TECHNICAL MEMORANDUM REGARDING PROPOSED CLOSURE OF THE HAZELWOOD MINE AND POWER STATION, INCLUDING FLOODING THE HAZELWOOD MINE VOID TO FORM A "PIT LAKE", MORWELL, GIPPSLAND, VICTORIA, AUSTRALIA

PREPARED BY:

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JULY 8, 2022

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1. SCOPE AND PURPOSE, INTRODUCTION, AND LIMITATIONS OF THIS TM

I was retained to provide independent analysis and opinions regarding aspects of a proposed plan to close the Hazelwood Mine (aka, Morwell open cut) and the associated Hazelwood Power Station (HPS) by flooding the mine to produce a large "pit lake". This Technical Memorandum (TM) is intended to assist Environmental Justice Australia with public, legislative, and regulatory outreach regarding the Project. The TM is not represented as a definitive evaluation of any aspect of any subject addressed herein, and I reserve the right to amend any aspect of this TM as additional information becomes available.

It will require an indeterminate number of decades to fill the Hazelwood mine void to the projected pit lake capacity. In coming months, the Hazelwood owner/operator, ENGIE Australia Pty Ltd (ENGIE), will prepare an Environment Effects Statement (EES) for the Hazelwood Rehabilitation Project (aka, the Project), which will include the mine, HPS, and associated industrial wastes and landfills. The Project footprint includes five recently-active (2017) Power Station waste landfills and at least six more "closed" landfills (e.g., AECOM, 2017) that include massive quantities of coal combustion residuals (CCRs; aka, coal ash). Other mining wastes at the Project include industrial wastes such as asbestos and very large dumps of unconsolidated overburden and waste coal. This TM is focused on aspects of the planned inundation of the open-pit mine, including full submergence of approximately 1.35 million cubic meters (m^3) of CCRs disposed inside the mine pit at the Hazelwood Ash Retention Area (HARA).

In mid-2017, ENGIE submitted to the Environment Protection Authority of Victoria (EPAV) an Environmental Audit (EA) of the HPS, associated CCR landfills, and other industrial non-CCR wastes (e.g., asbestos). I evaluated the EA (AECOM, 2017) and produced a TM in early 2020 (Campbell, 2020a). At that time, I had no access to post-EA reports or EPAV directives describing environmental assessments, contaminant monitoring, closure plans, etc. pertinent to the Project. I have recently obtained access to some post-2017 assessments and other documents evaluating or describing aspects of the Project. I am also aware of the existence of ENGIE documents that I do not yet possess that were submitted to the EPAV per a clean up notice (2020) and an environmental action notice (2021) issued to ENGIE. Therefore, this TM cannot and does not capture the full scale and scope of the Project.

2. SUMMARY OF THE PROJECT AND CRITIQUES AND CONCERNS

2.1 General Description of the Hazelwood Project

The Project involves the closure of one of three large open-cut coal mines in West Gippsland; Hazelwood, Loy Yang, and Yallourn (Figure 1). Each mine is, or was until 2017 for Hazelwood, the brown-coal fuel source for a mouth-of-mine electric generating station. All three mines and power stations store copious CCRs, and most CCR landfills have not been assessed, monitored, remediated, or closed (capped) in compliance with applicable EPAV rules and regulations (e.g., Hazelwood, per Campbell 2020b). In 2019, the Victorian government developed a regional master plan for the closure of the three mines, the Latrobe Valley Regional Rehabilitation Strategy (LVRRS; Mackay et al., 2019). The LVRRS produced technical studies that put the Hazelwood Project in a regional context.

