Louisiana CCA Scenario Bow Ties

Senex Risk Assessment

Risk Matrix - SENEX-CORP-RM-MTX-001

Senex Risk Matrix (Approved by SENEX ARC – Nov 2021)

			CONSEQUENCE				
		HEALTH AND SAFETY	First Aid Injury (FAI)	Medical Treatment (MTI)	Lost Time Injury (LTI)	Permanent Disability	Fatality
		FINANCIAL CASH IMPACT	Up to $200k	$200k - $2M	$2M - $15M	$15M - $30M	$30M +
		FINANCIAL VALUE IMPACT (NPV)	Up to $1M	$1M - $30M	$30M - $60M	$60M - $150M	$150m +
		REPUTATION	Minimal impact on business reputation, land holder only	Some impact on business reputation, local community exposure	Moderate impact on business reputation, local media exposure	Significant impact on business reputation, national media exposure	Critical impact on reputation, international media exposure
		ENVIRONMENT	Incident. No breach of regulations / EA. Minimal and short term impact to any local environment.	Minor breach of regulations / EA resulting in notification to regulator. Localised, short term, recoverable minor impact on flora and fauna.	Serious breach of regulations / EA resulting in reporting to regulator, investigation, environment notice or fines. Significant localised but short term environmental impact.	Major breach of legislation resulting in prosecution or litigation and regulatory intervention. Serious and long term ecological impact and environmental harm. Emergency Management activated.	Significant compliance breach resulting in prosecution / class action or loss of licence. Severe environmental harm with widespread or permanent impact. Crisis Management activated.
			Insignificant	Minor	Moderate	Major	Catastrophic
LIKELIHOOD	A common event that is likely to occur in the industry many times per year	Highly Likely	Intermediate (A1)	Intermediate (A2)	High (A3)	Extreme (A4)	Extreme (A5)
	An event likely to occur more than once a year in the industry	Likely	Low (B1)	Intermediate (B2)	Intermediate (B3)	High (B4)	Extreme (B5)
	An event that may occur in the industry over 10 years	Possible	Low (C1)	Low (C2)	Intermediate (C3)	Intermediate (C4)	High (C5)
	An event not likely to occur in the industry over 10 years	Unlikely	Negligible (D1)	Negligible (D2)	Low (D3)	Intermediate (D4)	Intermediate (D5)
	An event that has not previously been experienced in the industry but may occur in exceptional circumstances	Remote	Negligible (E1)	Negligible (E2)	Low (E3)	Low (E4)	Intermediate (E5)

Causes

1. Increased inflow, as result of:
a) New wells having higher water rate than forecast (P50)
b) Weather events (e.g. significant rainfall or reduced evaporation)
c) Reduced LH irrigation (1.3ML/Day) e.g., weather, crops, supply chain –(double check land access). Low absorbing rate.

2. Long-term systemic lack of operational inspection and awareness

3. Loss of access to land on which Dam situated

4. Inadequate dam design

Preventative Controls

1. Basis of design which informs DSA / MRL based on conservative modelling based on probabilistic water production rates and climate data

1, 2 & 3 Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

1. Implement other water uses e.g., dust suppression, grass irrigation

1. Temp. storage of produced water in existing tanks

1. Transfer water between dams (i.e. balance water storage across Senex tenures)

1. Activate Well Turning down plan – CRITICAL CONTROL

2. & 3. Telemetry and data analytics and live and ongoing remote monitoring of dam water levels and water production rates.

