Australian Government | ANSTO

NUCLEAR MEDICINE MANUFACTURING PROGRAM

NMMF Site Characteristics and Evaluation

For Siting Licence

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Table of Contents

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1. Purpose

The purpose of this Site Characteristics and Evaluation report is to describe the natural and human induced effects associated with the siting and development of the ANSTO Nuclear Medicine Manufacturing Facility (NMMF) at the Lucas Heights Science and Technology Centre (LHSTC).

The report describes information on the geological, seismological, hydrological and meteorological characteristics of the development site as well as projected population, land use and human activities that may affect selection of the proposed site. The report ensures compliance with relevant legislation, including the Australian Radiation Protection and Nuclear Safety (ARPANS) Act [Ref: (1)] and Regulations [Ref: (2)] and is an integral element of the ARPANSA Siting Licence Application.

ANSTO is committed to maintaining and optimising the high standard of radiation safety as described in the report and as recommended by the International Atomic Energy Agency (IAEA) and required by ARPANSA. The report is based on the ARPANSA Regulatory Guide – Applying for a licence for a nuclear installation (ARPANSA-GDE-1795) [Ref: (3)], Siting of controlled facilities (ARPANSA -GDE-1756), [Ref: (4)] and associated IAEA guides.

This plan should be read in conjunction with the NMMF Safety Analysis Report (SAR) [Ref: (6)] and Plans and Arrangements supporting the Siting Licence Application.

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Please note for clarity, NMMF refers to the Nuclear Medicine Manufacturing Facility, i.e., the physical structure. NMMP is the Nuclear Medicine Manufacturing Program which includes the NMMF, and the Program of works required to deliver the NMMF.

2. Scope

The scope of this report is to provide information on the site characteristics for the development of the new ANSTO Nuclear Medicine Manufacturing Facility, [redacted] at the LHSTC.

The scope includes investigation of natural and human induced events that could have a significant impact on safety.

Where a significant natural or human induced hazard is identified an evaluation of the characteristics is documented to support the argument that the facility will not pose an unacceptable risk to individuals, the surrounding population and environment, for the lifecycle of the facility.

The site characterisation process includes:

- Detailed site evaluation establishing the suitability of the site for the facility.
- Characteristics of the site, including the extent to which the site may be affected by natural and human events.
- Any environmental impact statement (EIS) requested or required by a government agency, and the outcome of the environmental assessment.

The following International Atomic Energy Agency (IAEA) safety standards are observed:

- Site Evaluation for Nuclear Installations (SSR-1, IAEA 2019) [Ref: (5)]
- Site Survey and Site Selection for Nuclear Installations (IAEA 2015) [Ref: (6)]
- Safety Guide: Seismic Hazards in Site Evaluation for Nuclear Installations (IAEA 2010b) [Ref: (7)]
- Safety Guide: Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations (IAEA 2011b) [Ref: (8)]
- Safety Guide: Volcanic Hazards in Site Evaluation for Nuclear Installations (IAEA 2012a) [Ref: (9)].

This report and specifically Section 5 Site Evaluation and Design Bases, provides information with an assessment to demonstrate that the LHSTC is a suitable site for the Nuclear Medicine Manufacturing Facility.

3. Site Characteristics

A comprehensive description of the whole ANSTO Lucas Heights campus (LHSTC) is provided in document AG-2430 ANSTO LHSTC Site Description [Ref: (10)].

The NMMF site has been the subject of a detailed assessment contained in the ANSTO Nuclear Medicine Manufacturing Facility Program – Site Design Basis – Stage 1, NMMP-1100-RT-0001 [Ref: (11)].

A summary table listing Natural and Human Induced Hazards considered in preparation of this report is included at Appendix A: .

3.1. Location

[redacted]

3.2. Surrounding Land Use

[redacted]

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3.3. Demography

3.3.1. On-site Population

During standard working hours (Monday to Friday, 7am to 7pm) the maximum number of people on-site at the LHSTC may be in the order of [redacted]. This is based on the number of current employees and average visitors each day, as per AG-2430 LHSTC Site Description [Ref: (10)]. Due to annual and sick leave, working off-site, and shift work, the total on any one working day is expected to be much less. [redacted]

At least [redacted] are on-site outside of normal working hours, including staff from OPAL operations, ANSTO Health production and the Australian Federal Police. Up to an additiona[redacted], and [redacted] may be present during the evening (Monday to Friday).

3.3.2. Off-site Population

The estimated population for land surrounding the LHSTC[redacted] based on *GeoScience Australia National Exposure Information System* data for 2020 and documented in AG-2430 LHSTC Site Description [Ref: (10)] The population is dominated at the north-east, east, and east-south-east of the site (this represents Barden Ridge, Engadine, and surrounding suburbs). Further from the site, the main population concentrations are to the north and north-east (towards Menai). The population is relatively low to the south of the site. The population projection of annual average growth rate every five years to 2041 for the Sutherland Shire Local Government Area (LGA) is around 1% [Ref: (10)].

Growth of off-site population will be considered within the NMMF Safety Analysis Report (SAR) [Ref: (12)] and reassessed upon revision of the SAR and as additional data becomes available.

3.4. Meteorology

ANSTO operates a meteorology laboratory (Building 34) on the Lucas Heights campus which has been recording data since 1968. The data captured includes wind speed and direction, relative humidity, atmospheric pressure, and rainfall and is available on ANSTO's website [Ref: (13)]. An extended table with more statistics about the rainfall is available through the Bureau of Meteorology [Ref: (14)].

3.4.1. Winds

The wind condition including wind speed and direction for the NMMF site is the same for the LHSTC and described in AG-2430 LHSTC Site Description [Ref: (10)]. Wind Roses at 10 m and 49 m above ground level document wind speed and direction at the LHSTC from 2010 to 2020. Average wind speeds are 2.1 to 2.4 m/s at 10 m above ground level and 4.4 to 4.8 m/s at 49 m above ground level. The natural hazard presented by high velocity winds is discussed in the LHSTC Site Descriptions [Ref: (10)] and the summarised in Table 1.

Table 1: Wind annual exceedance frequencies at designated mean velocities

The natural hazard presented by severe winds at the LHSTC is documented in the OPAL SAR Chapter 3 [Ref: (15)] noting an annual exceedance frequency of [redacted]. The HIFAR Probabilistic Safety Assessment (PSA) produced a tornado hazard analysis shown in Figure 2, determining an annual exceedance frequency of [redacted] [Ref: (16)]. Based on data from the HIFAR PSA the fastest mile wind speed is [redacted] for the LHSTC. At a similar exceedance level, the highest tornado-type wind speed is [redacted]

The Site Design Basis – Stage 1 [Ref: (11)] for the NMMF considered wind pressure effects, gusting effects, pressure drops and projectile effects in the case of the tornado-type winds. This data will be applied during detailed design of the NMMF.

Figure 2: Exceedance frequency curves for the fastest mile wind speed and tornado type wind

3.4.2. Ambient Temperature

The 15-minute average ambient temperature of the Lucas Heights campus, based on data recorded for 2010 – 2020, ranged from 9.9 ^{o}C to 24.4 ^{o}C at 2 m above ground level and 10.9 ^{o}C to 24.0 ^{o}C at 10 m above ground level as per AG-2430 LHSTC Site Description [Ref: (10)]. This data is applicable to the NMMF site.

3.4.3. Ambient Pressure

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The ambient pressure at the NMMF site is taken as the same ambient air pressure for the LHSTC. For the period 2010-2020 the maximum recorded 15-minute average air pressure at 2 m above ground level was 1020.35 hPa. For the same period the minimum recorded average air pressure was 897.9 hPa, refer AG-2430 LHSTC Site Description (10)].

