

CCOP/Petrad Seminar  
29 September 2010

# **OilSim CCS**



# Scenario

- You are an oil and gas company and you have found a big gas field with too much CO<sub>2</sub> content
- You will not be allowed to emit any of the excess CO<sub>2</sub>
- Your challenge is to make the field economically viable



\$260,532,000

OilSim version: 3.5

Deadline: 00:00:00 - 24 September 2010 09:59:35

team 1

Simulation Status (98)

Mailbox  
Mailbox is empty  
[more](#)

Options

- Home
- Apply for funds

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- Teams
- Credibility

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- About
- Concept
- Geology
- Partnerships
- Glossary
- FAQ
- Drilling Information

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- Presentation
- Logout

Map Surveys Block 550 Licenses

Legend

Offered Blocks	<input type="checkbox"/>	All Licensed Blocks	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Blocks Invested In	<input type="checkbox"/>	Operated blocks	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Blocks Drilled In	<input type="checkbox"/>	Blocks Where Oil or Gas Is	<input type="checkbox"/>	<input type="checkbox"/>

Map

Current Task

3. Partnering & Drilling

Task Information

Your current assignment is to drill exploration wells in the block(s) that you operate. This is divided into three separate tasks:

- \* Select Position
- \* Lease Rig and Buy Services
- \* Test Well (only if you find hydrocarbons)

The aim of these tasks is to find commercially viable volumes of oil in your block(s) using the least funds possible. Note, however, that it is very unlikely that you will find oil in one of your first wells. And even if you find something, a single well is not sufficient to prove commercially viable volumes.

Task Form

Licence: 550

You must farm out at least 20%

Drill

2. Bid for Licenses

1. Find Basins

# Schedule

- 08:45-10:00 Exploration drilling (task 1)  
Find the hidden potential
- 10:30-12:00 Appraisal (task 2)  
Make it commercially viable
- 13:30-15:00 Drainage and injection plan (task 3)  
Get it out and get it in. Enhanced Oil Recovery
- 15:30-16:30 Facilities plan (task 4)  
Define capacities. External sources
- 16:30-16:45 Debriefing

# First task

- Examine your license block closer
  - Find potential carbon storage reservoirs
  - Are there any additional oil or gas reservoirs?
- Procedure
  - Examine 3D seismic images
  - Drill one exploration well into each structure
  - Complete worksheet 1



# 3 tools to solve the task

- Block overview

Block 550						
Discovered Prospects						
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Quality Range (0-10 scale)	Volume Range (MBOE)	CO <sub>2</sub> amount
Alcatraz Island	2	11.9-13.4	229-260	6.2-7	685-989	38% Gas

Discovered CCS Prospects					
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Rate Range (0-10 scale)	Volume Range (Mt)
Antigua	3	4.2-16	86-372	0.38-1.17	16-260

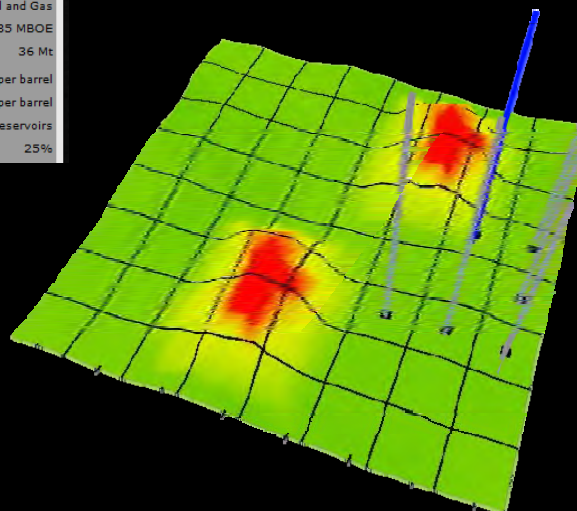
  

Calculation of Licence Value

Below you can see the calculation of the value of the licence when it is developed. Your share of the value is put on book.

	Oil and Gas
Total proven volume:	685 MBOE
Total amount of CO <sub>2</sub> :	36 Mt
Oil Price:	\$50 per barrel
Production Tax Rate:	\$6 per barrel
Number of reservoirs:	1 reservoirs
Recovery Factor:	25%

- 3D seismic images



- Drilling guide

**Drilling Guide - Licence: 550**

Select the rig that you want to use for drilling.

1 2 3 4 5 6 7 8

**Drillship**

**Drillship Alopex lagopus**  
Dayrate: \$400,000  
Max Water Depth: 1500m  
This rig is available

**Drillship Balaena glacialis**  
Dayrate: \$420,000  
Max Water Depth: 1500m  
This rig has a queue of 1 teams [Details](#)

**Semisubmersible**

**Semi-sub Dicrostonyx groenlandicus**  
Dayrate: \$200,000  
Max Water Depth: 600m  
This rig is available

**Semi-sub Erignathus barbatus**  
Dayrate: \$210,000  
Max Water Depth: 600m  
This rig is available



# Block overview

Block 550						
Discovered Prospects						
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Quality Range (0-10 scale)	Volume Range (MBOE)	CO <sub>2</sub> amount
Alcatraz Island	2	11.9-13.4	229-260	6.2-7	685-989	<b>38%</b> Gas
Discovered CCS Prospects						
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Rate Range (0-10 scale)	Volume Range (Mt)	
Antigua	3	4.2-16	86-372	0.38-1.17	16-260	
Calculation of Licence Value						
Below you can see the calculation of the value of the licence when it is developed. Your share of the value is put on book.						
					Oil and Gas	
Total proven volume:					685 MBOE	
Total amount of CO <sub>2</sub> :					36 Mt	
Oil Price:					\$50 per barrel	
Production Tax Rate:					\$6 per barrel	
Number of reservoirs:					1 reservoirs	
Recovery Factor:					25%	

- Overview of all discovered reservoirs
- All information needed to complete worksheet 1 is here



# Block overview 2

The CO<sub>2</sub> content in the gas field(s) is higher than the threshold accepted by the customers. Gas fields that have more than 5% CO<sub>2</sub> content are considered unusable.

