SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Scientific Inquiry

Year R-2

Finn Gelsthorpe

Prince Alfred College

ROWE SCIENTIFIC PTY. LTD. www.rowe.com.au

Australian Government
Department of Defence

Government of South Australia
Department for Education

SASTA South Australian Science Teachers Association

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1 Introduction

1.1 The Theory

The Urban Heat Island Effect is when it is hotter in the city than in the countryside (rural areas) due to the lack of vegetation and types of materials used for buildings and roads.

Urban areas such as the city experience high temperatures due to absorption, storage, and re-radiation of heat by built surfaces like concrete and asphalt rather than surfaces like grass and water.

The greatest differences in temperature between cities and rural areas are noticed during nighttime when the sun has gone down. This happens because of the re-radiation of heat from concrete and asphalt.

1.2 The Purpose

My purpose is to make hotter places, like Australia, more environmentally friendly places by working out what materials should be used to cool down the cities.

1.3 The Hypothesis

What is the best material for buildings to reduce the Urban Heat Island Effect?

I believe mud, straw and grass would be the best materials to use as they would reflect the heat.

2 Methodology

2.1 Equipment

The following equipment was used:

1. Surfaces
2. Heat lamp
3. Timer
4. Infra-red thermometer

The types of surfaces[1] were:

1. Concrete
2. Wood
3. Light metal
4. Grass
5. Mud

[1] I decided not to include asphalt as a surface type as I could not test its effects under the same conditions. It would not be a fair test.

2.2 Method

1. Prepare workstation - ensure that the surfaces are the same distances from the heat lamps.
2. Record baseline temperatures before switching on the heat lamps.
3. Turn on the heat lamps and start timer.
4. After 5 minutes record the temperature with the thermometer.
5. Record the temperature of the surfaces every 5 minutes until 30 minutes and then switch off heat lamps.
6. Record the temperature of the surfaces after 5 minutes and again after 10 minutes.
7. Change the surface types and repeat steps 2 to 6.

To ensure a fair test:

- Make sure that you measure the temperature of the surface at the same point.
- Set your workspace up in the same conditions and with the same weather conditions.

3 Results

The Data Collection Sheet is shown in Appendix A. The infrared photographs are in Appendix B.

The calculation tables are in Appendix C. Photographs of the experiment are shown in Appendix D.

The results are shown in the three graphs below.

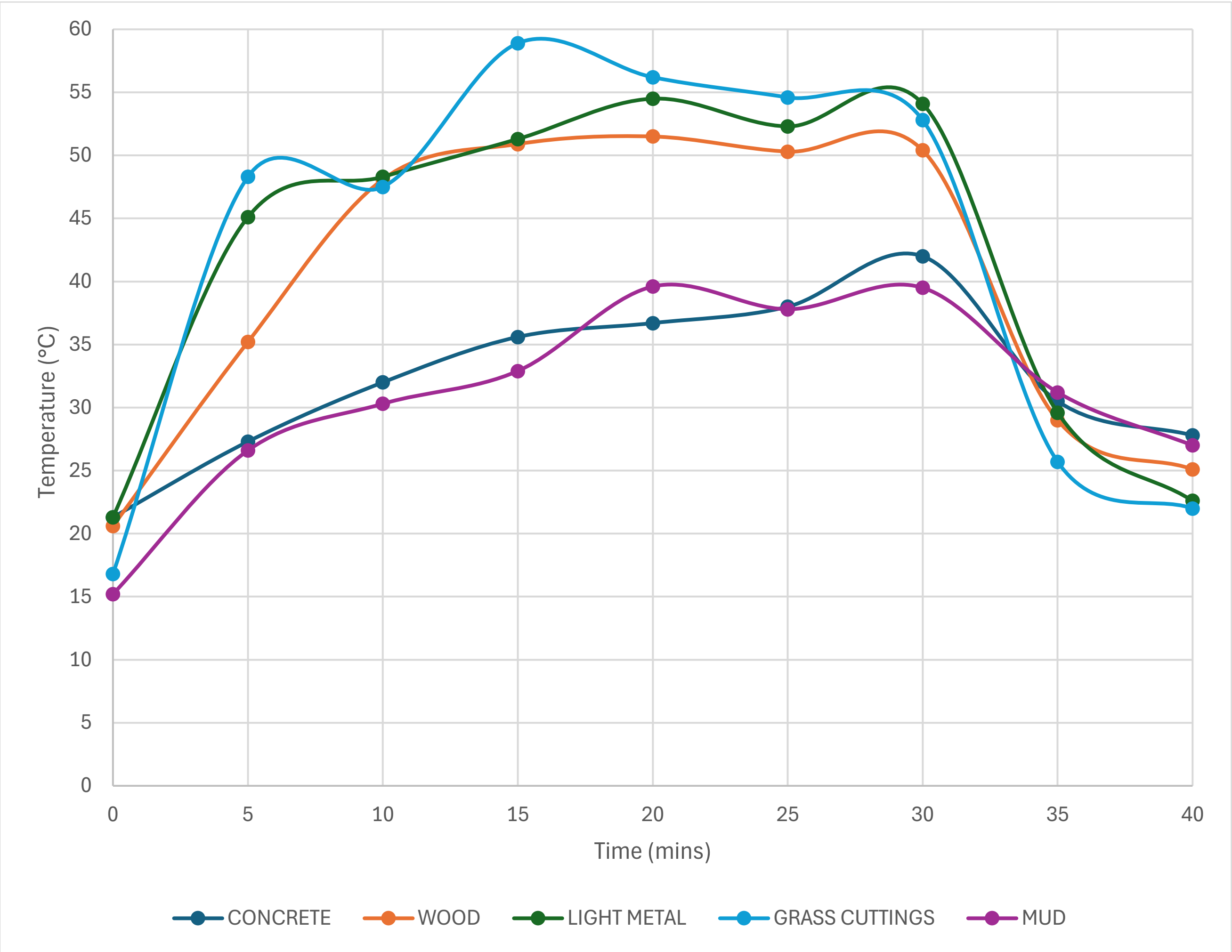

Figure 1: Recorded temperatures for each surface type. Heat was removed at 30 mins.