3.4.4. Atmospheric Turbulence

ANSTO uses the U.S. Environment Protection Authority (USEPA) [Ref: (17)] scheme for classifying atmospheric turbulence. This scheme uses the wind speed and fluctuation in wind direction data to determine atmospheric diffusion parameters called Pasquill Stability Categories. These categories range from A (the most unstable and most dispersive) to F (the most stable and least dispersive). Detailed Pasquill Stability Categories for the Lucas Heights campus is provided in AG-2430 LHSTC Site Description [Ref: (10)] and are summarised in Table 2.

Day/Night	Pasquill Stability Category						
	A	B	C	D	E	F	Total (%)
[redacted]							

Table 2: Representative Pasquill stability category and wind speed at 10m (2010-2020)

3.4.5. Inversions and Atmospheric Mixing Layers

The occurrence of stable temperature inversions leads to limited atmospheric mixing and worst-case conditions in terms of air pollution impact assessments. ANSTO has used an acoustic sounder to study the development of atmospheric mixing layers associated with inversions.

All recorded occurrences are ground-based nocturnal inversions. The top of the inversions is estimated to be on average 120 metres above the ground. This estimate is based on the time for elimination of nocturnal inversions by surface heating after sunrise. Nocturnal inversions occur on average 291 times per year with an average duration of 8 to 9 hours and an average intensity of 5 °C per 100 metres.

3.4.6. Rainfall

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Statistical data relating to rainfall at the LHSTC for the years 1958 to 2022 has been recorded by the Bureau of Meteorology [Ref: (18)] at Table 3. Recent rainfall data (2013-2024) presented at Figure 3.

Two aspects of rainfall have the potential to impact on the NMMF site:

- Rainfall and wind distribution
- High rainfall and flooding.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	96.6	111.4	130.6	92.3	75.8	101.7	63.4	69.0	50.8	72.2	90.1	75.7	1006.5
Lowest	7.1	11.0	10.4	0.5	4.1	2.3	0.3	0.0	0.6	0.0	8.1	1.0	556.3
5th %ile	11.2	16.1	22.6	8.4	7.8	9.4	0.8	4.0	4.1	6.0	14.7	14.9	586.1
10th %ile	22.5	19.4	34.1	12.8	12.4	16.3	6.4	6.0	7.5	11.1	19.5	19.5	666.2
Median	75.9	83.3	92.9	71.2	48.6	70.9	41.2	35.6	39.5	48.6	70.8	58.1	1012.6
90th %ile	190.2	242.5	280.2	205.0	153.9	221.1	139.0	212.3	102.4	195.3	153.0	163.2	1294.8

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
95th %ile	250.9	297.7	300.4	273.5	202.8	335.1	163.3	246.6	121.5	211.3	188.3	227.4	1503.1
Highest	270.7	443.0	567.2	397.6	358.4	449.7	647.9	403.8	249.3	219.1	432.2	273.1	1804.0

Table 3: Summary of rainfall statistics of Lucas Heights (ANSTO) for all year

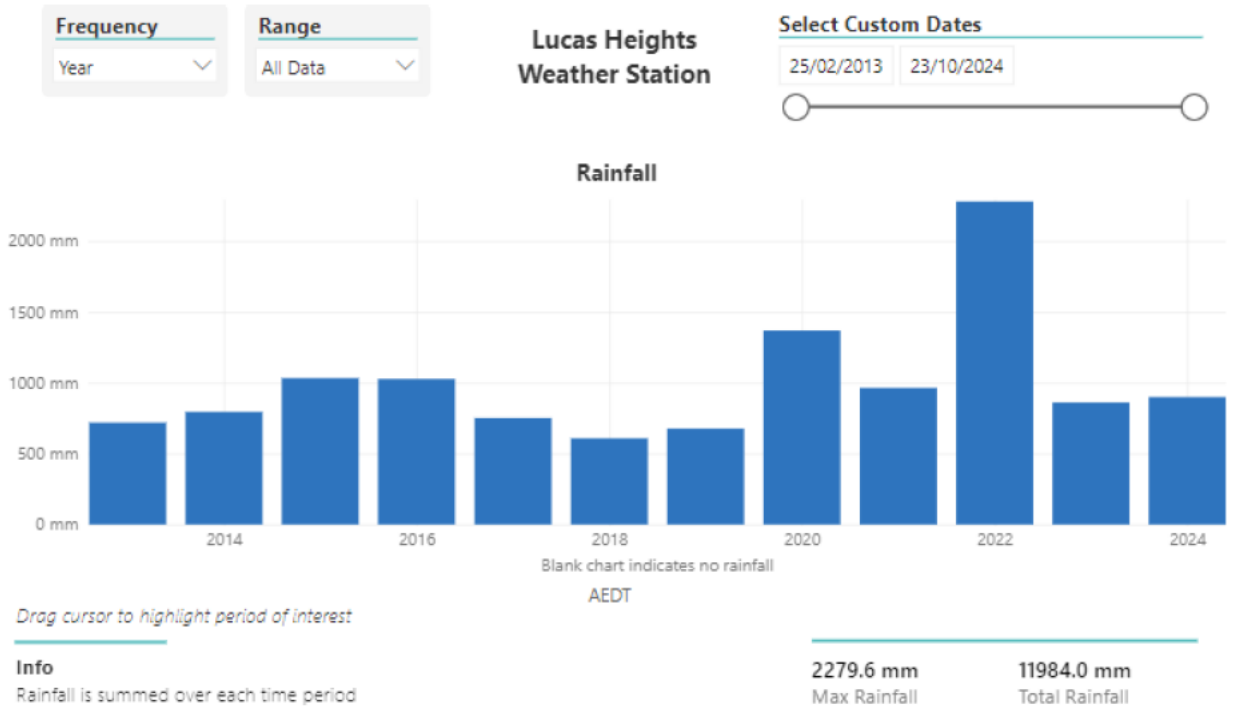

Figure 3: Lucas Heights annual rainfall

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Rainfall and wind distribution is important in determining the wet deposition or wash-out of atmospheric aerosols and gases. For the LHSTC rainfall occurs 4.05% of the time based on available data recorded for 2010 to 2020. Approximately 47% of the rain occurs with winds from the south-east to south and is generally low intensity (less than 1 mm per hour). A detailed assessment of monthly rainfall data has been undertaken for recent years of very high rainfall, in particular March and July 2022 with recorded rainfall of 567.2 and 647.9 mm compared with the mean rainfall (mm) of 130.6 and 63.4 mm respectively for years 1958-2024. High rainfall and flooding are recognised as a natural hazard with some areas of the LHSTC potentially prone to localised flooding. Impacts from flash floods can be affected by localised topography and drainage routs and there is always the potential for some facilities to be affected by run-off in extreme rain events. The potential for local external flooding has been considered as part of the NMMF design.

3.4.7. Bushfire Weather

The Lucas Heights campus is located near bushfire prone land. The risk of bushfire in the vicinity of the NMMF site (as with the rest of the campus) increases during dry weather and peaks on days of high temperature, low humidity, and strong winds.

The following bushfire protection measures for the Lucas Heights campus are already in place:

- An [redacted] two-way sealed perimeter road [redacted]
- External fire trail with turning areas.
- Hydrant points both internal and external to the security fence at regular intervals.

- Electricity to the NMMF site is located underground.
- Fixed building fire detection and protection systems.
- Management of internal landscaping to Asset Protection Zone (APZ) standards.

The main design considerations with the NMMF for avoiding or minimising hazards from bushfire include compliance with relevant Australian building standards, use of appropriate construction materials, appropriate design to avoid the collection of combustible material on or near buildings (e.g., leaves settling in guttering, roof, or eaves), and maintaining recommended fire hazard reduction distances from bushland.

Based on the existing measures, it was determined that no additional bushfire protection measures were required for the NMMF as the facility that falls beyond a 140 m buffer zone [Ref: (11)].