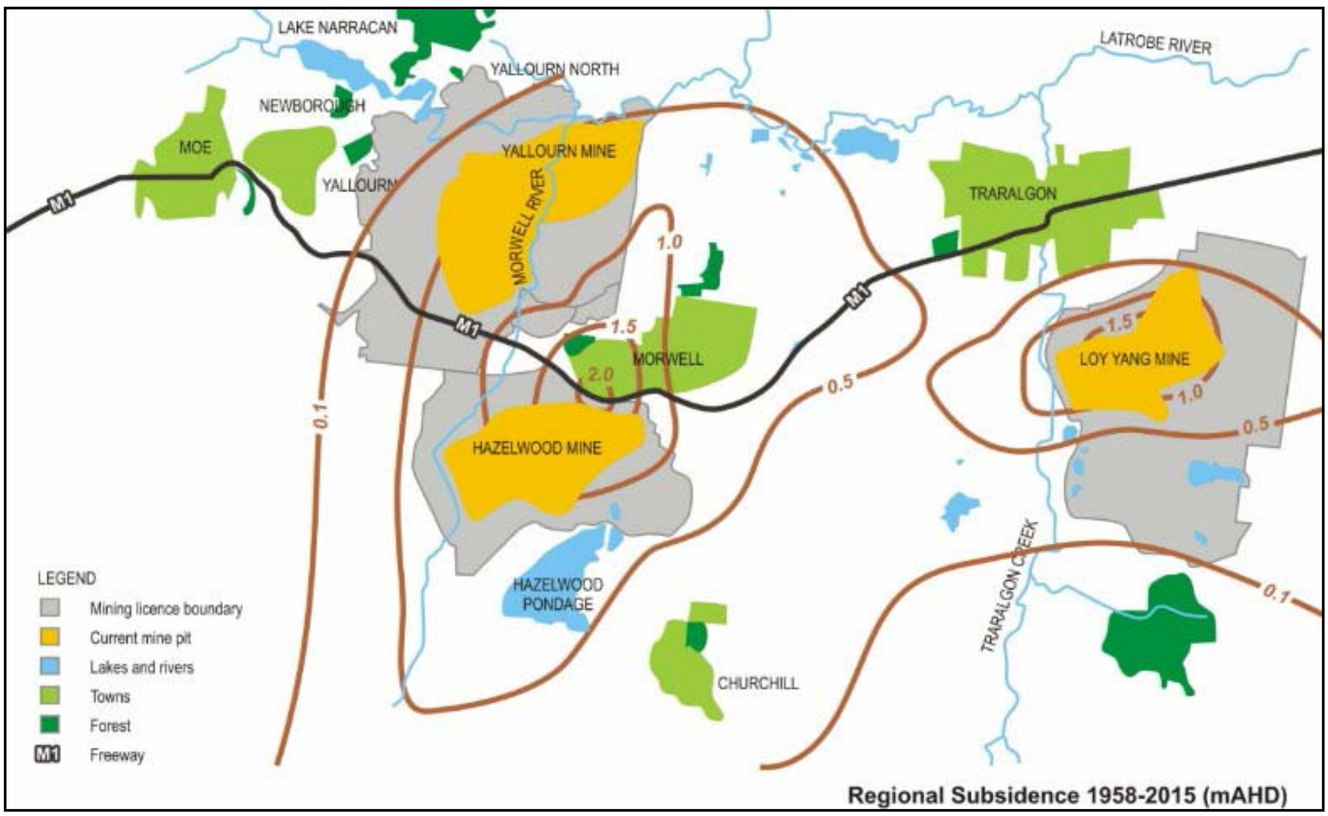

Figure 1: Locations of the three coal mines and contoured regional land subsidence in meters for the period 1958 to 2015 (image from Waghorne and Disfani, 2019).

Each mine has a different owner/operator, yet each has proposed to close the mine by flooding to produce pit lakes. Factors and events influencing closure by mine flooding include fire concerns resulting from the 2014 coal fire at Hazelwood (and other coal fires) and mine wall (batter) failures at Hazelwood (2011), Yallourn (2007, 2012), and Loy Yang (2007). The Victorian government and some major stakeholders appear to support the concept of mine flooding to produce "stable" areas that are "*rehabilitated for open space use such as agricultural or recreational purposes*" (Mackay et al., 2019, page 805). Although substantial public resources (e.g., LVRRS, 2020) have been employed by the Victorian government to develop the LVRRS plan, mine operators are not obligated to consider or employ any aspect of the LVRRS plan or supporting technical studies when developing their mine closure plans. For example, ENGIE proposes to use fresh water sources to create the Hazelwood pit lake, yet apparently has not investigated alternative sources despite LVRRS studies that conclude that using fresh water for mine closure is environmentally problematic (i.e., LVRRS, 2020).

2.2 CRITIQUES, CONCERNS, AND RECOMMENDATIONS FOR THE HAZELWOOD PROJECT

Key concerns for completing the Hazelwood Project include: (1) water sources and their sustainability; (2) stability of mine walls (batters) and the HARA during and after filling of the pit lake(s) (e.g., Mackay et al., 2019); (3) the fate of CCRs and other wastes located both inside and outside of the Hazelwood mine pit; and (4) the potential presence, distribution, and risk posed by the family of chemical compounds collectively known as PFAS (per- and poly-fluoroalkyl substances).

2.2.1 Water Resources and Sustainability

Significant time and money have been spent by the Victorian government to identify where and how these massive volumes of water can be secured and managed to mitigate a wide variety of impacts (e.g., LVRRS, 2020). The water supply challenge is paramount considering the Latrobe Valley's already allocated and stressed surface water and groundwater resources, climate change and robust projections of imminent or active regional aridification, and the difficulty in sustaining indefinitely a projected 5,676 hectares (~57 square kilometers, km^2; Mackay et al., 2019, table 1) of the three lake surfaces under persistent, and likely climate-driven increases, in evaporative losses (e.g., LVRRS, 2020). It is presumed that mine operators will apply to use existing water allocations for the mines and power plants for filling the pit lakes (e.g., LVRRS, 2020).

ENGIE's 2021 EESRF states, "*The proposed final landform for the former Hazelwood Mine void is a lake to a relative level (RL) of +45 metres Australian Height Datum (+45m AHD)*" (page 2), which equates to a maximum lake depth of 175 meters (Figure 2). The EESRF states that the Hazelwood pit lake will require approximately 637 GL (637 million cubic meters, m^3) of water to reach the targeted fill elevation (page 6), but that volume ignores substantial ongoing water losses (e.g., evaporation or subsurface loss) that must be balanced in perpetuity. Estimates of fill time vary widely as a function of assumptions and scenarios, but I opine that the stated period of one or two decades to fill the Hazelwood mine pit (e.g., EESRF, 2021, page 6) is more likely than not overly optimistic considering the many unknowns, including the likelihood of robust climate change which is likely to increase stress on water resources. ENGIE proposes to fill the Hazelwood mine pit using fresh water sources, but water availability depends on environmental impacts to be assessed via the EES and the Victorian government granting the necessary approvals to use fresh water for mine rehabilitation. I do not opine on the feasibility or appropriateness of using the limited water resources in this manner.

