

Figure 1. Diagrammatic representation of subsurface resources development in the northern Perth Basin. Page: 1. Section 1

Figure 2. Map of the northern Perth Basin showing locations of petroleum fields and facilities, and electricity generation. Page: 2. Section 1

Figure 3. Distribution of Aboriginal heritage sites, legislated lands, and agricultural areas. Page: 4. Section 1

Figure 4. Project area of interest in the northern Perth Basin with tectonic units. Page: 6. Section 1

Figure 5. Stratigraphy and petroleum systems of the Perth Basin (modified from A. Mory personal communication, 2025). The interval column shows the main stratigraphic intervals used for the evaluation of resource interactions. Page: 7. Section 1

Figure 6. Cross-section of the northern Perth Basin showing the distribution of the sedimentary sequences above the Precambrian basement. The intervals used for the suitability and interaction maps are labelled. Modified from Mory and Iasky (1996). Page: 8. Section 1

Figure 7. Salinity distribution in near-surface aquifers in the northern Perth Basin (modified from Department of Water, 2017). The red lines depict the approximate location of the cross-sections AA' and BB' shown in Figure 8 and Figure 9, respectively. Page: 11. Section 1

Figure 8. Conceptual hydrogeological W-E cross-section showing salinity distribution and flow directions of formation water in the northern part of the northern Perth Basin. The cross-section location is shown as line AA' in Figure 7. The salinity distribution and flow in the upper ~ 1000 m are based on maps and data from the Department of Water (2017). Deeper interpretations are highly uncertain and are based on less abundant pressure and salinity observations in petroleum wells. Page: 12. Section 1

Figure 9. Conceptual hydrogeological W-E cross-section showing salinity distribution and flow directions of formation water in the central part of the northern Perth Basin. The cross-section location is shown as line BB' in Figure 7. The salinity distribution and flow in the upper ~ 1000 m are based on maps and data from the Department of Water (2017). Deeper interpretations are highly uncertain and are based on less abundant pressure and salinity observations in petroleum wells. Page: 12. Section 1

Figure 10. Typical depth ranges for various subsurface resource activities (modified from Michael et al., 2016). Page: 13. Section 1

Figure 11. Typical concurrent and sequential uses of subsurface resources. [D: mainly at different depths; I: injectivity issues; S: sequential use potential, prioritise; C: Potential for concurrent use resources (adapted from Field et al., 2017)]. Page: 14. Section 1

Figure 12. Illustration of a) multi-usage basin and b) multi-usage aquifer resource development scenarios (modified from Michael et al., 2016). Page: 15. Section 1

Figure 13. Schematic representation of potential impacts related to CO<sub>2</sub> injection (Michael et al., 2016). The degree of pressure increase is reflected in the relative height of the dashed blue line, representing the potential height of displaced formation water in a hypothetical open conduit. Page: 16. Section 1

Figure 14. Steady-state pressure distribution in the vicinity of a) a well with a constant injection rate and fixed pressure at an outer radius, and b) 2 wells with equal injection rates. Axes values are dimensionless. IEAGHG (2010). Page: 17. Section 1

Figure 15. Pressure build-up at an early point in time (left) and later point in time (right) in a) an unbounded infinite reservoir and b) a bounded

reservoir. Both a) and b) are represented at the same time steps. Pressure values are truncated at  $p = 2$ , rather than the well. IEAGHG (2010). Page: 17. Section 1

Figure 16. Results of cumulative pressure response to fluid production and injection, from basin-scale analytical simulation. The figure shows simplified models of the Gippsland Basin in Victoria, illustrating the pressure distribution in the target aquifer after fluid production for: a) 1.2 million m<sup>3</sup> of petroleum production, and b) concurrent petroleum production (1.2 million m<sup>3</sup>) and CO<sub>2</sub> injection (2,000 Mt). Homogeneous reservoir with pre-production pressure of approximately 25 MPa. Hortle et al. (2014). Page: 18. Section 1

Figure 17. Flow diagram outlining a technical solution to optimise gas and bitumen recovery in Alberta, Canada.

[www.alberta.ca/system/files/custom\\_downloaded\\_images/gas-bit-flow-techroadmap.pdf](http://www.alberta.ca/system/files/custom_downloaded_images/gas-bit-flow-techroadmap.pdf)). Page: 19. Section 1

Figure 18. Draft schematic workflow of the assessment process for subsisting petroleum or geothermal titles (DEMIRS, 2023). Page: 26. Section 1

Figure 19. Schematic workflow for evaluation of resource interactions. Page: 29. Section 2

Figure 20. Key assessment intervals used in the assessment of resource interaction. Page: 30. Section 2

Figure 21. Outputs of resource assessment for the northern Perth Basin. Suitability maps, interaction maps, thematic interaction maps and the cumulative interaction map are shown with their respective assessment interval. Page: 32. Section 2

Figure 22. Schematic empirical permutation and combination laws for interaction maps of 3 resources. The first 3 rings from the centre represent resources A, B and C and their suitability (low, moderate, high). The outside ring represents the interaction intensity (low, moderate, high and dominant resource (#dom)). Page: 33. Section 2