3.4.8. Atmospheric Dispersion of Radioactivity

The important parameters for dispersion modelling of atmospheric releases are wind speed and dispersion stability category. The OPAL SAR Chapter 3 [Ref: (15)] gives consolidated information on this in a form that is directly usable in providing input to dispersion modelling. The recorded information on wind direction, speed, and Pasquil Stability Category for the Lucas Heights campus is summarised in Table 4 of OPAL SAR Chapter 3 [Ref: (15)].

The OPAL Siting Safety Assessment [Ref: (19)] refers to studies that indicate that models for predicting atmospheric dispersion under highly stable or inversion conditions and for flat terrain are satisfactory for approximating the transport of airborne materials at the LHSTC. These studies have used atmospheric tracers to show that wind flow patterns in the Woronora Valley are decoupled from the flow on the plateau above.

A Safety and Security Consequence Analysis [Ref: (20)] for the NMMF has considers future operations at the facility and using PC-Cosyma modelling tool to assess the radiological hazard for identifying potential consequences of the release outside the facility. The analysis was performed reflecting day and night conditions for projected effective doses and thyroid doses for exposure of adults, children, and infants at various distances from NMMF.

Three potential bounding case accidents were considered:

- Building fire
- Seismic event
- Security event.

It is assessed that a large-scale building fire, which has the potential to result in the airborne release of all the available radioactive materials stored in the facility, represents the bounding case accident with respect to releases to the environment. This analysis and assumptions will be revisited when the facility design is more mature to provide a more realistic assessment of consequences.

3.5. Hydrology

Geophysical and hydrogeological investigations of the Lucas Heights campus have been conducted periodically. The most significant having been undertaken for the OPAL Reactor site during the site assessment in June 1998. The geophysical study was undertaken to provide information on the subsurface conditions and any structures which may influence groundwater in the region. The reports of these investigations [Ref: (21), (22)] were submitted with the siting licence application for the OPAL Reactor as supporting documents.

3.5.1. Surface Hydrology

The surface hydrology is relevant to the safety aspects of the NMMF, because radioactive material deposited in or above the ground may find its way into drainage channels, creeks or rivers through surface runoff. There are no known private dams that could be fed by runoff from the area surrounding the LHSTC. The nearest major dam owned by a public utility is the Woronora Dam approximately 7 km south-east of the LHSTC, the public consumes water from the Woronora Dam. Neither dams nor groundwater bores are within a ground water catchment that could be directly influenced by runoff from LHSTC and hence form a possible dispersion pathway.

Three private dams and six bores are located within a 10 km radius of the LHSTC and are licenced by Water NSW, the three dams located adjacent to the LHSTC site are:

- Dam adjacent to the railway line 1 km north of the railway station at Heathcote (just east of the line).
- Small dam on the tributary of Kangaroo Creek 2 km south of Heathcote railway station.
- Woronora Dam approximately 7 km south-east of the Lucas Heights campus.

None of the dams and bores listed are within a groundwater catchment that could be directly influenced by runoff from the LHSTC site [Ref: (10)].

The general topographic environment is such that no part of the LHSTC is far removed from a natural drainage channel in the adjacent terrain. The principal surface stream immediately adjacent to the site is the Woronora River. It flows in a generally north-easterly direction from near the Woronora Dam and passes within approximately 2 km east of the site to eventually meet the Georges River estuary. The northerly side of the Lucas Heights campus, located on a ridge, is drained by Mill and Bardens Creeks, which also empty into the Georges River estuary. The near-surface low-level waste disposal site, known as the Little Forest Legacy Site, is located within the surface water catchment of Bardens Creek. More details of the topographical environment are described in the LHSTC Site Description [Ref: (10)].

3.5.2. Groundwater Hydrology

The groundwater flow around the Lucas Heights campus is characterised by the local topography. The LHSTC is situated on top of a gently north-sloping ridge. On the eastern side, several steep gullies drain into the Woronora River, and on the west are the shallow depressions forming the headwaters of Barden's and Mill creeks.

The groundwater hydrology is complicated by weathering and features of the Hawkesbury sandstone. The unweathered sandstone has a very low primary or intergranular permeability while the weathered sandstone has a considerably higher primary permeability.

The principal water-transmitting capability is dependent on secondary features such as joints and bedding planes in the Hawkesbury sandstone. Depending on local hydrogeological conditions, aquifers may respond in apparently confined, unconfined, or intermediate conditions. Consequently, water levels in boreholes may reflect local conditions and not give a true indication of regional hydraulic gradients.

A detailed baseline groundwater investigation for the LHSTC is documented in the OPAL SAR Chapter 3 Site Characteristics [Ref: (15)]. Standing groundwater levels are known for the northern area of the Lucas Heights campus and for the Little Forest Legacy Site. The overall hydraulic gradient is to the north although locally the gradient is strongly influenced by structural and topographical features. Reported investigations indicate a shallow groundwater zone between [redacted]m and a deeper regional zone between [redacted] below the surface [Ref: (15)].

Close to the Woronora River, the groundwater level varies sympathetically with the level in the river. This variation extends some 30 m from the centre of the river. Further from the river, it is expected that the groundwater level should generally only show a slight response to rainfall. As scattered claystone and shale bands occur in the Hawkesbury sandstone formation, there are likely a number of local subsurface conditions where a portion of the downward percolating groundwater is held back by these low permeability barriers.

Based on the geotechnical investigation conducted by Douglas Partners for the NMMF site [Ref: (23)]. groundwater seepage was observed in some of the test pits (TP) at depths in the range of [redacted], Australian Height Datum (AHD)) to [redacted] The observations of groundwater levels within the bedrock profile encountered within boreholes were precluded given the introduction of water during coring. Ephemeral seepage may occur from along the soil and rock interface following heavy rainfall and may also occur along bedding planes and fractured zones in the rock. It should be noted that groundwater levels are transient and that fluctuations may occur in response to climatic and seasonal conditions.

It is considered that from a geotechnical perspective, effective control of ground water at NMMF site will be readily achievable, provided appropriate design, site preparation, implementation of earthworks control procedures and sound engineering/ construction practices are adopted.

3.6. Geology and Soils

The geography of the development site is notionally the same as for the Lucas Heights campus described in AG-2430 LHSTC Site Description [Ref: (10)].

3.6.1. Regional and Local Geology of the Lucas Heights

The LHSTC is located on the Woronora Plateau at an elevation of approximately 150 m AHD, for which the dominant rock formation is Triassic Age Hawkesbury Sandstone. In the Lucas Heights region, this sandstone is approximately 192 m thick. This plateau extends south from Sydney and forms part of the Sydney Basin.

The predominant rock outcropping at Lucas Heights is medium to coarse quartzose sandstone. Minor components of dark grey shale, siltstone, and sandstone/ siltstone make up about 5% of the total. The sandstone units are composed mainly of medium-coarse quartz grains bound by a secondary quartz-siderite cement with a clay matrix.

Generally, the soil cover over rock is very shallow and consists of sandy loam, gravel, clay, and ironstone. The top layers of sandstone are often soft and underlain by clay seams of varying thickness. Water is often encountered during excavation. More details of the regional and local geology of the Lucas Heights campus are provided in AG-2430 LHSTC Site Description [Ref: (10)].

3.6.2. Geology of the NMMF Site

[redacted] and is an irregular shaped area of 1.6 ha. The maximum north-south and east-west dimensions are 130 m and 120 m respectively and is currently made up of a series of roads, and grassed areas. The surface levels fall 6 m (RL 157 m to 150 m) to the north with and average slope generally within the range 8° – 9°. The site slopes to a series of internal roads, carparks, and batters.

