MEMORANDUM

Project:	Dam Siting Study and Prelim CCA	Date:	24 April 2024
To:	Senex Energy Pty Ltd	From:	Miles Tremlett-Johnstone (RPEQ No. 30225)
ATT:	Phil Wilkinson	CC:	Andrew Vitale, Jacob Cumpstay
Subject:	Louisiana Project Area Dams – Basis of Design		

INTRODUCTION

Senex Energy Pty Ltd (Senex) has engaged Engeny Australia Pty Ltd (Engeny) to undertake the following works for its planned development activities in its Louisiana project area (PL 209 and PL 445):

- A conceptual location study to identify suitable areas where Senex could locate regulated or low consequence structures;
- A preliminary Consequence Category Assessment (CCA) applicable to all identified potential storage locations; and
- A preliminary basis of design for the structures.

The Louisiana Project covers an area of approximately 154 km^2 and is located adjacent to Senex's existing Atlas Project Area approximately 10 km southwest of Wandoan in Southern Queensland.

Engeny has recently completed a preliminary consequence category assessment for the proposed produced water and brine storages which concluded that the dams are likely to be classified as regulated structures. Senex now requires a basis of design to provide increased detail on the potential regulated structures within the Louisiana Project Area and demonstrate the effective management of associated risks.

This memorandum details a preliminary basis of design for the proposed produced water and brine storage dams regardless of the final selected location. The aim of the basis of design is to define design criteria and engineering controls that will be used to meet the requirements of the following documentation:

- Queensland Government Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (2016) ESR/2016/1933 Version 5.03, herein referred to as the 'Manual'.
- Louisiana Project Area Environmental Authority, P-EA-100112777, effective from 23 August 2021.

The preliminary basis of design will be reviewed and updated (if required) during the detailed design of the regulated structures. The basis of design for the detailed design of the regulated structures will be based on the final certified consequence category assessments for the structures.

STORAGE DETAILS

Key details of the proposed produced water and brine storage dams are provided in Table 1.

TABLE 1: KEY DETAILS OF PROPOSED STRUCTURES

Structure	Produced Water Dam	Brine Storage Dam
Max. Storage Capacity to MRL	700 ML	300 ML
Purpose of Structure	Storage of untreated CSG water.	Storage of reverse osmosis concentrate / brine.
Expected water quality[1]	pH: 8.9 Electrical Conductivity: 10,750 µS/cm Total Dissolved Solids: 6,527 mg/L	pH: 9.04 Electrical Conductivity: 72,950 µS/cm Total Dissolved Solids: 49,875 mg/L
Storage Type	HDPE geomembrane lined turkey's nest dams with earthfill perimeter embankments.	

Dam Locations	Louisiana Project Area (PL209 and PL445). The exact locations and number of potential dams are yet to be specifically determined.
Petroleum Lease and EA	Environmental Authority, P-EA-100112777, 23 August 2021.
Locational Constraints	Dams to be located clear of: - Ground truthed environmentally sensitive areas and their associated protection zones / buffers. - Atlas Stage 3 constraints protocol no-go areas. - 1:100 Annual Exceedance Probability (AEP) flood extents for watercourses of Stream Order 2 or higher. - Areas of excessively steep topography that are not suitable for cost-effective dam construction.
Overflow / Dam Break Destination	Lower order tributaries, Woleebee Creek, Jundah Creek, Dawson River.

1 – Based on the average of 2023 water quality monitoring data for the existing produced water dams and brine tanks at the Atlas Project Area.

CONSEQUENCE CATEGORY ASSESSMENT

Guidelines

A preliminary consequence category assessment for the produced water and brine storage dams was undertaken in accordance with the latest version (Version 5.03) of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures ESR/2016/1933 (DESI, 2024).

Documentation

The preliminary consequence category assessment is documented in *QC1051_006-MEM-001-1 Louisiana Dams – Prelim CCA* (Engeny, 2024).

Assessment Results

The outcomes of the preliminary consequence category assessment are summarised in Table 2 below. The produced water and brine storage dams are likely to be classified as regulated structures.

TABLE 2: PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT – RESULTS SUMMARY

Structure	Comments	Consequence Category	Overall Consequence Category
Produced water dam	Failure to contain – Seepage Failure to contain – Overtopping Dam break	Low Low Significant	Significant
	Regulated Structure?	Yes	-
Brine storage dam	Failure to contain – Seepage Failure to contain – Overtopping Dam break	Significant Significant High	High
	Regulated Structure?	Yes	-

HYDRAULIC PERFORMANCE CRITERIA

The following hydraulic performance criteria have been determined based on the requirements of the Manual and the EA.

Failure to Contain – Seepage

Based on the preliminary consequence category assessment, the hydrological design criteria applicable to the produced water and brine storage dams in relation to the 'failure to contain – seepage' scenario are summarised in Table 3.

