

# 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	FINANCIAL CASH IMPACT	FINANCIAL VALUE IMPACT (NPV)	REPUTATION	ENVIRONMENT
			First Aid Injury (FAI)	Medical Treatment (MTI)	Lost Time Injury (LTI)	Permanent Disability	Fatality
			Up to \$200k	\$200k - \$2M	\$2M - \$15M	\$15M - \$30M	\$30M +
			Up to \$1M	\$1M - \$30M	\$30M - \$60M	\$60M - \$150M	\$150m +
			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
			Incident.	Minor breach of regulations / EA resulting in notification to regulator.	Serious breach of regulations / EA resulting in reporting to regulator, investigation, environment notice or fines.	Major breach of legislation resulting in prosecution or litigation and regulatory intervention.	Significant compliance breach resulting in prosecution / class action or loss of licence.
			No breach of regulations / EA. Minimal and short term impact to any local environment.	Localised, short term, recoverable minor impact on flora and fauna.	Significant localised but short term environmental impact.	Serious and long term ecological impact and environmental harm. Emergency Management activated.	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)**

## Risk Ratings

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

## 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 <sup>3</sup>

**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

## Causes

## Preventative Controls

## Risk Source

## Mitigative Controls

## Effects <sup>4</sup>

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

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

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

**Top Risk / Hazard:  
Water production  
exceeds water  
storage capacity**

Top Risk Event



**Discharge to  
spillway (BRINE)**

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

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)				
	Unlikely	Moderate	Low (D3)				
Target: (with controls) 🎯							

Mitigative Controls

Risk Source

Preventative Controls

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. Degradation of dam liner and subsequent failure during operations
- 5. Grass fire around the dam impacting inlet/outlet pipes with potential to damage liner

- 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
- 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

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

**Top Risk Event**

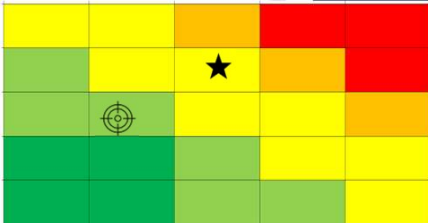


**Loss of integrity of dam liner and resulting seepage (PRODUCED WATER)**

- 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

- 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

Risk Ratings

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

## Causes

## Preventative Controls

## Risk Source

## Mitigative Controls

- 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

- 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

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

**Top Risk Event**

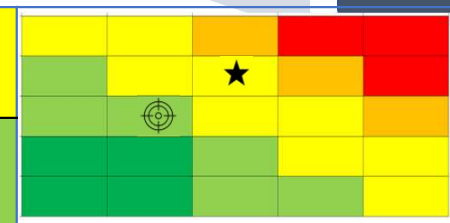
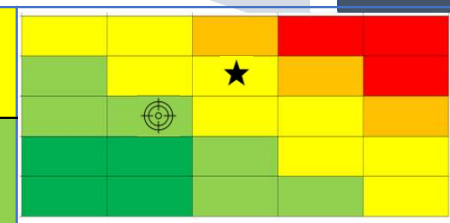


**Loss of integrity of dam liner and resulting seepage (BRINE)**

- 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

- 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)				

## Causes

## Preventative Controls

## Risk Source

## Mitigative Controls

## Effects

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

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)

**Top Risk / Hazard:  
Loss of containment**

Top Risk Event



**Dam Break and uncontrolled release (PRODUCED WATER)**

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

**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

## Risk Ratings

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

### 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.

- 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)	