	No-Threshold	With threshold
Sales value:	\$4,294,967,295	\$0
Production Tax:	\$515,396,075	\$0
CO <sub>2</sub> Tax:	\$1,084,583,333	\$0
Drilling and Well Opex:	\$512,966,393	\$512,966,393
Drilling and Well Capex:	\$685,000,226	\$685,000,226
Facilities Opex:	\$170,988,798	\$170,988,798
Facilities Capex:	\$1,000,000,000	\$1,000,000,000
Total expenses:	\$3,968,934,826	\$2,368,955,417
Value of license:	\$326,032,469	-\$2,368,955,417
		\$0

Partners

Team	Share
team 1 (operator)	80%
NiceOil	20%

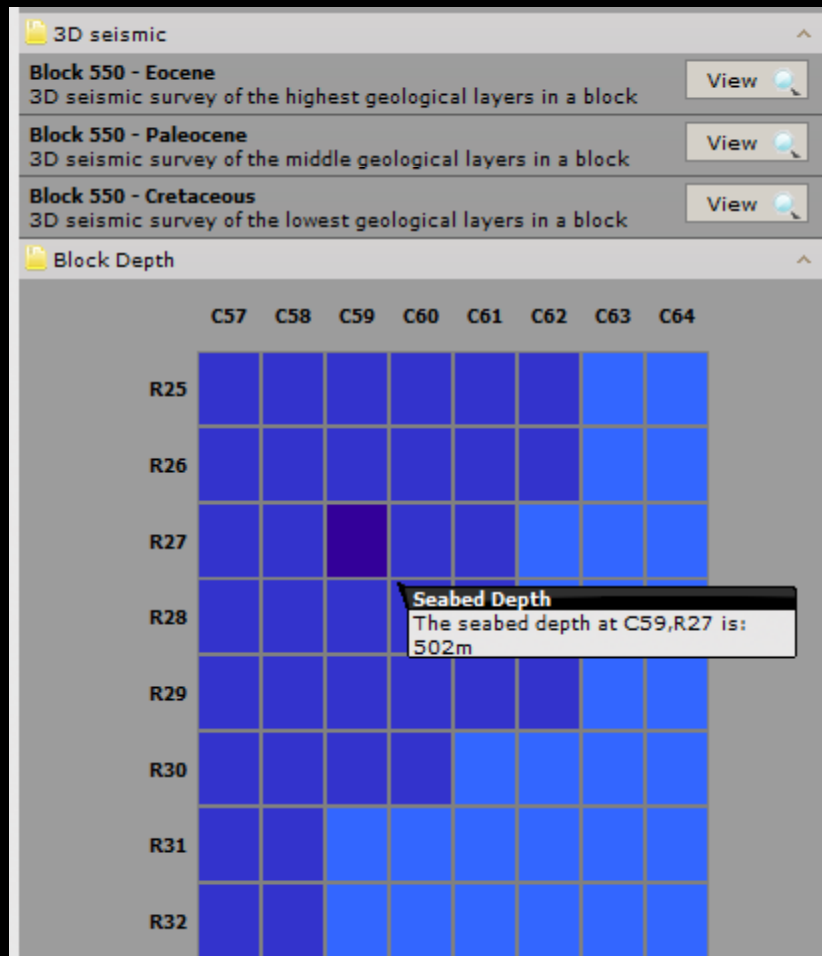
The wells in this licence block are tight. This means that very limited information is available to companies that do not own a share in the licence. To get more information, you need to farm-in.

3D seismic

Block 550 - Eocene \$400,000	Buy
Block 550 - Paleocene \$600,000	Buy
Block 550 - Cretaceous \$1,000,000	Buy

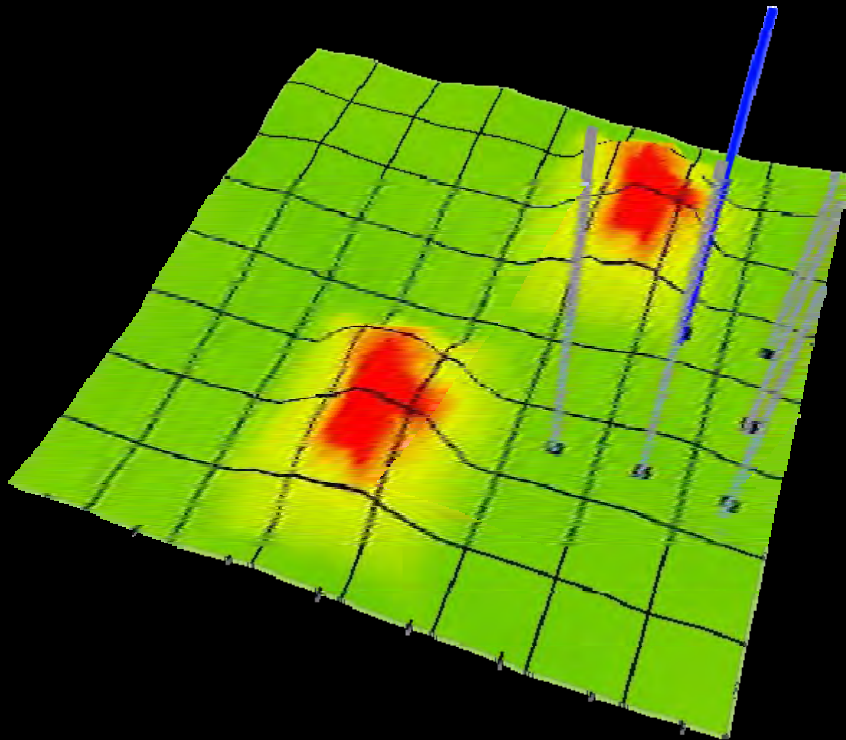
- Calculation of license value
- There are two columns:
  - First one assumes that the high CO<sub>2</sub> content would be accepted
  - Second shows the value with a 5% CO<sub>2</sub> threshold

# Block overview 3



- 3D interpretations of seismic surveys of the block
- Seabed depth
  - Hover the mouse over to see depth

# 3D interpretation



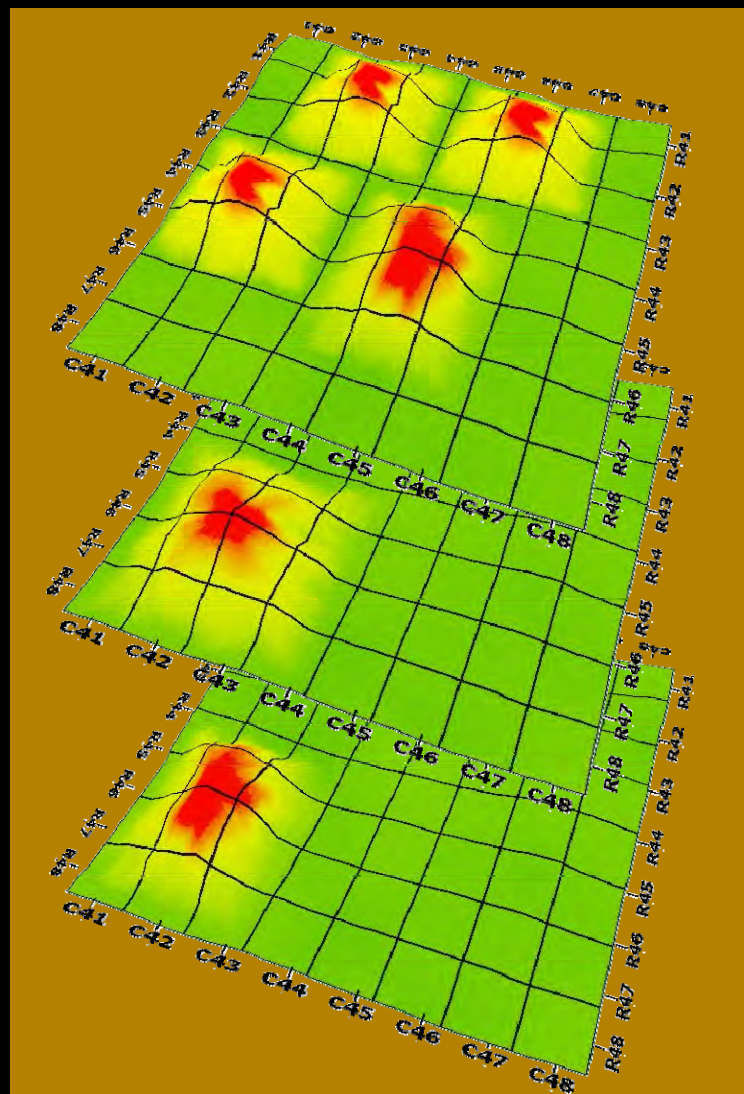
- Shows one of three geological horizons
- Prospect structures
- Exploration wells drilled - with colour coding depending on result