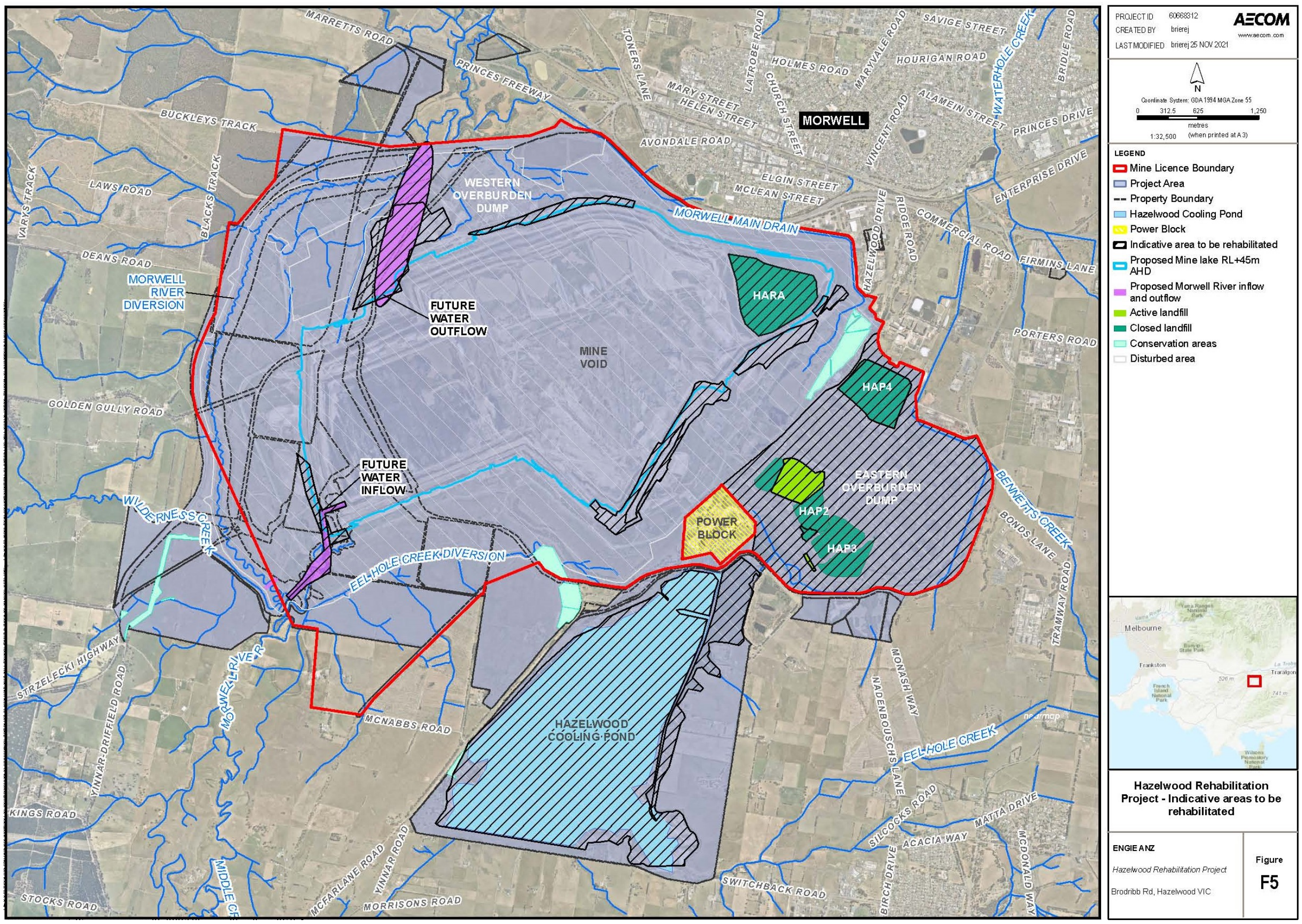

Figure 2: Hazelwood Project footprint (purple overlay) and surface extents of the proposed mine pit lake (blue line) flooded to +45 meters AHD (image from ENGIE's 2021 EESRF). Note the locations of the HARA and other CCR landfills (e.g., HAP4) at the EOD east of the mine void.

2.2.2 Mine Wall (Batter) and HARA Stability During Mine and Land Surface Rebound

Decades of groundwater withdrawals from artesian aquifers for mine dewatering and other purposes has produced measurable land subsidence (surface elevation decreases) on the order of 0.1 to 2 meters across the Morwell area (Figure 1). Mechanical stability assessments of Hazelwood's mine walls (batters) and mine floor during lake filling and projected land rebound (surface elevation increases) are focused on the impacts of swelling and heaving of *in situ* sedimentary materials comprising the mine, including batters composed of lignite (brown coal) and fine-grained sediments (primarily clay) (Waghorne and Disfani, 2019; Simmons, 2020). Buttressing of mine batters by added sediments and the mass of the pit lake's water is projected to add stability to these inherently unstable features (Narendranathan et al., 2021). Approximately 25% to 40% of the historic subsidence (Figure 1) is projected to rebound (rise) over the next century (Waghorne and Disfani, 2019), with roughly 0.5 meter of rise projected at and near the Hazelwood mine (Figure 3).