2. & 3. Routine field inspections of water infrastructure (supports remote monitoring capability)

4. Construction in accordance with Dam Design and Operating Plan – inclusive of ESS, DSA / MRL and MOL. Prepared, Approved and certified by SPQ and RPEQ - including detailed geotechnical investigations, and on-site construction supervision by RPEQ. CRITICAL CONTROL

Risk Source

Top Risk / Hazard: Water production exceeds water storage capacity

Top Risk Event

Discharge to spillway (PRODUCED WATER)

Mitigative Controls

1-4. Ability to transfer water between dams (i.e. balance water storage across Senex tenures)* prior to exceedance of ESS - e.g. pipeline or trucking

1-4. Activate Well Turning down plan. CRITICAL CONTROL

1-4. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

Effects

A1. Regulatory Engagement
Enviro: Minor
Cost: Minor
Reputation: Minor

A2. Community Dissatisfaction:
Cost: Minor
Reputation: Minor

A3. Fauna / Flora Mortality:
Enviro: Insignificant
Reputation: Minor
Cost: Minor

Risk Ratings

Inherent: (without controls) ★	Possible	Moderate	Intermediate (C3)
Target: (with controls) ◎	Unlikely	Minor	Negligible (D2)

Senex
Senex Energy Limited

AM4

Causes

1. Weather events e.g., significant rain or reduced evaporation

2. Long-term systemic lack of operational inspection and awareness

3. Loss of access to land on which Dam situated

4. Inadequate dam design

Preventative Controls

1. Basis of design which informs DSA / MRL based on conservative modelling based on probabilistic water production rates and climate data

1. Temp. storage in existing tanks

1. Transfer water between dams (i.e. balance water storage across Senex tenures)

1. Stop brine inflow – CRITICAL CONTROL

AM3

1, 2 & 3. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

2. Routine field inspections of water infrastructure (supports remote monitoring capability)

2. & 3. Telemetry and data analytics and live and ongoing remote monitoring of dam water levels and water production rates.

4. Construction in accordance with Dam Design and Operating Plan – inclusive of ESS, DSA / MRL and MOL (volumetric limits are lower / ullage is higher than for produced water) Prepared, Approved and certified by SPQ and RPEQ - including detailed geotechnical investigations, and on-site construction supervision by RPEQ. CRITICAL CONTROL

Risk Source

Top Risk / Hazard: Water production exceeds water storage capacity

Top Risk Event

Discharge to spillway (BRINE)

Mitigative Controls

1 - 4. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

1-4. Stop brine inflow – CRITICAL CONTROL

1-4. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

AM1

Effects

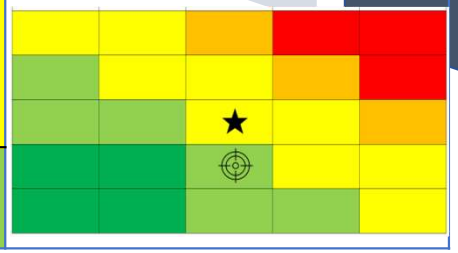
A1. Regulatory Engagement:
Enviro: Moderate
Cost: Moderate
Reputation: Moderate

A2. Community Dissatisfaction:
Cost: Moderate
Reputation: Moderate

A3. Fauna / Flora mortality
Enviro: Moderate
Cost: Minor
Reputation: Moderate

Risk Ratings

Inherent: (without controls) ★	Possible	Moderate	Intermediate (C3)
Target: (with controls) ◎	Unlikely	Moderate	Low (D3)



Senex
Senex Energy Limited

Slide 4

AM0 I can not work out which cause this control is treating? I think you might need to add a cause e.g., Cause 6 in the previous slide?
Alycia Moore, 2024-04-10T23:35:51.257

AM1 This looks similar to prevention control 1. Consider if they need to be separate, amalgamated or clarified.
Alycia Moore, 2024-04-10T23:36:45.471

AM2 Any telemetry on this type of dam? As a good monitoring control (lead indicator)
Alycia Moore, 2024-04-10T23:38:59.200

AM3 I assume this control would be implemented before discharge, therefore, it is a preventative control.
Alycia Moore, 2024-04-10T23:40:04.312

AM4 In general compare this to the previous bowtie. If causes are the same, I would expect the controls to be the same, but this doesn't seem to be the case at the moment, please mirror the controls for consistency.
Alycia Moore, 2024-04-10T23:43:52.913

AM8

Causes

PW10

1. Physical damage to liner, e.g. from wind uplift or vehicle movement

AM1

2. Incorrect liner installation / faulty seam welding

AM0

3. Uplift pressure on liner from shallow groundwater potentially causing liner failure

AM5

4. Degradation of dam liner and subsequent failure during operations

AM6

5. Grass fire around the dam impacting inlet/outlet pipes with potential to damage liner

Preventative Controls

1, 2 & 3 Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

1, Installation of fencing around dam perimeter

1, Appropriate design of ballast and anchor trench to counteract wind uplift

AM3

2. Dam design and construction in accordance with Dam Design and Operating Plan which includes detailed geotechnical investigations to provide necessary understanding of shallow groundwater and sub-grade.