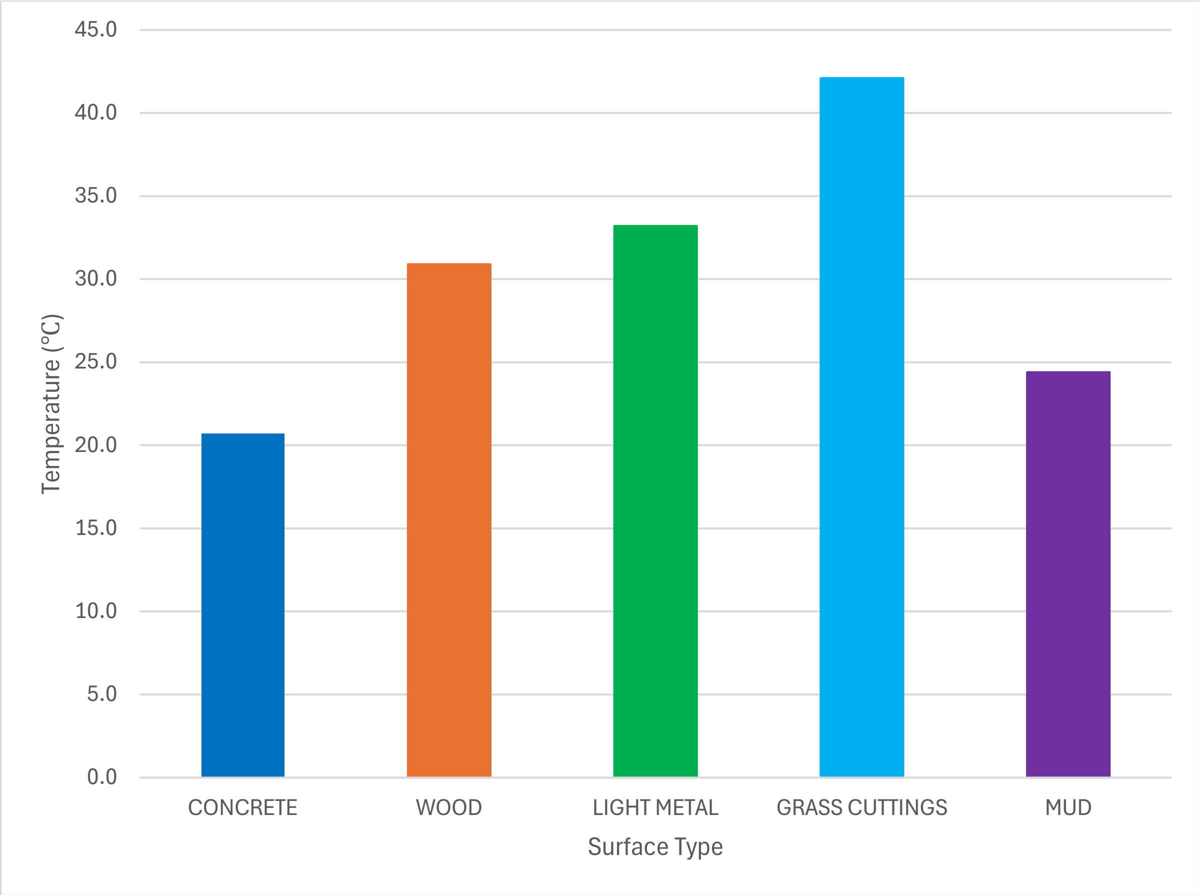

Figure 2: Increases in temperature when heated

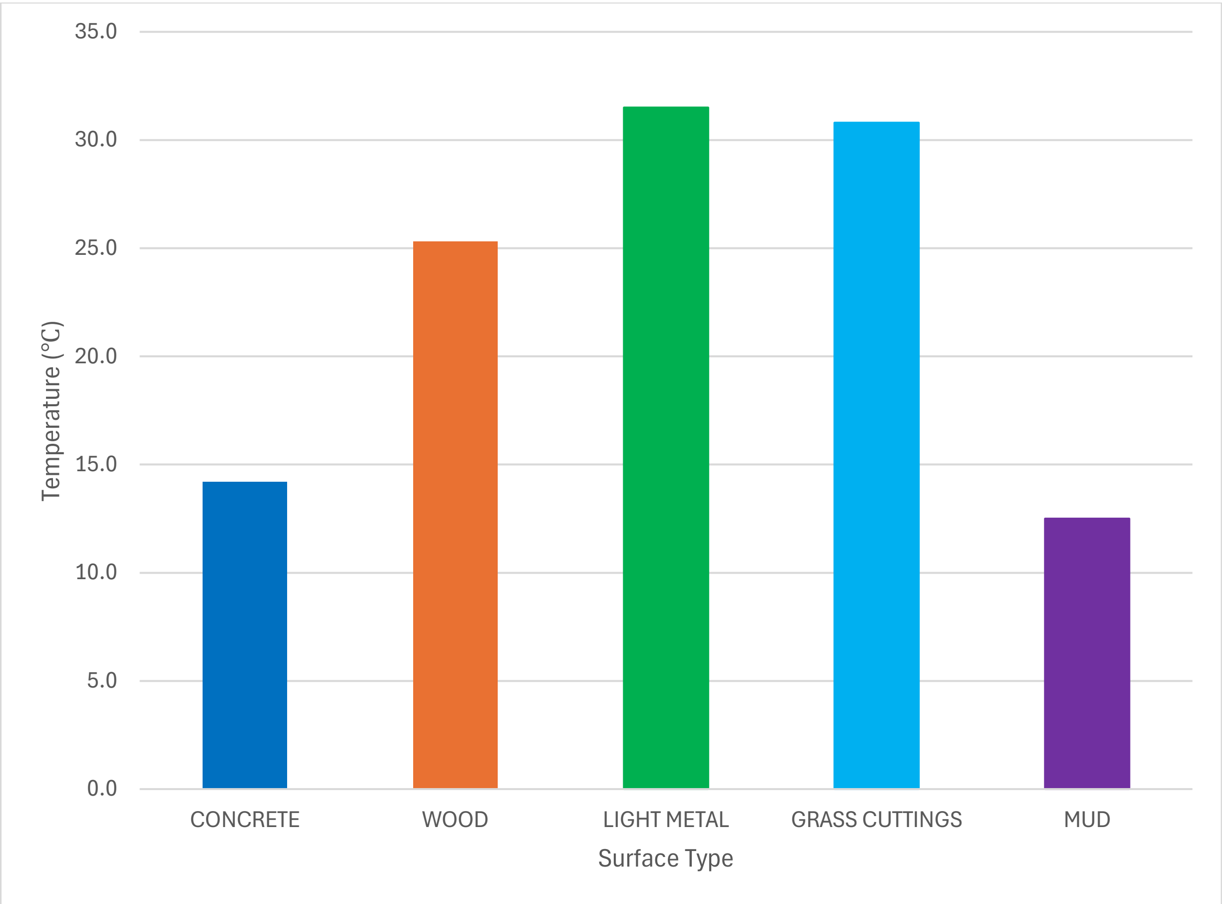

Figure 3: Decreases in temperature once heat removed

The following results were seen:

- Generally, the surfaces reached their highest temperatures at 20 minutes.
- The maximum temperature was recorded for the grass cuttings, but they cooled down the quickest.
- Mud was generally the coolest surface put maintained its heat. Concrete behaved similarly to mud and stayed cooler and retained the heat.
- The grass cuttings increased by the most with an increase of a whopping 42°C, followed by light metal with an increase of 33.2°C. Concrete had the least increase of 20.7°C.
- Light metal and grass cuttings cooled down the most once the heat was removed.