# Three horizons

Layer 3 Eocene

Layer 2 Paleocene

Layer 1 Cretaceous



# Drilling guide

Drilling Guide - Licence: 550

1 2 3 4 5 6 7 8

Select the rig that you want to use for drilling.

**Drillship**

- Drillship Alopes jagopus  
Dayrate: \$400,000  
Max. Water Depth: 1500m  
This rig is available
- Drillship Balansa glactalis  
Dayrate: \$420,000  
Max. Water Depth: 1500m  
This rig has a queue of 2 teams

**Semi-submersible**

- Semi-sub Dicostonyx groenlandicus  
Dayrate: \$200,000  
Max. Water Depth: 600m  
This rig is available
- Semi-sub Eriognathus barbatus  
Dayrate: \$210,000  
Max. Water Depth: 600m  
This rig is available

Drilling Guide - Licence: 550

1 2 3 4 5 6 7 8

Select the service providers that you want to use in your drill types of service providers to select.

**Analysis**

- Solv Analysis  
Dayrate: \$30,000
- Malus Analysis  
Dayrate: \$25,000
- Ulmus Analysis  
Dayrate: \$21,000
- Quercus Analysis  
Dayrate: \$18,000
- Betula Analysis  
Dayrate: \$15,000

**Shore Base**

- Port Malus  
Dayrate: \$10,000
- Port Quercus  
Dayrate: \$8,000
- Port Betula  
Dayrate: \$5,000
- Port Solv  
Dayrate: \$4,000
- Port Ulmus  
Dayrate: \$2,000

**Vessels**

- Ulmus Vessels  
Dayrate: \$50,000
- Quercus Vessels  
Dayrate: \$44,000
- Malus Vessels

Back

Drilling Guide - Licence: 550

1 2 3 4 5 6 7 8

Below you will see the overview of the drilling operation, check that all the details are correct before proceeding with drilling.

**Rig leased**

- Semi-sub Dicostonyx groenlandicus  
Dayrate: \$200,000  
Max. Water Depth: 600m  
You got 4 minutes left of oil lease time

**Providers selected**

- Solv Analysis  
Dayrate: \$30,000
- Port Malus  
Dayrate: \$10,000
- Ulmus Vessels  
Dayrate: \$50,000
- Betula Well Services  
Dayrate: \$60,000
- Quercus Always  
Dayrate: \$10,000

**Drilling positions**

	C37	C38	C39	C40	C41	C42	C43	C44		C37	C38	C39	C40	C41	C42	C43	C44		C37	C38	C39	C40	C41	C42	C43	C44
R25																										
R26																										
R27																										
R28																										
R29																										
R30																										
R31																										
R32																										

**Estimated drilling cost**

Drill/Well Control: Yes

Estimated cost for drilling: 16200000

is optimal

Back

Drilling Guide - Licence: 550

1 2 3 4 5 6 7 8

Select the position where the drill is going to enter the sub-sea.

	C37	C38	C39	C40	C41	C42	C43	C44
R25								
R26								
R27								
R28								
R29								
R30								
R31								
R32								

view 3d seismic

Back

Drilling Guide - Licence: 550

1 2 3 4 5 6 7 8

Select the position where you want to continue to drill to this

	C37	C38	C39	C40	C41	C42	C43	C44
R25								
R26								
R27								
R28								
R29								
R30								
R31								
R32								

view 3d seismic

Back

Drilling Guide - Licence: 550

1 2 3 4 5 6 7 8

Select the position where you want to continue to drill to this

	C37	C38	C39	C40	C41	C42	C43	C44
R25								
R26								
R27								
R28								
R29								
R30								
R31								
R32								

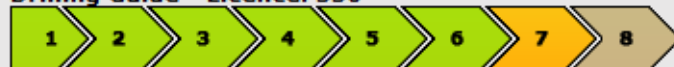
view 3d seismic

Back

# Drilling results



## Drilling Guide - Licence: 550



This is the result of your drilling, if you have found oil or gas

### Drilling Result

#### Appraisal well successful

You have drilled into a gas reservoir  
 You have drilled into a potential carbon storage reservoir

Estimated cost for drilling \$16,200,000

Drilling cost \$9,000,000

Knowledge Points: 0 of 10

### Prospect(30356): Antigua, Eocene

CO2 Injection rate  
 (Mb/year): 0.5 To 1.09

CO2 Volume (Mt):  
 46.94 To 243.61

Do you want to make tests to better assess the carbon storage potential?

### Prospect(30323): Albatross Island, Paleocene

Area Range (km2):  
 1.8 To 13.8


Thickness Range (m):  
 80 To 369

Quality Range (0-10  
 scale): 1.5 To 9



# Tick Testing check-boxes

**Drilling Guide - Licence: 550**



This is the result of your drilling, if you have found oil or gas you

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Estimated cost for drilling \$16,200,000  
 Drilling cost \$9,000,000  
 Knowledge Points: 0 of 10

---

**Prospect(30356): Antigua, Eocene**

CO2 Injection rate (Mb/year): 0.5 To 1.09

CO2 Volume (Mt): 46.94 To 243.61

Do you want to make tests to better assess the carbon storage potential?

---

**Prospect(30323): Albatross Island, Paleocene**

Area Range (km2): 1.8 To 13.8

Thickness Range (m): 80 To 369

Quality Range (0-10 scale): 1.5 To 9

Volume Range (MBOE): 9 To 1858


Do you want to test this well?

