3.13	0.35
MatsieSteyn_6	0.21	0.02	0.97	0.11	13.37	1.49
MatsieSteyn_7	0.08	0.01	0.36	0.04	6.15	0.68
Mareka Ward 13_1	0.07	0.13	0.34	0.63	1.91	3.55
Mareka Ward 13_2	0.07	0.12	0.32	0.60	1.38	2.55
Mareka Ward 13_3	0.01	0.02	0.05	0.08	0.67	1.24
Mareka Ward 13_4	0.08	0.15	0.30	0.57	1.01	1.87
Mareka Ward 13_5	0.28	0.51	0.49	0.91	2.00	3.71
Mareka Ward 13_6	0.21	0.38	0.54	1.01	3.85	7.15

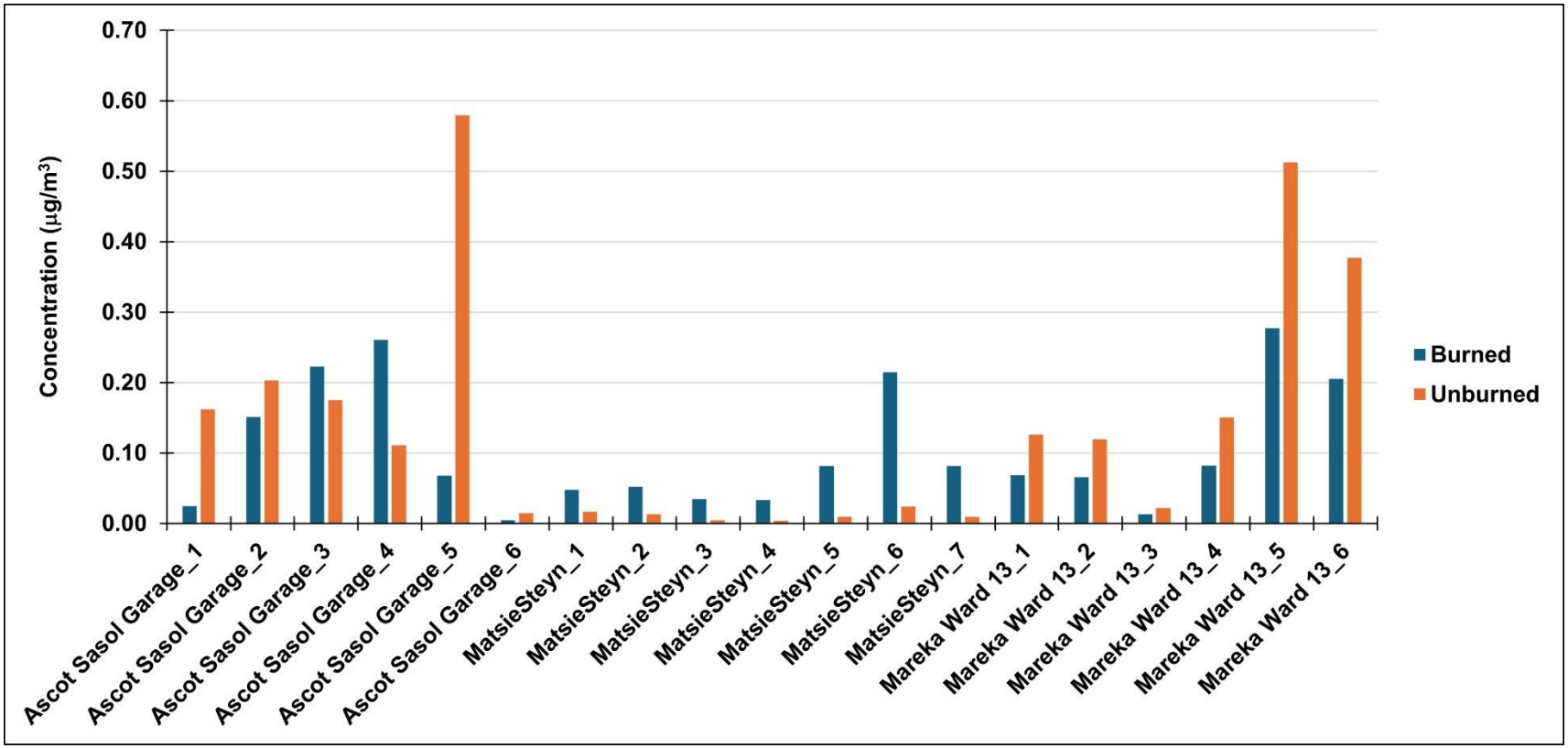


Figure 4-144: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 6 (1-hour averages).

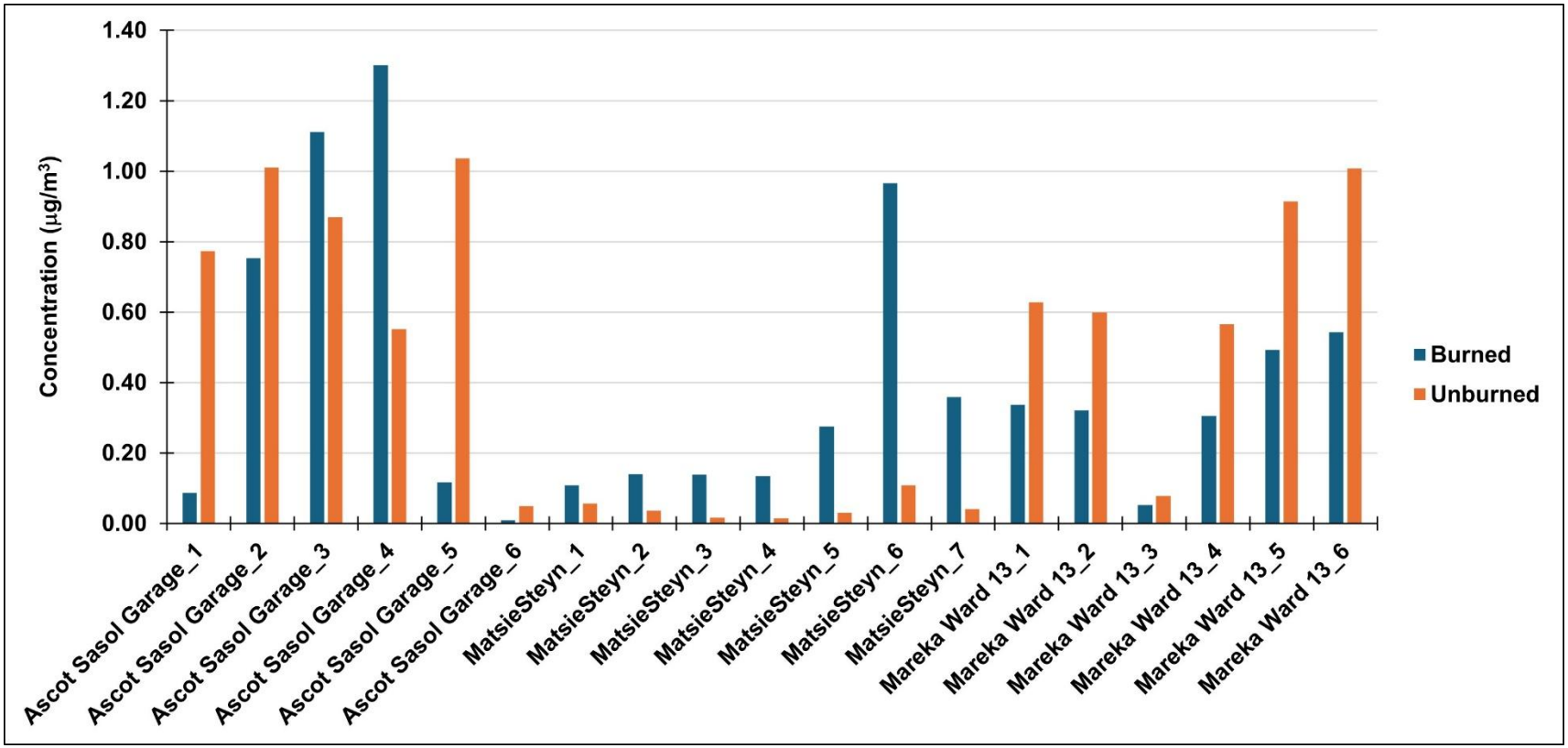


Figure 4-145: Simulated maximum 24-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 6 (5-days).

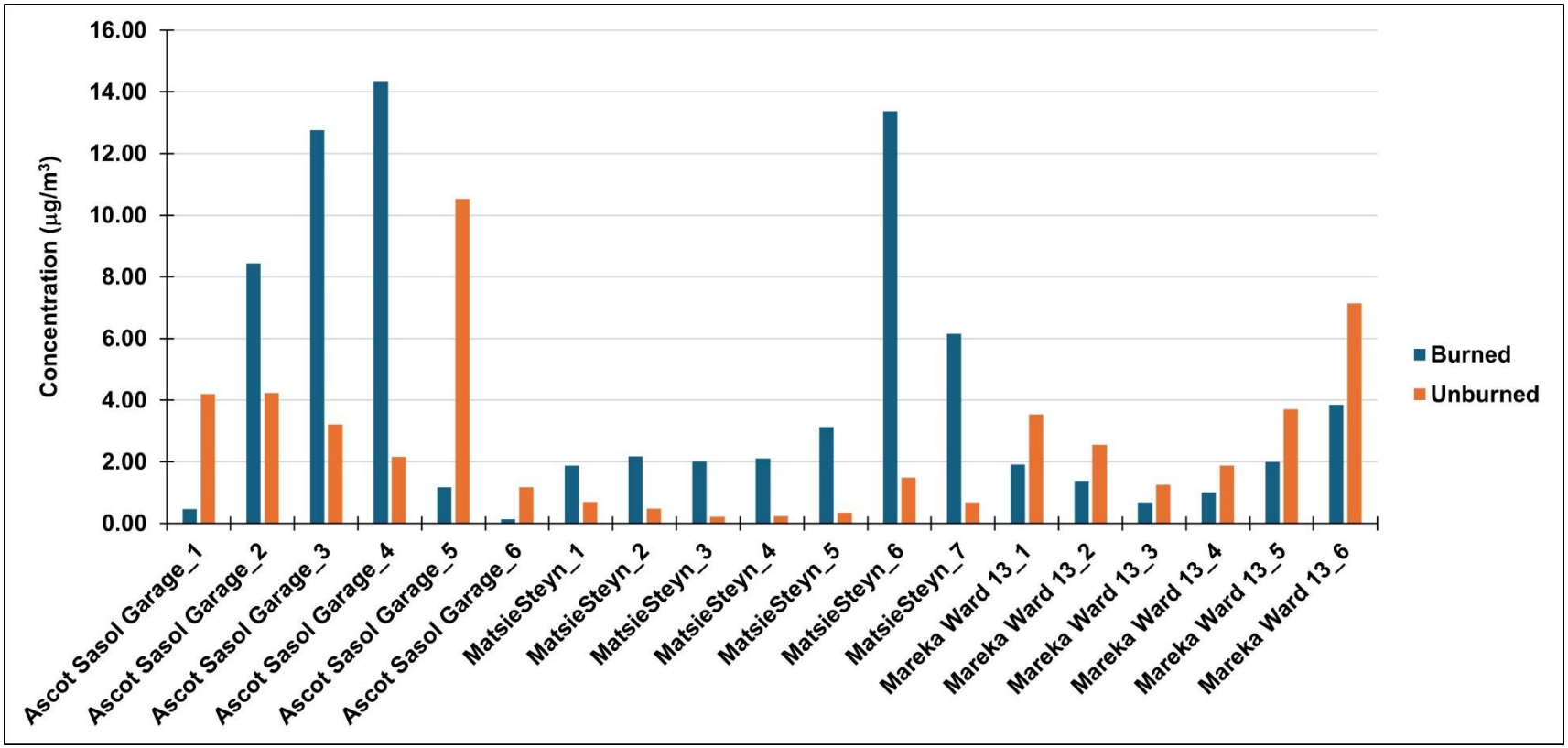


Figure 4-146: Simulated maximum 1-Hour ambient PM_{10} concentrations at the sensitive receptors for Campaign 6 (5-days).

4.2.6.2 Particulate Matter ($PM_{2.5}$)

Figure 4-147 illustrates the simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 6 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. The 5-day ambient maximum concentrations of 0.28 $\mu g/m^3$ and 0.58 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for an annual time average is 20 $\mu g/m^3$.

Figure 4-148 illustrates the simulated maximum 24-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 6. Maximum 24-hour concentrations of 1.30 $\mu g/m^3$ and 1.03 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the $PM_{2.5}$ NAAQS for a 24-hour time average is 40 $\mu g/m^3$.

Figure 4-149 illustrates the simulated maximum 1-hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 6. Maximum 1-hour concentrations of 14.27 $\mu g/m^3$ and 10.48 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. No $PM_{2.5}$ NAAQS standard exist for a 1-hour time average.

Table 4-21 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-150 to 4-152 are graphical representations of Table 4-21.

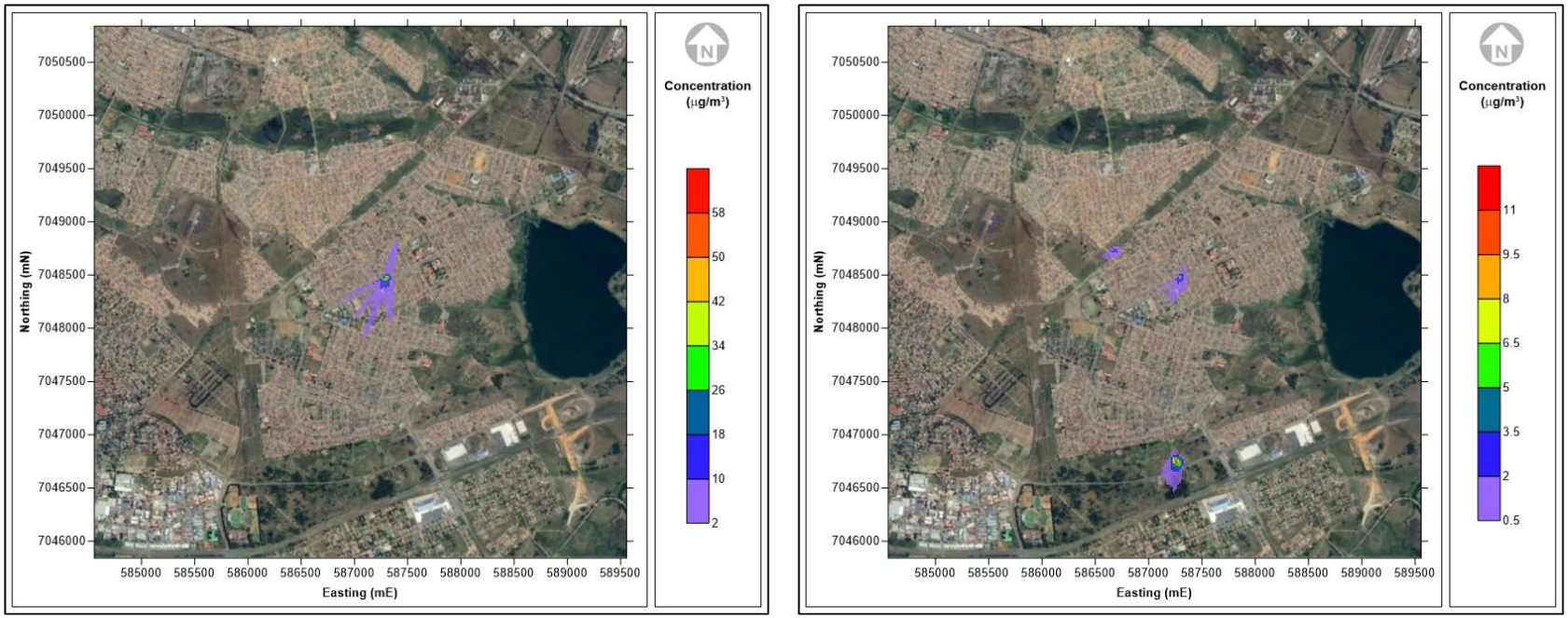


Figure 4-147 Simulated 5-day mean ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 6 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