4 Conclusion

Based on my findings, concrete absorbs heat and does not cool down quickly as it re-radiates heat. This means there will be a lot of heat in the evening when heat from the sun has gone as heat continues to radiate from concrete.

Metal and grass heat up fast and get to the hottest temperature. They cool the most as they do not absorb the heat and instead re-radiate it. This means that they are hot in the daytime when the sun is shining but at night time it will be cooler.

Based on my findings, the best materials for buildings to reduce the Urban Heat Island Effect are metal and glass. This can be achieved by having metal roofs with grass on top of them; this is called a green or cool roof.

5 Limitations

One of the limitations of this study is that the infrared thermometer gun was unable to show us if the material was reflecting or absorbing the heat. To counteract this issue we focused on the cooling of the material once the heat had been turned off.

We don't know if grass cuttings would behave the same as grass planted in the ground. However, we couldn't move our heat lamps out as it wouldn't be a fair test. Therefore, we decided to cut grass and bring it to the test area.

6 Glossary

Absorb = to take heat without giving back.

Cool roof = it reflects sunlight and retains less heat.

Green roof = a roof that is covered with plants. the plants are not in [pots pr containers. Instead, they are part of the roof itself.

Radiate = gives off heat as a source.

Reflect = bounces of like a light of a surface.

Re-radiate = gives off heat after absorbing it.

Rural = countryside

Urban = city

Urban Heat Island Effect = Urban areas tend to be warmer than surrounding rural areas due to heat absorbing materials like asphalt and concrete.

(Word Count: 848)

My parents have helped me with my organisation and by asking lots of questions.

7 References

Earth Observatory for Kids (2017). *Urban heat islands: Hot times in the city*. NASA.

Hiti, S., & Midthun, J. (2012). *Heat*. Capstone.

Knight, R. (2009). *Living green: Green buildings*. Heinemann-Raintree.

Lesley, J. (2020). *Turn up the heat: Heat and energy*. Crabtree Publishing.

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Woolf, A. (2019). *The science of buildings: The sky-scraping story of structures*. Wayland.

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☑ Models & Inventions and ☐ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Finn Gelsthorpe ID: ____________

SCHOOL: Prince Alfred College

Activity: Give a brief outline of what you are planning to do.

Measure the temperature of surfaces under a heat lamp.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
1. Burning myself from heat lamp.	1. Ask my parents to help set up the heat lamps.
2. Cutting myself on sharp edges of metal.	2. Use care under adult support.
3. Electrical risk from plugging in heat lamps.	3. Get my parents to pulg in the heat lamps.
4. Burning myself on heated surfaces.	4. Measure temperature of surface with IR thermometer and wait for them to cool down before moving.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Finn Gelsthorpe

SIGNATURE(S): Gelsthorpe

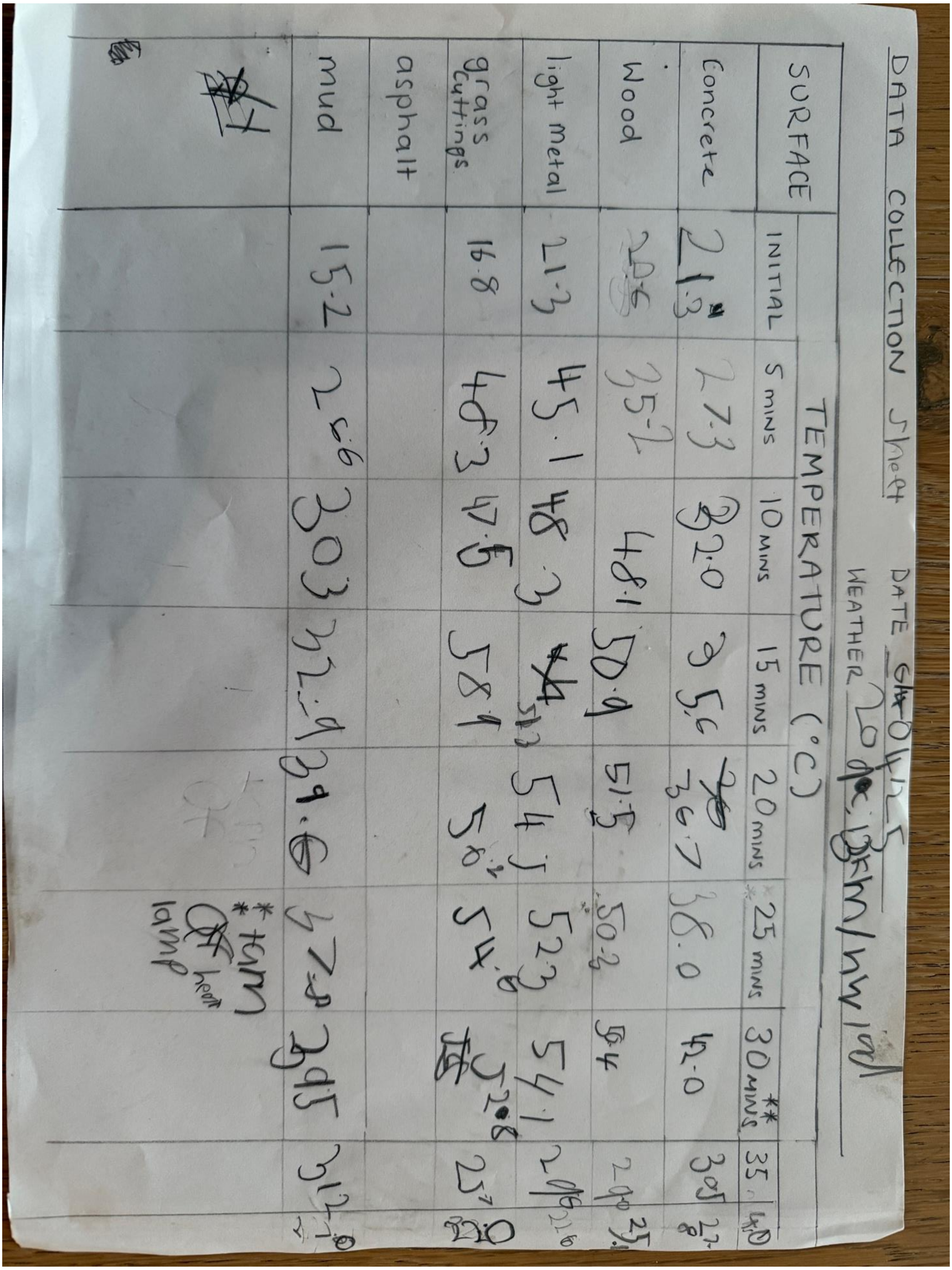
☑ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: ____________