---

**Prospect(30307): Æbele, Cretaceous**

This prospect was dry, no need to examine it further

# Review testing results




**Drilling Guide - Licence: 550**

1
2
3
4
5
6
7
8

This is the final result of the drilling operation. If you want to


You have drilled into a potential carbon storage reservoir

**Testing cost:** \$3,600,000


 Prospect: Antigua, Eocene ^

CO2 Injection rate (Mb/year): 0.67 To 1.05 0.67 1.05

CO2 Volume (Mt): 77.5 To 226.25 77.5 226

 Prospect: Æbelø, Cretaceous ^

This prospect was dry, no need to examine it further

 Prospect: Albatross Island, Paleocene ^

Area Range (km2): 3.3 To 11.9 3.3 11.9

Thickness Range (m): 149 To 354 149 354

Quality Range (0-10 scale): 2.8 To 8.3 2.8 8.3

Volume Range (MBOE): 56 To 1417 56 1417

# Updated block tab

Block 550							
Discovered Prospects							
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Quality Range (0-10 scale)	Volume Range (MBOE)	CO <sub>2</sub> amount	
Albatross Island	2	3.3-11.9	149-354	2.8-8.3	56-1417	5%	Gas
Alcatraz Island	2	11.9-13.4	229-260	6.2-7	685-989	38%	Gas
Æbele	1	<i>No trap over prospect (dry prospect)</i>					
Discovered CCS Prospects							
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Rate Range (0-10 scale)	Volume Range (Mt)		
Antigua	3	10.7-16	166-324	0.67-1.05	78-226		

- Now it includes the new reservoirs and updated numbers for the reservoirs that we have drilled appraisal wells into

# Updated license value

## Calculation of Licence Value

Below you can see the calculation of the value of the licence when it is developed. Your share of the value is put on book.

	Oil and Gas
Total proven volume:	741 MBOE
Total amount of CO <sub>2</sub> :	37 Mt
Oil Price:	\$50 per barrel
Production Tax Rate:	\$6 per barrel
Number of reservoirs:	2 reservoirs
Recovery Factor:	25%
Discount rate:	10%
	With threshold
Sales value:	<b>\$2,774,510,745</b>
Production Tax:	\$332,941,289
CO <sub>2</sub> Tax:	\$0
Drilling and Well Opex:	\$554,902,985
Drilling and Well Capex:	\$741,001,116
Facilities Opex:	\$184,967,662
Facilities Capex:	\$1,000,000,000
Total expenses:	<b>\$2,813,813,052</b>
Value of license:	<b>\$-39,302,307</b>
	<b>\$0</b>

- Notice that the CO<sub>2</sub> amount that the Antigua structure can hold is higher than the total amount in the two gas reservoirs
- Thus we are past the threshold and do not need to pay any CO<sub>2</sub> tax

# 3 tools to solve the task

- Block overview

Block 550						
Discovered Prospects						
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Quality Range (0-10 scale)	Volume Range (MBOE)	CO <sub>2</sub> amount
Alcatraz Island	2	11.9-13.4	229-260	6.2-7	685-989	38% Gas

Discovered CCS Prospects					
Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Rate Range (0-10 scale)	Volume Range (Mt)
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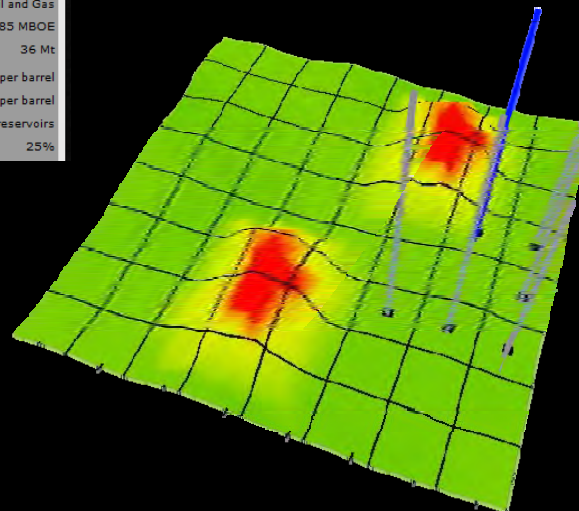
  

Calculation of Licence Value

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	Oil and Gas
Total proven volume:	685 MBOE
Total amount of CO <sub>2</sub> :	36 Mt
Oil Price:	\$50 per barrel
Production Tax Rate:	\$6 per barrel
Number of reservoirs:	1 reservoirs
Recovery Factor:	25%

- 3D seismic images



- Drilling guide

**Drilling Guide - Licence: 550**

Select the rig that you want to use for drilling.

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**Drillship**

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Dayrate: \$400,000  
Max Water Depth: 1500m  
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Dayrate: \$420,000  
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This rig has a queue of 1 teams [Details](#)

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Max Water Depth: 600m  
This rig is available

**Semi-sub Erignathus barbatus**  
Dayrate: \$210,000  
Max Water Depth: 600m  
This rig is available

# Solve the first task

- Drill into all structures in your block
- Complete worksheet 1



## Second task

- For the oil reservoir, each of the two gas reservoirs, and the carbon storage reservoir, drill enough appraisal wells so that the proven volume is at least half of the possible volume
- Procedure
  - Use the same tools as in challenge 1 to drill appraisal wells
  - Complete worksheet 2

# Proven and possible volumes

Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Quality Range (0-10 scale)	Volume Range (MBOE)	CO <sub>2</sub> amount	
Albatross Island	2	6-9.9	225-320	4.9-7.6	268-976	5%	Gas
Alcatraz Island	2	11.9-13.4	229-260	6.2-7	685-989	<b>38%</b>	Gas
Æbelø	1	<i>No trap over prospect (dry prospect)</i>					


## Discovered CCS Prospects

Prospect	Layer	Area Range (km <sup>2</sup> )	Thickness Range (m)	Rate Range (0-10 scale)	Volume Range (Mt)
Antigua	3	13.5-16	221-290	0.81-1	130-203

# Proven/Possible

- For Albatross Island
  - Proven: 268 MBOE
  - Possible: 976 MBOE
  - Ratio: 27%
- Get the ratio over 50% for all reservoirs

# Worksheet 2



**OilSim CCS Worksheet 2**

Team name: \_\_\_\_\_

License block number: \_\_\_\_\_

Time: \_\_\_\_\_

Calculate the license value

Item	Value	Unit
Total proven volume of oil and gas		MBOE
Total recoverable volume of proven oil and gas <i>Proven multiplied by recovery rate</i>		MBOE
Total proven CO <sub>2</sub> storage capacity		Mt
Total CO <sub>2</sub> amount		Mt
Estimated sales value Recoverable		\$
Estimated taxes <i>12% of sales value + CO<sub>2</sub> taxes</i>		\$
Estimated Operational expenses <i>Drilling and facilities</i>		\$
Estimated Capital expenses <i>Drilling and facilities</i>		\$
Estimated Value of license <i>Sales value minus taxes and expenses</i>		\$
Your share of the value 80%		\$

- Complete the calculation of the value of the license
  - As seen before the field development planning has started

# Review of exploration phase

- You have discovered all the reservoirs in your license block
  - Gas, Oil, Carbon storage
- You have found a preliminary solution to your CO<sub>2</sub> challenge, and it is commercially viable