4. Dam design accounts for water quality and associated material selection process.

1 Routine field inspections of water infrastructure including condition of dam liner

5. Requirement for fire break/ separation distance considered during detailed design.

AM4

1-5. Leak collection system to capture inflow between liners. Volume of system designed for modelled flow rates. Has remote telemetry (SCADA) for monitoring purposes. CRITICAL CONTROL

1-5. All dams have a dual lining, including CCL and HDPE liner (produced water) and CCL and dual HDPE liner (Brine) . CRITICAL CONTROL

Risk Source

Top Risk / Hazard: Seepage results in adverse impacts to groundwater

Top Risk Event

Loss of integrity of dam liner and resulting seepage (PRODUCED WATER)

Mitigative Controls

1-5. Seepage monitoring network implemented

1-5. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan, which includes but is not limited to repairing the liner.

1-5. Leak collection system to capture inflow between liners. Volume of system designed for modelled flow rates. Has remote telemetry (SCADA) for monitoring purposes. CRITICAL CONTROL

AM2

Effects

A1. Regulatory Engagement:
Enviro: Minor
Cost: Moderate (to allow for liner repair)
Reputation: Minor

A2. Community Dissatisfaction:
Reputation: Minor
Cost: Minor

A3. Fauna / Flora Mortality.
Enviro: insignificant
Reputation: Insignificant
Cost: Minor

A5: Groundwater contamination:
Enviro: Minor
Reputation: Minor
Cost: Minor

AM

Risk Ratings

Inherent: (without controls) ★	Possible	Moderate	Intermediate (B3)
Target: (with controls) ◎	Unlikely	Minor	Low (C2)

Senex
Senex Energy Limited

Slide 5

AM0 Usually some quality assurance inspections or testing are good controls during construction.
Alycia Moore, 2024-04-10T23:46:40.850

AM1 Good controls could include limiting certain equipment around the dam (mobile or static) or on the dam.
Alycia Moore, 2024-04-10T23:47:33.379

AM2 Good control. As it is capturing leaks, it is a mitigation control. Consider commenting that it is a critical control.
Alycia Moore, 2024-04-10T23:48:26.924

AM3 Good control. Consider commenting that it is a critical control.
Alycia Moore, 2024-04-10T23:49:22.804

AM4 Good control - isolation.
Alycia Moore, 2024-04-10T23:50:08.451

AM5 I do not see any prevention control addressing this cause?
Alycia Moore, 2024-04-10T23:50:38.186

AM6 I think you need more preventative controls for this e.g., is mem brane on the dam or the water treatment plant? Can degradation be monitored as a lead indicator? What other controls do we have to ensure the performance of the water treatment plant e.g., 24hour operator?
Alycia Moore, 2024-04-10T23:53:51.173

AM7 Currently limited controls ID for this cause. Other controls might be the design ir tie-down points, Inspection or maintenance plans.
Alycia Moore, 2024-04-10T23:55:11.426

AM8 Is there a control to do with being able to do minor repairs?
Alycia Moore, 2024-04-10T23:55:58.973

PW8 0 Listed in Dam operating plan
Phil Wilkinson, 2024-04-12T01:32:38.141

AM9 There doesn’t seem to be any mitigation controls for this impact?
Alycia Moore, 2024-04-10T23:57:40.431

PW9 0 All controls designed to limit / prevent seepage are relevant to this one. If seepage occurs it is viewed by regulator as contamination.
Phil Wilkinson, 2024-04-12T01:32:13.002