TABLE 3: APPLICABLE HYDROLOGICAL DESIGN CRITERIA FOR 'FAILURE TO CONTAIN – SEEPAGE' SCENARIO

Design Criteria	Produced Water Dam	Brine Storage Dam
Consequence Classification for Failure to Contain – Seepage	Low	Significant
Containment	N/A	Dam to be lined to contain the wetting front and any entrained contaminants within the bounds of the containment system. Dam to incorporate a system for the collection and proper disposal of any contaminants that move beyond the bounds of the containment system.
Leak Detection / Monitoring	N/A	Requires a system that will detect any passage of the wetting front or entrained contaminants through the floor or sides of the dam.
Rectification	N/A	N/A

Failure to Contain – Overtopping

Based on the preliminary consequence category assessment, the hydrological design criteria applicable to the produced water and brine storage dams in relation to the 'failure to contain – overtopping' scenario are summarised in Table 4.

TABLE 4: APPLICABLE HYDROLOGICAL DESIGN CRITERIA FOR 'FAILURE TO CONTAIN – OVERTOPPING' SCENARIO

Design Criteria	Produced Water Dam	Brine Storage Dam
Consequence Classification for Failure to Contain – Overtopping	Low	Significant
Containment – Extreme Storm Storage / Mandatory Reporting Level	N/A	Larger of the 1:10 AEP 72-hour duration storm or wave run-up for 1:10 AEP wind
Containment – Design Storage Allowance	N/A	1:20 AEP

Dam Break

Based on the preliminary consequence category assessment, the hydrological design criteria applicable to the produced water and brine storage dams in relation to the 'dam break' scenario are summarised in Table 5.

TABLE 5: APPLICABLE HYDROLOGICAL DESIGN CRITERIA FOR 'DAM BREAK' SCENARIO

Design Criteria	Produced Water Dam	Brine Storage Dam
Consequence Classification – Dam Break	Significant	High
Spillway Capacity	1:100 AEP to 1:1,000 AEP	1:1,000 AEP to 1:10,000 AEP
Flood Level for Embankment Crest Levels	Spillway design flood peak level + wave run-up for 1:10 AEP wind	Spillway design flood peak level + wave run-up for 1:10 AEP wind

CIVIL DESIGN CRITERIA

Dams

The proposed basis of design for the produced water and brine storage dams is summarised in Table 6 below. A typical section of the dams is illustrated in Figure 1.

TABLE 6: BASIS OF DESIGN – DAMS

Item	Value[1]	Basis
Design life	25 years	Nominated
Dam embankment crest width	6.0m minimum	Trafficable crest
Dam embankment crossfall	3% toward downstream batter	Prevent ponding on crest
Dam embankment batters	Downstream Batter: 1V:4H Upstream Batter: 1V:3H	Safety during construction, stability
Dam embankment crest surfacing	Gravel capping	Trafficability for inspections and monitoring
Dam embankment upstream batter surfacing	HDPE Geomembrane Liner system	Nominated
Dam embankment downstream batter surfacing	Topsoil and grass seed (additional erosion minimisation controls to be determined during design)	Minimise erosion
Impoundment excavation surfacing (batters and floor)	HDPE Geomembrane Liner system	Nominated
External catchments	Diverted around dams via diversion drains and bunds to prevent ponding or flow against dam embankments	Nominated
Embankment zoning	Homogenous earthfill embankment	Dams incorporate a liner system
Embankment fill material	General fill	Dams incorporate a liner system
Fill material borrow area	Impoundment excavation	Achieve cut/fill balance
Liner System	Processed Water Dam – Single HDPE Geomembrane Liner Brine Storage Dam – Double HDPE Geomembrane Liner	Consequence classification of low and significant for Seepage
Leakage collection and extraction system	Produced Water Dam: Present below the primary liner to detect, collect and remove leakage resulting from holes and defects in the primary liner and return into the dam storage.	Nominated
	Brine Storage Dam: Present below the primary liner to detect, collect and remove leakage resulting from holes and defects in the primary liner and return into the dam storage.	Consequence classification of low for Seepage
Seepage collection and extraction system	Produced Water Dam: N/A	Consequence classification of low for Seepage
	Brine Storage Dam: Present beneath the secondary liner to detect, collect and remove leakage resulting from holes and defects in the secondary liner and return into the dam storage.	Consequence classification of significant for Seepage