SIGNATURE: ____________ DATE: ____________

Appendices

Appendix A – Data Collection Sheet



DATA COLLECTION SHEET

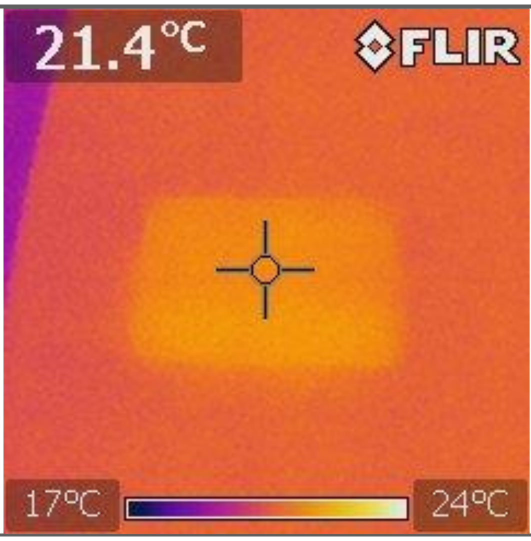
DATE 6/04/25

WEATHER 20°C, 13km/h wind

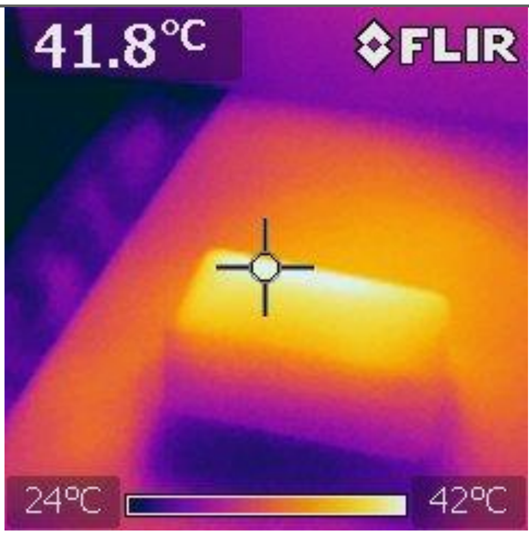
SURFACE	TEMPERATURE (°C) INITIAL	5 MINS	10 MINS	15 MINS	20 MINS	25 MINS	30 MINS **	35	40
Concrete	21.3	27.3	32.0	35.6	36.7	36.0	42.0	30.5	27.8
Wood	20.6	35.2	48.1	50.9	51.5	50.3	54	29.0	25.4
light metal	21.3	45.1	48.3	51.3	54.5	52.3	54.1	29.6	21.6
grass cuttings	16.8	48.3	47.5	58.1	58.2	54.8	52.8	25.7	22.0
asphalt									
mud	15.2	26.6	30.3	32.9	39.6	37.0	39.5	31.2	27.0

** turn off heat lamp

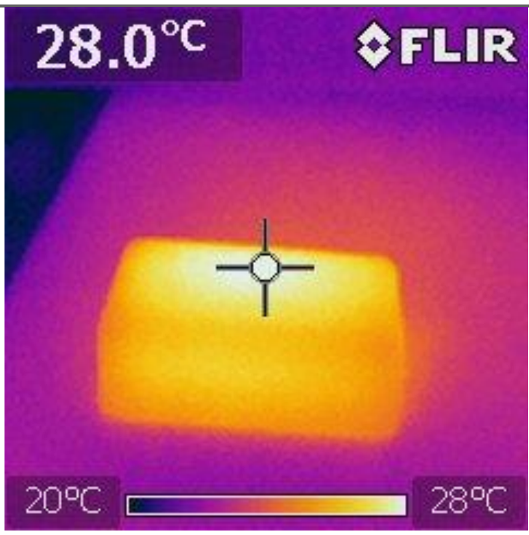
Appendix B – Infrared Photographs



Photograph 1: Initial Temperature (°C)

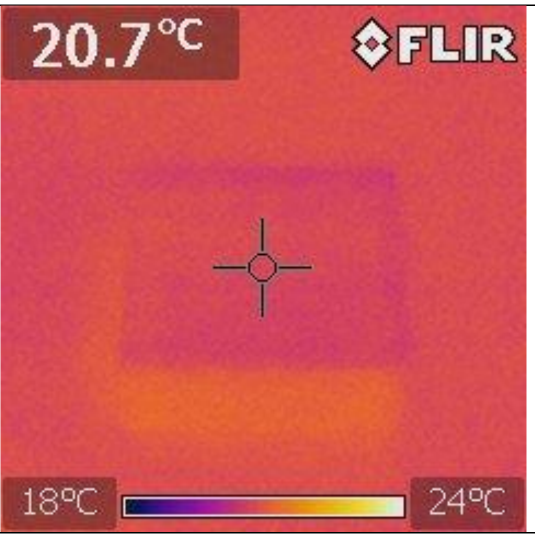


Photograph 2: Maximum Temperature (°C)