The general subsurface profile encountered following a geotechnical investigation conducted by Douglas Partners for the NMMF site [Ref: (23)] included:

- **Fill layer**
  - Typically, silty sand and silty clay fill with sandstone and igneous gravels, to depths in the range of 0.4 m to 0.9 m, overlying a natural layer.
- **Natural layer**
  - Fine to medium grained sand and gravelly sand, with traces of silt and clay, generally in a medium dense to dense condition, encountered to depths between 0.7 m and 1.5 m overlying clayey sand and sand.
  - Clayey sand and sand, generally medium dense then dense, fine to medium grained sand to depths of 1.2m and 2.5 m.
  - Sandy/ gravelly clay and clay, encountered in two test pits (TP6 to TP8), between depths of 0.8 m to 2.2 m depth; underlain by a sandstone layer.
- **Sandstone layer**
  - Very low to low strength, moderately weathered, fine to medium grained, with bands of iron-cemented sandstone to depths between 4.4 m, (encountered in bore hole (BH)1 only); underlain by medium to high strength sandstone.
  - Medium to high strength, moderately weathered to fresh sandstone to a depth of the investigation. BH1 encountered a layer of slightly weathered low strength band between about 7 – 8 m depth.

3.7. Seismology

The Lucas Heights campus is located on a sandstone plateau in the Sydney Basin. The current earthquake hazard map of south-eastern Australia [Ref: (24)] shows the Sydney Basin to lie in a low intensity seismic zone. While there are a number of geological features in the Sydney Basin indicative of past earthquake activity, no seismically active geological structures have been identified, and there are no major faults within 35 km of the Lucas Heights campus [Ref: (15)]. From a global tectonics' perspective, Australia is regarded as an intraplate setting, thousands of kilometres from an active plate boundary.

In 2001, the seismic hazard at the Lucas Heights campus was assessed and the results were documented in Table 18 of AG-2430 LHSTC Site Description [Ref: (10)]. This is consistent with Figure 3.2(A) in AS 1170.4-2007 [Ref: (25)], which shows that the Sydney Basin lies in a low intensity seismic zone with a peak ground acceleration less than approximately 0.09 g for a 500-year return period.

The assessed seismic hazard at Lucas Heights used in the design basis earthquake for the OPAL Reactor was set at a recommended mean peak horizontal ground acceleration of 0.37 g for the 10,000-year return period earthquake with the response spectrum based on the Loma Prieta earthquake [Ref: (10)].

3.7.1. Seismic

A Hazard Factor (Z) of 0.08 would be appropriate for the NMMF site in accordance with Australian Standard AS 1170.4 – 2007 Structural design actions – Part 4: Earthquake actions in Australia [Ref: (25)]. The site sub-soil class would be Class B.

3.8. Site Services

The nominated site for the NMMF will utilise several services currently in place to service adjacent buildings and facilities. Interruption to these services (such as power, communications, water, compressed air, and drainage) should be minimal, however; they may have the potential for initiating an event with some systems in the facility and will be assessed in the NMMF SAR [Ref: (12)].

3.8.1. Water Supply

The water reticulation system consists of supply pipelines, storage facilities, pump systems, and site distribution systems. [redacted]) via a gravity-fed pipeline. On reaching the Lucas Heights campus, water is received into [redacted] before being pumped to a [redacted]. It is then gravity-fed throughout the system by ring mains around each sector of the site. The multiple-pump system is controlled with valves and the water tower [redacted]. The total water storage capacity on the site is [redacted]. Should additional demand be required i.e. operation of multiple wet fire protection systems the Lucas Heights Reservoir System can be drawn upon to back up the two balance tanks.

Water supply required during the NMMF construction phase would not be significant and the existing supply system is more than able to cope. The Lucas Heights Reservoir System has the capacity to supply the equivalent to another [redacted] per month and as such, it would easily accommodate water supply requirements during construction as well as additional operational demand. It is concluded that the capacity of the existing water supply system is sufficient to meet both construction and operational requirements of the facility.

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3.8.2. Wastewater

Infrastructure is currently in place at the Lucas Heights campus for the treatment and discharge of low-level liquid wastes (B-line wastewater), trade wastes (C-line wastewaters), contact handled liquid waste (D-line) and non-radioactive sewage. This infrastructure includes delay tanks for collection from buildings with pipework to the low-level liquid and trade waste treatment facilities, a sewage treatment plant, and a liquid waste disposal pipeline, most of which is located at the south-east corner of the Lucas Heights campus. Wastewater is managed by ANSTO Waste Management Service (WMS). The NMMF will require additional collection pipelines, effluent treatment plant upgrades for the treatment of facility effluent i.e., D-line as described in the NMMF Waste Management Plan [Ref: (40)]. The design for new effluent holding and treatment facilities will be incorporated into the NMMF SAR [Ref: (12)] and assessed through the detailed design process. It is not envisaged that there will be any requirement to alter existing wastewater or trade waste agreements with Sydney Water.

3.8.3. Stormwater

Stormwater runoff from the Lucas Heights campus does not contribute to any public drinking water supply. It drains to three main discharge points and a few smaller stormwater drainage outlets. The main discharge points include:

- MDP Creek, which flows into the Woronora River.
- Strassman Creek, which flows into the Woronora River.
- Bardens Creek, which flows into Georges River via Mill Creek.

Small capacity concrete retention bunds exist at each of these discharge points. Any accidental spills or releases of contaminated liquid which enter the site stormwater system can be contained and pumped back to the wastewater treatment system. The systems have been designed to current best practice and in accordance with NSW EPA to meet ANSTO land management constraints.

Silt and sediment control will be closely managed and monitored during the construction phase of the NMMF. Stormwater control during the facility operational phase will be incorporated into the NMMF detailed design.

3.8.4. Electricity

[redacted] The NMMF design incorporated additional backup and uninterruptable power supplies and will be described in the facility SAR.

During construction of the NMMF power will be supplied from adjacent buildings via a temporary site switchboard. Other electricity requirements for construction will be addressed using temporary power boards or mobile generators as appropriate. All temporary electrical wiring, power boards and equipment will conform with construction wiring codes and practices.

3.8.5. Compressed Air Supply,

General usage compressed air is supplied from on-site compressors through a reticulation system. Backup or additional compressed air services as in the case of the NMMF will involve specific facility plant and equipment to meet air quality requirements and will be assessed in the detailed design phase and described in the NMMF SAR [Ref: (12)].

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3.8.6. Communications/ Data Services

The communications system at the Lucas Heights campus consists of the following components:

a. Public Address (PA) System

The PA system provides site wide coverage and is used for major broadcasts to staff including emergency announcements. The system consists of two duplicated systems of amplifiers, cables, and loudspeakers. The network covers the whole of the Lucas Heights campus and is divided into zones which can be selected to control the required range of coverage. Loudspeakers for both systems are positioned as well as outdoor areas of the campus. Broadcasts may be made from the ANSTO Security Operations Centre (ASOC) or Emergency Operations Centre (EOC). The existing PA system will be extended to cover all areas of the NMMF.

b. Safety and Plant Alarm System

The Safety and Plant Alarm System, consists of a network of alarm sensors which detect events such as changes in the status of safety and plant systems, including those associated with Structures, Systems and Components (SSCs). [redacted] Safety alarms and access control requirements for the NMMF will be extended from to and integrated into safety and plant alarm system network.

c. Telecommunications

The telephone system consists of a network of in-ground cables providing external STD and IDD voice communications. The network is based on distributed PABX systems linked via optical fibre cables to form a single virtual PABX with enhanced reliability. The network covers the whole of the LHSTC including all occupied and unoccupied buildings and structures. The telecommunications network will be extended and incorporated into the NMMF. A description of the telecommunications network will be included in the NMMF SAR.

d. Computer Network

The ANSTO computer network and data communication system consists of an extensive network [redacted] General computer requirements for the NMMF will be met by extending the existing Ethernet network system through underground fibre-optic cables.

e. Security System

The main security system provides for the physical protection [redacted] in accordance with national and international obligations. [redacted]

3.9. Nearby Facilities

3.9.1. Facilities and Activities at the ANSTO Lucas Heights Campus

A wide range of activities take place on the LHSTC, typical of a small industrial facility or university campus. These include various research activities in nuclear, health, minerals, materials, environmental and industrial applications, including the production, manufacture, and distribution of nuclear medicines; neutron beam analysis; ion beam analysis; accelerator mass spectrometry; silicon and gamma irradiation; and radiative waste treatment and management activities.