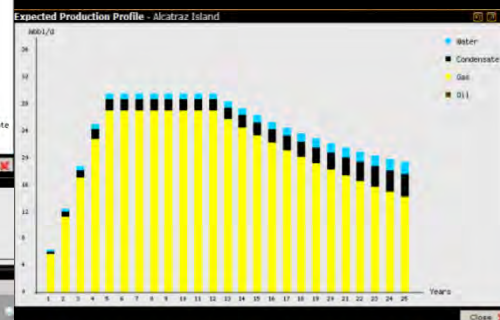
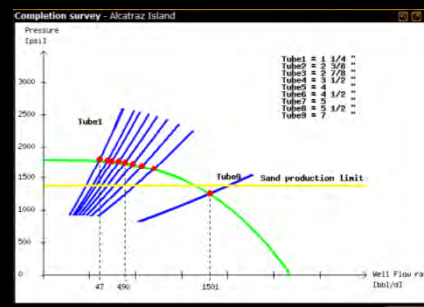
# Third task

- Make optimal drainage/injection plans for all reservoirs
  - Include increased oil recovery with CO<sub>2</sub> injection and injection plan for CO<sub>2</sub> storage reservoirs
- Procedure
  - Study completion surveys and expected production profile
  - Experiment with different well plans and examine resulting reservoir values
  - Complete worksheet 3



# 5 tools to solve the task

- Completion surveys
- Production profile
- Reservoir overview
- Reservoir information
- Well plan



Block Information

Due to hurricane activity the maximum number of drilling days for this block is 278.

Block Layers

Reservoir List

- Alcatraz Island
  - Layer: Paleocene
  - Proven volume: 268MBOE
  - 95
- Albatraz Island
  - Layer: Paleocene
  - Proven volume: 682MBOE
  - 95
- Achique
  - Layer: Escane
  - CO2 emplaced

Current Task

4. Drainage plan

Task Information

Your current assignment is to create a drainage plan that is part of a solution. There can only be one solution submitted at any time, but several solutions can be drafted.

Task Form

Solution Submitted

328 - Version: 1

Reservoir Information

Name: Albatraz Island  
 Reservoir Type: Gas  
 Proven volume: 268MBOE

Porosity: 13.86%  
 Permeability: 62.72md

Viscosity: 0.006Pa·s

Reservoir Pressure: 26250kPa  
 Expected recovery factor: 38.3%

Block Depth: 360m

Sales value: \$3,254,864,152  
 Production Tax: \$390,583,698

Drilling and Well Capex: \$1,288,000,000  
 Drilling and Well Opex: \$335,487,399

Reservoir value: \$1,240,793,055

Facilities Capex(all reservoirs): \$500,000,000  
 Facilities Opex(all reservoirs): \$599,084,641

Plan Wells

Plan the wells for the current reservoir.

CO<sub>2</sub> storage wells: 20

Tubing size: 7

Submit Close

# Worksheet 3

**OilSim CCS Worksheet 3**

Team name: \_\_\_\_\_ Time: \_\_\_\_\_

*Reservoir values with different tubing sizes and different number of wells*

Reservoir	MBOE	Tubing	Wells	Reservoir value	Chosen?
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
		-"		\$	
				Total	\$
				Facilities capex	\$
				Facilities opex	\$
				License value	\$

- For each reservoir list four possible well plans and the corresponding reservoir value
- Choose one for each and add up
- Subtract facilities capex and opex to get license value

# Reservoirs

Map
Surveys
Block 550
✕ Licenses
Reservoir

### Block Information

Due to hurricane activity the maximum number of drilling days for this block is 278. [Show all wells](#)

### Block Layers

### Licence Profile

### Reservoir List

- Licence: 550
  - Albatross Island**
  - Layer: Paleocene
  - Proven volume: 268MBOE gas
- Alcatraz Island**
  - Layer: Paleocene
  - Proven volume: 685MBOE gas
- Antigua**
  - Layer: Eocene
  - CCS prospect

### Current Task

- 4. Drainage plan
  - Task Information

Your current assignment is to create a drainage plan that is part of a solution, there can only be one solution submitted at any time, but several solutions can be drafted.

- Task Form
- Solution Submitted

- 328 - Version: 1

# Reservoir details

## Reservoir Information

**Name: Angoche Island**

Reservoir Type: Gas

Proven volume: 559MBOE

Porosity: 19.44%

Permeability: 195.88md

Viscosity: 0.019Pa·s

Reservoir Pressure: 15750kPa

# Buying surveys

Map | Surveys | Block 550 | Licenses | Reservoir

**Completion surveys acquired**

No surveys have been bought for this survey type.

**Expected Profile Acquired**

No surveys have been bought for this survey type.

**3D seismic surveys acquired**

**Block 550 - Cretaceous**  
3D seismic survey of the lowest geological layers in a block. [View](#)

[Send](#)

**Available Surveys**

- Completion survey
  - Completion survey - Albatross Island \$555,555 [Buy](#)
  - Completion survey - Alcatraz Island \$555,555 [Buy](#)
- Expected Production Profile
  - Expected - Albatross Island \$550,000 [Buy](#)
  - Expected - Alcatraz Island \$550,000 [Buy](#)
- 3D seismic

Map | Surveys | Block 550 | Licenses | Reservoir

**Completion surveys acquired**

- Completion survey - Alcatraz Island** [View](#)  
Inflow Performance Relationship and Tube Performance Relationship
- Completion survey - Albatross Island** [View](#)  
Inflow Performance Relationship and Tube Performance Relationship

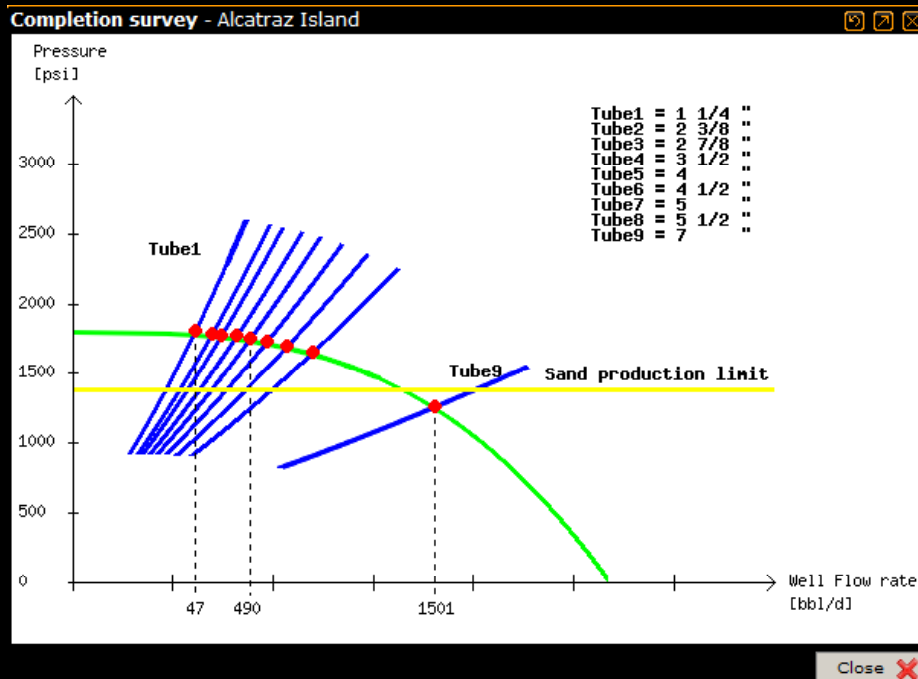
**Expected Profile Acquired**

- Expected Production Profile - Alcatraz Island** [View](#)  
This is a survey of the expected production profile for this prospect.
- Expected Production Profile - Albatross Island** [View](#)  
This is a survey of the expected production profile for this prospect.