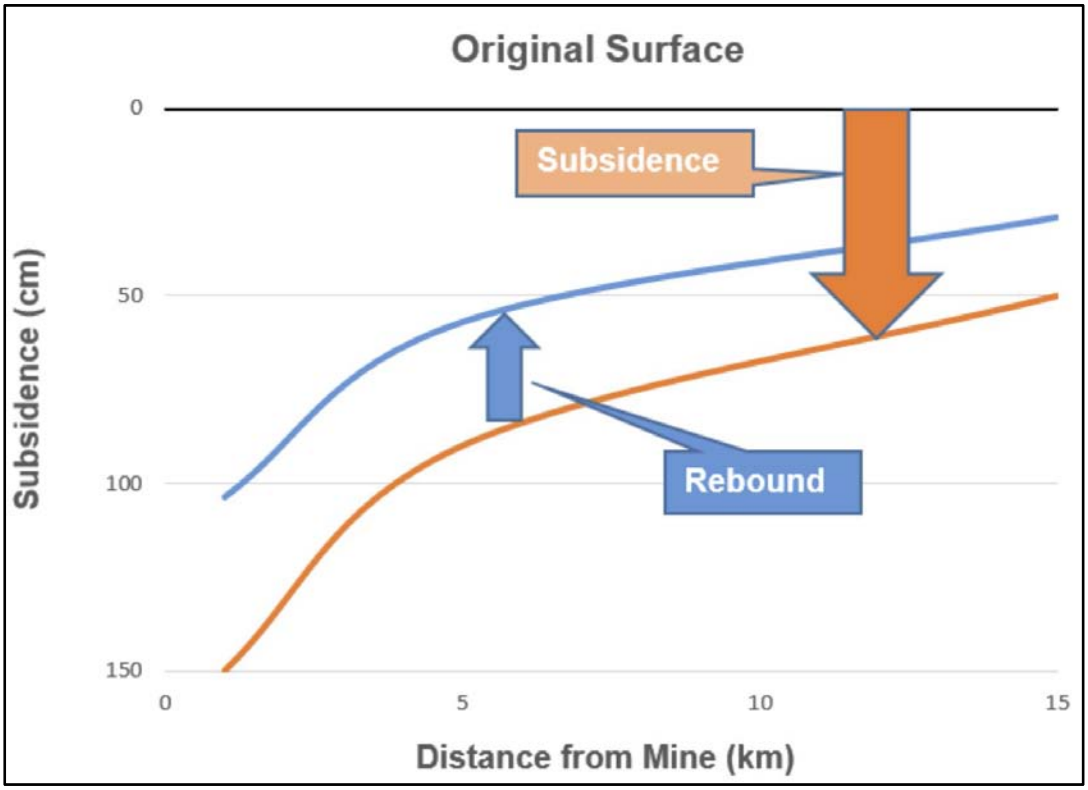

Figure 3: Historic land surface subsidence (red) and projected rebound (blue) with distance from the Hazelwood mine (image from Waghorne and Disfani, 2019).

I have encountered <u>no</u> quantitative or qualitative assessment of the mechanical stability of disposed CCRs in the HARA (Figure 2), both during and after mine pit filling as the mine floor heaves and/or settles, and as the mine walls adjust (unevenly) to land rebound. The HARA is located atop 50 meters of unconsolidated overburden filling part of the mine pit, and a one-meter clay layer separates most of the CCRs from the underlying rubble (Figure 4). The northern margin of the HARA is the mine's "Northern Batters" that partially failed in 2011, and those batters are a known concern for future stability of the mine and the adjacent Princes Freeway (Narendranathan et al., 2021). Construction of the 1-kilometer-long retaining dam (HARA Embankment; aka, HARE) forming the western boundary of the HARA <u>and</u> "multiple areas" of the HARA clay layer were <u>not</u> in compliance with the construction plans (AECOM, 2017, page 12). Specifically, the clay "liner" is <u>not</u> considered "*adequately constructed or wasn't constructed in accordance with the Construction Quality Assurance Plan*" (AECOM, 2017, page 12). ENGIE has <u>not</u> evaluated or expressed concern for the mechanical stability of the HARE or the HARA's apparently defective "liner", including uneven settling of the unconsolidated rubble of mine wastes underlying those structures (Figure 4). I have noted previously that the HARA's "liner" does <u>not</u> comply with EPAV standards (Campbell, 202b). Likewise, ENGIE has provided <u>no</u> descriptions of proposed construction, appropriateness, and stability of any presumptive EPAV-compliant cap for the HARA, including during and after pit filling.