Some of the activities conducted at the LHSTC have the potential to release minor quantities of hazardous materials. The safety of facilities and activities at the LHSTC, including those in adjacent buildings to the NMMF development site, are highly regulated by a dedicated Safety and Reliability Assurance (SRA), Nuclear Materials Officer and Area Health Physicist all with detailed responsibilities documented in ANSTO Safety Standard Guides.

Operations at the Lucas Heights campus involving conventional industrial activities are subject to the Commonwealth, Work Health and Safety Act [Ref: (26)] and Regulations [Ref: (27)] and, where no specific legislation exists, to the SafeWork NSW Work Health and Safety requirements. Any industrial accident occurring at the Lucas Heights campus, or within the NMMF site will be managed through the Principal Contractor in accordance with the WHS Act [Ref: (26)].

3.9.2. Nearby Industrial Facilities

The ANSTO Innovation Precinct is located on the northern side of the main Lucas Heights campus area. This site is leased to various private companies.

The [redacted] is located within the ANSTO buffer zone. The resource recovery park is a general waste disposal site taking in municipal and industrial solid waste from the southern Sydney area. The site accepts waste from households, small businesses, and councils and is visited by over 157,000 cars and trucks per year.

The Lucas Heights Resource Recovery Park also utilises municipal and industrial waste to capture methane gas from landfill to power two electricity generating plants operated by Energy Developments Limited. The nearest generating plant is rated at 12 MW and is located approximately 450m northwest of the NMMF site. The second smaller plant is less than 4 MWe and is located 3 kilometres north-east of the site. There is an underground 4-kilometre by 250 mm diameter gas pipeline between the two plants. Failure of the underground service pipeline and potential release methane gas has been the subject of an assessment which concluded that the EDL facility does not present a hazard to the Lucas Heights campus Ref (30). There are no major pipelines transporting gas within 10 km of the LHSTC.

A review of the list of licenced sites storing dangerous goods [Ref: (28), (29)] [redacted] LHSTC [Ref: (16)] reveals that there are no oil refineries, chemical plants, plastic manufacturing plants, or any industrial complexes that handle Dangerous Goods. A paint manufacturing plant is located within 8 km of the site. The type and quantity of the hazardous materials stored in that location are considered not to pose a threat to the proposed facility. The nearest facilities handling Dangerous Goods and nominated Major Hazard Facilities are at Kurnell, Port Botany, Mascot, Matraville, and Holsworthy. None are sufficiently close to LHSTC to be capable of affecting operations, even under a worst-case accident scenario. The effect of these nearby facilities is assessed in section 5.2.4.

3.9.3. Military Facilities

The Holsworthy Training Area is run by the Australian Army and includes an artillery range. It lies to the north, west, and south of Lucas Heights, the boundary following the Heathcote Road and the Woronora River. Artillery practices are controlled by the Commander, Liverpool Area, whose standing orders invoke standard instructions for practice artillery training.

The army takes great care to ensure that all practices using live ammunition at the Holsworthy Military Training Area are carried out safely. The frequency of artillery practice has been gradually scaled down and therefore, the likelihood of any military incident affecting ANSTO is low [Ref: (30)].

3.10. Transport Routes

Nearby transport accidents have the potential to affect the facility through overpressure following explosions, fires, generation of projectiles, and release of toxic material. The following describes the local and regional characteristics involving air, road, rail, and water transport.

3.10.1. Air Transportation

There are two airports in the vicinity of the LHSTC, Sydney (Kingsford Smith) Airport at Mascot, and Bankstown Airport. Sydney Airport is approximately [redacted] of the site and accommodates all aircraft types. [redacted]. Military aircraft occasionally operate in the vicinity of the site owing to its proximity to the Holsworthy Army Training Area.

The LHSTC is on the boundary of the Sydney air traffic control area where the lower [redacted]. All civil and military aircraft are prohibited from entering the restricted airspace above the Lucas Heights campus unless the pilot has obtained prior air traffic clearance from the Civil Aviation Safety Authority (CASA). [redacted]

3.10.2. Road Transportation

The main road near the Lucas Heights campus along which hazardous chemicals may be transported is Heathcote Road. The Heathcote Road and the New Illawarra Road are used by suppliers of certain hazardous materials for local demands, such as those of ANSTO and the Holsworthy military base, as well as a route to other destinations. The hazardous materials for local demands are primarily petrol and diesel. [redacted] The Ampol Oil Refinery, a major supplier of petrol and diesel, uses the Heathcote Road [redacted] from the company site at Silverwater to Wollongong.

[redacted] Although no large amounts of pressurised gas or toxic materials currently pass close to the LHSTC, it is prudent to consider that such transport might commence at some point in the future. The OPAL Siting Safety Assessment [Ref: (19)] cites an analysis of possible transport accidents at the nearest road (New Illawarra Road) (approximately 520m) and the nearest railway line (approx. 2,200m away).

Five bounding scenarios were developed and assessed for road and rail transport accidents close to the LHSTC [Ref: (10)] These scenarios are:

- Boiling Liquid Expanding Vapour Expansion (BLEVE) of a full road tanker of LPG.
- LPG flash fire and vapour cloud explosion.
- Fire with possible explosion of a full road tanker of petrol.
- Explosion of a [redacted].
- Rupture of a full road tanker of chlorine.

The analysis [Ref: (19)] concluded that the bounding scenarios for LPG BLEVE, petrol [redacted] would have negligible consequences to people located in the open at the Lucas Heights campus during any incidents and would have no significant impact on buildings, apart from the possibility of glass windows breaking from the explosion.

The rupture of an LPG road tanker and subsequent formation of a gas cloud could cause a flash fire killing people within the gas cloud up to 285 metres from the site of the rupture. There is a possibility of this gas cloud exploding in the bush surrounding the LHSTC. This would result in significant overpressure that could cause injury to people in the open and damage to unprotected structures. However, the greater distance together with the design and construction of the facility and the storage vessels would ensure that, in the unlikely event of a rupture of an LPG tanker, there would be no effect on the radioactive material in the NMMF.

The worst consequences from a major leak of chlorine could lead to fatalities of people at 240 m from the rupture, unless they could shelter inside a sealed building with air not contaminated by the chlorine. At 3000 m from the leak there is a low likelihood of fatalities to people who remain outside during the incident, however, this is considered to be a conservative estimate. At present, there is no chlorine transported along the roads near the Lucas Heights campus, and no such transport is planned by NSW authorities. Even if such transport occurred, the likelihood of a major road accident on the section of road near the Lucas Heights campus would be low.

3.10.3. Rail Transportation

The Illawarra railway line passing through Engadine and Heathcote is approximately [redacted]. The railway companies that use this line are Sydney Trains, Freight Rail, and National Rail. Sydney Trains are normally a passenger service and do not carry hazardous materials. National Rail cargo can include steel, coal, explosives, and sodium cyanide pellets on the Illawarra line through Engadine. Ammonia and chlorine may be transported via this line only if there is a problem with the usual route along the Sydney-to-Melbourne line. Use of the Illawarra line to transport chlorine and ammonia by National Rail is an infrequent event.

3.10.4. Water Transportation

The Woronora River, [redacted] to the east of the Lucas Heights campus and is not a navigable waterway.

4. Environmental Regulation and Monitoring

4.1.1. Environmental Approval and Regulation

ANSTO has submitted a referral to construct and operate a new Nuclear Medicine Manufacture Facility at Lucas Heights, NSW. The referral was for a proposed action under Section 68 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The delegate for the Minister for the Environment and Water has confirmed that the proposed action is not a controlled action, provided it is taken in the manner described in decision document (EPBC Act referral 2023/09748) [Ref: (32)].