**Available Surveys**

- Completion survey
- Expected Production Profile
- 3D seismic
- 2D seismic surveys
- Order surveys [Buy](#)
- Common Risk Segment
  - Eocene \$500,000 [Buy](#)
  - Paleocene \$500,000 [Buy](#)
  - Cretaceous \$500,000 [Buy](#)

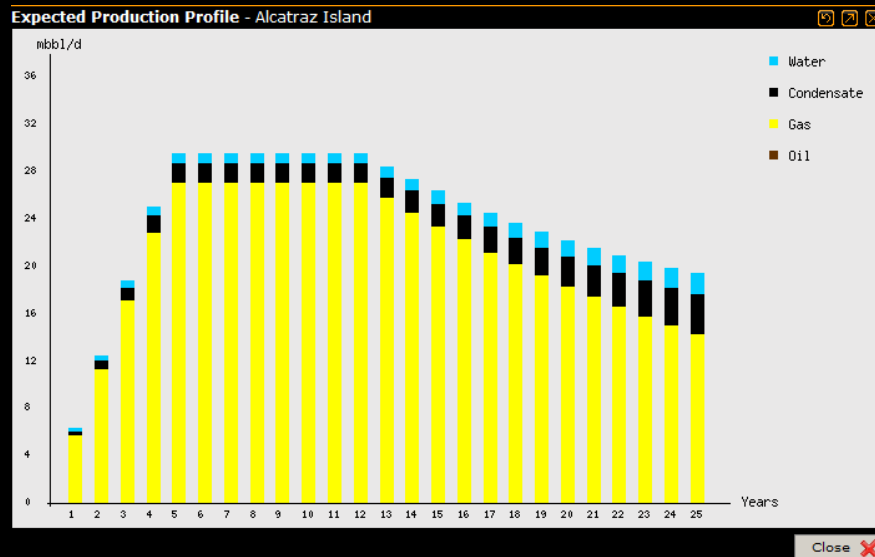
# Completion survey



- This shows the expected production in bbl/d with different well tubing sizes



# Expected production profile



- This shows the average production in each of the next 25 years with 25% recovery factor
- mbbl/d = 1000 BOE per day

# Well plans

**Plan Wells**  
Plan the wells for the current reservoir.

Production Wells

Tubing size

Submit

**Plan Wells**  
Plan the wells for the current reservoir.

CO<sub>2</sub> storage wells

Tubing size

Submit

**Plan Wells**  
Plan the wells for the current reservoir.

Production Wells

Tubing size

Gas Injection Wells

Tubing size

Water Injection Wells

Tubing size

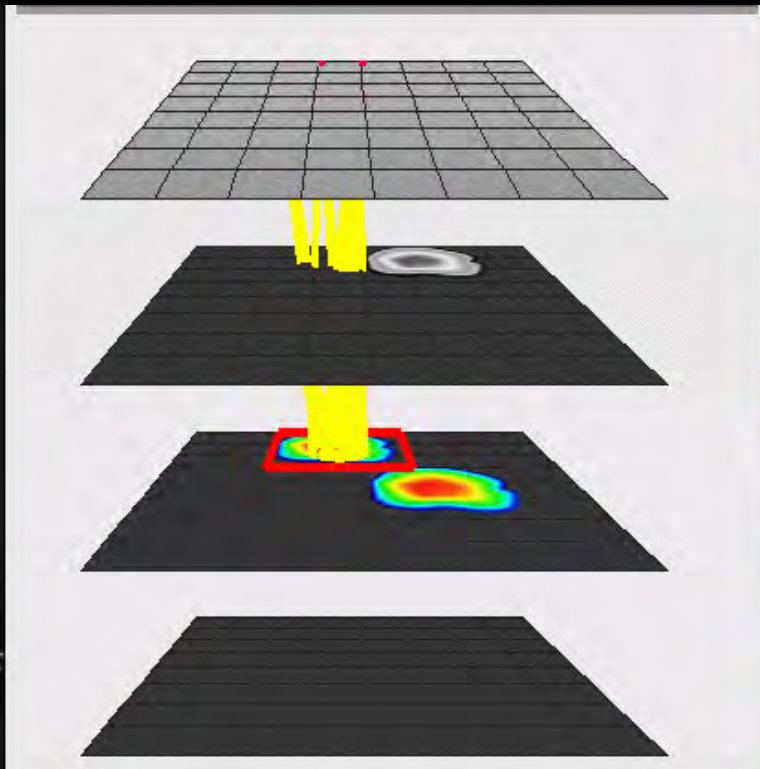
CO<sub>2</sub> injection wells

Tubing size

Submit

- Choose number and size of wells to drill in each reservoir

# Wells in the reservoir




**Reservoir Information**

**Name:** Albatross Island  
**Reservoir Type:** Gas  
**Proven volume:** 268MBOE

Porosity: 13.86%  
 Permeability: 62.72md

Viscosity: 0.006Pa·s

Reservoir Pressure: 26250kPa  
 Expected recovery factor: 38.3%



**Albatross Island**  
 Layer: Paleocene  
 Proven volume: 268MBOE  
 gas

**Alcatraz Island**  
 Layer: Paleocene  
 Proven volume: 685MBOE  
 gas

**Antigua**  
 Layer: Eocene  
 CCS prospect

**Current Task**

4. Drainage plan

Task Information

Your current assignment is to create a drainage plan that is part of a solution, there can only be one solution submitted at any time, but several solutions can be drafted.