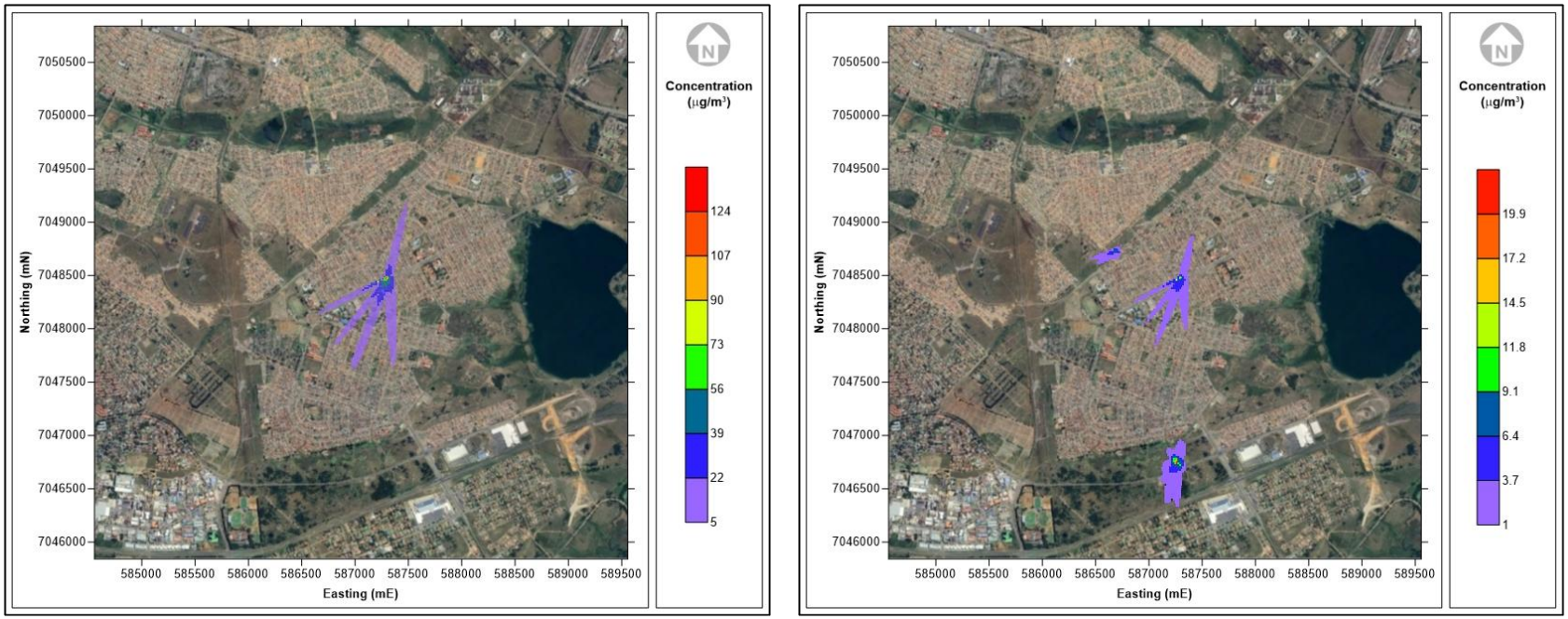


Figure 4-148: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

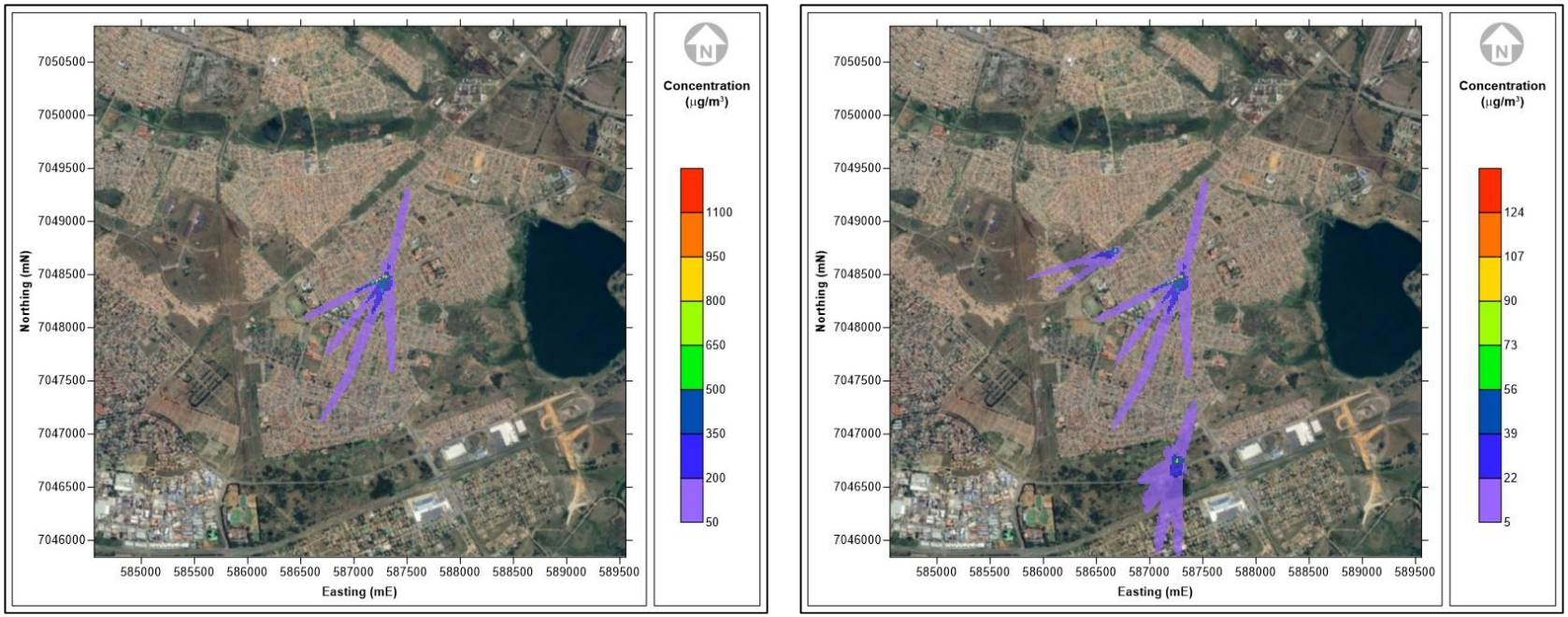


Figure 4-149: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-21: Simulated ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 6.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.02	0.16	0.09	0.77	0.46	4.17
Ascot Sasol Garage_2	0.15	0.20	0.75	1.01	8.41	4.21
Ascot Sasol Garage_3	0.22	0.17	1.11	0.87	12.71	3.19
Ascot Sasol Garage_4	0.26	0.11	1.30	0.55	14.27	2.14
Ascot Sasol Garage_5	0.07	0.58	0.12	1.03	1.16	10.48
Ascot Sasol Garage_6	0.00	0.01	0.01	0.05	0.13	1.17
MatsieSteyn_1	0.05	0.02	0.11	0.06	1.87	0.69
MatsieSteyn_2	0.05	0.01	0.14	0.04	2.17	0.48
MatsieSteyn_3	0.03	0.00	0.14	0.02	1.99	0.22
MatsieSteyn_4	0.03	0.00	0.13	0.01	2.11	0.23
MatsieSteyn_5	0.08	0.01	0.27	0.03	3.12	0.35
MatsieSteyn_6	0.21	0.02	0.96	0.11	13.31	1.48
MatsieSteyn_7	0.08	0.01	0.36	0.04	6.12	0.68
Mareka Ward 13_1	0.07	0.13	0.34	0.63	1.90	3.53
Mareka Ward 13_2	0.07	0.12	0.32	0.60	1.37	2.55
Mareka Ward 13_3	0.01	0.02	0.05	0.08	0.67	1.24
Mareka Ward 13_4	0.08	0.15	0.30	0.56	1.00	1.86
Mareka Ward 13_5	0.28	0.51	0.49	0.91	1.99	3.70
Mareka Ward 13_6	0.20	0.38	0.54	1.00	3.83	7.12

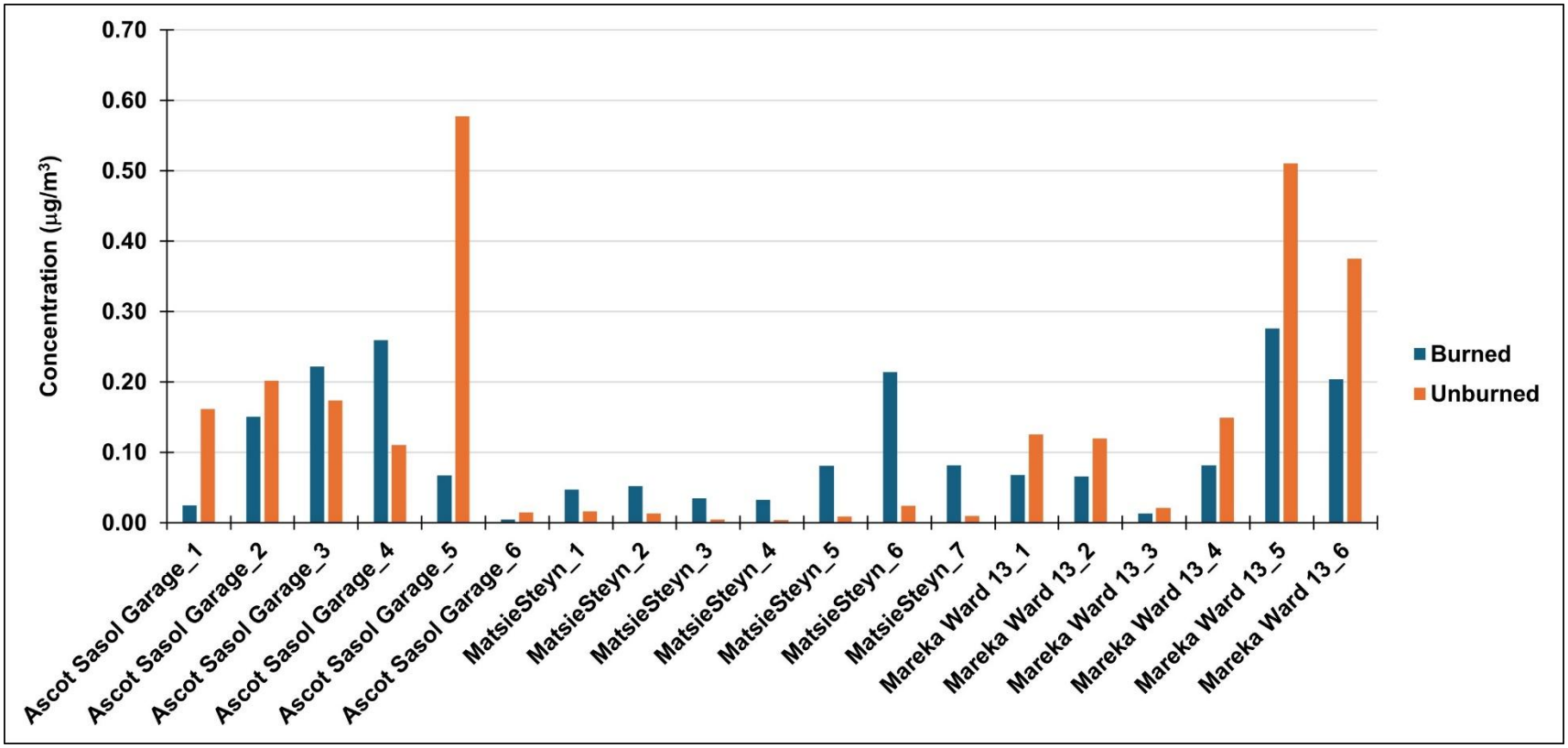


Figure 4-150: Simulated 5-day mean ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 6 (1-hour averages).

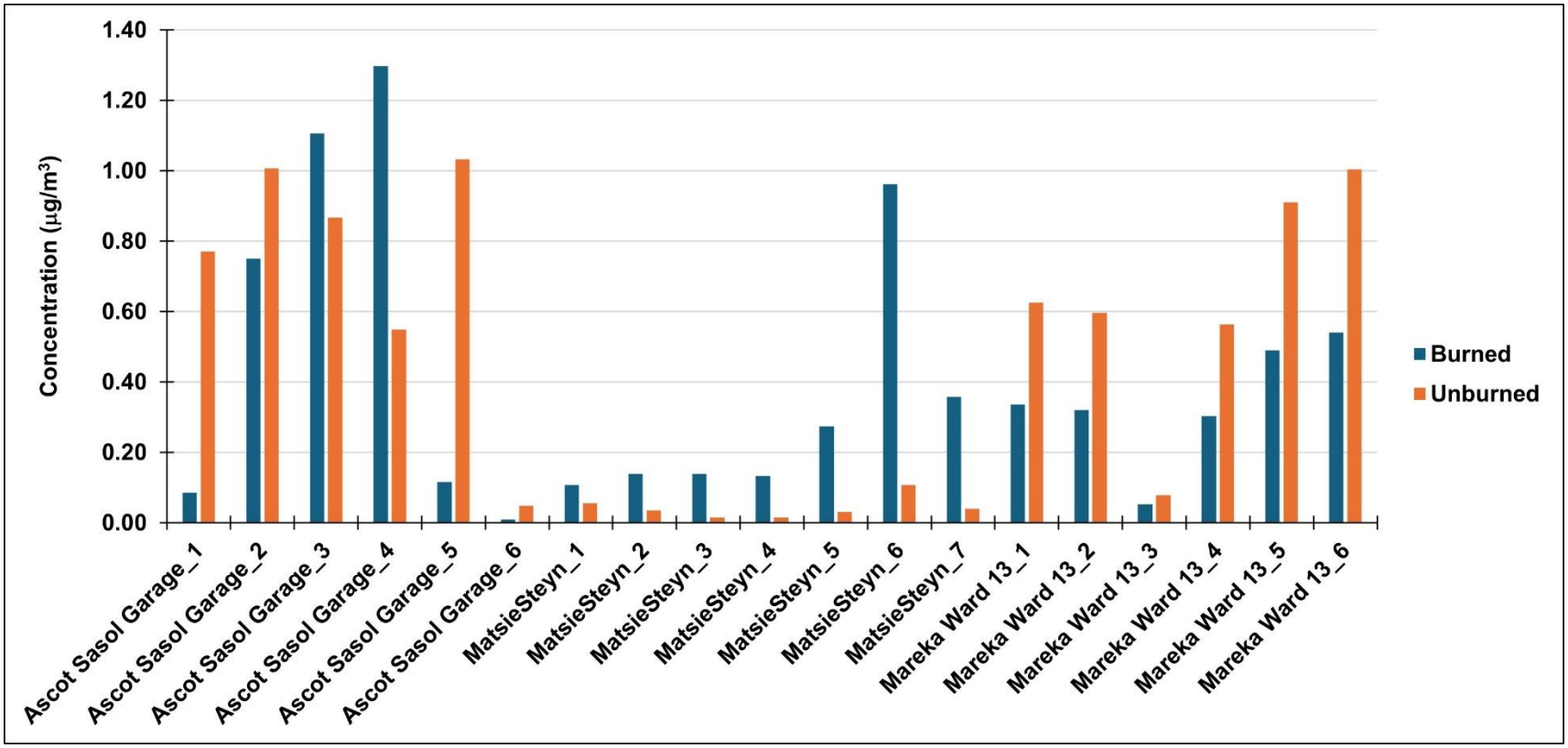


Figure 4-151: Simulated maximum 24-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 6 (5-days).