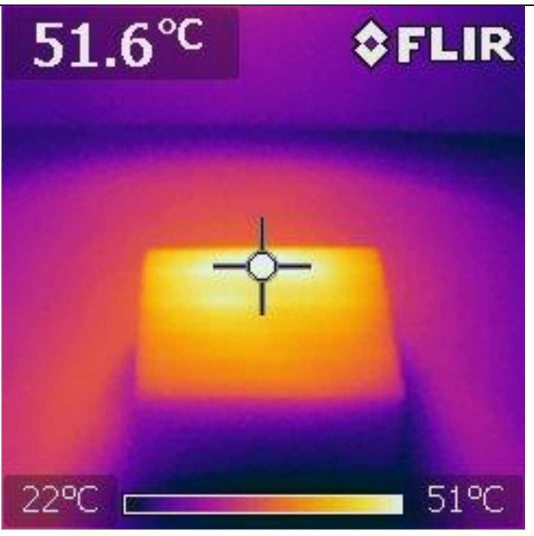


Photograph 3: Final Temperature (°C)

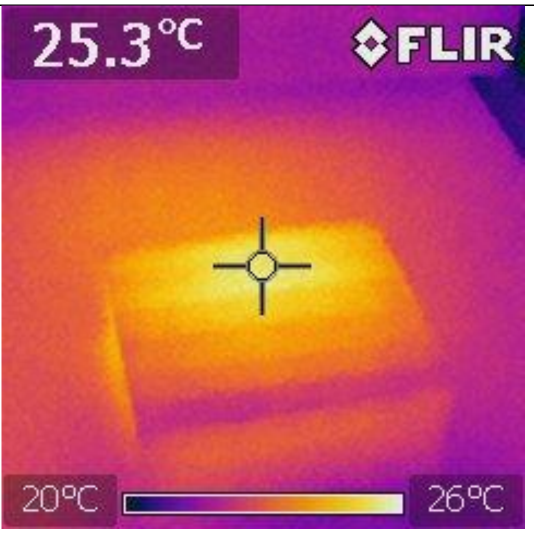
Project: Urban Heat Island Effect	**Surface Type:** Concrete	**Page** 1 of 5
Notes: Displayed temperature in photographs may differ slightly from recorded temperature		



Photograph 4: Initial Temperature (°C)

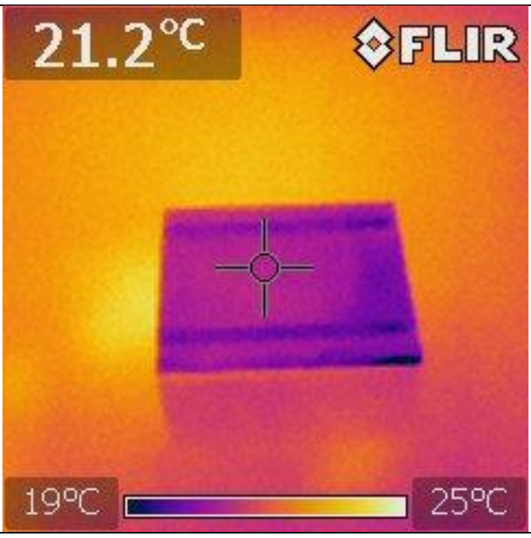


Photograph 5: Maximum Temperature (°C)

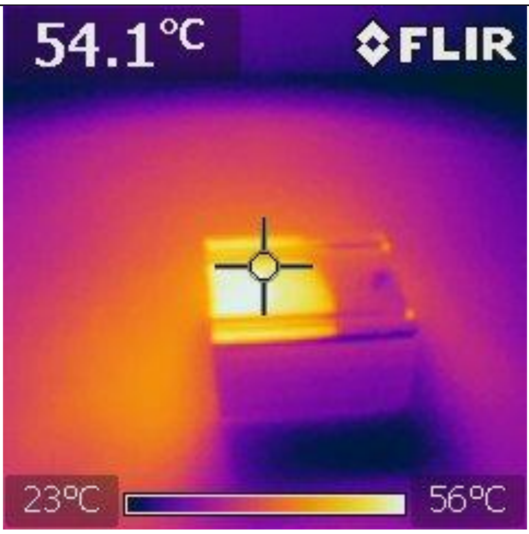


Photograph 6: Final Temperature (°C)

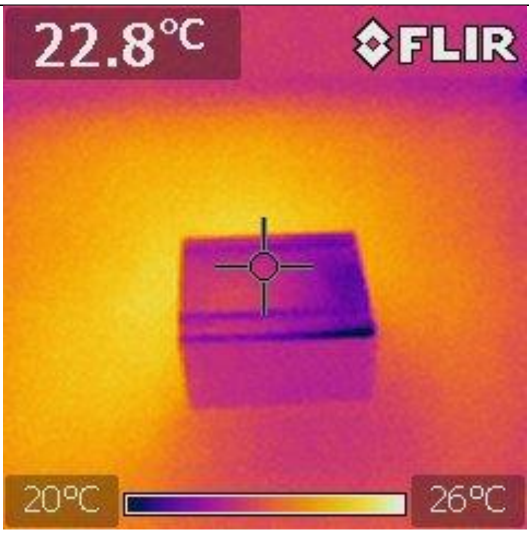
Project: Urban Heat Island Effect	**Surface Type:** Wood	**Page** 2 of 5
Notes: Displayed temperature in photographs may differ slightly from recorded temperature		



Photograph 7: Initial Temperature (°C)

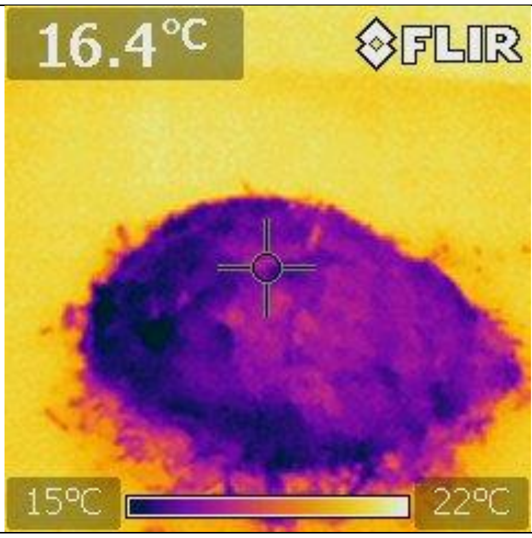


Photograph 8: Maximum Temperature (°C)