Task Form

Solution Submitted

328 - Version: 1

Solution Draft

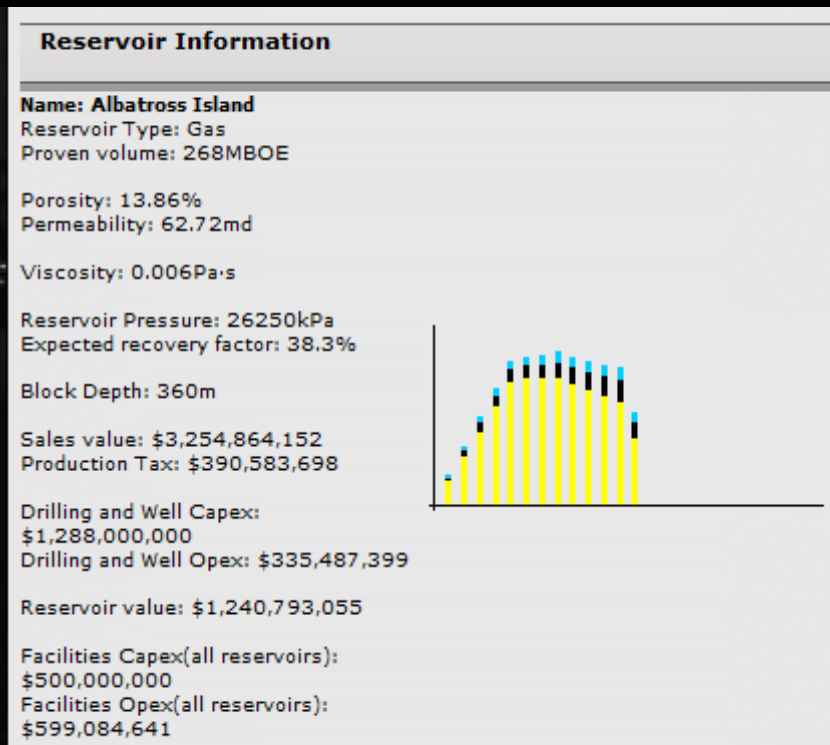
3. Partnering & Drilling

2. Bid for Licenses

1. Find Basins

- When you have made the well plan, the wells for that reservoir can be seen in the overview

# Updated reservoir information

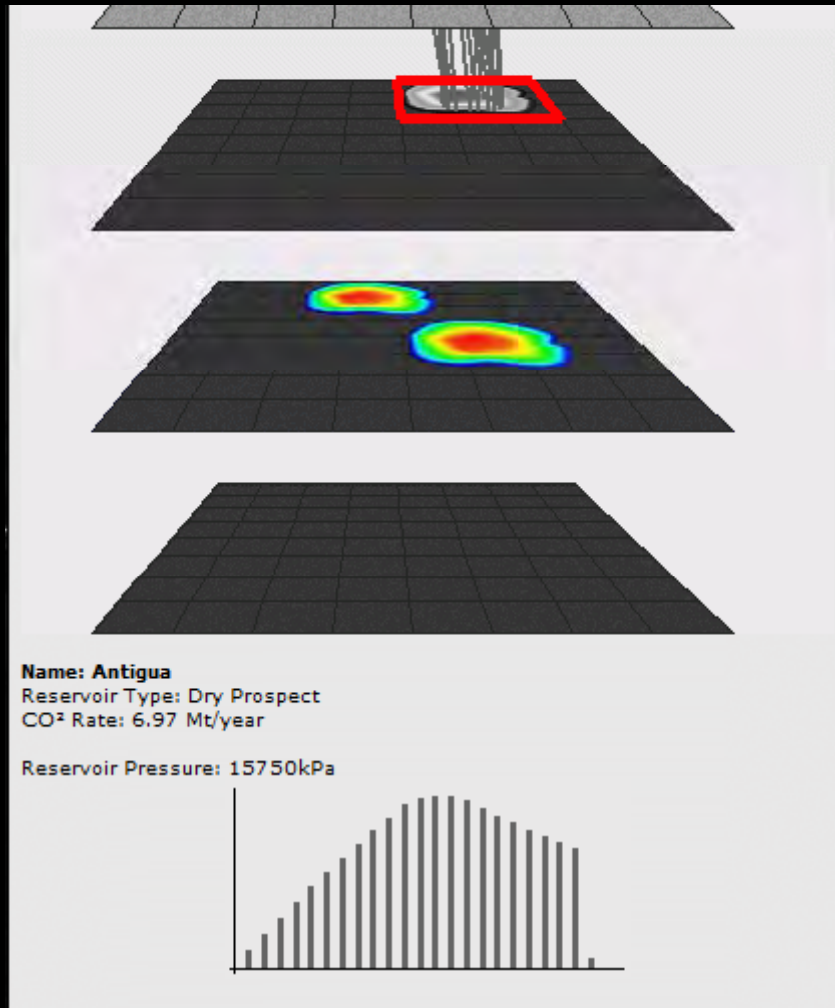


- When you have chosen a well plan the reservoir info is updated
- Recovery factor updated
- Detailed calculation of reservoir value

# Reservoir value

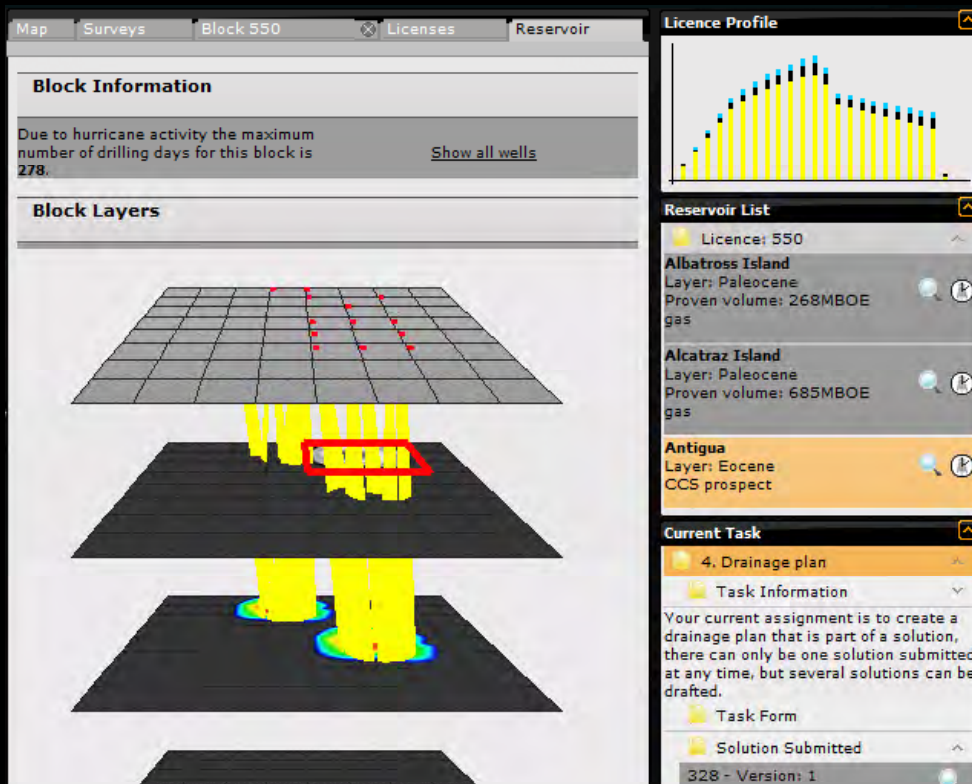
- Sales value
- - Taxes
- - Drilling and Well Capex
- - Drilling and Well Opex
- = Reservoir value
  
- License value =
  - Sum (Reservoir values)
  - - Facilities capex and opex

# Updated CO<sub>2</sub> storage info



- The CO<sub>2</sub> rate shows how much carbon will be injected per year with the current well plan
- Measured in million tonnes per year (Mt/year)

# Show all wells



The screenshot displays the OilSim 3 interface with the following components:

- Block Information:** A text box stating "Due to hurricane activity the maximum number of drilling days for this block is 278." with a "Show all wells" link.
- Block Layers:** A 3D visualization showing a grid of wells on a surface, with a red box highlighting a specific well. Below it, a cross-section view shows the well's structure and its connection to the reservoir.
- Licence Profile:** A bar chart showing the distribution of wells across different licence profiles.
- Reservoir List:** A list of reservoirs with details:
  - Albatross Island:** Layer: Paleocene, Proven volume: 268MBOE gas
  - Alcatraz Island:** Layer: Paleocene, Proven volume: 685MBOE gas
  - Antigua:** Layer: Eocene, CCS prospect
- Current Task:** A task titled "4. Drainage plan" with a "Task Information" section containing the text: "Your current assignment is to create a drainage plan that is part of a solution, there can only be one solution submitted at any time, but several solutions can be drafted." Below this are sections for "Task Form" and "Solution Submitted".