PW10 Consider adding likelihood to causes as per effects.
Phil Wilkinson, 2024-04-26T01:17:33.873

AM0

Causes

1. Physical damage to liner, e.g. from wind uplift or vehicle movement

2. Incorrect liner installation / faulty seam welding

3. Uplift pressure on liner from shallow groundwater potentially causing liner failure

4. Membrane degradation and subsequent failure during operations

5. Grass fire around the dam impacting inlet/outlet pipes with potential to damage liner

Preventative Controls

1-5. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan

1, Installation of fencing around dam perimeter

1, Appropriate design of ballast and anchor trench to counteract wind uplift

3. Dam design and construction in accordance with Dam Design and Operating Plan which includes detailed geotechnical investigations to provide necessary understanding of shallow groundwater and sub-grade.

4. Dam design accounts for water quality and associated material selection process.

4. Routine field inspections of water infrastructure including condition of dam liner

5. Requirement for fire break/ separation distance considered during detailed design.

1-5. Leak collection system to capture inflow between liners. Volume of system designed for modelled flow rates. Has remote telemetry (SCADA) for monitoring purposes. CRITICAL CONTROL

1-5. All dams have a dual lining, including CCL and HDPE liner (produced water) and CCL and dual HDPE liner (Brine) . CRITICAL CONTROL

Risk Source

Top Risk / Hazard: Seepage results in adverse impacts to groundwater

Top Risk Event

Loss of integrity of dam liner and resulting seepage (BRINE)

Mitigative Controls

1-5. Seepage monitoring network implemented

1-5. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan, which includes crisis management.

1-5. Leak collection system to capture inflow between liners. Volume of system designed for modelled flow rates. Has remote telemetry (SCADA) for monitoring purposes. CRITICAL CONTROL

Effects

A1. Regulatory Engagement:
Enviro: Minor
Cost: Moderate to allow for liner repair
Reputation: Minor

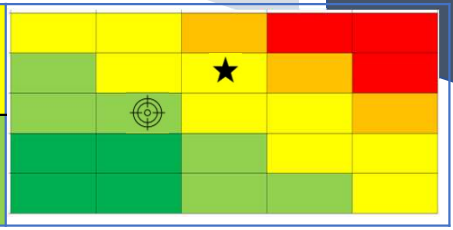
A2. Community Dissatisfaction:
Reputation: Minor
Cost: Minor

A3. Fauna / Flora Mortality.
Enviro: insignificant
Reputation: Insignificant
Cost: Minor

A4. Groundwater contamination
Enviro: Moderate
Reputation: Minor
Cost: Minor

Risk Ratings

Inherent: (without controls) ★	Possible	Moderate	Intermediate (B3)
Target: (with controls) ⌖	Unlikely	Minor	Low (C2)



Senex
Senex Energy Limited

Slide 6

AM0 Refer to my comments on the previous slide

Alycia Moore, 2024-04-10T23:58:09.021

AM0

Causes

1. Embankment foundation not adequately prepared leading to foundation failure
2. In-situ borrow material largely comprises soil with high shrink-swell potential that can lead to cracking within the embankment.
3. In-situ borrow material largely comprises highly dispersive / erosion sensitive soils
4. Inadequate batter / slope design leading to embankment failure
5. Piping / scour erosion below spillway impacts structural integrity of spillway and embankment
6. Poor compaction of embankment fill
7. Inadequate / ineffective stormwater management leading to run-off eroding embankment

Preventative Controls

1-3. Appropriate geotechnical assessment of dam location to provide necessary understanding of shallow groundwater and sub-grade

1-3. Foundation / subgrade preparation requirements (e.g. removal of root matter, soft spots, DCP testing etc, to be specified in the Dam Design Plan

1-6. Appropriate sub-grade and embankment construction measures such as: capping layers, moisture control liners, zoned embankments etc. to be included in the Dam Design Plan

1-7. RPEQ verification of installation and construction as per dam design plan. CRITICAL CONTROL

1-6. Inspection and testing of materials by Level 2 earthworks testing (AS 3798 – 2007). CRITICAL CONTROL

1-7. Routine field inspections of water infrastructure (supports remote monitoring capability)

Risk Source

Top Risk / Hazard: Loss of containment

Top Risk Event

Dam Break and uncontrolled release (PRODUCED WATER)

Mitigative Controls

1 - 7. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan, which includes crisis management.