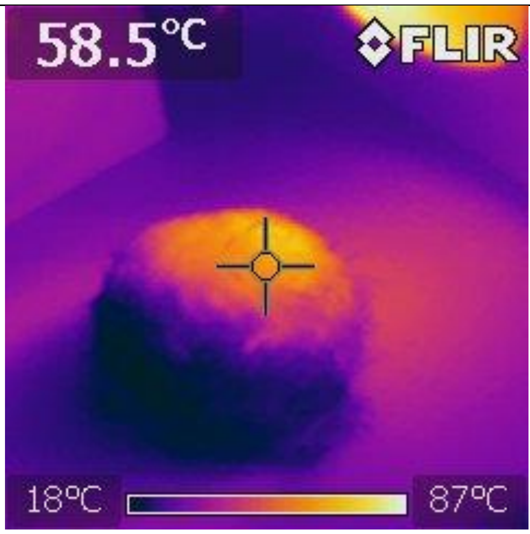


Photograph 9: Final Temperature (°C)

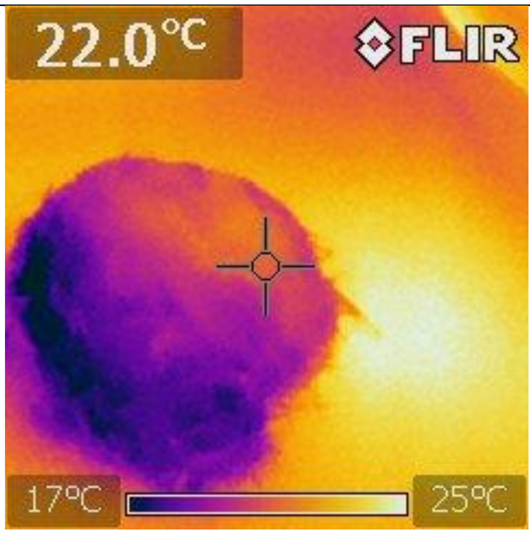
Project: Urban Heat Island Effect	**Surface Type:** Light Metal	**Page** 3 of 5
Notes: Displayed temperature in photographs may differ slightly from recorded temperature		



Photograph 10: Initial Temperature (°C)



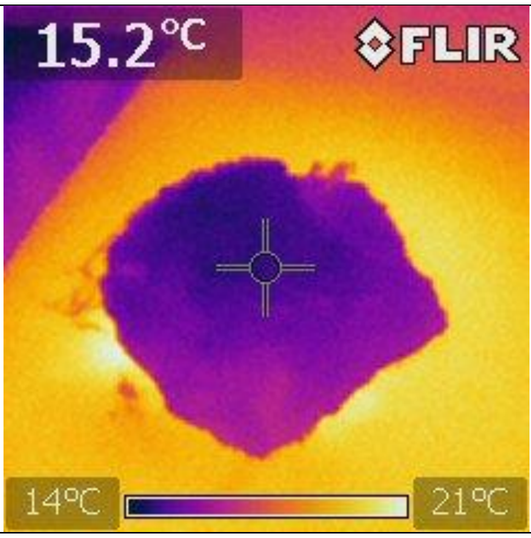
Photograph 11: Maximum Temperature (°C)



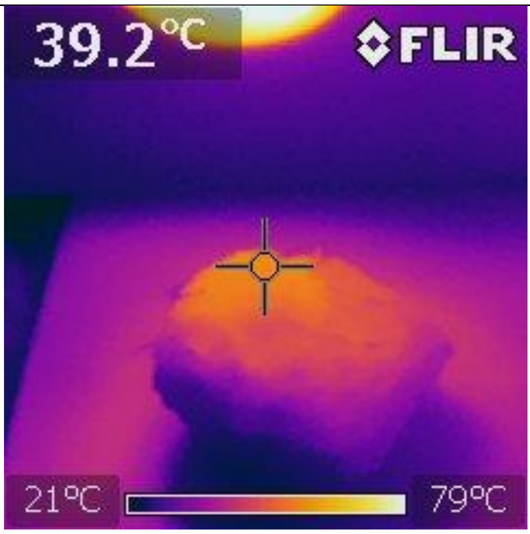
Photograph 12: Final Temperature (°C)

Project: Urban Heat Island Effect	**Surface Type:** Grass Cuttings	**Page** 4 of 5

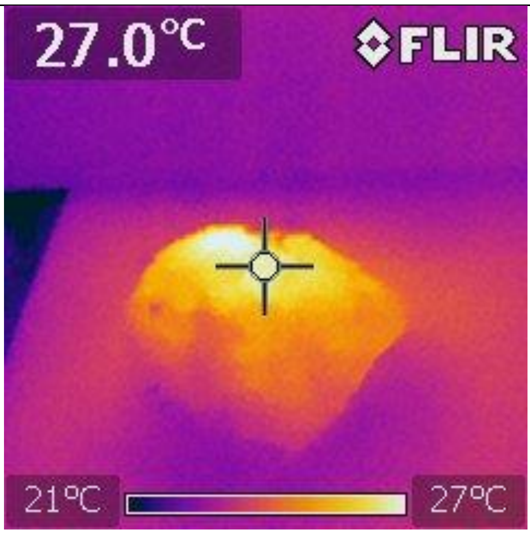
Notes: Displayed temperature in photographs may differ slightly from recorded temperature. Shape of grass pile changed slightly in an attempt to decrease it from drying out under heat



Photograph 13: Initial Temperature (°C)



Photograph 14: Maximum Temperature (°C)



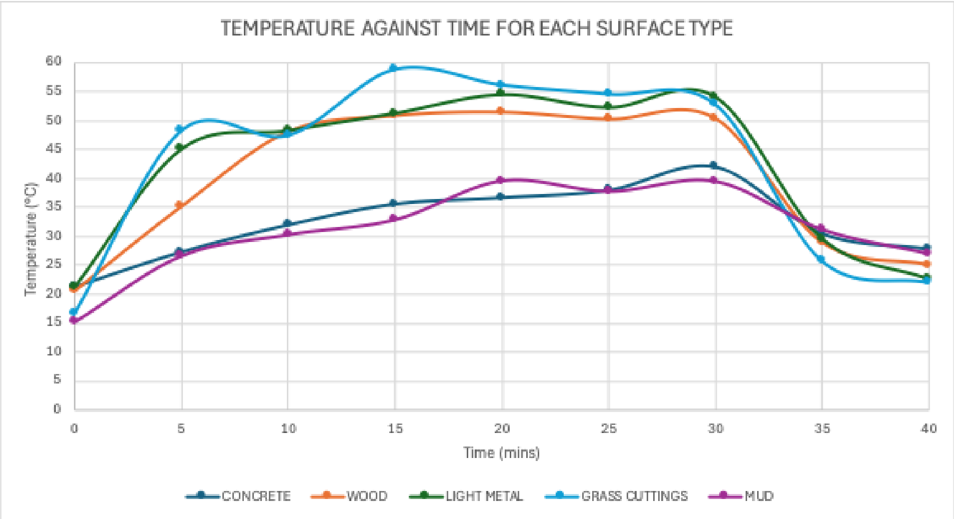
Photograph 15: Final Temperature (°C)