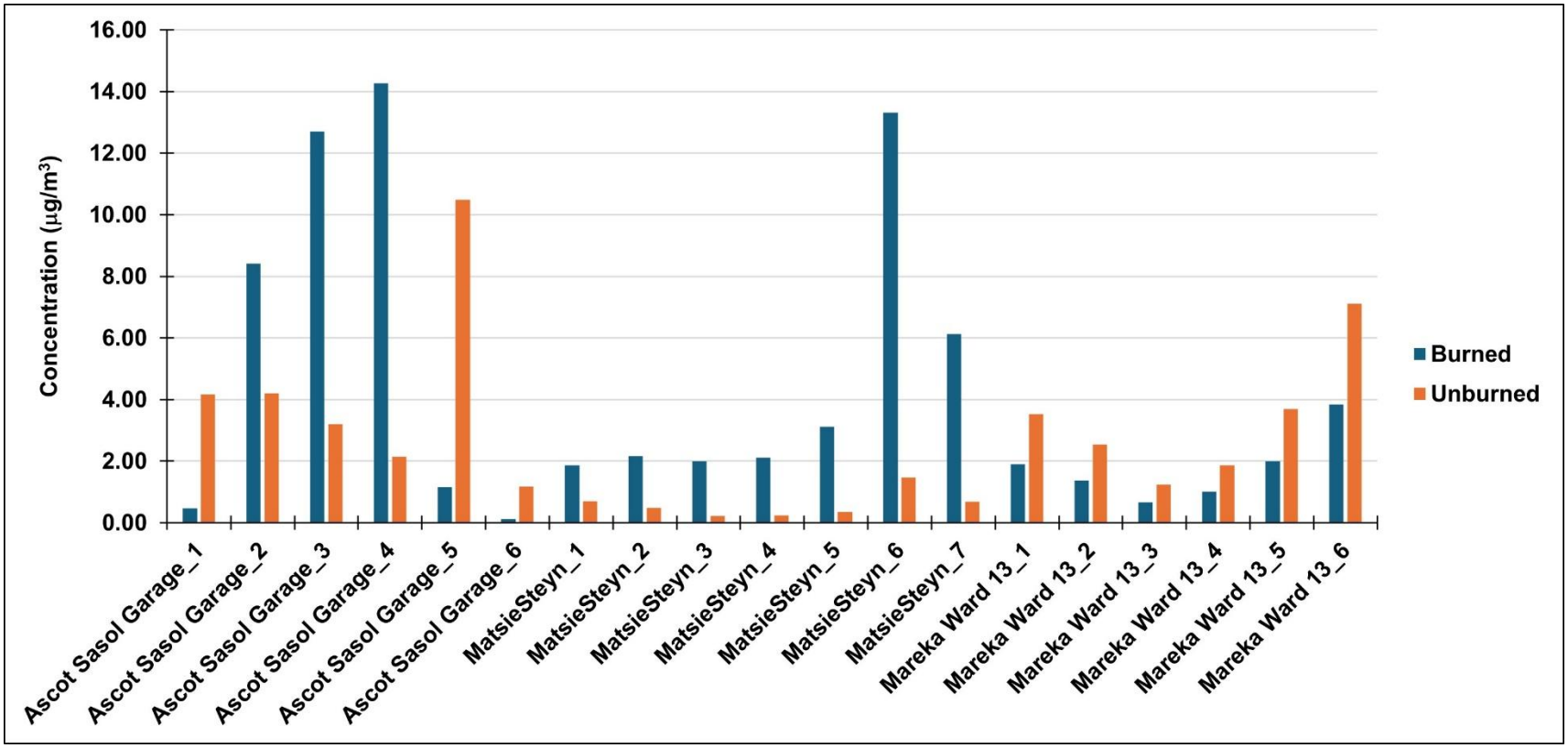


Figure 4-152: Simulated maximum 1-Hour ambient $PM_{2.5}$ concentrations at the sensitive receptors for Campaign 6 (5-days).

4.2.6.3 Sulphur Dioxide (SO_2)

Figure 4-153 illustrates the simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 6 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.01 $\mu g/m^3$ were simulated for both the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for an annual time average is 50 $\mu g/m^3$.

Figure 4-154 illustrates the simulated maximum 24-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 6. Maximum 24-hour concentrations of 0.03 $\mu g/m^3$ and 0.02 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 24-hour time average is 125 $\mu g/m^3$.

Figure 4-155 illustrates the simulated maximum 1-hour ambient SO_2 concentrations over the Sharpeville region for Campaign 6. Maximum 1-hour concentrations of 0.29 $\mu g/m^3$ and 0.21 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Table 4-22 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-156 to 4-158 are graphical representations of Table 4-22.

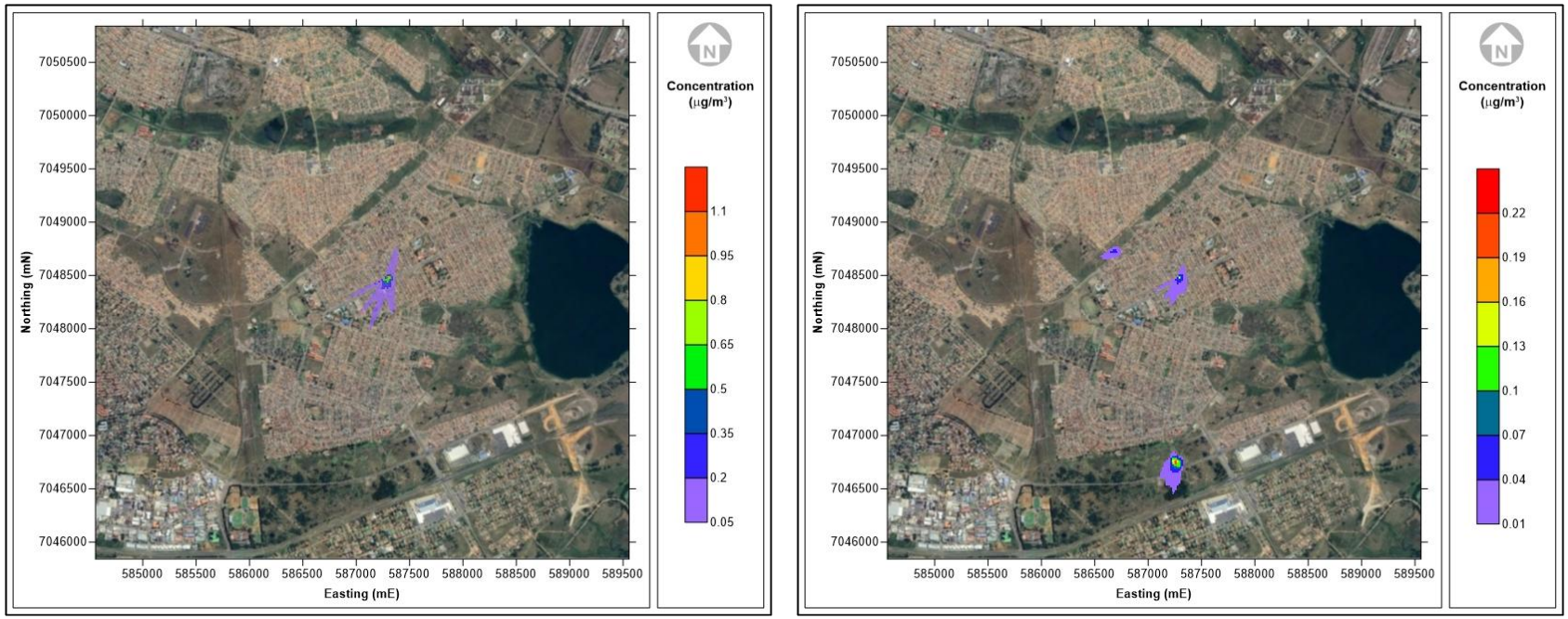


Figure 4-153: Simulated 5-day mean ambient SO_2 concentrations over the Sharpeville region for Campaign 6 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

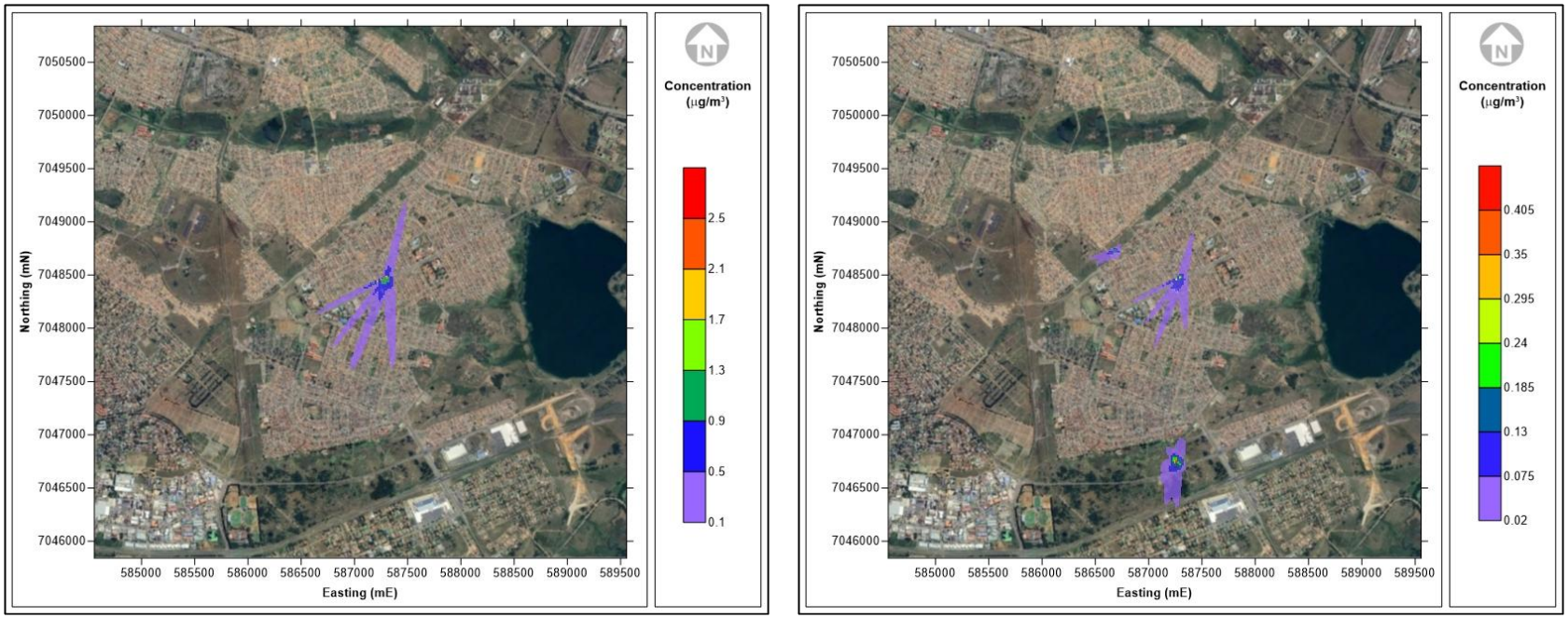


Figure 4-154: Simulated maximum 24-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

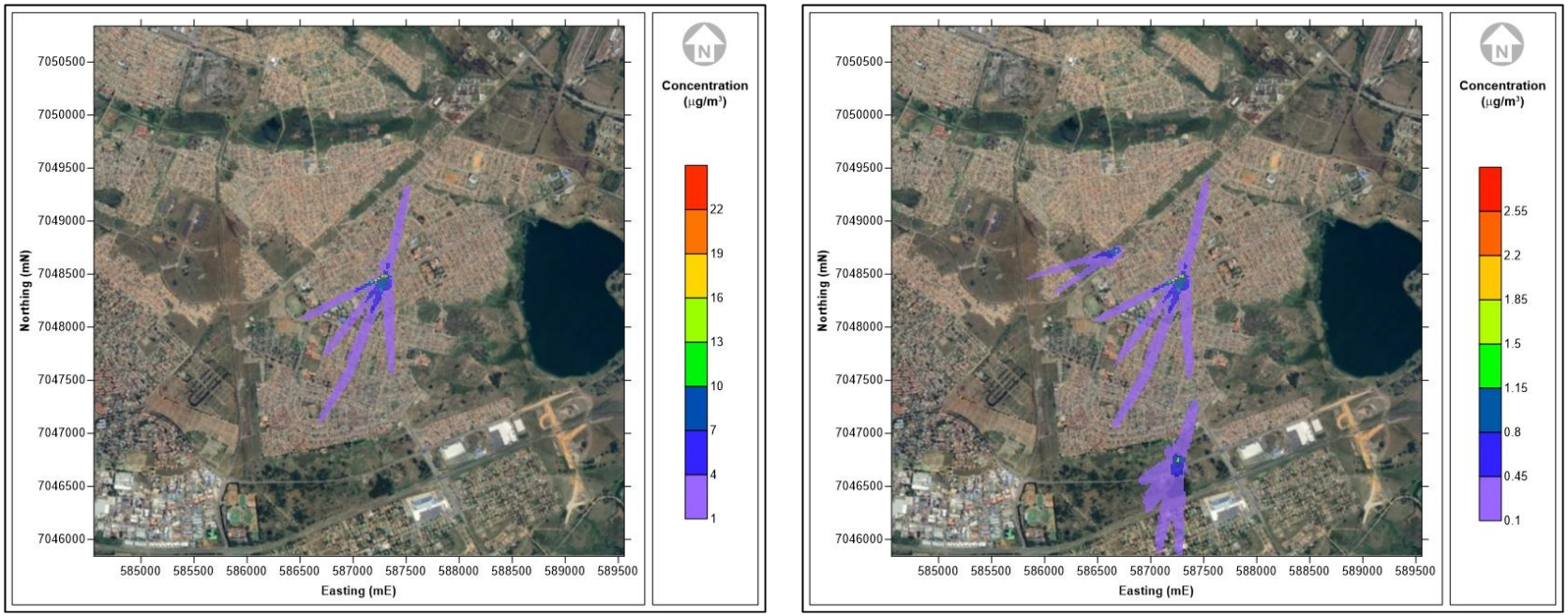


Figure 4-155: Simulated maximum 1-Hour ambient SO_2 concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-22: Simulated ambient SO_2 concentrations at the sensitive receptors for Campaign 6.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 24-Hr Maximum ($\mu g.m^{-3}$)	Unburned 24-Hr Maximum ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.0005	0.003	0.002	0.016	0.009	0.085
Ascot Sasol Garage_2	0.0031	0.004	0.015	0.020	0.171	0.086
Ascot Sasol Garage_3	0.0045	0.004	0.022	0.018	0.258	0.065
Ascot Sasol Garage_4	0.0053	0.002	0.026	0.011	0.290	0.044
Ascot Sasol Garage_5	0.0014	0.012	0.002	0.021	0.023	0.213
Ascot Sasol Garage_6	0.0001	0.000	0.000	0.001	0.003	0.024
MatsieSteyn_1	0.0010	0.000	0.002	0.001	0.038	0.014
MatsieSteyn_2	0.0011	0.000	0.003	0.001	0.044	0.010
MatsieSteyn_3	0.0007	0.000	0.003	0.000	0.041	0.005
MatsieSteyn_4	0.0007	0.000	0.003	0.000	0.043	0.005
MatsieSteyn_5	0.0016	0.000	0.006	0.001	0.063	0.007
MatsieSteyn_6	0.0043	0.000	0.020	0.002	0.271	0.030
MatsieSteyn_7	0.0017	0.000	0.007	0.001	0.125	0.014
Mareka Ward 13_1	0.0014	0.003	0.007	0.013	0.039	0.072
Mareka Ward 13_2	0.0013	0.002	0.006	0.012	0.028	0.052
Mareka Ward 13_3	0.0003	0.000	0.001	0.002	0.014	0.025
Mareka Ward 13_4	0.0017	0.003	0.006	0.011	0.020	0.038
Mareka Ward 13_5	0.0056	0.010	0.010	0.019	0.040	0.075
Mareka Ward 13_6	0.0041	0.008	0.011	0.020	0.078	0.145

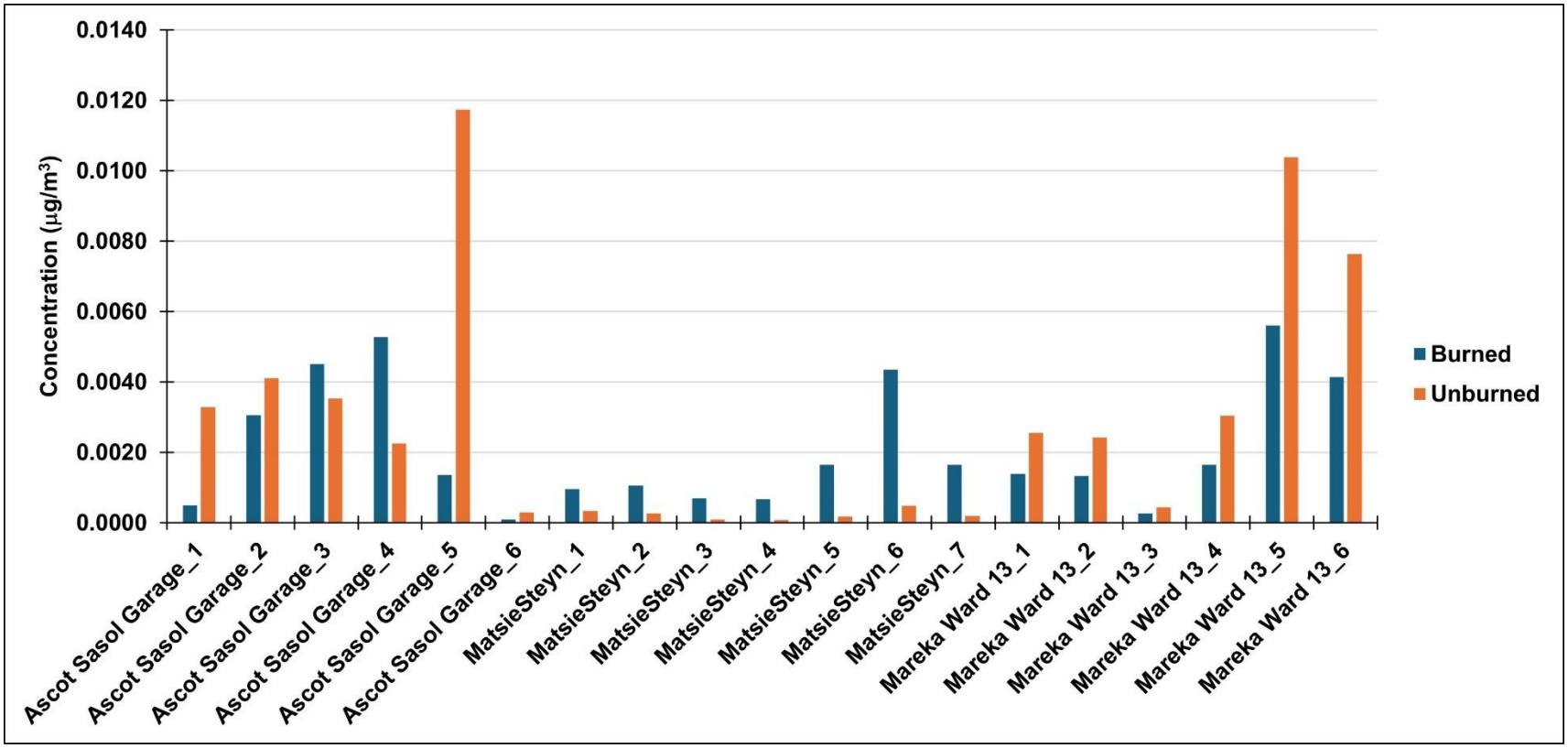


Figure 4-156: Simulated 5-day mean ambient PM_{10} concentrations at the sensitive receptors for Campaign 6 (1-hour averages).