Effects

A1. Regulatory Engagement.
Enviro: Major (EPO, investigations, audits etc)
Cost: Major
Reputation: Moderate / Major

A2. Community Dissatisfaction:
Enviro: Moderate
Cost: Moderate
Reputation: Minor

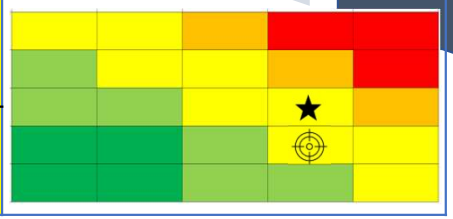
A3. Fauna / Flora mortality.
Enviro: Moderate
Cost: Minor
Reputation: Moderate

A5: Contamination.
Enviro: Major
Cost: Moderate
Reputation: Major

AM

Risk Ratings

Inherent: (without controls) ★	Possible	Major	Intermediate (C4)
Target: (with controls)	Unlikely	Major	Intermediate (D4)



Senex
Senex Energy Limited

Slide 7

AM0 General comment regarding prevention controls. List controls are really good in regards to assessments, design, qualified people inspecting and signing off. Consider adding prevention control post dam commissioning e.g., inspection and maintenance plans.
Alycia Moore, 2024-04-11T00:26:16.040

AM1 Need to add mitigation controls.
Alycia Moore, 2024-04-11T00:28:12.429

AM0

Causes

1. Embankment foundation not adequately prepared leading to foundation failure
2. In-situ borrow material largely comprises soil with high shrink-swell potential that can lead to cracking within the embankment.
3. In-situ borrow material largely comprises highly dispersive / erosion sensitive soils
4. Inadequate batter / slope design leading to embankment failure
5. Piping / scour erosion below spillway impacts structural integrity of spillway and embankment
6. Poor compaction of embankment fill
7. Inadequate / ineffective stormwater management leading to run-off eroding embankment

Preventative Controls

1-3. Appropriate geotechnical assessment of dam location to provide necessary understanding of shallow groundwater and sub-grade

1-3. Foundation / subgrade preparation requirements (e.g. removal of root matter, soft spots, DCP testing etc, to be specified in the Dam Design Plan

1-6. Appropriate sub-grade and embankment construction measures such as: capping layers, moisture control liners, zoned embankments etc. to be included in the Dam Design Plan

1-7. RPEQ verification of installation and construction as per dam design plan. CRITICAL CONTROL

1-6. Inspection and testing of materials by Level 2 earthworks testing (AS 3798 – 2007). CRITICAL CONTROL

1-7. Routine field inspections of water infrastructure (supports remote monitoring capability)

Risk Source

Top Risk / Hazard: Loss of dam integrity

Top Risk Event

Dam Break and uncontrolled release (BRINE)

Mitigative Controls

1-7. Implementation of formally staged escalation process as per Emergency Response Plan in Dam Operating Plan, which includes crisis management.

Effects

A1. Regulatory Engagement.
Enviro: Major EPO, investigations, audits etc)
Cost: Major
Reputation: Major

A2. Community Dissatisfaction:
Enviro: Major
Cost: Major
Reputation: Major

A3. Fauna / Flora mortality
Enviro: Major
Cost: Moderate
Reputation: Major

A5: Contamination.
Enviro: Major
Cost: Catastrophic
Reputation: Major

Risk Ratings

Inherent: (without controls) ★	Possible	Catastrophic	High (C5)
Target: (with controls) ◎	Unlikely	Catastrophic	Intermediate (D5)

Senex
Senex Energy Limited

Slide 8

AM0 Refer to my comments on the previous slide.
Alycia Moore, 2024-04-11T00:28:33.237