Project: Urban Heat Island Effect	**Surface Type:** Mud	**Page** 5 of 5
Notes: Displayed temperature in photographs may differ slightly from recorded temperature		

Appendix C – Calculation Tables

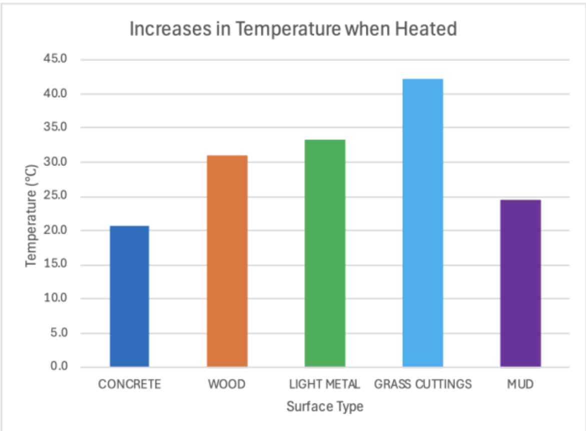
Data Collection Sheet

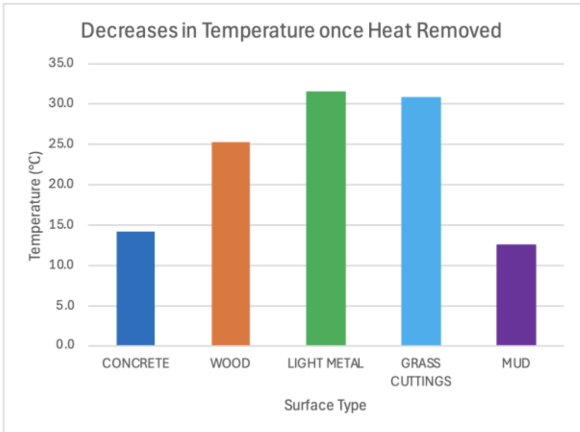
SURFACE	TEMPERATURE (°C)								
	INITIAL	5 MINS	10 MINS	15 MINS	20 MINS	25 MINS	30 MINS	35 MINS	40 MINS
	0	5	10	15	20	25	30	35	40
CONCRETE	21.3	27.3	32.0	35.6	36.7	38.0	42.0	30.5	27.8
WOOD	20.6	35.2	48.1	50.9	51.5	50.3	50.4	29.0	25.1
LIGHT METAL	21.3	45.1	48.3	51.3	54.5	52.3	54.1	29.6	22.6
GRASS CUTTINGS	16.8	48.3	47.5	58.9	56.2	54.6	52.8	25.7	22.0
MUD	15.2	26.6	30.3	32.9	39.6	37.8	39.5	31.2	27.0



Surface	Initial Temp	Max temp	Temperature Increase (°C)
CONCRETE	21.3	42	20.7
WOOD	20.6	51.5	30.9
LIGHT METAL	21.3	54.5	33.2
GRASS CUTTINGS	16.8	58.9	42.1
MUD	15.2	39.6	24.4

Surface	Temp when Lamp Switched off	End temp	Temperature Decrease (°C)
CONCRETE	42.0	27.8	14.2
WOOD	50.4	25.1	25.3
LIGHT METAL	54.1	22.6	31.5
GRASS CUTTINGS	52.8	22.0	30.8
MUD	39.5	27.0	12.5

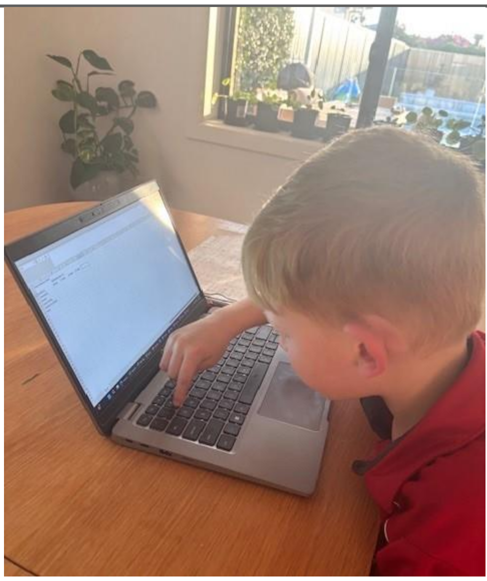




Appendix D -Photographs of Experiment

Photograph 1: Data Collection

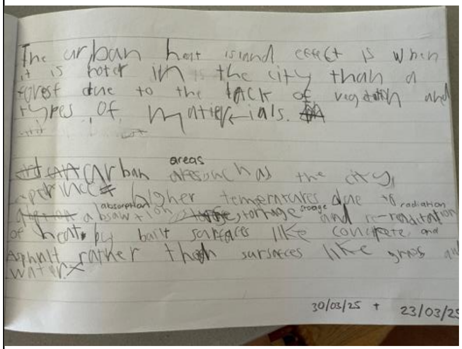
Photograph 2: Equipment and Set-up



Photograph 3: Analysis

Appendix E – Photos of Logbook

1.

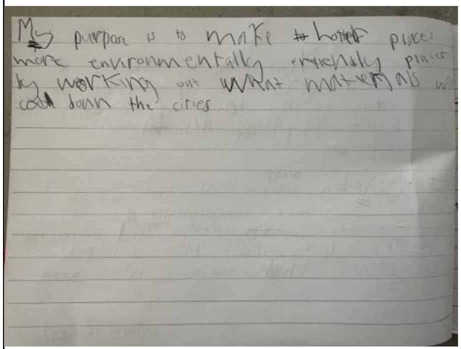


The urban heat island effect is when it is hoter in the city than a forest due to the lack of vegetation and types of materials.

Urban areas such as the city experience higher temperatures due to absorption, storage and re-radiation of heat by built surfaces like concrete and asphalt rather than surfaces like grass and water.

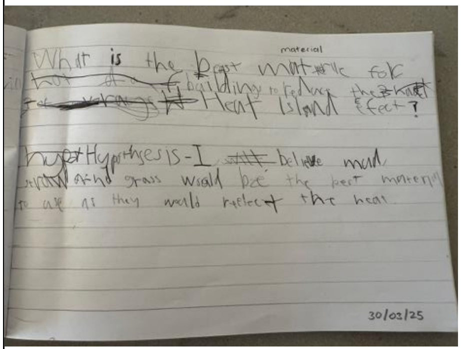
30/03/25 + 23/03/25

2.