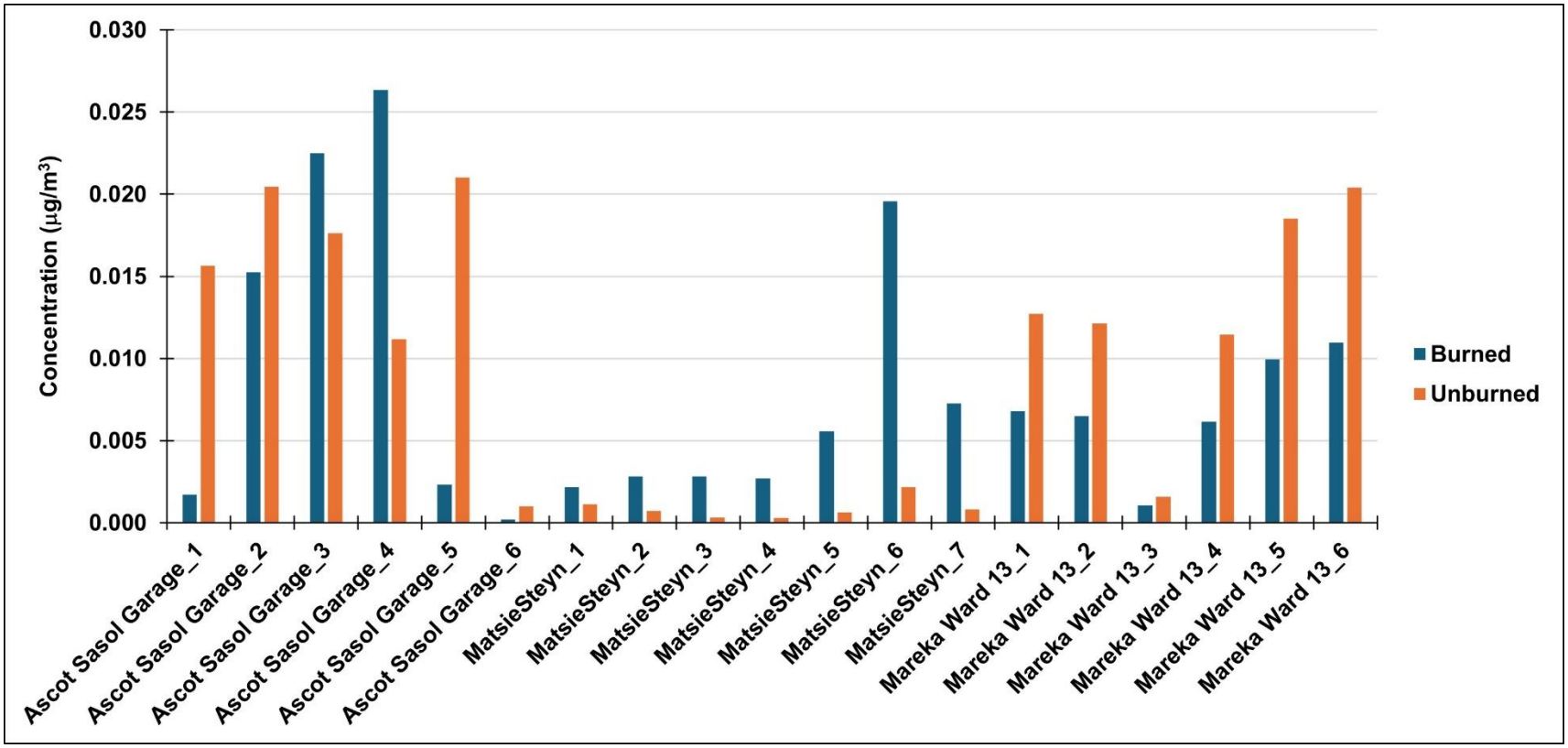


Figure 4-157: Simulated maximum 24-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 6 (5-days).

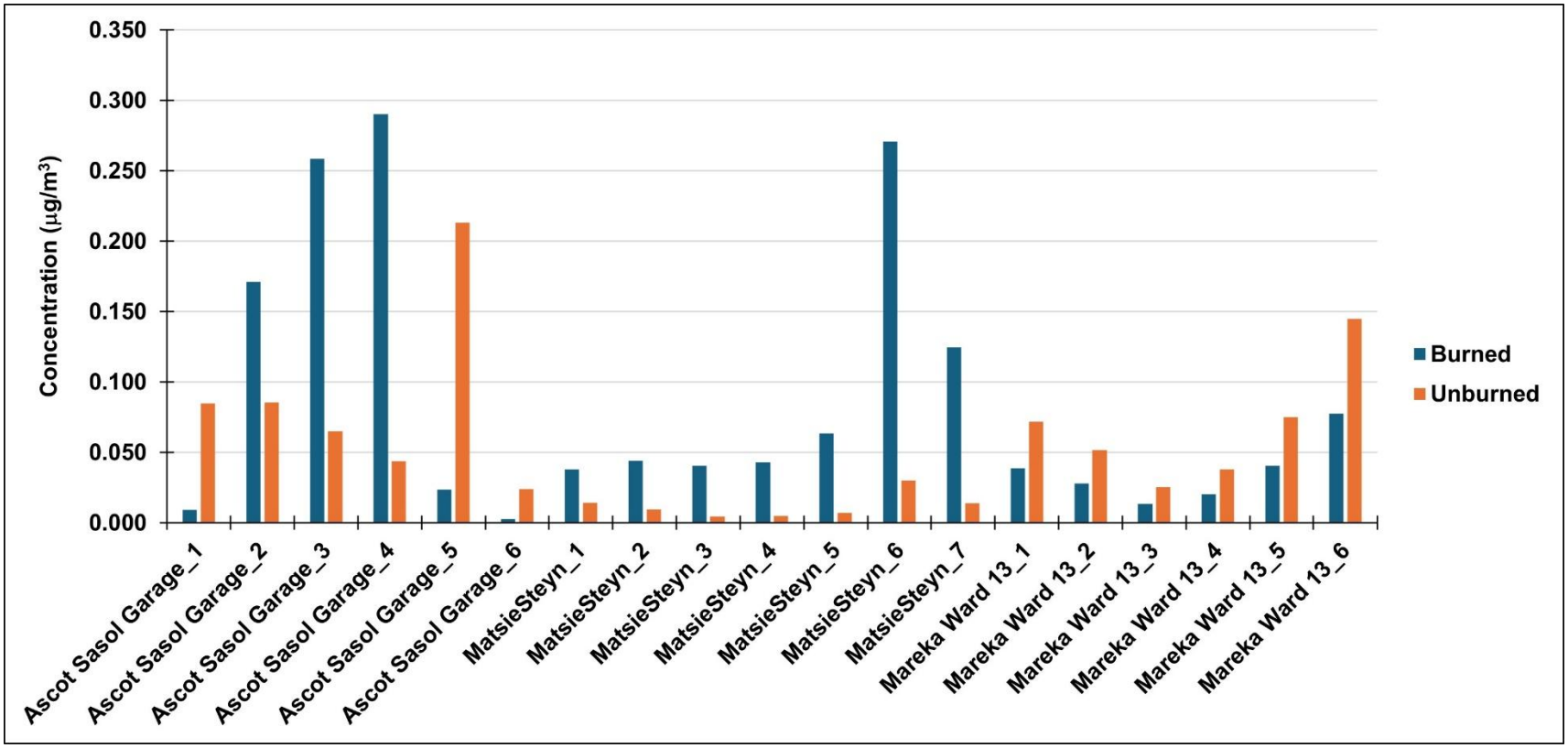


Figure 4-158: Simulated maximum 1-Hour ambient SO_2 concentrations at the sensitive receptors for Campaign 6 (5-days).

4.2.6.4 Nitrogen Dioxide (NO_2)

Figure 4-159 illustrates the simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 6 (based 1-hour averages). The 5-day ambient concentrations are low, and the impact region localised around each site. Maximum concentrations of 0.03 $\mu g/m^3$ and 0.06 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for an annual time average is 40 $\mu g/m^3$.

Figure 4-160 illustrates the simulated maximum 1-hour ambient NO_2 concentrations over the Sharpeville region for Campaign 6. Maximum 1-hour concentrations of 1.47 $\mu g/m^3$ and 1.08 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. It should be noted that the NO_2 NAAQS for a 1-hour time average is 200 $\mu g/m^3$.

Table 4-23 summarises the simulated ambient concentrations at the specific sensitive receptors around the burning sites for the specific time averages. Figures 4-161 and 4-162 are graphical representations of Table 4-23.

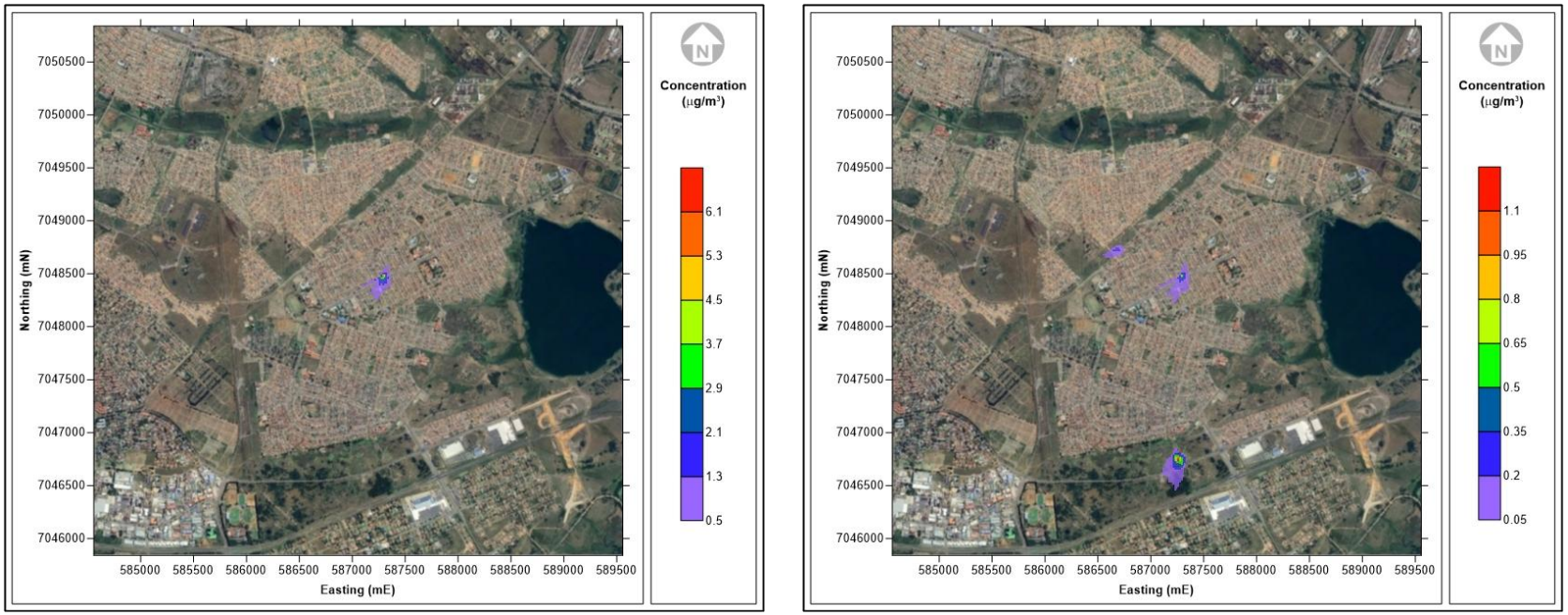


Figure 4-159: Simulated 5-day mean ambient NO_2 concentrations over the Sharpeville region for Campaign 6 (1-hour averages). Impact of burned waste (left), and unburnt waste (right).

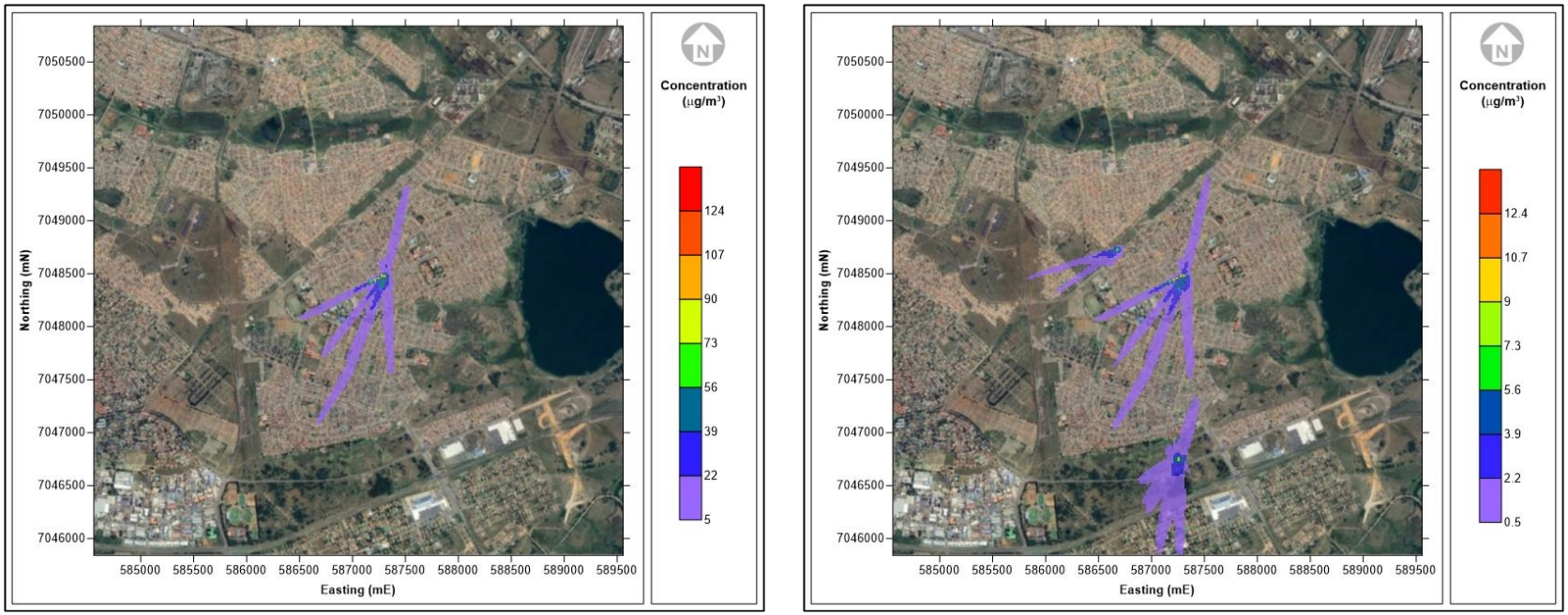


Figure 4-160: Simulated maximum 1-Hour ambient NO_2 concentrations over the Sharpeville region for Campaign 6 (5-days). Impact of burned waste (left), and unburnt waste (right).