Formal comments on the referral were received from:

- National Indigenous Australians Agency (NIAA)
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
- Department of Industry, Science and Resources (DISR).

Geoscience Australia concurred with ANSTO that construction of the NMMF is not likely to have a significant impact to the environment and should not be considered a controlled action.

4.1.2. Environmental Monitoring

Monitoring of environmental aspects at the LHSTC is conducted under a formally approved Environmental Monitoring Program (AG-1304) [Ref: (33)]. This program involves monitoring environmental pathways (airborne, waterborne, ingestion and external) radioactivity in local environmental samples. The ANSTO Environmental Monitoring Group provides a detailed description of the types of samples collected, analysis techniques used and are responsible for characterisation of radiological effluent releases to assess the environmental aspects of site operations. The Environmental Monitoring Sampling Schedule (G-3900) [Ref: (34)] and the Stack Monitoring Sampling, Calibration and Maintenance Schedule (G-6092) [Ref: (35)] describes in detail application of the site Environmental Monitoring Program [Ref: (33)].

The routine environmental surveys of the site and surrounding areas, monitor for specific radionuclides in sediment, air, surface water, and marine biota samples and aquatic systems. Environmental gamma radiation is continuously measured using dosimeters around the Lucas Heights campus and local area. Following detailed analysis and assessment two sources of radiological impact could potentially occur from operating facilities and could result in contamination of land and water or dose to people and wildlife. These aspects are due to airborne emissions or liquid effluent discharges. Specified facilities are licenced to release small quantities of radioactive airborne emissions via stack and/or liquid effluent discharge as trade waste. Both discharge results are compared to Discharge Notification Levels set out in the Facility Licence Conditions.

The Environmental Monitoring Group also routinely measures radioactivity concentrations in site stormwaters, as well as in surface waters from local creeks and the Woronora River. Radioactivity concentrations in stormwaters and surface waters are typically very low. In 2023, Environmental Monitoring results for stormwaters and surface waters were below the Australian Drinking Water Guidelines screening levels for gross alpha and gross beta, and below the World Health Organisation drinking water guidance level for tritium.

The Environmental Monitoring Program operates within a quality system compliant with ISO 9001:2000 series for Quality Management Systems. Compliance with ISO 9001 includes commitment to continual improvement, traceability of samples and standards and participation in inter-comparison proficiency exercises conducted by the IAEA ALMERA network and Australian Radioanalytical Laboratory Network in line with ISO 14001 Environmental Management System Obligations.

Information on the results of the environmental monitoring program for the Lucas Heights campus and its vicinity are reported in the ANSTO annual environmental monitoring reports and externally to ARPANSA in quarterly and annual discharge reports. These reports provide results of measured radioactivity and radiation levels for airborne emissions, low-level liquid effluent, and external radiation. All results are within the relevant discharge authorisations which also specify the standard or guideline (e.g., WHO Guidelines for Drinking Water Quality) against which compliance is assessed. ANSTO is committed to its ongoing program of monitoring all potential environmental aspects.

The NMMF will be integrated into the ANSTO Environmental Monitoring Program and be subject to routine and scheduled monitoring of airborne and effluent discharges. Continuous sampling and weekly analysis of airborne stack discharges will be required to demonstrate compliance with the ARPANSA discharge limits. During the construction phase controls will be in place to minimise dust, waste and storm waters.

5. Site Evaluation and Design Basis

This section of the report utilises the site characteristics presented in section 3 above to justify the suitability of the site for development of the ANSTO Nuclear Medicine Manufacturing Facility. The report considers the NMMF asset lifecycle including operational phase and ultimate decommissioning. It is also used during development of the NMMF Design Basis to identify potential effects of internal and/or external events that could impact on the safety and security of the site [Ref: (11))]. The aim being to have systems in place to prevent and or mitigate any foreseeable accident event. The Design Basis also utilises the potential accident scenarios and external events identified during development of the preliminary Safety and Security Consequence Analysis [Ref: (20)] and bounding case accident scenarios for the facility.

5.1. Site Evaluation for External Natural Events

5.1.1. Seismic Evaluation

The seismological condition of the site is discussed at section 3.7 the following addresses the argument for seismic risk control. The NMMF location is such that it can be safely designed with respect to earthquakes and surface faulting. The worst foreseeable seismic scenario with the potential for off-site consequences would be an earthquake leading to the release of significant radioactive material. The consequence is described as one of the bounding case accidents within the NMMF Safety and Security Consequence Analysis [Ref: (20)]. The radiological emergency planning and categorisation for a seismic event is documented within the NMMF Emergency Management Plan [Ref: (36)]]. The design for the NMMF building structures, systems, and components shall meet the seismic requirement for ground motion of the NMMF site with a frequency of exceedance less than or equal to 10^{-4} per annum and corresponds to a Peak Horizontal Ground Acceleration (PHGA) of 0.37 g.

The site investigation report [Ref: (23)] indicates that, in accordance with AS 1170.4 – 2007 Structural design actions – Part 4: Earthquake actions in Australia [Ref: (25)], the development site has a low seismic risk Hazard Factor (Z) of 0.08 (less than 0.15) and the site sub-soil class would be Class B_e.

5.1.2. Meteorological Evaluation

An analysis of meteorological data and events has been discussed at section 3.4. The following provides justification that extreme meteorological phenomena can be managed and/or controlled for the NMMF site [Ref: (5)]. ANSTO maintains a weather monitoring station at Lucas Heights and has recorded meteorological data since 1958 for the Sydney region.

5.1.2.1. Wind

An analysis of the potential hazards associated with high velocity winds is discussed at section 3.4.1. The NMMF Site Design Basis – Stage 1 identified the facility shall consider the fastest wind speed of 105 mph (170 kph) for the LHSTC and the design should account for pressure effects associated with the wind, gusting effects, pressure drops, and projectile effects in the case of the tornado-type winds.

The Detailed Design Basis for the facility must address the natural hazard of high velocity winds in the building structure design and referenced against the requirements of AS-1170.2 [Ref: (37)]. The NMMF SAR must identify conformance requirements with AS-1170.2 and justify compliance with ARPANSA Regulatory requirements for high velocity winds as well as evidence of verification post construction.

The design basis for the facility will include not only the pressure effects associated with wind but also the gusting effects, the pressure drops, and the missile effects in the case of the tornado-type winds. This will be considered in detail in the detailed design and will be assessed in the SAR if such incidents are found to be relevant and credible.

5.1.2.2. High and Low Temperature

While prolonged periods of high temperature can be expected during the summer at the LHSTC other than fire, temperature control within the facility can be managed through the HVAC system. High temperature effects (e.g. risk of fire) on the NMMF will be monitored and controlled through fixed fire detection and protection systems. The NMMF design limit for high temperatures is 50°C and for low temperature 1°C. The NMMF SAR [Ref: (12)] will incorporate a discussion on high and low temperature controls with a specific argument to address bushfire prevention and control.

5.1.2.3. Intense Rainfall and Hail

High rainfall and flooding are recognised as natural hazards with some areas of the LHSTC. The potential for local external flooding and the ability of the NMMF structure to cope with high rainfall and hail has been considered in the facility design, refer section 3.4.6. The layout of the NMMF and the capability of the structure to cope with heavy rainfall, local external flooding and stormwater drainage is very manageable and addressed in the detailed design with justification in the NMMF SAR [Ref: (12)].

5.1.2.4. Lightning

Frequent lightning strikes can be expected at the Lucas Heights campus. The potential effects on plant and equipment will be considered as part of the detailed design of the facility. The NMMF will not be overly tall and is set on a slope such that other buildings and stacks in the vicinity will be significantly higher. Lightning strike is a very low risk natural hazard to the NMMF and personnel.