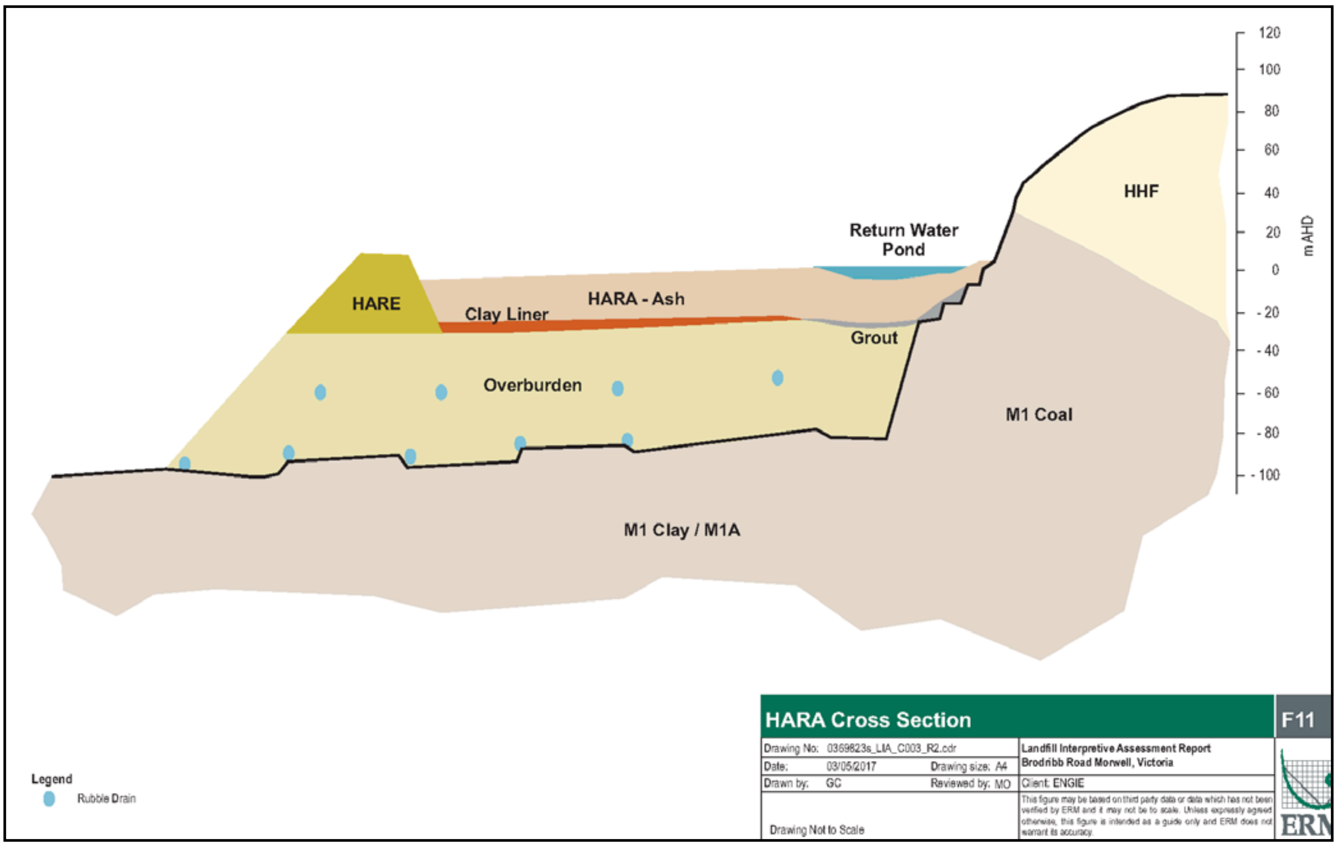

Figure 4: Cross section of the HARA (from figure F11 in Appendix F of AECOM, 2017)

ENGIE's projected pit lake surface elevation is +45 meters Australian Height Datum (AHD; i.e., mean sea level), and CCRs in the HARA will be fully submerged at +19 meters AHD, long before the pit lake is full. My concerns for stability of the HARA include impacts from settling, heaving, swelling, and/or rupture of the existing clay layer and any presumptive cap components as the zone of water saturation migrates upward into the HARA. I have similar concerns for the HARE due to potential settling and heaving of the underlying mine wastes, as well as the fact that the northern end of the HARE abuts the "Northern Batters" (Narendranathan et al., 2021). Swelling of currently dry CCRs containing slurry muds and slimes within the HARA may produce additional instability within the stack of disposed CCRs and any overlying cap. ENGIE has not acknowledged potential physical impacts on the HARA of wave erosion during pit filling, and the only references to erosion at Hazelwood during filling concern shorelines of the mine void at the reshaped mine batters (e.g., EESRF, 2021, page 8).

2.2.3 Fate of CCRs and Other Wastes Located Inside and Outside of the Mine Void

ENGIE's 2021 EES Referral Form (EESRF) does not identify the fate of CCRs and other wastes located within the Hazelwood mine pit (Figure 2). Impacts of concern to me include the mechanical stability of the HARA's CCRs (and any installed cap) during the erosive period of lake filling, maintaining indefinite stability once the coal ash is fully submerged (plus or minus periodic climate- or water management-driven reexposures), geochemical leaching of those CCRs to liberate toxic metals into the groundwater and lake water, and unrestricted migration of those dissolved toxins to other areas (e.g., via groundwater flow, the Morwell River, etc.). Approximately 80% to 90% of the CCRs produced at Hazelwood was fly ash (Fridell et al., 2019), a percentage that implies that fly ash comprises well over 1 million m^3 of the 1.35 million m^3 of HARA CCRs to be submerged. Much fly ash occurs as tiny, thin-walled, glass-encased bubbles called cenospheres (e.g., Joseph et al., 2013). This morphological type of coal ash has a density much less than water, so cenospheres have a strong tendency to float (e.g., Cenospheres | ADAA | Ash Development Association of Australia). I opine that breaching of the HARA from physical movements (e.g., settling and heaving of the underlying mine rubble) during or after mine pit filling and/or wave erosion during pit filling will more likely than not liberate cenospheres, and therefore a floating layer of coal ash may be prominent and persistent at the Hazelwood pit lake and its outfall(s) to other water bodies. Aqueous leaching of CCRs to liberate dissolved toxins to groundwater and surface water is addressed below.

The EESRF makes no definitive statement about remediating the HARA prior to inundation, and in fact ENGIE is noncommittal about even installing the typical EPAV-approved cap on the HARA. Because the HARA's clay "liner" is not preventing groundwater contamination from those CCRs (AECOM, 2017), I opine that situation will only become worse if the HARA is flooded with water. I opine that typical EPAV requirements to cap the HARA would not be appropriate considering the HARA's reportedly defective and regulatorly-inadequate clay "liner" (and the reportedly defective HARE) and that groundwater contamination is currently migrating through and away from the HARA (e.g., AECOM, 2017). Obviously, capped or uncapped, the HARA would provide no barrier to CCR inundation and inevitable chemical leaching when the Hazelwood mine pit becomes flooded with water. Removal of CCRs from the mine pit prior to flooding is not considered or advocated within the EESRF or other ENGIE documents that I have evaluated. I advocate for CCR removal below.

ENGIE's 2021 EESRF comments only generically on the environmental risk posed by submerging the HARA, stating that "*Assessment of the HARA in the context of the Mine void filling shows minor water quality effects for some metals/metalloids in the short-term, however, modeling results indicate that…*(concentrations)…*would be below the ADWG and the Australian guidelines for livestock drinking water.*" "*The current statutory audit being conducted will further investigate the HARA and its potential impacts to both groundwater and final Mine lake water quality*." (page 51) Notably, ENGIE's EESRF does not address water quality in the context of their claim that the pit lake will provide "recreational uses". A significant unknown for pit lake water quality is the fate of the HARA, including but not limited to impacts if those CCRs are left in the pit and flooded. I am not aware of any environmental audits or geochemical modeling results that address impacts from the submergence of at least 1.35 million m^3 of CCRs disposed inside the mine pit at the HARA. EPAV issued a Clean Up Notice (2020) and an Environmental Action Notice (2021) that identify some of these same concerns, and EPAV specifically directs assessment and remediation actions at Hazelwood, including the HARA.