Table 4-23: Simulated ambient NO_2 concentrations at the sensitive receptors for Campaign 3.

Receptor	Burned 5-Day Average ($\mu g.m^{-3}$)	Unburned 5-Day Average ($\mu g.m^{-3}$)	Burned 1-Hr Maximum ($\mu g.m^{-3}$)	Unburned 1-Hr Maximum ($\mu g.m^{-3}$)
Ascot Sasol Garage_1	0.0025	0.017	0.048	0.431
Ascot Sasol Garage_2	0.0155	0.021	0.868	0.434
Ascot Sasol Garage_3	0.0229	0.018	1.311	0.330
Ascot Sasol Garage_4	0.0268	0.011	1.473	0.221
Ascot Sasol Garage_5	0.0070	0.060	0.120	1.082
Ascot Sasol Garage_6	0.0005	0.002	0.013	0.121
MatsieSteyn_1	0.0049	0.002	0.193	0.072
MatsieSteyn_2	0.0053	0.001	0.224	0.049
MatsieSteyn_3	0.0036	0.000	0.206	0.023
MatsieSteyn_4	0.0034	0.000	0.217	0.024
MatsieSteyn_5	0.0083	0.001	0.322	0.036
MatsieSteyn_6	0.0221	0.002	1.374	0.153
MatsieSteyn_7	0.0084	0.001	0.632	0.070
Mareka Ward 13_1	0.0070	0.013	0.196	0.364
Mareka Ward 13_2	0.0068	0.012	0.141	0.263
Mareka Ward 13_3	0.0014	0.002	0.069	0.128
Mareka Ward 13_4	0.0084	0.015	0.104	0.192
Mareka Ward 13_5	0.0285	0.053	0.205	0.382
Mareka Ward 13_6	0.0211	0.039	0.396	0.735

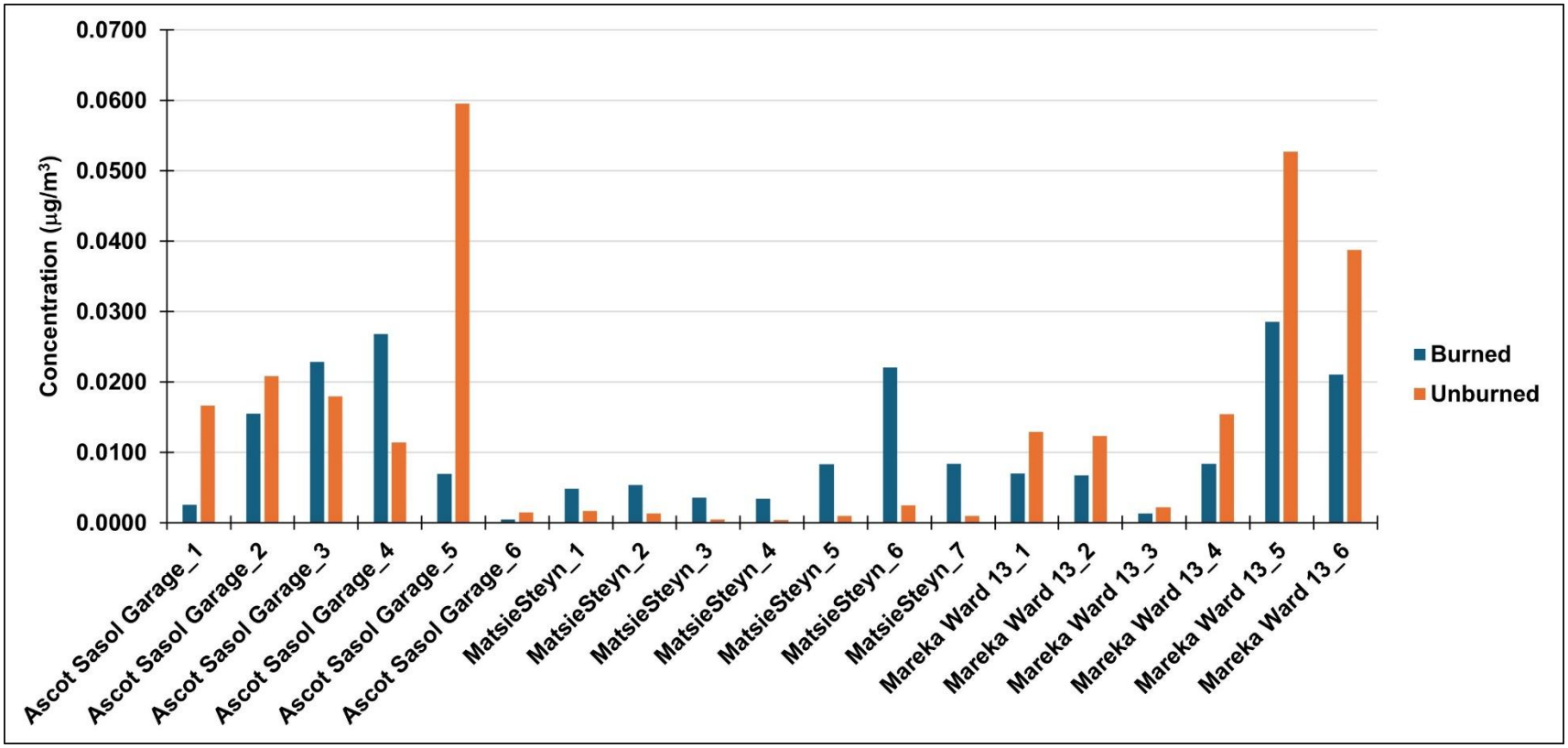


Figure 4-161: Simulated 5-day mean ambient NO_2 concentrations at the sensitive receptors for Campaign 6 (1-hour averages).

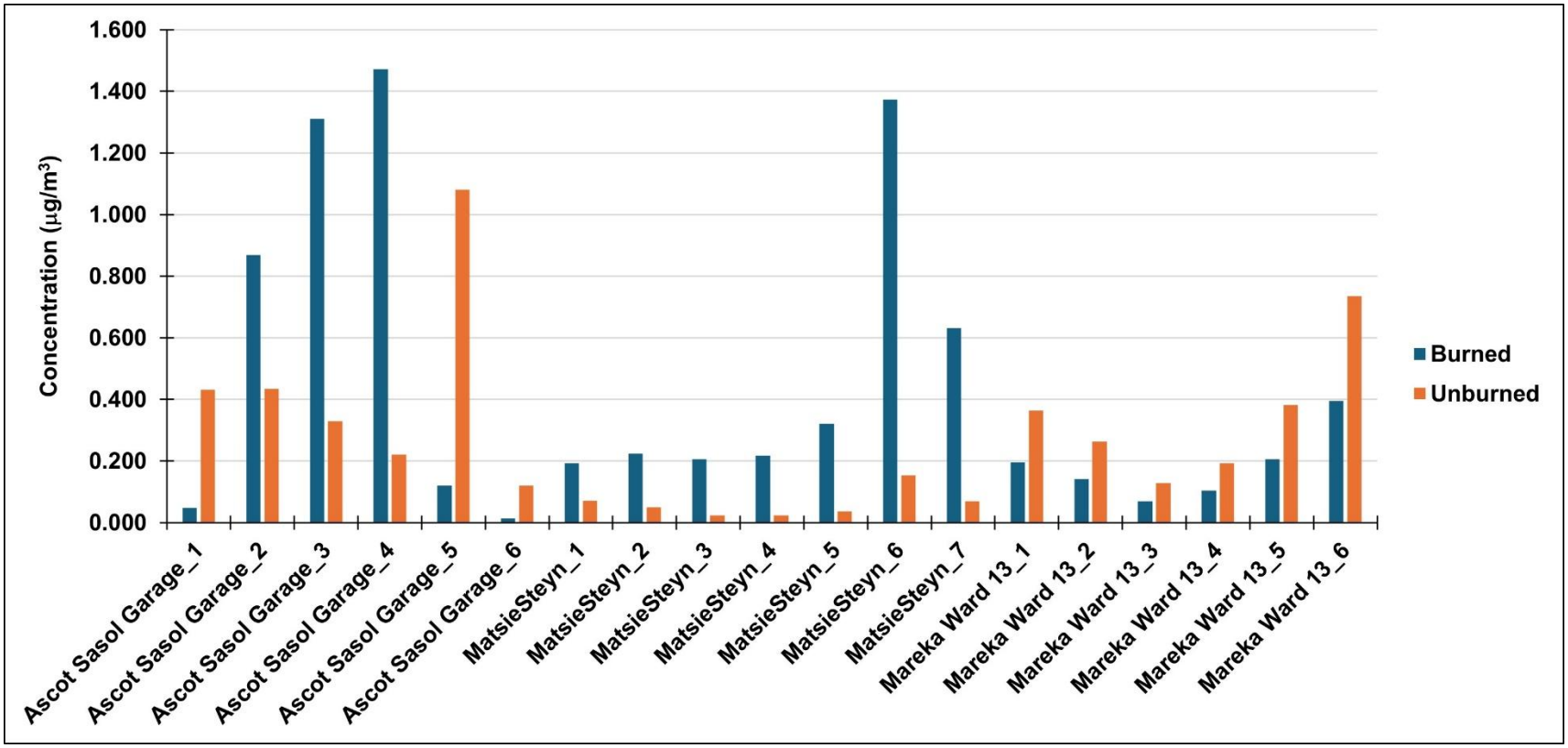


Figure 4-162: Simulated maximum 1-Hour ambient NO_2 concentrations at the sensitive receptors for Campaign 6 (5-days).

5 DISCUSSION

The following section evaluates compliance with the National ambient air quality standards (NAAQS). Additionally, this section provides a summary of the potential nett ambient air quality benefit of Eskom's Sharpeville AQO Project during clean-up campaigns 1 to 3.

5.1 NAAQS EVALUATION

The modelling period (5-days) coincided with the clean-up campaigns, hence comparing the 5-day average to an annual NAAQS would be unscientific. The discussions that will follow will focus on the comparison of simulated ambient concentrations of pollutants to available NAAQS.

5.1.1 CAMPAIGN 1

It's evident from Table 4-1, that the emissions rates for both PM_{10} and $PM_{2.5}$ are very similar thus leading to comparable results in the model predicted concentrations of particulate matter (PM_{10} and $PM_{2.5}$). Maximum 24-hour concentrations of 10.20 $\mu g/m^3$ and 2.30 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. These simulated concentrations are below the PM_{10} NAAQS for a 24-hour time average (75 $\mu g/m^3$), as well as the $PM_{2.5}$ NAAQS for a 24-hour time average (40 $\mu g/m^3$). It is important to note that these simulated concentrations exclude other emission sources that could potentially contribute to the ambient concentrations.

Maximum 24-hour concentrations for SO_2 of 0.20 $\mu g/m^3$ and 0.05 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the SO_2 NAAQS for a 24-hour time average (125 $\mu g/m^3$). Results well below the NAAQS were the same for the SO_2 1-hour time averages. Maximum concentrations

of 2.30 μg/m^3 and 0.40 μg/m^3 were simulated for the burned and unburned emission scenarios, whilst the SO_2 NAAQS for a 1-hour time average is 350 μg/m^3. Maximum 1-hour concentrations for NO_2 of 11.2 μg/m^3 and 2.1 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the NO_2 NAAQS for a 1-hour time average of 200 μg/m^3.

5.1.2 CAMPAIGN 2

Table 4-2 illustrates that the emissions rates for both PM_{10} and $PM_{2.5}$ are very similar thus leading to comparable results in the model predicted concentrations of particulate matter (PM_{10} and $PM_{2.5}$). Maximum 24-hour concentrations for PM_{10} of 30.40 μg/m^3 and 4.40 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated PM_{10} concentrations for the burned emissions exceed the PM_{10} NAAQS for a 24-hour time average (75 μg/m^3), whilst the unburnt emission concentrations are below the NAAQS. Maximum 24-hour concentrations for $PM_{2.5}$ 30.20 μg/m^3 and 4.40 μg/m^3 were simulated for the burned and unburned emission scenarios, and the burned as well as the unburned results exceed the $PM_{2.5}$ NAAQS for a 24-hour time average (40 μg/m^3). It is important to note that these simulated concentrations exclude other emission sources that could potentially contribute to a further increase in the ambient concentrations. Simulated ambient concentrations for all sensitive receptors around the waste burning sites are in compliance with the NAAQS.

Maximum 24-hour concentrations for SO_2 of 0.60 μg/m^3 and 0.09 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the SO_2 NAAQS for a 24-hour time average (125 μg/m^3). Results were the same for the SO_2 1-hour time average. Maximum 1-hour concentrations for SO_2 of 6.10 μg/m^3 and 0.60 μg/m^3 were simulated for the burned and unburned emission scenarios, whilst the SO_2 NAAQS for a 1-hour time average is 350 μg/m^3. Simulated ambient

concentrations for all sensitive receptors around the waste burning sites are in compliance with the NAAQS.

Maximum 1-hour concentrations for NO_2 31.00 μg/m^3 and 3.50 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the NO_2 NAAQS for a 1-hour time average of 200 μg/m^3. Simulated ambient concentrations for all sensitive receptors around the waste burning sites are in compliance with the NAAQS.

5.1.3 CAMPAIGN 3

As noted, in Table 4-3, that the emissions rates for both PM_{10} and $PM_{2.5}$ are very similar thus leading to comparable results in the model predicted concentrations of particulate matter (PM_{10} and $PM_{2.5}$). These simulated concentrations are below the PM_{10} NAAQS for a 24-hour time average (75 μg/m^3). Maximum 24-hour concentrations for PM_{10} of 22.40 μg/m^3 and 28.70 μg/m^3 were simulated for the burned and unburned emission scenarios. However, for $PM_{2.5}$ maximum 24-hour concentrations of 22.40 μg/m^3 and 28.70 μg/m^3 were simulated for the burned and unburned emission scenarios. The burned emission exceeded the NAAQS for $PM_{2.5}$ for a 24-hour time average (40 μg/m^3).

Maximum 24-hour concentrations of 0.45 μg/m^3 and 0.58 μg/m^3 were simulated for the burned and unburned emission scenarios which are well below the SO_2 NAAQS for a 24-hour time average (125 μg/m^3). Additionally, the simulated maximum 1-hour concentrations for all sensitive receptors around the waste burning sites are in compliance with the NAAQS. Similarly, the maximum 1-hour NO_2 concentrations 24.20 μg/m^3 and 28.60 μg/m^3 were simulated for the burned and unburned emission scenarios which is well below the 1-hour NO_2 NAAQS of 200 μg/m^3.

5.1.4 CAMPAIGN 4

It's evident from Table 4-4, that the emissions rates for both PM_{10} and $PM_{2.5}$ are very similar thus leading to comparable results in the model predicted concentrations of particulate matter (PM_{10} and $PM_{2.5}$). Maximum 24-hour concentrations of 3.90 $\mu g/m^3$ and 1.50 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. These simulated concentrations are below the PM_{10} NAAQS for a 24-hour time average (75 $\mu g/m^3$), as well as the $PM_{2.5}$ NAAQS for a 24-hour time average (40 $\mu g/m^3$). It is important to note that these simulated concentrations exclude other emission sources that could potentially contribute to the ambient concentrations.

Maximum 24-hour concentrations for SO_2 of 0.08 $\mu g/m^3$ and 0.03 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the SO_2 NAAQS for a 24-hour time average (125 $\mu g/m^3$). Results well below the NAAQS were the same for the SO_2 1-hour time averages. Maximum concentrations of 0.90 $\mu g/m^3$ and 0.27 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios, whilst the SO_2 NAAQS for a 1-hour time average is 350 $\mu g/m^3$.