Seepage monitoring	Produced Water Dam: Shallow groundwater monitoring bores around dam.	Consequence classification of low for Seepage
	Brine Storage Dam: Seepage collection system and shallow groundwater monitoring bores around dam.	Consequence classification of significant for Seepage
Emergency egress	Liner to be textured to allow for emergency egress. Life rings to be located at multiple locations along the crest.	Safety in for operation / maintenance personnel
Design Storage Allowance (DSA)	Produced Water Dam: No regulatory requirement, but a Maximum Allowable Operating Level (MAOL) to be specified to achieve 1:20 AEP wet season containment to reduce likelihood of spillway overflows.	Consequence classification of low for Overtopping
	Brine Storage Dam: 1:20 AEP wet season containment.	Consequence classification of significant for Overtopping
Mandatory Reporting Level (MRL)	Produced Water Dam: N/A	Consequence classification of low for Overtopping
	Brine Storage Dam: Mandatory Reporting Level (MRL) set to contain the larger of the 1:10 AEP 72-hour duration rainfall event or wave run-up for 1:10 AEP wind below the spillway level.	Consequence classification of significant for Overtopping
Design earthquake loading	Operating Basis Earthquake (OBE): 1:100 AEP Maximum Design Earthquake (MDE): 1:1,000 AEP	ANCOLD Guidelines
Acceptable Factors of Safety (FoS) against embankment instability	Long term drained: FoS ≥ 1.5 Short term undrained (potential loss of containment): FoS ≥ 1.5 Short term undrained (no potential loss of containment): FoS ≥ 1.3 Post Seismic: FoS ≥ 1.1	ANCOLD Guidelines

1 – Applicable to both the produced water and brine storage dams unless specified otherwise.

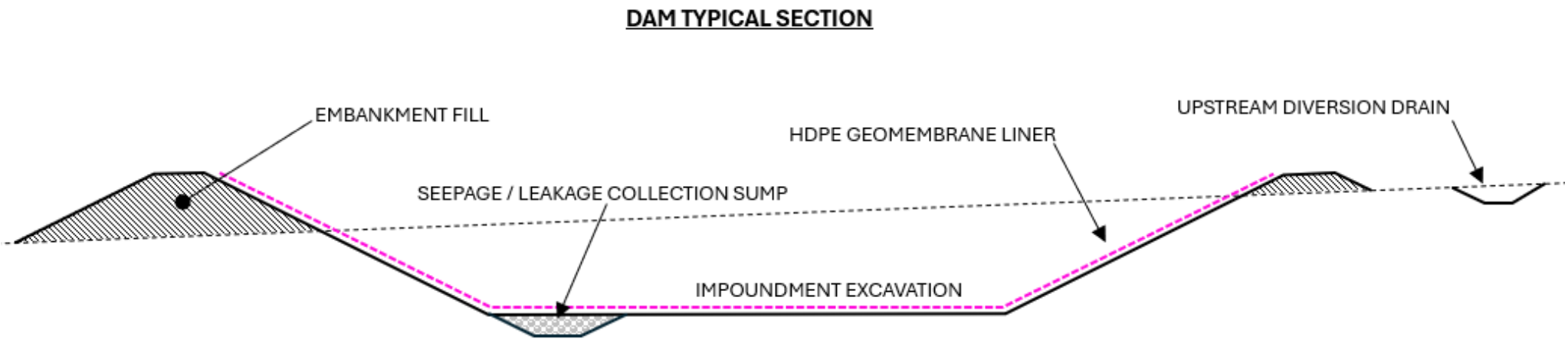

FIGURE 1: DAM TYPICAL SECTION

Emergency Spillways

The proposed basis of design for the dam emergency spillways is summarised in Table 7 below.

TABLE 7: BASIS OF DESIGN – EMERGENCY SPILLWAYS

Item	Value[1]	Basis
Emergency spillway type	Overflow spillway	Turkeys Nest structure
Emergency spillway capacity	Produced Water Dam: 1:1,000 AEP + wave run-up for 1:10 AEP wind.	Consequence classification of **significant** for Dam Break
	Brine Storage Dam: 1:1,000 AEP + wave run-up for 1:10 AEP wind. Dam will be operated with a DSA meaning that the is a low probability that dam will be at spillway level at the start of spillway design flood event.	Consequence classification of **high** for Dam Break
Emergency spillway crest	Concrete cut-off sill	Concrete sill to maintain level.
	Liner system upstream of concrete sill	Minimise erosion
	Dumped rock underlain by geofabric or rock mattress downstream of sill.	
Emergency spillway chute	Dumped rock underlain by geofabric or rock mattress dependent on velocity.	Minimise erosion
Dissipation basin	Spillway dissipation basin to be surfaced with dumped rock underlain by geofabric or rock mattress and sized to contain the design event hydraulic jump.	Nominated
	Flow from dissipation basin to be directed away from dam embankment.	

1 – Applicable to both the produced water and brine storage dams unless specified otherwise.

Diversion Drains and Bunds

The proposed basis of design for diversion drains and bunds is summarised in Table 8 below.

TABLE 8: BASIS OF DESIGN – DIVERSION DRAINS & BUNDS

Item	Value	Basis
Purpose	Divert external catchments around dams to inhibit ponding or flow against dam embankments	Nominated
Design Capacity	1: 20 AEP peak flow from contributing catchment	Consistent with DSA
Batter slopes	Drains: 1V:4H Bunds: 1V:3H	Minimise erosion, safety during construction, stability
Drain surfacing	Flow velocities ≤ 1.5 m/s – topsoil and grass seed.	Minimise erosion
	Flow velocities > 1.5 m/s – dumped rock underlain by geofabric	

DISCLAIMER

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