Outside and east of the mine is the massive Eastern Overburden Dump (EOD; Figure 2) that hosts numerous CCR and industrial waste landfills (Figure 2). Mining wastes comprising the EOD also reportedly contains unknown volumes of admixed CCRs (AECOM, 2017). I opine that this occurrence of admixed CCRs at the EOD indicates that it is more likely than not that CCRs are also present inside the mine pit but outside the footprint of the HARA, and are most likely mixed to an unknown extent within two large "overburden" dumps (i.e., the Former East Field Internal Overburden Dump and the South East Field Internal Dump, EESRF, page 18). The EPAV considers these dumps as one "Internal Overburden Dump" (EPAV CUN, page 7, item 1.36), a general dump description used by others (e.g., AECOM, 2017; Weaver at al., 2019). Mined overburden materials and waste coal dumped inside the mine void would be fully submerged long before the pit lake is full. Physical destabilization (and geochemical leaching) of those dump materials during settling, wave erosion, mine floor heaving, and eventual land rebound are not addressed in the ENGIE reports and studies that I have obtained and reviewed to date. I opine that the omission of such assessments presents a significant gap in data and analysis that present potential for adverse impacts from ENGIE's mine pit filling plan.

My 2020 assessment (Campbell, 2020a) of the 2017 Hazelwood EA (AECOM, 2017) identifies numerous areas of environmental concern, noncompliance with applicable regulatory requirements (i.e., EPAV 2006, 2015, 2016; Victoria SEPP, 2018), and other issues requiring substantial and immediate attention (e.g., CCR-derived groundwater contamination emanating from EOD landfills). Those observations and concerns are not repeated here except to reiterate that (1) assessment of contaminant sources at the Hazelwood complex is inadequate and incomplete, (2) sparse and sporadic groundwater and surface water sampling and testing (monitoring) is not comprehensive, protective, or proactive, and (3) contaminant sources and associated groundwater contamination have not been remediated. EPAV's 2020 regulatory review of many of these same topics resulted in a Clean Up Notice (CUN) issued to ENGIE on October 2, 2020. The CUN identifies several investigative reports (e.g., pages 3 and 4) that I have not yet been able to obtain or assess. Of the 11 Hazelwood landfills that EPAV identified in 2020, only two cap designs were approved, with "*cap designs for HAP4, HARA and HAP1 in progress*" (CUN page 4). ENGIE's 2021 EESRF states that four of five landfill caps will be installed by 2024-2025, but notably their action list does <u>not</u> indicate that the HARA will be capped (page 8). EPAV's CUN (page 4, item 1.4) notes that the defective construction and structural integrity of the HARE retaining dam and the HARA's clay liner were identified to be at risk of failure from "differential settling" as early as 2005. Even if the HARE and HARA were structurally sound, water would still migrate into the CCRs coincident with the rising pit lake's level. Significant known and potential groundwater contamination derived from CCR leaching was identified by EPAV (CUN pages 4 and 9), both at the HARA and at the EOD landfills. However, EPAV states that ENGIE's assessment "*has not considered the contribution that*…(mine void contaminants)…*may have to the resultant pit lake water quality*" (page 6, item 1.29), nor does ENGIE "*consider directly the eventual water quality in the proposed pit lake, or the likely interaction of the pit lake water with surface and groundwater in the area"* (page 4, item 1.32). EPAV's CUN states clearly and repeatedly that groundwater quality in the mine void <u>is</u> contaminated, those dumped wastes "*will increase the risk of altering the environment and…further impact…groundwater users"* (page 9), and that other "*yet to be assessed"* and "*site wide"* contaminant sources exist at Hazelwood (page 9). The CUN directed that ENGIE "*supply to EPA an environmental audit report"* by September 15, 2021 (page 11).

On December 10, 2021, EPAV issued an Environmental Action Notice (EAN) that extended ENGIE's deadline to produce the CUN-required environmental audit to January 11, 2023 (page 3). The EAN identifies reports that I have not obtained or been provided, including the "*Detailed Site Investigation*

Report – Hazelwood Mine Void' dated 7 May 2020, produced by Environmental Resources Management Australia Pty Ltd (ERM)" (page 5). The EAN identifies ENGIE's assertion that "*the quality of groundwater and surface water in the mine void…do not pose a risk to current on-site environmental or human receptors"* (page 6), yet EPAV concluded that the report "*has not considered the contribution that these* (mine void contaminants) *may have to the resultant pit lake water quality…which will be determined by* (future) *technical studies"* (page 6). Significantly, the EAN states that the cited ENGIE report does not identify the "*potential impact that the HARA might have on the water quality in the proposed mine void pit lake"* (page 7). Similar statements in the EAN apply to CCRs and other contaminant sources located outside the proposed pit lake (e.g., at HAP4).

My 2020 assessment of Victorian rules and regulations, including those promulgated by EPAV, identified that physical closure of CCR landfills require, at a minimum, an approved design and installation of an "impermeable" cap (Campbell, 2020b). I have not found reference to other CCR landfill closure methods employed in Victoria, and it appears that installation of an EPAV-approved cap over the CCRs is de facto the only closure action used to mitigate formation of toxic leachate that contaminates water resources and poses risk to human health and the environment. However, on July 1, 2021, the Environmental Protection Act 2017 (EPA 2017) came into force (https://www.environment.vic.gov.au/sustainability/environment-protection-act-2017), and EPA 2017 requires ENGIE to mitigate the risk of their operations to human health and the environment. Even though EPAV guidelines require, at minimum, an impermeable cap on CCR landfills, it is likely that ENGIE has a duty under Sections 6 and 25 of EPA 2017 to mitigate harm to human health and the environment. Therefore, I opine that installation of a cap on the HARA and other CCR landfills may not be deemed adequate or appropriate if a cap is unlikely to prevent harm to human health and the environment. I consider installation of a cap on the HARA to be superfluous and ineffective considering that ENGIE intends to submerge the HARA before the pit lake is half full. I also opine that breaches in the HARA will more likely than not release floating coal ash cenospheres that will be visible as a white film of ash on the rising pit lake. Furthermore, CCRs in contact with groundwater and surface water will leach toxins such as heavy metals, and those recalcitrant pollutants will become mobile in the aqueous environment.