Figure 23. Petroleum wells, gas pipelines and petroleum facilities in the northern Perth Basin. Page: 38. Section 3

Figure 24. Petroleum fields and prospect distribution in the northern Perth Basin. Page: 39. Section 3

Figure 25. Petroleum permits distribution in the northern Perth Basin. Page: 40. Section 3

Figure 26. a) Application types for geothermal resources and b) temperature ranges for typical use of geothermal resources (US DOE, 2019). Page: 42. Section 3

Figure 27. Schematic representation and hypothetical geological settings of different geothermal resource styles as a function of depth (approximates temperature) and enhancements required to produce the required flow rates. ‘Type A’ represents shallow, direct use; ‘Type B’ represents hot saline aquifer (HSA); and ‘Type C’ represents EGS. Huddlestone-Holmes (2014). Page: 44. Section 3

Figure 28. Temperature at the top of the Kockatea Shale (and equivalent strata) and location of geothermal titles and applications. Page: 46. Section 3

Figure 29. Temperature at the top of the Kingia Sandstone and location of geothermal titles and applications. Page: 47. Section 3

Figure 30. Schematic showing compression and injection of CO<sub>2</sub>. Page: 49. Section 3

Figure 31. Preliminary delineation of optimum storage windows (1000–3000 m depth; green hashed areas) in various northern Perth Basin formations (From Ellis et al., 2024). Page: 51. Section 3

Figure 32. Burial depth of potential storage formations and location of

prospective areas (red outline) for CO<sub>2</sub> geological storage identified by 3D-GEO (2013). Page: 52. Section 3

Figure 33. a) Potential CO<sub>2</sub> storage prospects in the northern Perth Basin (modified from Varma et al., 2013). Prospective CO<sub>2</sub> storage resources (> 1 Mt) in the northern Perth Basin in b) depleted gas fields, and c) producing or un-produced fields. Page: 53. Section 3

Figure 34. Hybrid CO<sub>2</sub> storage model in depleted Woodada gas field and underlying aquifers (Varma et al., 2013). Page: 54. Section 3

Figure 35. Schematic cross-section showing key principles for UGS. Page: 55. Section 3

Figure 36. Schematic diagram of the Mondarra gas storage facility showing the location of: A), B), and C) injection/production wells, D) aerial reciprocating compressors, E) gas processing facility, F) cooler and separator, G) conditioning package unit, H) evaporation pond, and I) gas engine alternators. The facility is connected to the Dampier to Bunbury Natural Gas Pipeline (DBNGP) and the Parmelia Gas Pipeline (PGP). APA (2013). Page: 56. Section 3

Figure 37. Shallow aquifers and aquitards below superficial formations or superficial deposits (Department of Water, 2017). Also shown are the Dongara, Eneabba and Gillingarra cross-section lines in Figure 38. Page: 60. Section 3

Figure 38. Hydrogeological cross-sections showing salinity (mg/l) distribution and inferred water flow directions (blue arrows): a) Dongara line, b) Eneabba line, c) Gillingarra line. See Figure 37 for location of cross-section lines. Modified from Department of Water (2017). Page: 61. Section 3

Figure 39. Schematic diagram showing the seawater-groundwater interface in aquifers along the coastline (Department of Water, 2017). Page: 62. Section 3

Figure 40. Groundwater management areas in the northern Perth Basin (Rutherford et al., 2005) and distribution of groundwater production wells. Page: 63. Section 3

Figure 41. Drilled depth of water wells in the northern Perth Basin. Depth is shown on a logarithmic scale along the y-axis. Page: 64. Section 3

Figure 42. Suitability and interaction maps for the Lower Permian (G1low) interval (descriptions are available in Appendix 2 and Appendix 3): A) petroleum suitability map, B) CGS suitability map, C) UGS suitability map, D) geothermal suitability map, E) interaction map. Page: 67. Section 4

Figure 43. Suitability and interaction maps for the Upper Permian (G1up) interval (description available in Appendix 2 and Appendix 3): A) petroleum suitability map, B) CGS suitability map, C) UGS suitability map, D) geothermal suitability map, E) interaction map. Page: 68. Section 4

Figure 44. Suitability and interaction maps for the Triassic - Lower Jurassic (G2A1) interval (description in Appendix 2 and Appendix 3): A) petroleum suitability map, B) CGS suitability map, C) UGS suitability map, D) groundwater suitability map, E) interaction map. Page: 69. Section 4

Figure 45. Suitability maps for the groundwater for the Upper Jurassic to Cainozoic intervals (description in Appendix 2): A) Yarragadee aquifer, Upper Jurassic suitability map (A2), B) Leederville-Parmelia aquifer, Lower Cretaceous suitability map (abA2), C) superficial aquifer, Cainozoic suitability map (abA2). Page: 70. Section 4

Figure 46. Distribution of resource with moderate to high suitability across assessment intervals. Page: 71. Section 4