Maximum 1-hour concentrations for NO_2 of 4.53 $\mu g/m^3$ and 1.35 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the NO_2 NAAQS for a 1-hour time average of 200 $\mu g/m^3$.

5.1.5 CAMPAIGN 5

Table 4-4 indicates that the emissions rates for both PM_{10} and $PM_{2.5}$ are very similar thus leading to comparable results in the model predicted concentrations of particulate matter (PM_{10} and $PM_{2.5}$). Maximum 24-hour concentrations for PM_{10} of 3.94 $\mu g/m^3$ and 4.01 $\mu g/m^3$ were simulated for the burned and unburned emission scenarios. These simulated concentrations are below the PM_{10} NAAQS for a 24-hour time average (75 $\mu g/m^3$). $PM_{2.5}$

maximum concentrations of 3.93 μg/m^3 and 3.99 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated $PM_{2.5}$ results are well below the NAAQS for $PM_{2.5}$ NAAQS for a 24-hour time average (40 μg/m^3). It is important to note that these simulated concentrations exclude other emission sources that could potentially contribute to the ambient concentrations.

Maximum 24-hour concentrations for SO_2 of 0.08 μg/m^3 were simulated for the burned as well as the unburned emission scenarios. These simulated concentrations are well below the SO_2 NAAQS for a 24-hour time average (125 μg/m^3). Results well below the NAAQS were the same for the SO_2 1-hour time averages. Maximum concentrations of 1.14 μg/m^3 and 1.59 μg/m^3 were simulated for the burned and unburned emission scenarios, whilst the SO_2 NAAQS for a 1-hour time average is 350 μg/m^3.

Maximum 1-hour concentrations for NO_2 of 5.79 μg/m^3 and 8.09 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the NO_2 NAAQS for a 1-hour time average of 200 μg/m^3.

5.1.6 CAMPAIGN 6

It's evident from Table 4-6, that the emissions rates for both PM_{10} and $PM_{2.5}$ are very similar thus leading to comparable results in the model predicted concentrations of particulate matter (PM_{10} and $PM_{2.5}$). Maximum 24-hour concentrations for PM_{10} of 1.30 μg/m^3 and 1.04 μg/m^3 were simulated for the burned and unburned emission scenarios. The burned emissions have led to an exceedance of the PM_{10} NAAQS for a 24-hour time average (75 μg/m^3), however the simulated concentrations emanating from the unburned emissions are well below the PM_{10} NAAQS for a 24-hour time average. Maximum 24-hour concentrations for $PM_{2.5}$ of 1.30 μg/m^3 and 1.03 μg/m^3 were simulated for the burned and unburned emission scenarios. The burned emissions have led to an exceedance of

the $PM_{2.5}$ NAAQS for a 24-hour time average (40 μg/m^3), however the simulated concentrations emanating from the unburned emissions are well below the $PM_{2.5}$ NAAQS for a 24-hour time average.

Maximum 24-hour concentrations for SO_2 of 0.03 μg/m^3 and 0.02 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the SO_2 NAAQS for a 24-hour time average (125 μg/m^3). Results well below the NAAQS were the same for the SO_2 1-hour time averages. Maximum concentrations of 0.29 μg/m^3 and 0.21 μg/m^3 were simulated for the burned and unburned emission scenarios, whilst the SO_2 NAAQS for a 1-hour time average is 350 μg/m^3.

Maximum 1-hour concentrations for NO_2 of 1.47 μg/m^3 and 1.08 μg/m^3 were simulated for the burned and unburned emission scenarios. These simulated concentrations are well below the NO_2 NAAQS for a 1-hour time average of 200 μg/m^3.

5.2 The ambient air quality benefit attributable to Eskom's Sharpeville AQO Project

Table 5-1 summarises the potential nett ambient air quality benefit of Eskom's Sharpeville AQO Project during clean-up campaigns 1 to 6. It's noted that the highest impacts are predicted to occur with a close proximity of each site.

The short-term (1-hourly) maximum ambient air quality improvement ranges between:

i. 10.48 μg/m^3 to 278.00 μg/m^3 for PM;
ii. 0.21 μg/m^3 to 5.60 μg/m^3 for SO_2;
iii. 1.08 μg/m^3 to 28.60 μg/m^3 for NO_2.

Whereas the long-term (24-hourly) maximum ambient air quality improvement ranges between:

i. 1.03 μg/m^3 to 28.87 μg/m^3 for PM;

ii. 0.02 μg/m^3 to 0.58 μg/m^3 for SO_2.

It is worth noting that the daily PM_{10} NAAQS is 75 μg/m^3. Therefore, these results suggest that waste-burning incidents may have the potential to locally increase PM_{10} concentrations in certain instances. However, this hypothesis will be tested as part of ARM *Activity 12.13: Dispersion modelling for 2023 – Sharpeville* wherein the emissions inventory for a myriad of sources (power generation, biomass burning, vehicular emissions, residential fuel burning and waste burning) will be simulated for the Sharpeville airshed.

Table 5-1: The potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project

Model predicted maximum concentration in μg/m3							
Pollutant	**PM_{10}**		**$PM_{2.5}$**		**SO_2**		**NO_2**
Averaging period	**1-hour**	**24-hour**	**1-hour**	**24-hour**	**1-hour**	**24-hour**	**1-hour**
Campaign 1	19.10	2.40	19.10	2.30	0.40	0.05	2.10
Campaign 2	33.90	4.40	33.80	4.40	0.60	0.09	3.50
Campaign 3	278.0	28.87	277.45	28.75	5.60	0.58	28.60
Campaign 4	12.99	1.57	12.95	1.56	0.27	0.03	1.35
Campaign 5	78.69	4.01	78.38	3.99	1.59	0.08	8.09
Campaign 6	10.52	1.04	10.48	1.03	0.21	0.02	1.08

It should be noted that any dispersion model will have an associated degree of error in the predictions due to simplifications in the model algorithms which are used to describe complex and inherently random atmospheric dispersion processes. Thus, the accuracy of the emissions and meteorological data which are input to the model have a significant effect upon the accuracy of the predicted concentrations, this level of uncertainty will be transferred to any pollutant concentration predictions. Predictions of the pollutant concentrations are at the very best +/- 50% of the true value.

6 RECOMMENDATIONS

It's proposed that Eskom considers to exclusively clean up designated illegal waste sites in Sharpeville characterized by the practice of waste burning.

6.1 TO EXCLUSIVELY CLEAN UP DESIGNATED ILLEGAL WASTE SITES IN SHARPEVILLE CHARACTERIZED BY THE PRACTICE OF WASTE BURNING

6.1.1 THE NUMBER OF WASTE BURNING SITES IDENTIFIED DURING CLEAN-UP CAMPAIGNS 1 TO 6

The primary goal of the Sharpeville AQO initiatives is to clean up designated illegal waste sites in Sharpeville, along with removing litter in the vicinity of the cleared areas (Matimolane, 2024). During campaigns 1 to 6, a total of 38 illegal sites were cleaned up, but waste burning practices were only conducted at 20 of these sites (Table 6-1).

Table 6-1: Summary of sites where waste burning practices occurred

Campaign	Total number of illegal sites cleaned up by Eskom	Total number of sites where burning occurred	Percentage of sites where burning occurred
1	7	4	57%
2	5	3	60%
3	8	3	38%
	2	2	100%
	6	5	83%
	10	3	30%
Total	**38**	**20**	**52%**

6.1.2 DFFE'S AIR QUALITY OFFSETS REGULATION

The *DFFE's Air Quality Offsets Regulation* (DFFE, 2016) defines air emissions offsets as an intervention, or interventions, specifically implemented to counterbalance the adverse and residual environmental impact of atmospheric emissions in order to deliver a net

ambient air quality benefit within, but not limited to, the affected airshed where ambient air quality standards are being or have the potential to be exceeded and whereby opportunities and need for offsetting exist. Therefore, as per the DFFE's definition (DFFE, 2016) its pivotal that an offset intervention is able to demonstrate a quantitative net ambient air quality benefit in an airshed.

6.1.3 PROPOSED WAY FORWARD FOR ESKOMS CONSIDERATION

According to the DFFE's definition (DFFE, 2016), it is crucial for an offset intervention to show a measurable positive impact on ambient air quality in a specific region. However, in campaigns 1 to 6, only 50% of the illegal waste sites where waste burning occurred were addressed (Table 6-1). This presents an opportunity to enhance the air quality benefits of Eskom's Sharpeville AQO initiatives. By focusing specifically on cleaning up designated illegal waste sites in Sharpeville known for waste burning practices, there is potential to achieve greater reductions in PM, SO_2, and NO_2 emissions linked to Eskom's Sharpeville AQO Project. This targeted approach is expected to lead to significant improvements in ambient air quality relating to these pollutants.

6.2 TO EVALUATE THE EMISSIONS REDUCTIONS AND THE OVERALL NET BENEFIT TO AMBIENT AIR QUALITY FROM ESKOM'S SHARPEVILLE AQO FUTURE PROJECTS

6.2.1 SHARPEVILLE ILLEGAL DUMPS CLEAN-UP CAMPAIGNS

It's noted that for the Sharpeville AQO Project, cleaning illegal waste dumping sites will occur every three months for 18 months or as necessary. This plan involved conducting at least six cleaning initiatives over 18 months. The first six (6) campaigns were executed

successfully, meeting deadlines without any safety incidents. Table 6-2 provides an indication of the timing of these campaigns.

Table 6-2: Sharpeville illegal dumps clean-up campaigns (Matimolane, 2024)

Campaign	Start Date	Finish Date	Total volume waste collected/cleaned (m^3)
1st Campaign	17 July 2023	21 July 2023	1562
2nd Campaign	30 October 2023	03 November 2023	1627
3rd Campaign	05 February 2024	09 February 2024	1756
4th Campaign	11 March 2024	15 March 2024	2320
5th Campaign	20 May 2024	21 May 2024	872
6th Campaign	19 August 2024	23 August 2024	898

6.2.2 Discrepancy between the information gathered & DFFE AQO Regulation

According to the DFFE, it is crucial that an offset intervention in an airshed shows a clear positive impact on ambient air quality in quantitative terms. Although the amount of waste removed from Eskom's Sharpeville Air Quality Offset (AQO) project is measured, this data is not currently being used to calculate the resulting atmospheric emissions or the overall net benefit to ambient air quality. This creates a discrepancy between the information gathered for Eskom's Sharpeville AQO Project and the standards outlined in the DFFE's Air Quality Offsets Regulation.

6.2.3 Proposed way forward for ESKOMs consideration

The study has assessed the emissions reductions and the overall net improvement in ambient air quality associated with Eskom's Sharpeville AQO Project. This analysis was conducted for clean-up campaigns 1 through 6. It is proposed that Eskom continue with

these waste collection initiatives to and quantify overall net benefit to ambient air quality from Eskom's Sharpeville AQO future Projects.

7 CONCLUSION

This study calculated the net reductions in PM, SO_2 and NO_2 emissions as well as the potential improvement in ambient air quality due to Eskom's Sharpeville AQO Project. This was done for the first three clean-up campaigns that Eskom has executed in Sharpeville. According to the DFFE's definition (DFFE, 2016), it is crucial for an offset intervention to show a measurable positive impact on ambient air quality in a specific region. The findings of this study have definitively demonstrated that Eskom's Sharpeville AQO Project shows a clear positive impact on ambient air quality in quantitative terms for the Sharpeville airshed.

In summary, it is proposed that Eskom should consider the following recommendations for future actions:

i. Focus on cleaning up specific illegal waste sites in Sharpeville where waste burning exclusively occurs.
ii. Continue with these waste collection initiatives to increase the overall net benefit to ambient air quality from Eskom's Sharpeville AQO Project.

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10 ANNEXURE 1: WASTE SITES BURN CHARECTERISTICS

Tables 9-1 to 9-3 outlines the sites wherein waste was collected for each campaign. Whereas Tables 9-4 to 9-6 outlines the amount of unburned and burned waste per campaign.

Table 9-1: Waste sites and total waste collected during Campaign 1 (Eskom, 2024)

Site Number	Site Name	Total Waste Collected (m^3)
1	Vuyo Primary School	**1562**
2	Mareka Ward 13	
3	Ward 12/Ward 13 Police Station	
4	Phelindaba Cemetery	
5	Ward 12 Hostel	
6	Phumasibathe	
7	Ward 14 Ascot Sasol Garage	

Table 9-2: Waste sites and total waste collected during Campaign 2 (Eskom, 2024)

Site Number	Site Name	Total Waste Collected (m^3)
1	Ward 14 Ascot Sasol Garage	**1627**
2	Mareke Street Ward 13	
3	Ward 12/Ward 13 Police Station	
4	Vuyo Primary School	
5	Lebowa Church Ward 12 (Malisa Street)	

Table 9-3: Waste sites and total waste collected during Campaign 3 (Eskom, 2024)

Site Number	Site Name	Total Waste Collected (m^3)
1	Ward 14 Ascot Sasol Garage	**1756**
2	Mohloli Secondary School	
3	Ward 12/Ward 13 Police Station	
4	Lebowa Church Ward 12	
5	Ebenza & NG Kerk	
6	Ward 13 Tsoelepedi	
7	Kgomocho Primary School	
8	Roma Church	

Table 9-4: Waste sites and total waste collected during Campaign 4 (Eskom, 2024)

Site Number	Site Name	Area Waste Collected (m^3)	Total Waste Collected (m^3)
1	Vuka Cemetery Ward 14	480	**2320**
2	Phumasibathe	1840	

Table 9-5: Waste sites and total waste collected during Campaign 5 (Eskom, 2024)

Site Number	Site Name	Area Waste Collected (m^3)	Total Waste Collected (m^3)
1	Ward 14 Ascot Sasol Garage	430	**872**
2	Vuka Cemetery Ward 14	442	
3	Roma Church		
4	Matsie Steyn Primary School		
5	Mareke Street Ward 13		
6	Putswatsene		

Table 9-5: Waste sites and total waste collected during Campaign 5 (Eskom, 2024)

Site Number	Site Name	Area Waste Collected (m^3)	Total Waste Collected (m^3)
1	Ward 14 Ascot Sasol Garage	228	**898**
2	Motlodi Primary School	242	
3	Roma Church		
4	Matsie Steyn Primary School	248	
5	Ward 13 Tsoelepele (Primary School)		
6	Ward 13 Tsoelepele (Site 2)		
7	Mareke Street Ward 13	150	
8	Phelindaba Cemetary		
9	Immanuel Primary School (Sobhuza)	30	
10	Assembly of God		

Table 9-4: Amount of unburned and burned waste per site during Campaign 1.

Site Number	Site Name	Unburned Waste (%)	Burned Waste (%)	Unburned Waste (m^3)	Burned Waste (m^3)	Time of Burning	Month of Burning	Intensity of fire
1	Vuyo Primary School	n/av	n/av	n/av	n/av	n/av	n/av	n/av
2	Mareka Ward 13	65	35	106.69	57.45	06:00 to 17:00	January - December	Faint
3	Ward 12/Ward 13 Police Station	10	90	3.52	31.72	06:00 to 09:00	May - July	Smouldering
4	Phelindaba Cemetary	n/av	n/av	n/av	n/av	n/av	n/av	n/av
5	Ward 12 Hostel	n/av	n/av	n/av	n/av	n/av	n/av	n/av
6	Phumasibathe	80	20	910.43	227.61	06:00 to 09:00	May - July	Smouldering
7	Ward 14 Ascot Sasol Garage	90	10	118.28	13.14	06:00 to 17:00	January to December	Faint

Table 9-5: Amount of unburned and burned waste per site during Campaign 2.

Site Number	Site Name	Unburned Waste (%)	Burned Waste (%)	Unburned Waste (m^3)	Burned Waste (m^3)	Time of Burning	Month of Burning	Intensity of fire
1	Ward 14 Ascot Sasol Garage	90	10	423.52	47.06	06:00 to 17:00	January - December	Faint
2	Mareke Street Ward 13	65	35	382.01	205.70	06:00 to 17:00	May - July	Faint
3	Ward 12/Ward 13 Police Station	10	90	12.62	113.57	06:00 to 09:00	May - July	Smouldering
4	Vuyo Primary School	n/av	n/av	n/av	n/av	n/av	n/av	n/av
5	Lebowa Church Ward 12 (Malisa Street)	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 9-6: Amount of unburned and burned waste per site during Campaign 3.