If CCRs in the HARA are not removed from the mine void prior to inundation, then I opine that relocation of those CCRs to a properly designed and constructed, durable, fully-encapsulated, dry repository within the mine site may be the only method to avoid physical liberation of CCRs, chemical leaching of the coal ash, and release of those dissolved toxins during mine flooding. However, such a hypothetical repository submerged in the pit lake is very likely to fail at preventing water from entering (and exiting) the HARA's CCRs, and it would not be possible to monitor the condition of the CCRs and the physical integrity of the repository. Therefore**, I opine that relocation of the HARA CCRs to a properly designed, installed, and monitored landfill located outside of the mine void is more protective of human health and the environment.** Furthermore, relocation of CCRs outside of the mine pit to a properly lined and capped repository is more consistent with standard practices in the United States and elsewhere (e.g., USEPA, 2015).

2.2.4 Occurrence of PFAS Compounds at Hazelwood

EPAV's 2021 EAN noted that a 2021 ENGIE assessment report "*recommended that PFAS (Poly fluoroalkyl Substances) compounds should be included in the analytical schedule in future surface water sampling at the HARA Return Water Sump"* (page 9) and that "*PFAS compounds should be included in the analytical schedule in future groundwater sampling at pumping bore H2326"* (page 10). Well H2326 is a mine dewatering well whose location is not identified on any maps that I have seen to date (e.g., ENGIE's 2021 EESRF and 2017 EA). This is the first time that I have seen reference to PFAS at Hazelwood, but EPAV does not identify the origin of ENGIE's concerns about PFAS. PFAS is a widely-used family of chemicals (e.g., in fire-fighting foam) known for their toxicity, recalcitrance, and mobility in aqueous environments. The USEPA determined very recently (June 21, 2022) that PFAS compounds (e.g., PFOA) are extremely toxic, with new human health-based ingestion standards set at fractions of a part per trillion (e.g., 0.004 PPT for PFOA; USEPA, 2022). In 2019, the Australian Department of Health established a permissible daily intake concentration for PFOA of 160 PPT (ADOH, 2019), which is much lower than the 560 PPT concentration for PFOA cited only a year earlier in the 2018 Australian Drinking Water Guidelines (ADWG, 2018). **Based on my experience with PFAS compounds, I opine that that if one or more PFAS compound is detected at a Hazelwood water sampling point, then it is more likely than not that PFAS is present in water elsewhere at the Project.** Because almost any quantifiable concentration of a PFAS compound will exceed applicable Australian standards, it is not clear how ENGIE can assume that the pit lake will be safe for recreation or other uses. The presence, distribution, and risk posed by PFAS at Hazelwood, as well as remediation of the source and aqueous migration of the chemical(s), would fall under the guidance of EPA 2017.

3. SUMMARY, DATA GAPS, AND RECOMMENDATIONS

3.1 SUMMARY

Each owner/operator of the three existing mouth-of-mine power complexes located in the Latrobe Valley advocate for closing their large open-cut coal mine by flooding the mine void. The Hazelwood Project is the first of the three complexes slated for closure (Mackay, 2019). A significant amount of public time and money has been spent to develop and prepare the LVRRS plan (e.g., LVRRS, 2020), yet there is no requirement for mine operators to propose rehabilitation plans that conform with any aspect of the LVRRS. Primary drivers for this general plan to create approximately 57 km^2 of lakes are reportedly to (1) reduce risk of fire, both accidental and spontaneous, of the unmined coal and waste coal, and (2) increase the mechanical stability of mine walls (batters) during and after the pit lakes are filled (Mackay et al., 2019). The notorious 2014 fire at the Hazelwood mine and recent mine batter failures (Hazelwood, 2011; Yallourn, 2007, 2012; Loy Yang, 2007) are obvious drivers of mine closure by flooding. Coal mine closure by flooding is not a common rehabilitation method for the mining industry (Schultze et al., 2011a), although examples of mine pit lakes are known from Germany (Schultze at al., 2011b) and in Victoria at Alcoa's Eden Project (eden-project-anglesea-concept-community-response-july-2019.pdf (alcoa.com)). I simply note that the settings and/or objectives of these examples are significantly different from the Hazelwood Project or the LVRRS.

I have not encountered conceptual or specific mine-closure alternative plan(s) to the LVRRS or the Hazelwood Project. I am not aware of any studies or documents proposing removal of CCRs and other contaminant sources from within the Hazelwood mine void prior to pit flooding. I opine that a combination of contaminant (CCR) source removal and mine flooding may be the most environmentally sound and fiscally appropriate closure method for such a large edifice as Hazelwood Mine. Allocating the water required to fill and maintain the Hazelwood pit lake could have significant environmental impacts, but this TM does not consider or evaluate the most appropriate source of water used to fill the mine void. Obviously, removal of CCRs in the HARA from the mine void prior to flooding is more proactive, protective, and expensive than ENGIE's preference to flood the mine and abandon the site once the pit lake reaches capacity. Other contaminant source areas (e.g., CCR landfills) exist outside of the Hazelwood mine void, and the mine flooding component of the Project does not eliminate the need of expeditious EPAV-approved assessment and remediation of those contaminant sources (i.e., per EPA 2017).