Figure 47. Thematic interaction maps (description available in Appendix 4). On the maps, the resources are labelled P (petroleum), C (CGS), G (geothermal), U (UGS), GW (groundwater), h (high suitability), and m (moderate suitability). A) Interaction with petroleum resources in the Lower Permian interval (G1low), B) interaction with CGS resources in the Lower Permian interval (G1low), C)

interaction with petroleum resources in the Upper Permian interval (G1up), D) interaction with CGS resources in the Upper Permian interval (G1up), E) interaction with petroleum resources in the Triassic-Lower Jurassic interval (G2A1), F) interaction with CGS resources in the Triassic-Lower Jurassic interval (G2A1), and G) interaction with groundwater resources in the Triassic-Lower Jurassic interval (G2A1). Page: 77. Section 4

Figure 48. Cumulative interaction map for the Lower Permian-Lower Jurassic intervals (G1low, G1up, G2A1). Page: 81. Section 4

Figure 49. Integration of groundwater demand and resource cumulative interaction. A) Groundwater bore distribution and density (shown as quantiles), used as proxy for water usage, B) cumulative interaction map (Figure 48) and groundwater bores, C) integrated map, interaction and bore; bore density is reclassified and used to adjust the deep resource cumulative interactions for water use intensity. Warmer colours indicate a higher potential for dual-resource stress between deeper resources and shallow aquifers. Page: 82. Section 4

Figure 50. Integration of potential pathways and resource cumulative interaction. A) Distribution of faults potentially acting as migration pathways; regional faults (purple) and fault displacing the Cadda and Kockatea seals (red), B) distribution of petroleum wells potentially acting as migration pathways, C) cumulative interaction map, D) integrated map, interaction and pathways; pathway density is reclassified and used to adjust the deep resource cumulative interactions for pathways intensity. Warmer colours indicate a higher potential for vertical migration of deeper resources. Page: 83. Section 4

Figure 51. Potential soft interaction between Lower Permian-Lower Jurassic resources and aquifers. A) Cumulative interaction map and outline of Lesueur-Eneabba-Cattamarra aquifers, B) cumulative interaction map and outline of Yarragadee aquifer, C) cumulative interaction map and outline of Leederville-Parmelia aquifers, D) cumulative interaction map and outline of superficial aquifers. Page: 84. Section 4

Figure 52. Dongara-Beharra Springs-Donkey Creek Terraces. A) Cumulative interaction map showing aggregated interaction data across Lower Permian-Lower Jurassic intervals, B) integrated map, interaction and pathways showing potential for vertical migration of deeper resources. Page: 85. Section 4

Figure 53. Diagrammatic west-east cross-section showing vertical temperature distribution and potential locations of future geothermal energy production and CO<sub>2</sub> injection in relation to existing gas fields. Page: 86. Section 4

Figure 54. Formations targeted by different subsurface developments in the northern Perth Basin suggesting potential overlap of natural gas, CO<sub>2</sub> storage, UGS and geothermal resources below the Kockatea Shale, and b) limited overlap of groundwater, natural gas and CO<sub>2</sub> storage in the Cattamarra Coal Measures-Eneabba/Lesueur interval. Faded colours imply limited suitability. Page: 88. Section 5

Figure 55. Summary of resource interactions. A) E-W cross-section across the northern interaction hotspot for the Permian intervals; the resources are shown schematically on the intervals; CGS and petroleum are the main interacting resources, geothermal and UGS are secondary resources; high-interaction hotspot aligns with the western flank of the basin, B) E-W cross-section across the N-S interaction corridor for the Permian intervals; the resources are shown schematically on the intervals; CGS and Petroleum are the main interacting resources; high-interaction corridor aligns with the western flank of the basin, C) E-W cross-section across the northern part of the interaction corridor for the Triassic-Lower Jurassic intervals; the resources are shown

schematically on the intervals; CGS and petroleum are the main interacting resources; high-interaction corridor aligns with the western flank of the basin; groundwater resources in the Upper Jurassic-Cainozoic intervals are shown with a yellow outline, D) E-W cross-section across the southern part of the interaction corridor for the Triassic-Lower Jurassic intervals; the resources are shown schematically on the intervals; CGS and petroleum are the main interacting resources; groundwater is present to the west where the intervals outcrop; high-interaction corridor aligns with the western flank of the basin; groundwater resources in the Upper Jurassic-Cainozoic intervals are shown with a yellow outline, E) cumulative interaction map showing aggregated interaction data across Lower Permian-Lower Jurassic intervals. Page: 95.

## Section 6

Table 1. Description of tectonic units. Page: 9. Section 1

Table 2. Summary of resource conflict examples. Page: 22. Section 1

Table 3. Underground hydrogen potential in oil and gas fields in the northern Perth Basin (RISC, 2021). Page: 57. Section 3

Table 4. Hydrostratigraphy and aquifer use in the northern Perth Basin (simplified from Department of Water, 2017). Page: 59. Section 3