My purpose is to make places more environmentally friendly places by working out what materials will cool down the cities

3.

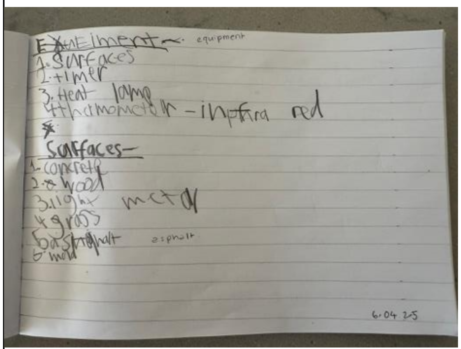


What is the best material for building to reduce the Heat Island Effect?

Hypothesis - I believe mud and grass would be the best material to use as they would reflect the heat.

30/03/25

4.

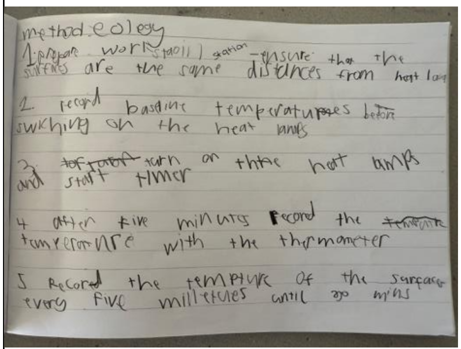


Equipment -
1. Surfaces
2. timer
3. Heat lamp
4. thermometer - infra red

Surfaces -
1. concrete
2. wood
3. light metal
4. grass
5. asphalt
6. mud

6.04.25

5.



Methodology

1. prepare work station - ensure that the surfaces are the same distances from heat lamp

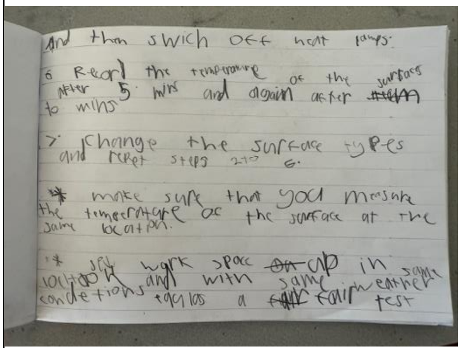
2. record baseline temperatures before swiching on the heat lamps

3. turn on the heat lamps and start timer

4. after five minutes record the temperature with the thermometer

5. Record the tempreture of the surface every five millerules until 30 mins

6.



And then swich off heat lamps.

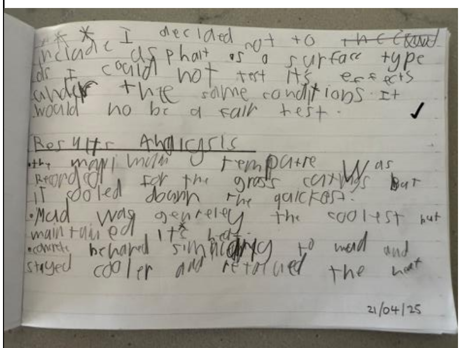
6. Record the temperature of the surface after 5 mins and again after 10 mins

7. Change the surface types and repet steps 2 to 6.

* make sure that you mesure the temperature of the surface at the same location.

* set work space up in same location and with same weather conditions to allow a fair test

7.



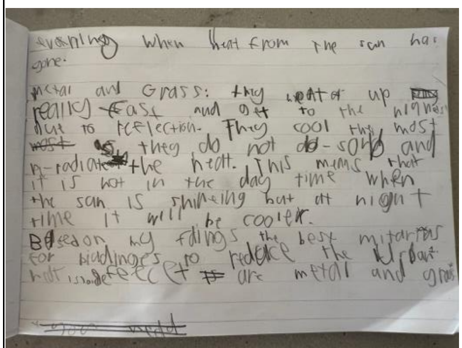
* I decided not to include asphalt as a surface type as I could not test its effects under the same conditions. It would not be a fair test. ✓

Results Analysis

- the maximum temperature was recorded for the grass coatings but it cooled down the quickest.
- Mud was generally the coolest but maintained its heat.
- concrete behaved similarly to mud and stayed cooler and retained the heat

21/04/25

8.

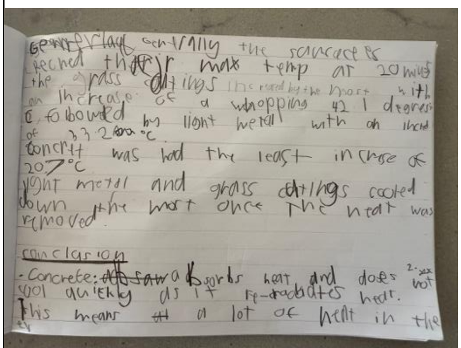


evening when heat from the sun has gone.

Metal and Grass: they heat up really fast and get to the highest due to reflection. They cool the most as they do not absorb and re-radiate the heat. This means that it is hot in the day time when the sun is shining but at night time it will be cooler.

Based on my findings the best materials for buildings to reduce the Urban heat island effect are metal and grass

9.

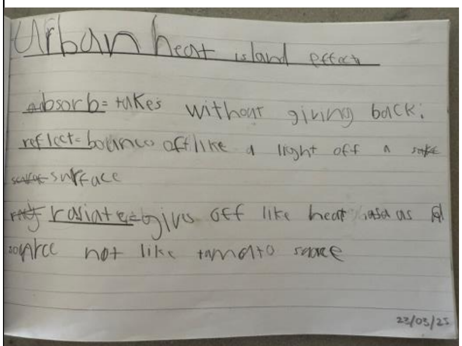


Generally the surfaces reached their max temp at 20 mins. The grass coatings increased by the most with an increase of a whopping 42.1 degrees C, followed by light metal with an increase of 33.2 °C. Concrete was had the least increase of 20.7 °C. Light metal and grass coatings cooled down the most once the heat was removed.

Conclusion

- Concrete: absorbs heat and does not cool quickly as it re-radiates heat. This means a lot of heat in the

10.



Urban heat island effect

absorb = takes without giving back.

reflect = bounces off like a light off a surface

radiate = gives off like heat such as a surface not like tomato sauce

23/03/25