A major impediment to implementing the LVRRS plan is water availability, and significant effort has been invested to identify where and how these massive volumes of water can be secured and managed to accommodate and mitigate a wide variety of impacts (e.g., LVRRS, 2020). Identifying water sources and their impacts include quantifying already allocated and stressed surface water and groundwater resources in the Latrobe Valley, identifying and accommodating climate change and robust projections of imminent or active regional aridification, and finding and securing both the initial and sustaining water required to maintain in perpetuity a projected 57 km^2 of combined lake surface. Estimates of pit fill time vary widely as a function of assumptions and scenarios, but I opine that the oft-stated period of one or two decades to fill the Hazelwood mine pit (i.e., EESRF, 2021, page 6) is more likely than not overly optimistic considering the many unknowns, including the likelihood of robust climate change. ENGIE states that the Hazelwood mine pit lake will require approximately 637 GL (637 million m^3) of water, but I reiterate that this volume does <u>not</u> include ongoing water losses via groundwater seepage and evaporation that must be replenished in perpetuity.

The Hazelwood Project footprint includes numerous and significant contaminant sources outside of the mine void such as at the many EOD landfills. Those landfills and the CCRs in the mine-pit HARA require assessment and remediation per applicable EPAV and Victoria rules and regulations (e.g., Campbell, 2020b), including EPA 2017. <u>Nothing</u> that I have read since production of my 2020 assessment of the 2017 EA changes my evaluation, critiques, conclusions, and recommendations provided in that TM (see Campbell, 2020a). EPAV's Clean Up Notice (2020) and Environmental Action Notice (2021) are unambiguous directives that ENGIE conduct contamination assessment <u>and</u> remediation per applicable rules and regulations (e.g., EPA 2017). EPAV identifies assessment, monitoring, computer simulations, and the design, approval, and installation of landfill caps as some of the issues requiring compliance by ENGIE. Reports identified in EPAV's documents indicate that there is substantial information not yet available to me, so I reiterate that this TM is <u>not</u> represented as a definitive evaluation of any aspect of any subject addressed herein.

3.2 DATA GAPS

The following data gaps present impediments for evaluating the forthcoming Hazelwood Project EES based on my evaluation of the EESRF and EPAV's regulatory notices issued to ENGIE, as well as my review of documents related to the Hazelwood Project and the LVRRS plan. Data gaps have been identified and described throughout this TM, so only a bulleted list of key items is provided below.

The following topic order does not reflect my impressions or opinions about the degree of difficulty and/or level of concern or risk for human health and the environment posed by these data gaps.

- ENGIE has yet to identify and assess in appropriate detail an adequate and sustainable water supply for both initial Hazelwood mine void flooding (probably requiring decades) and for sustaining the pit lake in perpetuity at the nominal elevation of +45 meters AHD. Simply stating a preferred water source also ignores available Latrobe Valley technical studies.
- Site-specific engineering characterization, design, and implementation of mine batter composition, structure, and rehabilitation prior to, during, and after filling the Hazelwood pit lake do not yet exist.
- ENGIE has not produced or divulged phycial and geochemical assessment of the fate of the CCRs at the HARA, including design of an appropriate EPAV-approved cap and an implementation plan for long-term protection of the CCRs from both mechanical release and aqueous leaching to liberate toxins to surface water and groundwater.
- There is no comprehensive assessment of the presence, concentrations, horizontal and vertical extents, and environmental risks to human health and the environment posed by the family of chemical compounds collectively known as PFAS (per- and poly-fluoroalkyl substances) that may occur in surface water and/or groundwater located both inside and outside of the mine void.
- Appropriate assessment, monitoring, and remediation of CCRs and other wastes located outside of the mine void, including the CCRs and other industrial wastes located in landfills at the EOD, have not been completed or divulged by ENGIE.

3.3 Recommendations

Recommendations listed below pertain primarily to the anticipated evaluation of, and public comment on, the forthcoming Hazelwood Project EES draft study plan. Therefore, these recommendations do not necessarily pertain directly to the list of data gaps provided in TM Section 3.2.

- Identify and obtain documents that ENGIE has produced to EPAV that have been used to inform two recent EPAV regulatory responses (i.e., the 2020 CUN and 2021 EAN). Titles of those ENGIE documents indicate that they include information and data pertinent to the forthcoming EES (e.g., Detailed Site Investigation Report – Hazelwood Mine Void, dated May 7, 2020, produced by Environmental Resources Management Australia Pty Ltd (ERM)).
- A central issue that ENGIE does not yet appear to address is the fate of the CCRs disposed iinside the mine pit within the HARA. Basic environmental assessment, cap design, etc. appear to be either perfunctory or simply ignored in the documents that I have reviewed. At a

minimum, my evaluations indicate that the HARA must be assessed, monitored, and remediated consistent with applicable Victorian and EPAV rules and regulations (e.g., EPA 2017). However, a conventional cap installed atop the HARA will probably not prevent erosion of the HARA during pit filling, and water saturation and geochemical leaching of the CCRs during and after mine void filling are unavoidable. Therefore, I envision two alternatives; dry encapsulation of the entire mass of HARA CCRs in a new repository located inside the mine pit, or removal and relocation of those CCRs to a properly designed and constructed CCR landfill located outside of the mine void. I opine that the first option is not likely to succeed, nor can the structure or CCRs be monitored once the pit lake is filled. I opine that the option to remove and relocate the HARA CCRs outside of the mine void is most protective of human health and the environment.

- ENGIE's preference to close the mine by inundation may be the soundest method available considering the vast size of the Hazelwood mine void and mitigating factors (e.g., coal fires). However, ENGIE has not identified any conceptual or specific alternatives to mine inundation. Flooding the mine pit should reduce the risk of coal fires, both accidental and spontaneous, which is a primary concern that led to the LVRRS plan. A history of mine batter failures at the three mines included in the LVRRS plan has also influenced the preference to flood the mines. Buttressing of reshaped mine batters by the mass of the pit lake's water is projected to add stability to these inherently unstable features. Although flooding of the Hazelwood Mine to form a pit lake may be a viable closure method, it is obvious that copious and sustained water resources must be used to fill the mine void and to maintain the pit lake in perpetuity. I do not opine on the feasibility or appropriateness of using the Latrobe Valley's limited surface water and groundwater resources in this manner.

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