5.1.3. Hydrological Evaluation

The hydrological conditions associated with the NMMF site is discussed at section 3.5 and evaluated below.

5.1.3.1. Surface Water (stormwater)

Significant quantities of radioactive materials will be present within the NMMF both as active and intermediate process solutions as well as active waste in storage for decay. These solutions will be contained in purpose designed pipelines, containment cells and storage vessels. The NMMF will be designed with multiple layers of protection to ensure active material cannot enter surface water (stormwater). All process and plant areas will have contained active drainage systems which under normal operations contain no significant activity, however; should a significant leak occur, it will be contained and collected in drainage systems for testing prior to disposal via the ANSTO active wastewater line.

Surface water and stormwater will be managed to ensure drainage way from the facility to minimise the potential for flooding. The facility design and arrangements are such that there no pathways for active materials to enter surface water flows outside the NMMF building.

5.1.3.2. Groundwater Hydrology

The groundwater hydrology is complicated by weathering and features of the Hawkesbury sandstone. Based on the geotechnical investigation conducted by Douglas Partners for the NMMF site [Ref: (23)]. With the robust design there is a low likelihood of significant leakage and entry to surrounding watercourses.

5.1.4. Geological Evaluation

The geology of the NMMF site has been evaluated through a geotechnical investigation conducted by Douglas Partners [Ref: (23)] and described in detail at section 3.6.2. The soil classification assessment and geotechnical investigation indicate the geology of the NMMF site is stable and suitable for the planned structure. The potential for soil shrink-swell consolidation will be taken into account in the detailed design of the facility.

5.1.5. Bushfire Evaluation

The LHSTC is surrounded by bushfire prone land control measures associated with bushfire weather conditions are described at section 3.4.7. Based on the existing site control measures and that the facility is within a 140 m buffer zone [Ref: (11)] it was considered no additional bushfire protection measures were required for the NMMF. This bushfire evaluation is to be included in the NMMF SAR [Ref: (12)]. The main design considerations for avoiding or minimising hazards from bushfire include compliance with relevant Australian building standards, the use of appropriate construction materials, appropriate design to avoid the collection of combustible material on or near buildings (e.g., leaves settling in guttering, roof, or eaves), and maintaining recommended fire hazard reduction distances from bushland.

5.2. Site Evaluation for Human Induced External Events

5.2.1. Aircraft Transport Evaluation

The potential for an air traffic and transport event impacting on the NMMF site is discussed in section 3.10.1. [redacted]

5.2.2. Road Transport Risk Evaluation

Road Transport risk to safety of the NMMF site is discussed in section 3.10.2. The primary road transport risk associated with the main road near the LHSTC is likely to be from hazardous chemicals transported along Heathcote and New Illawarra Roads. Hazardous materials for local demands are primarily petrol and diesel. [redacted]

Based on the bounding scenarios [Ref: (19)] for LPG BLEVE, petrol fire [redacted] would have negligible consequences to people located in the open at the LHSTC during any incidents and would have no significant impact on buildings, apart from the possibility of breaking glass windows from the explosion. The rupture of an LPG road tanker and subsequent formation of a gas cloud could cause a flash fire, potentially killing people within the gas cloud up to 285 metres from the site of the rupture. There is also a possibility of this gas cloud exploding in the bush surrounding the LHSTC. This could result in significant overpressure that could cause injury to people in the open and damage to unprotected structures. The worst consequences from a major leak of chlorine could lead to fatalities to people at 240 m from the rupture, unless they could shelter inside a sealed building with air not contaminated by the chlorine. The likelihood of a major road accident on the stretch of road near the LHSTC would be low. Therefore, despite the finding of the consequence analysis, road transport incidents are considered to present a low risk to the LHSTC.

5.2.3. Rail Transport Accident Evaluation

Rail Transport risk to safety of the NMMF site is discussed in section 3.10.3. The Illawarra railway line passing within [redacted] Hazardous materials including ammonia and chlorine may be transported on this line but only if there is a problem with the usual Sydney-to-Melbourne route. The Illawarra line is also used to transport ammonia and chlorine which may be transported via this line only if there is a problem with the usual route along the Sydney-to-Melbourne line and is therefore an infrequent event. The Illawarra line is also used to transport sodium cyanide in pellet form, when transported by rail this material is kept at least 250 m away from any acid on the train. In addition, when the railway transports the cyanide pellets, it does not transport any fuels or liquids on the same train. This practice will preclude the railway accident scenario in which burning fuel (spilled and then ignited during the accident) comes into contact with the cyanide pellets spilled from their containers. The transport of sodium cyanide carried by rail is considered too far away to affect the LHSTC in the event of an accident.

5.2.4. Evaluation of Nearby Industrial Activities

The potential impact of Industrial Activities near the NMMF development site is discussed in section 3.9.2. The assessment identified that under worst case scenarios (bounding accident) four adjacent nuclear installations may have an impact on the facility and must be addressed at a future licencing stage and incorporated within the NMMF SAR [Ref: (12)].

A review of sites licenced under the Dangerous Goods Act or nominated as Major Hazard Facilities within an 8 km radius of Lucas Heights, revealed that no oil refineries, chemical plants, plastic manufacturing plants, or any industrial complex that handles large quantities of hazardous materials are sufficiently close to the LHSTC to be capable of affecting operations, even in the worst-case accident at such a facility.

The assessment of industrial activity adjacent to the LHSTC has concluded that it is very unlikely that external industrial activities nor operations at the LHSTC would have an impact on the NMMF.

A1

[redacted]

5.3. Effect of On-site Activities

5.3.1. Activities in Other Site Buildings

On-site activities have the potential to affect the facility through: overpressure following explosions, fires, generation of projectiles, and releases of toxic material, cryogenic or radioactive material initiated by either plant or human means.

A complete inventory of radioactive materials at the Lucas Heights campus is provided to ARPANSA as a licensing requirement. The potential for an accident leading to an uncontrolled release of radioactive material from any building on the LHSTC is small and a building fire involving an entire facility is principally used as the bounding case accident with respect to releases to the environment and the potential radiological impacts. A computer package, PC-Cosyma (Version 2), is used to estimate doses due to accidental airborne releases. The assessment considers the maximum and current inventory of radioactive material within the facility. Two calculations are performed based on average day conditions, normal associated with the most significant on-site consequences and the other reflecting night conditions for the worst consequences for off-site receptors. The weather conditions applicable are D stability category with a wind speed of 3 m/s for daytime conditions and E and F stability categories with a wind speed of 1 m/s to reflect the most conservative night-time conditions.

There are no large high energy rotating machines or large high-pressure machines on the Lucas Heights campus. The effect of generation of projectiles by other means is bounded by an aircraft crash.

5.3.2. Further Work

The ANSTO Site Works Descriptive Report [Ref: (38)] and Basis of Design Report [Ref: (39)] lists the following works required for preparation and establishment of the NMMF site:

5.3.2.1. Site Preparation Works – Enabling projects includes:

- Demolition of buildings [redacted]. (The status of works is detailed in Table 4.)
- Rerouting of existing [redacted].
- Relocation of existing utilities within the proposed site of NMMF, including liquid, and solid waste systems[redacted]
- [redacted]
- Removal/ relocation of existing roadways, access routes, and carparks as detailed in Table 5.

5.3.2.2. Site Establishment Works

- Site survey, crib rooms, connection of temporary services
- Temporary crane pad or foundation required for construction crane erection
- Earthworks (Excavation and backfill of earthworks material)
- Ground improvement activities such as piling
- Installation of inground services.