Site Number	Site Name	Unburned Waste (%)	Burned Waste (%)	Unburned Waste (m^3)	Burned Waste (m^3)	Time of Burning	Month of Burning	Intensity of fire
1	Ward 14 Ascot Sasol Garage	90	10	527.04	58.56	06:00 to 17:00	January to December	Faint
2	Mohloli Secondary School	n/av	n/av	n/av	n/av	n/av	n/av	n/av
3	Ward 12/Ward 13 Police Station	10	90	15.70	141.34	06:00 to 09:00	May to July	Smouldering
4	Lebowa Church Ward 12	n/av	n/av	n/av	n/av	n/av	n/av	n/av
5	Ebenza & NG Kerk	n/av	n/av	n/av	n/av	n/av	n/av	n/av
6	Ward 13 Tsoelepedi	n/av	n/av	n/av	n/av	n/av	n/av	n/av
7	Kgomocho Primary School	95	5	175.06	9.21	06:00 to 09:00	May to July	Smouldering
8	Roma Church	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 9-7: Amount of unburned and burned waste per site during Campaign 4.

Site Number	Site Name	Unburned Waste (%)	Burned Waste (%)	Unburned Waste (m^3)	Burned Waste (m^3)	Time of Burning	Month of Burning	Intensity of fire
1	Vuka Cemetery Ward 14	90	10	432.00	48.00	06:00 to 09:00	May to July	Smouldering
2	Phumasibathe	80	20	1472.00	368.00	06:00 to 09:00	May to July	Smouldering

Table 9-8: Amount of unburned and burned waste per site during Campaign 5.

Site Number	Site Name	Unburned Waste (%)	Burned Waste (%)	Unburned Waste (m^3)	Burned Waste (m^3)	Time of Burning	Month of Burning	Intensity of fire
1	Ward 14 Ascot Sasol Garage	90	10	387.00	43.00	06:00 to 17:00	January to December	Faint
2	Vuka Cemetery Ward 14	90	10	255.44	28.38	06:00 to 09:00	May to July	Smouldering
3	Roma Church	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Matsie Steyn Primary School	10	90	1.84	16.58	06:00 to 09:00	May to July	Smouldering
	Mareke Street Ward 13	65	35	55.76	30.02	06:00 to 17:00	May to July	Faint
	Putswatsene	90	10	19.34	2.15	06:00 to 09:00	May to July	Smouldering

Table 9-9: Amount of unburned and burned waste per site during Campaign 6.

Site Number	Site Name	Unburned Waste (%)	Burned Waste (%)	Unburned Waste (m^3)	Burned Waste (m^3)	Time of Burning	Month of Burning	Intensity of fire
1	Ward 14 Ascot Sasol Garage	90	10	205.20	22.80	06:00 to 17:00	January to December	Faint
2	Motlodi Primary School	n/av	n/av	n/av	n/av			
3	Roma Church	n/av	n/av	n/av	n/av			
4	Matsie Steyn Primary School	10	90	19.67	176.99	06:00 to 09:00	May to July	Smouldering
5	Ward 13 Tsoelepele (Primary School)	n/av	n/av	n/av	n/av			
6	Ward 13 Tsoelepele (Site 2)	n/av	n/av	n/av	n/av			
7	Mareke Street Ward 13	65	35	85.73	46.16	06:00 to 17:00	May to July	Faint
8	Phelindaba Cemetary	n/av	n/av	n/av	n/av			
9	Immanuel Primary School (Sobhuza)	n/av	n/av	n/av	n/av			
10	Assembly of God	n/av	n/av	n/av	n/av			

11 ANNEXURE 2: WASTE SEGREGATION & AMOUNTS

Table 10-1 to 10-6 summarises the waste segregation (%) for each site during the three waste clean-up campaigns.

Table 10-1: Waste segregation (%) for each site during Campaign 1.

Site Number	Site Name	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
1	VPS	50	30	0	0	0	0	15	0	0	5	0	0
2	MW13	45	45	0	3	0	0	5	0	0	2	0	0
3	W12PS	41	41	0	3	3	0	10	1	1	0	0	0
4	PC	40	40	2	1	1	1	10	0	0	5	0	0
5	W12H	50	40	0	0	0	0	10	0	0	0	0	0
6	PH	38	30	1	1	5	1	15	1	1	5	1	1
7	W14SG	45	45	0	3	0	0	5	0	0	2	0	0

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-2: Waste segregation (%) for each site during Campaign 2.

Site Number	Site Name	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
1	W14SG	45	45	0	3	0	0	5	0	0	2	0	0
2	MW13	45	45	0	3	0	0	5	0	0	2	0	0
3	W12PS	41	41	0	3	3	0	10	1	1	0	0	0
4	VPS	40	40	0	0	1	1	15	0	0	3	0	0
5	LCW12	43	43	0	1	0	0	10	0	0	0	0	3

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-3: Waste segregation (%) for each site during Campaign 3.

Site Number	Site Name	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
1	W14SG	45	45	0	3	0	0	5	0	0	2	0	0
2	MSS	42	40	1	1	1	1	10	0	0	4	0	0
3	W12PS	41	41	0	3	3	0	10	1	1	0	0	0
4	LCW12	43	43	0	1	0	0	10	0	0	0	0	3
5	ENGK	40	40	0	1	2	1	15	0	0	1	0	0
6	W13T	40	40	0	0	0	10	7	0	0	3	0	0
7	KPS	40	40	0	0	1	1	15	0	0	3	0	0
8	RC	45	40	0	0	0	0	10	0	0	5	0	0

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-4: Waste segregation (%) for each site during Campaign 4.

Site Number	Site Name	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
1	VCW14	30	30	5	5	7	5	15	0	1	1	1	0
2	Phum	38	30	1	1	5	1	15	1	1	5	1	1

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-5: Waste segregation (%) for each site during Campaign 5.

Site Number	Site Name	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
1	W14SG	45	45	0	3	0	0	5	0	0	2	0	0
2	VCW14	30	30	5	5	7	5	15	0	1	1	1	0
3	RC	45	40	0	0	0	0	10	0	0	5	0	0
4	MSPS	41	41	0	3	3	0	10	1	1	0	0	0
5	W13T	45	45	0	3	0	0	5	0	0	2	0	0
6	Puts	45	45	0	3	0	0	5	0	0	2	0	0

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-6: Waste segregation (%) for each site during Campaign 6.

Site Number	Site Name	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
1	W14SG	45	45	0	3	0	0	5	0	0	2	0	0
2	MPS	42	40	1	1	1	1	10	0	0	4	0	0
3	RC	45	40	0	0	0	0	10	0	0	5	0	0
4	MSPS	41	41	0	3	3	0	10	1	1	0	0	0
5	W13TPS	40	40	0	0	0	10	7	0	0	3	0	0
6	W13TS2	40	40	0	0	0	10	7	0	0	3	0	0
7	W13T	45	45	0	3	0	0	5	0	0	2	0	0
8	PC	40	40	2	1	1	1	10	0	0	5	0	0
9	IPS	40	40	0	0	0	10	7	0	0	3	0	0
10	AoG	40	40	0	0	0	10	7	0	0	3	0	0

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-7 to 10-12 summarises the amount of waste (m^3) for the unburned and burned fractions each site during the three waste clean-up campaigns.

Table 10-7: Waste amounts (m^3) for each site during Campaign 1.

Site Name	Unburned / Burned Fraction	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
VPS	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
MW13	Unburned	48.01	48.01	0.00	3.20	0.00	0.00	5.33	0.00	0.00	2.13	0.00	0.00
	Burned	25.85	25.85	0.00	1.72	0.00	0.00	2.87	0.00	0.00	1.15	0.00	0.00
W12PS	Unburned	1.44	1.44	0.00	0.11	0.11	0.00	0.35	0.04	0.04	0.00	0.00	0.00
	Burned	13.00	13.00	0.00	0.95	0.95	0.00	3.17	0.32	0.32	0.00	0.00	0.00
PC	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
W12H	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
PH	Unburned	345.96	273.13	9.10	9.10	45.52	9.10	136.56	9.10	9.10	45.52	9.10	9.10
	Burned	86.49	68.28	2.28	2.28	11.38	2.28	34.14	2.28	2.28	11.38	2.28	2.28
W14SG	Unburned	53.23	53.23	0.00	3.55	0.00	0.00	5.91	0.00	0.00	2.37	0.00	0.00
	Burned	5.91	5.91	0.00	0.39	0.00	0.00	0.66	0.00	0.00	0.26	0.00	0.00

Notes:

VPS: Vuyo Primary School; MW13: Mareka Ward 13; W12PS: Ward 12/Ward 13 Police Station; PC: Phelindaba Cemetery; W12H: Ward 12 Hostel; PH: Phumasibathe & W14SG: Ward 14 Ascot Sasol Garage.

Table 10-8: Waste amounts (m^3) for each site during Campaign 2.

Site Name	Unburned / Burned Fraction	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
W14SG	Unburned	190.58	190.58	0.00	12.71	0.00	0.00	21.18	0.00	0.00	8.47	0.00	0.00
	Burned	21.18	21.18	0.00	1.41	0.00	0.00	2.35	0.00	0.00	0.94	0.00	0.00
MW13	Unburned	171.90	171.90	0.00	11.46	0.00	0.00	19.10	0.00	0.00	7.64	0.00	0.00
	Burned	92.56	92.56	0.00	6.17	0.00	0.00	10.28	0.00	0.00	4.11	0.00	0.00
W12PS	Unburned	5.17	5.17	0.00	0.38	0.38	0.00	1.26	0.13	0.13	0.00	0.00	0.00
	Burned	46.57	46.57	0.00	3.41	3.41	0.00	11.36	1.14	1.14	0.00	0.00	0.00
VPS	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
LCW12	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MW13: Mareka Ward 13; W12PS: Ward 12/Ward 13 Police Station; VPS: Vuyo Primary School & LCW12: Lebowa Church Ward 12 (Malisa Street).

Table 10-9: Waste amounts (m^3) for each site during Campaign 3.

Site Name	Unburned / Burned Fraction	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
W14SG	Unburned	237.17	237.17	0.00	15.81	0.00	0.00	26.35	0.00	0.00	10.54	0.00	0.00
	Burned	26.35	26.35	0.00	1.76	0.00	0.00	2.93	0.00	0.00	1.17	0.00	0.00
MSS	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
W12PS	Unburned	6.44	6.44	0.00	0.47	0.47	0.00	1.57	0.16	0.16	0.00	0.00	0.00
	Burned	57.95	57.95	0.00	4.24	4.24	0.00	14.13	1.41	1.41	0.00	0.00	0.00
LCW12	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
ENGK	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
W13T	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
KPS	Unburned	70.03	70.03	0.00	0.00	1.75	1.75	26.26	0.00	0.00	5.25	0.00	0.00
	Burned	3.69	3.69	0.00	0.00	0.09	0.09	1.38	0.00	0.00	0.28	0.00	0.00
RC	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School & RC: Roma Church.

Table 10-10: Waste amounts (m^3) for each site during Campaign 4.

Site Name	Unburned / Burned Fraction	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
VCW14	Unburned	129.60	129.60	21.60	21.60	30.24	21.60	64.80	0.00	4.32	4.32	4.32	0.00
	Burned	14.40	14.40	2.40	2.40	3.36	2.40	7.20	0.00	0.48	0.48	0.48	0.00
Phum	Unburned	559.36	441.60	14.72	14.72	73.60	14.72	220.80	14.72	14.72	73.60	14.72	14.72
	Burned	139.84	110.40	3.68	3.68	18.40	3.68	55.20	3.68	3.68	18.40	3.68	3.68

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-11: Waste amounts (m^3) for each site during Campaign 5.

Site Name	Unburned / Burned Fraction	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
W14SG	Unburned	174.15	174.15	0.00	11.61	0.00	0.00	19.35	0.00	0.00	7.74	0.00	0.00
	Burned	19.35	19.35	0.00	1.29	0.00	0.00	2.15	0.00	0.00	0.86	0.00	0.00
VCW14	Unburned	76.63	76.63	12.77	12.77	17.88	12.77	38.32	0.00	2.55	2.55	2.55	0.00
	Burned	8.51	8.51	1.42	1.42	1.99	1.42	4.26	0.00	0.28	0.28	0.28	0.00
RC	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
MSPS	Unburned	0.76	0.76	0.00	0.06	0.06	0.00	0.18	0.02	0.02	0.00	0.00	0.00
	Burned	6.80	6.80	0.00	0.50	0.50	0.00	1.66	0.17	0.17	0.00	0.00	0.00
W13T	Unburned	25.09	25.09	0.00	1.67	0.00	0.00	2.79	0.00	0.00	1.12	0.00	0.00
	Burned	13.51	13.51	0.00	0.90	0.00	0.00	1.50	0.00	0.00	0.60	0.00	0.00
Puts	Unburned	8.70	8.70	0.00	0.58	0.00	0.00	0.97	0.00	0.00	0.39	0.00	0.00
	Burned	0.97	0.97	0.00	0.06	0.00	0.00	0.11	0.00	0.00	0.04	0.00	0.00

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

Table 10-12: Waste amounts (m^3) for each site during Campaign 6.

Site Name	Unburned / Burned Fraction	Paper	Plastic	Leather & Rubber	Textile & Fibre	Vegetation	Organic	Glass	Metal	Ceramic	Wood	Electronic Goods	Other
W14SG	Unburned	92.34	92.34	0.00	6.16	0.00	0.00	10.26	0.00	0.00	4.10	0.00	0.00
	Burned	10.26	10.26	0.00	0.68	0.00	0.00	1.14	0.00	0.00	0.46	0.00	0.00
MPS	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
RC	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
MSPS	Unburned	8.06	8.06	0.00	0.59	0.59	0.00	1.97	0.20	0.20	0.00	0.00	0.00
	Burned	72.56	72.56	0.00	5.31	5.31	0.00	17.70	1.77	1.77	0.00	0.00	0.00
W13TPS	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
W13TS2	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
W13T	Unburned	38.58	38.58	0.00	2.57	0.00	0.00	4.29	0.00	0.00	1.71	0.00	0.00
	Burned	20.77	20.77	0.00	1.38	0.00	0.00	2.31	0.00	0.00	0.92	0.00	0.00
PC	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
IPS	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
AoG	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Notes:

W14SG: Ward 14 Ascot Sasol Garage; MSS: Mohloli Secondary School; W12PS: Ward 12/Ward 13 Police Station; LCW12: Lebowa Church Ward 12; ENGK: Ebenza & NG Kerk; W13T: Ward 13 Tsoelepedi; KPS: Kgomocho Primary School; RC: Roma Church; VCW14: Vuka Cemetery Ward 14; Phum: Phumasibathe; MSPS: Matsie Steyn Primary School; Puts: Putswatsene; MPS: Motlodi Primary School; W13TPS: Ward 13 Tsoelepele (Primary School); W13TS2: Ward 13 Tsoelepele (Site 2); PC: Phelindaba Cemetery; IPS: Immanuel Primary School (Sobhuza) & AoG: Assembly of God.

In order to calculate pollutant emissions emanating from the waste fractions (Tables 10-7 to 10-12), the amount of waste (m^3) per site needed to be converted to a mass unit (kg). Since Tables 10-1 to 10-6 highlighted that the paper and plastic fractions for all sites during the campaigns were approximately ~83 to 87% of the total waste collected, only the paper and plastic fractions were utilised to calculate the pollutant emissions.

Literature highlights that paper density ranges from 250 kg/m^3 (for tissue paper) to 1500 kg/m^3 for some specialty paper. The density of paper used for printing is about 800 kg/m^3. An assumption was made for this study that the density for paper is assumed to be 875 kg/m^3 (average of 250 kg/m^3 and 1500 kg/m^3), to compensate for the different paper types collected.

A density for plastic of 1.4 kg/m^3 was adopted for this study. Literature indicate that the densities of specific plastics can vary from 1.40 kg/m^3 for PET (Polyethylene Terephthalate) to 0.91 kg/m^3 for LDPE (Low Density Polyethylene) (Table 10-13).

Table 10-13: Different densities of plastic.

Material	Density (kg/m^3)
PET (Polyethylene Terephthalate)	1.40
HDPE (High Density Polyethylene)	0.941
PVC (Polyvinyl Chloride)	1.40
LDPE (Low Density Polyethylene)	0.91
PP (Polypropylene)	0.905
PS (Polystyrene)	0.96

Utilising the adopted paper and plastic densities in conjunction with Tables 10-7 to 10-12, the amount of paper and plastic (kg) can be calculated. These amounts are summarised in Table 10-14 to 10-19 for the different campaigns.