[redacted]	**Status as at June 2024**
	Demolition complete
	Demolition complete
	Capital Investment Case to be raised. Works must be completed prior to site establishment for the NMMF Construction – December 2025.
	Capital Investment Case to be raised. Works must be completed prior to site establishment for the NMMF Construction – December 2025.
	Capital Investment Case to be raised. ARPANSA Application for [redacted] demolition included in the applications for the decommissioning of HIFAR. Works must be completed prior to site establishment for the NMMF Construction – December 2025.
	Demolition complete.
	Capital Investment Case to be raised. Works must be completed prior to site establishment for the NMMF Construction – December 2025.

Table 4: Demolition status of buildings

[redacted]	**Schedule Requirement**
	Prior to NMMF Site Establishment
	Prior to NMMF Site Establishment
	Prior to NMMF Site Establishment
	Prior to NMMF Site Establishment

Table 5: Removal/relocation of existing roadways, access routes and carparks

6. Conclusions

Based on the site characteristics, geotechnical and demographic information as well as specific site-related design considerations, it is concluded that the development of the Nuclear Medicine Manufacturing Facility (NMMF), within the LHSTC, does not have any negative features which cannot be eliminated or controlled with a reasonably high standard of engineering design, construction and operation expected by the ANSTO Board and Executive.

The benefit to the Australian community in securing a safe, reliable sovereign supply of nuclear medicines through development of the NMMF cannot be underestimated.

Foreseeable design basis external events (DBEEs) and design extension conditions (DECs) with the potential to have a significant impact on the NMMF development site were identified through the NMMF Safety and Security Consequence Analysis Report [Ref: (20)] and bounding case accident scenarios for the facility.

These DBEEs and DECs included major building fire, security and seismic events which have been addressed when considering the effects of potentially significant natural or human induced external events. The effect of these events will be further analysed during detailed design of the facility.

In summary, the new ANSTO Nuclear Medicine Manufacturing Facility is considered safe and suitable and has been selected because of the following features:

- The existing nuclear site has extensive security infrastructure with access control by the Australian Federal Police.
- Existing mature and reliable infrastructure including power, water supply, waste services, and communications.
- Stable geological location with minimal history of seismic activity.
- Well contained natural surface and ground water systems, overlaying a purpose-built wastewater system.
- Existing staff with the expertise in the areas of radiation protection, maintenance and engineering, asset management, waste management, and emergency response capabilities.
- An established environmental monitoring program.

7. Definitions

The following abbreviations/ definitions have been used in this document.

Term	Definition
AHD	Australian Height Datum
ANM	ANSTO Nuclear Medicine
ANSTO	Australian Nuclear Science and Technology Organisation
APZ	Asset Protection Zone
ARPANS	Australian Radiation Protection and Nuclear Safety
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASOC	ANSTO Security Operations Centre
BH	Bore Hole
BLEVE	Boiling Liquid Expanding Vapour Expansion
CASA	Civil Aviation Safety Authority
CEO	Chief Executive Officer
DBEE	Design Basis External Event
EDL	Energy Developments Limited
EOC	Emergency Operations Centre
IAEA	International Atomic Energy Agency
IPTS	Inter Pneumatic Transfer System
kV	kilovolt
LGA	Local Government Area
LHSTC	Lucas Heights Science and Technology Centre
LPG	Liquefied Petroleum Gas
NMMF	Nuclear Medicine Manufacturing Facility
NMMP	Nuclear Medicine Manufacturing Program
OPAL	Open Pool Light-water Reactor
PA	Public Address
PABX	Private Automatic Branch Exchange
PHGA	Peak Horizontal Ground Acceleration
PSA	Probabilistic Safety Assessment
RL	Reduced Level
SAR	Safety Analysis Report
SRA	Safety and Reliability Assurance
TP	Test Pit
USEPA	U.S. Environmental Protection Authority
WMS	ANSTO Waste Management Services

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Appendix A: Natural and Human Induced Hazards

Natural Hazard	Comments
Avalanche	The site location precludes this event.
Bushfires	Must be considered in the design; compliance with relevant Australian building standards, use of appropriate construction materials, design to avoid collection of combustible material on or near buildings and maintain buffer zone from bushland. Smoke from a bushfire can result in spurious actuation of fire alarms, Heavy smoke can also impact HVAC intake filters.
Coastal erosion	The site location precludes this event.
Hail	Considered in the design, compliance with relevant Australian building standards.
High ambient temperatures	Need to be considered in detailed design.
High rainfall and flooding	Some areas on site could be prone to localised flooding. Also flooding due to internal events should be considered. The NMMF site location precludes regional flooding.
High velocity wind	Might need to be considered in the design.
Landslide	The site location precludes this event. Landslides away from the site, into gullies, causing subsidence on-site have occurred and might need to be considered in the design.
Lightning	Might need to be considered in the design.
Low ambient temperatures	Temperatures rarely drop below 0°C. Damage to pipes, structures etc. by freezing is not credible.
Low rainfall and drought	Might need to be considered in the design.
Meteorite strike	Meteorite strikes are not considered credible.
River diversion	The site location precludes this event.
Sandstorm	The site location precludes this event. However, severe dust storms have occurred across the site and can cause clogging of HVAC intake filters and spurious actuation of fire detection systems and might need be considered in design.
Seismic activity	Might need to be considered in the design.
Sinkhole	The site location precludes this event*. *This is precluded for NMMF given detailed geological investigation performed for the OPAL site and adjacent location.
Snowstorm	The site location precludes this event.
Soil / rock freeze / thaw cycle	The site location precludes this event.
Soil shrink – swell	Might need to be considered in the design.
Storm surge	The site location precludes this event.
Tsunami	The site location precludes this event.
Volcanic activity	The site location precludes this event.

Natural Hazard	Comments
Waves	The site location precludes this event.
Population/Demography	Growth of off-site population to be considered within the NMMF SAR [Ref: (12)] and reassessed upon revision of the SAR or as additional data is available.
Industrial Activity – Adjacent site	The assessment of industrial activity at LHSTC is very unlikely to impact on the structure and operations at the NMMF.
Industrial Activity - Region	Assessment of industrial activity adjacent to the LHSTC concluded that it is very unlikely that external industrial activities would have an impact on the LHSTC and NMMF.
[redacted]	[redacted]
Services/Utilities - Water	Concluded the capacity of the existing LHSTC water supply system is sufficient to meet construction and operational requirements.
Services/Utilities - Electricity	NMMF design will incorporate backup and uninterruptable power supplies and included facility SAR and updated with detailed design.
Services/Utilities - Gas (Natural/LPG)	LPG/Natural Gas will not be a reticulated service to the NMMF and is precluded from facility design.
Services/Utilities - Compressed Air/Gases, Nitrogen	Compressed air services for NMMF will be specific facility plant and equipment to meet air quality requirements which will be assessed in the detailed design phase and described in the NMMF SAR [Ref: (12)].
Services/Utilities - Sewage/Liquid Waste	Referenced and controls addressed in NMMF Waste Management Plan [Ref: (40)].
Services/Utilities - Solid Waste	Referenced and controls addressed in NMMF Waste Management Plan [Ref: (40)].
[redacted]	[redacted]
Transport - Road	Bounding scenarios would have negligible consequences to people located in the open at the LHSTC and would not have a significant impact, apart from possibility of breaking glass windows.
Transport - Rail	Rail line and rail transport of hazardous materials is too far away to affect the LHSTC and NMMF site.
Transport - Water	The Woronora River, approximately 2 km to the east of the LHSTC is not a navigable waterway.
Telecommunication	A description of the telecommunications network will be included in the NMMF SAR [Ref: (12)].
[redacted]	[redacted]
[redacted]	[redacted]

Combined related external hazards that occur simultaneously may be due to:

1. External events that may be reasonably assumed to occur in conjunction with one another; or

2. External events that may occur as a consequence of another; or

3. External events that may occur coincidentally but independent of each other.

Note: that natural events may also cause other external events, e.g., impacts from failures at other facilities onsite and should be considered in the design (e.g., a bushfire that also results in impairment of site services).

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