Table 10-14: Waste amounts (kg) for each site during Campaign 1.

Site Number	Site Name	Unburned / Burned Fraction	Paper (kg)	Plastic (kg)
1	Vuyo Primary School	Unburned	n/av	n/av
		Burned	n/av	n/av
2	Mareka Ward 13	Unburned	42 007.54	67.21
		Burned	22 619.44	36.19
3	Ward 12/Ward 13 Police Station	Unburned	1 264.33	2.02
		Burned	11 379.01	18.21
4	Phelindaba Cemetery	Unburned	n/av	n/av
		Burned	n/av	n/av
5	Ward 12 Hostel	Unburned	n/av	n/av
		Burned	n/av	n/av
6	Phumasibathe	Unburned	302 717.60	382.38
		Burned	75 679.40	95.60
7	Ward 14 Ascot Sasol Garage	Unburned	46 572.04	74.52
		Burned	5 174.67	8.28

Table 10-15: Waste amounts (kg) for each site during Campaign 2.

Site Number	Site Name	Unburned / Burned Fraction	Paper (kg)	Plastic (kg)
1	Ward 14 Ascot Sasol Garage	Unburned	166 759.38	266.82
		Burned	18 528.82	29.65
2	Mareke Street Ward 13	Unburned	150 415.37	240.66
		Burned	80 992.89	129.59
3	Ward 12 / Ward 13 Police Station	Unburned	4 527.17	7.24
		Burned	40 744.55	65.19
4	Vuyo Primary School	Unburned	n/av	n/av
		Burned	n/av	n/av
5	Lebowa Church Ward 12 (Malisa Street)	Unburned	n/av	n/av
		Burned	n/av	n/av

Table 10-16: Waste amounts (kg) for each site during Campaign 3.

Site Number	Site Name	Unburned / Burned Fraction	Paper (kg)	Plastic (kg)
1	Ward 14 Ascot Sasol Garage	Unburned	207 523.02	332.04
		Burned	23 058.11	36.89
2	Mohloli Secondary School	Unburned	n/av	n/av
		Burned	n/av	n/av
3	Ward 12/Ward 13 Police Station	Unburned	5 633.82	9.01
		Burned	50 704.39	81.13
4	Lebowa Church Ward 12	Unburned	n/av	n/av
		Burned	n/av	n/av
5	Ebenza & NG Kerk	Unburned	n/av	n/av
		Burned	n/av	n/av
6	Ward 13 Tsoelepedi	Unburned	n/av	n/av
		Burned	n/av	n/av
7	Kgomocho Primary School	Unburned	61 272.32	98.04
		Burned	3 224.86	5.16
8	Roma Church	Unburned	n/av	n/av
		Burned	n/av	n/av

Table 10-17: Waste amounts (kg) for each site during Campaign 4.

Site Number	Site Name	Unburned / Burned Fraction	Paper (kg)	Plastic (kg)
1	Vuka Cemetery Ward 14	Unburned	113400.00	181.44
		Burned	12600.00	20.16
2	Phumasibathe	Unburned	489440.00	618.24
		Burned	122360.00	154.56

Table 10-18: Waste amounts (kg) for each site during Campaign 5.

Site Number	Site Name	Unburned / Burned Fraction	Paper (kg)	Plastic (kg)
1	Ward 14 Ascot Sasol Garage	Unburned	152381.25	243.81
		Burned	16931.25	27.09
2	Vuka Cemetery Ward 14	Unburned	67052.10	107.2833581
		Burned	7450.23	11.92
3	Roma Church	Unburned	n/av	n/av
		Burned	n/av	n/av
4	Matsie Steyn Primary School	Unburned	660.77	1.06
		Burned	5946.95	9.52
5	Mareke Street Ward 13	Unburned	21954.18	35.13
		Burned	11821.48	18.91
6	Putswatsene	Unburned	7615.00	12.18
		Burned	846.11	1.35

Table 10-19: Waste amounts (kg) for each site during Campaign 6.

Site Number	Site Name	Unburned / Burned Fraction	Paper (kg)	Plastic (kg)
1	Ward 14 Ascot Sasol Garage	Unburned	80797.50	129.28
		Burned	8977.50	14.364
2	Motlodi Primary school	Unburned	n/av	n/av
		Burned	n/av	n/av
3	Roma church	Unburned	n/av	n/av
		Burned	n/av	n/av
4	Matsie Steyn Primary School	Unburned	7054.89	11.29
		Burned	63494.01	101.59
5	Ward 13 Tsoelepele (Primary School)	Unburned	n/av	n/av
		Burned	n/av	n/av
6	Ward 13 Tsoelepele (Site 2)	Unburned	n/av	n/av
		Burned	n/av	n/av
7	Mareka Street Ward 13	Unburned	33755.07	54.01
		Burned	18175.81	29.08
8	Phelindaba Cemetery	Unburned	n/av	n/av
		Burned	n/av	n/av
9	Immanuel Primary School (Sobhuza)	Unburned	n/av	n/av
		Burned	n/av	n/av
10	Assembly of God	Unburned	n/av	n/av
		Burned	n/av	n/av

12 ANNEXURE 3: POLLUTANT EMISSSIONS FOR PAPER & WASTE

Tables 11-1 to 11-12 outlines the individual paper and plastic emissions for each campaign.

Table: 11-1: Pollutant emissions (kg) for paper waste during Campaign 1.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Vuyo Primary School	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Mareka Ward 13	Unburned	59 062.60	4 251.16	34.03	36.13	69.73	13.86	638.93	636.83
	Burned	31 802.94	2 289.09	18.32	19.45	37.55	7.46	344.04	342.91
Ward 12 / Ward 13 Police Station	Unburned	1 777.65	127.95	1.02	1.09	2.10	0.42	19.23	19.17
	Burned	15 998.89	1 151.56	9.22	9.79	18.89	3.76	173.07	172.51
Phelindaba Cemetery	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 12 Hostel	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Phumasibathe	Unburned	425 620.94	30 635.02	245.20	260.34	502.51	99.90	4 604.33	4 589.20
	Burned	106 405.24	7 658.76	61.30	65.08	125.63	24.97	1 151.08	1 147.30
Ward 14 Ascot Sasol Garage	Unburned	65 480.29	4713.09	37.72	40.05	77.31	15.37	708.36	706.03
	Burned	7 275.59	523.68	4.19	4.45	8.59	1.71	78.71	78.45

Table 11-2: Pollutant emissions (kg) for plastic waste during Campaign 1.

Site	Unburned / Burned Fraction	Plastic Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Vuyo Primary School	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Mareka Ward 13	Unburned	168.43	6.80	0.05	0.06	0.11	0.02	1.02	1.02
	Burned	90.69	3.66	0.03	0.03	0.06	0.01	0.55	0.55
Ward 12 / Ward 13 Police Station	Unburned	5.07	0.37	0.01	0.01	0.02	0.001	1.32	1.46
	Burned	45.63	3.35	0.07	0.13	0.19	0.01	11.85	13.15
Phelindaba Cemetery	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 12 Hostel	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Phumasibathe	Unburned	958.24	70.32	1.43	2.63	4.06	0.14	248.93	276.26
	Burned	239.56	17.58	0.36	0.66	1.01	0.03	62.23	69.06
Ward 14 Ascot Sasol Garage	Unburned	186.74	13.70	0.28	0.51	0.79	0.03	48.51	53.84
	Burned	20.75	1.52	0.03	0.06	0.09	0.003	5.39	5.98

Table 11-3: Pollutant emissions (kg) for paper waste during Campaign 2.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	234 463.69	16 876.05	135.08	143.41	276.82	55.03	2536.41	2528.07
	Burned	26 051.52	1 875.12	15.01	15.93	30.76	6.11	281.82	280.90
Mareka Ward 13	Unburned	211 484.01	15 222.04	121.84	129.36	249.69	49.64	2 287.82	2 280.30
	Burned	113 876.01	8 196.48	65.60	69.65	134.45	26.73	1 231.90	1 227.85
Ward 12 / Ward 13 Police Station	Unburned	6 365.20	458.15	3.67	3.89	7.52	1.49	68.86	68.63
	Burned	57 286.84	4 123.35	33.00	35.04	67.64	13.45	619.72	617.69
Vuyo Primary School	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Lebowa Church Ward 12 (Malisa Street)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 11-4: Pollutant emissions (kg) for plastic waste during Campaign 2.

Site	Unburned / Burned Fraction	Plastic Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	668.64	49.07	1.00	1.83	2.83	0.10	173.70	192.77
	Burned	74.29	5.45	0.11	0.20	0.31	0.01	19.30	21.42
Mareka Ward 13	Unburned	603.11	44.26	0.90	1.65	2.55	0.09	156.67	173.87
	Burned	324.75	23.83	0.48	0.89	1.37	0.05	84.36	93.62
Ward 12 / Ward 13 Police Station	Unburned	18.15	1.33	0.03	0.05	0.08	0.00	4.72	5.23
	Burned	163.37	11.99	0.24	0.45	0.69	0.02	42.44	47.10
Vuyo Primary School	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Lebowa Church Ward 12 (Malisa Street)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 11-5: Pollutant emissions (kg) for paper waste during Campaign 3.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	291 777.36	21 001.33	168.09	178.47	344.49	68.48	3 156.43	3 146.05
	Burned	324 19.71	2 333.48	18.68	19.83	38.28	7.61	350.71	349.56
Mohloli Secondary School	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 12 / Ward 13 Police Station	Unburned	7 921.15	570.14	4.56	4.85	9.35	1.86	85.69	85.41
	Burned	71 290.37	5 131.28	41.07	43.61	84.17	16.73	771.21	768.68
Lebowa Church Ward 12	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ebenza & NG Kerk	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 13 Tsoelepedi	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Kgomocho Primary School	Unburned	86 148.88	6 200.76	49.63	52.69	101.71	20.22	931.95	928.89
	Burned	4 534.15	326.36	2.61	2.77	5.35	1.06	49.05	48.89
Roma Church	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 11-6: Pollutant emissions (kg) for plastic waste during Campaign 3.

Site	Unburned / Burned Fraction	Plastic Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol Garage	Unburned	832.08	61.06	1.24	2.28	3.52	0.12	216.16	239.89
	Burned	92.45	6.78	0.14	0.25	0.39	0.01	24.02	26.65
Mohloli Secondary School	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 12 / Ward 13 Police Station	Unburned	22.59	1.66	0.03	0.06	0.10	0.00	5.87	6.51
	Burned	203.30	14.92	0.30	0.56	0.86	0.03	52.81	58.61
Lebowa Church Ward 12	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ebenza & NG Kerk	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 13 Tsoelepedi	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Kgomocho Primary School	Unburned	245.68	18.03	0.37	0.67	1.04	0.04	63.82	70.83
	Burned	12.93	0.95	0.02	0.04	0.05	0.00	3.36	3.73
Roma Church	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 11-7: Pollutant emissions (kg) for paper waste during Campaign 4.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Vuka Cemetery Ward 14	Unburned	159440.40	11476.08	91.85	97.52	188.24	37.42	1724.81	1719.14
	Burned	17715.60	1275.12	10.21	10.84	20.92	4.16	191.65	191.02
Phumasibathe	Unburned	688152.64	49531.33	396.45	420.92	812.47	161.52	7444.38	7419.91
	Burned	172038.16	12382.83	99.11	105.23	203.12	40.38	1861.10	1854.98

Table 11-8: Pollutant emissions (kg) for plastic waste during Campaign 4.

Site	Unburned / Burned Fraction	Plastic Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Vuka Cemetery Ward 14	Unburned	454.69	33.37	0.68	1.25	1.93	0.07	118.12	131.08
	Burned	50.52	3.71	0.08	0.14	0.21	0.01	13.12	14.56
Phumasibathe	Unburned	1549.31	113.69	2.31	4.25	6.56	0.22	402.47	446.66
	Burned	387.33	28.42	0.58	1.06	1.64	0.06	100.62	111.66

Table 11-9: Pollutant emissions (kg) for paper waste during Campaign 5.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol garage	Unburned	214248.04	15420.98	123.43	131.05	252.95	50.29	2317.72	2310.10
	Burned	23805.34	1713.44	13.71	14.56	28.11	5.59	257.52	256.68
Vuka Cemetery Ward 14	Unburned	94275.25	6785.67	54.31	57.66	111.31	22.13	1019.86	1016.51
	Burned	10475.03	753.96	6.03	6.41	12.37	2.46	113.32	112.95
Roma Church	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Matsie Steyn Primary School	Unburned	929.05	66.87	0.54	0.57	1.10	0.22	10.05	10.02
	Burned	8361.42	601.83	4.82	5.11	9.87	1.96	90.45	90.16
Mareke Street Ward 13	Unburned	30867.57	2221.76	17.78	18.88	36.44	7.24	333.92	332.83
	Burned	16621.00	1196.33	9.58	10.17	19.62	3.90	179.80	179.21
Putswatsene	Unburned	10706.69	770.64	6.17	6.55	12.64	2.51	115.82	115.44
	Burned	1189.63	85.63	0.69	0.73	1.40	0.28	12.87	12.83

Table 11-10: Pollutant emissions (kg) for plastic waste during Campaign 5.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol garage	Unburned	610.99	44.84	0.91	1.67	2.59	0.09	158.72	176.15
	Burned	67.89	4.98	0.10	0.19	0.29	0.01	17.64	19.57
Vuka Cemetery Ward 14	Unburned	268.85	19.73	0.40	0.74	1.14	0.04	69.84	77.51
	Burned	29.87	2.19	0.04	0.08	0.13	0.00	7.76	8.61
Roma Church	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Matsie Steyn Primary School	Unburned	2.65	0.19	0.00	0.01	0.01	0.00	0.69	0.76
	Burned	23.84	1.75	0.04	0.07	0.10	0.00	6.19	6.87
Mareke Street Ward 13	Unburned	88.03	6.46	0.13	0.24	0.37	0.01	22.87	25.38
	Burned	47.40	3.48	0.07	0.13	0.20	0.01	12.31	13.67
Putswatsene	Unburned	30.53	2.24	0.05	0.08	0.13	0.00	7.93	8.80
	Burned	3.39	0.25	0.01	0.01	0.01	0.00	0.88	0.98

Table 11-11: Pollutant emissions (kg) for paper waste during Campaign 6.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol garage	Unburned	113601.29	8176.71	65.45	69.49	134.12	26.66	1228.93	1224.89
	Burned	12622.37	908.52	7.27	7.72	14.90	2.96	136.55	136.10
Motlodi Primary school	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Roma church	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Matsie Steyn Primary School	Unburned	9919.18	713.95	5.71	6.07	11.71	2.33	107.30	106.95
	Burned	89272.58	6425.59	51.43	54.60	105.40	20.95	965.74	962.57
Ward 13 Tsoelepele (Primary School)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 13 Tsoelepele (Site 2)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Mareka Street Ward 13	Unburned	47459.63	3416.01	27.34	29.03	56.03	11.14	513.41	511.73
	Burned	25555.19	1839.39	14.72	15.63	30.17	6.00	276.45	275.55
Phelindaba Cemetery	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Immanuel Primary School (Sobhuza)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Assembly of God		n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
		n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

Table 11-12: Pollutant emissions (kg) for plastic waste during Campaign 6.

Site	Unburned / Burned Fraction	Paper Emissions (kg of pollutant / kg of fuel burnt)							
		CO_2	CO	NO (as NO_2)	NO_2	NO_X (as NO_2)	SO_2	$PM_{2.5}$	PM_{10}
Ward 14 Ascot Sasol garage	Unburned	323.97	23.77	0.48	0.89	1.37	0.05	84.16	93.40
	Burned	36.00	2.64	0.05	0.10	0.15	0.01	9.35	10.38
Motlodi Primary school	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Roma church	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Matsie Steyn Primary School	Unburned	28.29	2.08	0.04	0.08	0.12	0.00	7.35	8.16
	Burned	254.59	18.68	0.38	0.70	1.08	0.04	66.14	73.40
Ward 13 Tsoelepele (Primary School)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Ward 13 Tsoelepele (Site 2)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Mareka Street Ward 13	Unburned	135.34	9.93	0.20	0.37	0.57	0.02	35.16	39.02
	Burned	72.88	5.35	0.11	0.20	0.31	0.01	18.93	21.01
Phelindaba Cemetery	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Immanuel Primary School (Sobhuza)	Unburned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
	Burned	n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
Assembly of God		n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av
		n/av	n/av	n/av	n/av	n/av	n/av	n/av	n/av

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