- Click on the Show all wells link to see all planned wells in all reservoirs

# Optimum drainage plan

- Use the expected production profile and completion graphs as starting points
  - Beware to have tubing sizes narrow enough so that the reservoirs are not destroyed
- Experiment with different number of wells and different tubing sizes to find
  - The highest license value for each oil or gas reservoir
  - The least number of wells for each carbon storage reservoir needed to store the captured CO<sub>2</sub>

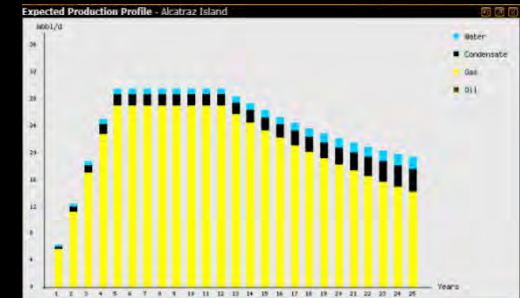
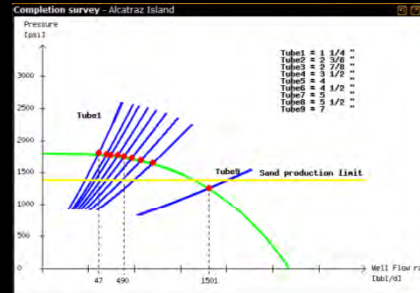


# Caveats

- Remember to make well plans for all reservoirs
- The license value calculation in the block tab is NOT updated before the deadline
- If you choose too wide tubing sizes, the value of that reservoir will be zero

# 5 tools to solve the task

- Completion surveys
- Production profile
- Reservoir overview
- Reservoir information
- Well plan



**Reservoir Information**

**Name:** Albatross Island  
**Reservoir Type:** Gas  
**Proven volume:** 268MBOE

**Porosity:** 13.86%  
**Permeability:** 62.72md

**Viscosity:** 0.006Pa·s

**Reservoir Pressure:** 26250kPa  
**Expected recovery factor:** 38.3%

**Block Depth:** 360m

**Sales value:** \$3,254,864,152  
**Production Tax:** \$390,583,698

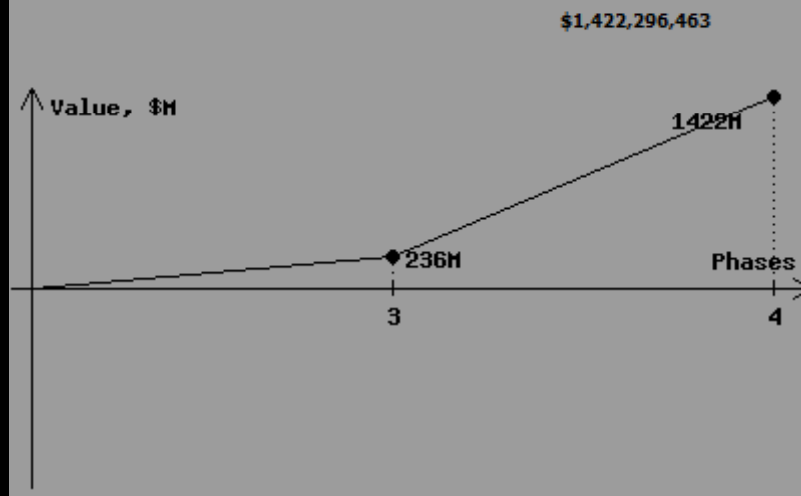
**Drilling and Well Capex:** \$1,288,000,000  
**Drilling and Well Opex:** \$335,487,399

**Reservoir value:** \$1,240,793,055

**Facilities Capex(all reservoirs):** \$500,000,000  
**Facilities Opex(all reservoirs):** \$599,084,641

# Review of third task

Sales value:	\$8,345,227,937
Production Tax:	\$1,001,427,352
Recovery Factor:	39%
Discount rate:	10%
Drilling and Well Capex:	\$3,088,000,000
Drilling and Well Opex:	\$734,877,160
Facilities Capex:	\$1,200,000,000
Facilities Opex:	\$898,626,962
Total expenses:	\$6,922,931,474



- Your recovery factor has gone up
- Increased sales value, increased taxes
- Adjusted drilling and well capex and opex
- Graph shows changes in net present value

# Review

## Drainage Plan Evaluation

From: System, Sent: 24 September 14:11:50

The solution that your team has submitted the result for the licence value is displayed in the block page for the individual blocks and the result for the knowledge points awarded are below.

Knowledge point acquired for your solution:

Optimal number of wells: 26 / 25 KP  
 Tube Size: 25 / 50 KP

Total: 51 / 100 KP

Reservoir: Albatross Island


Optimal Tube Size: **5 1/2"** - Your choice was: **5 1/2"**  
 Optimal Number of Wells: **29** - Your choice was: **56**  
 Optimal Value: **\$1,839,600,516** - Your choice was: **\$1,240,793,055**

Reservoir: Alcatraz Island

Optimal Tube Size: **5 1/2"** - Your choice was: **4 1/2"**  
 Optimal Number of Wells: **52** - Your choice was: **100**  
 Optimal Value: **\$3,469,061,602** - Your choice was: **\$2,280,130,370**

Team	Credibility points
------	--------------------

team 1	51
--------	----

Close 

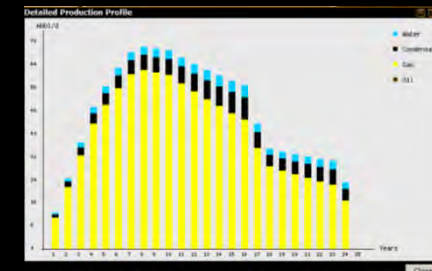
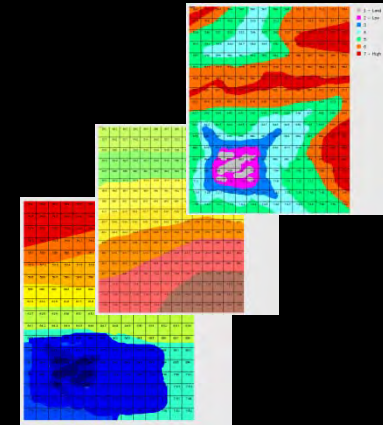
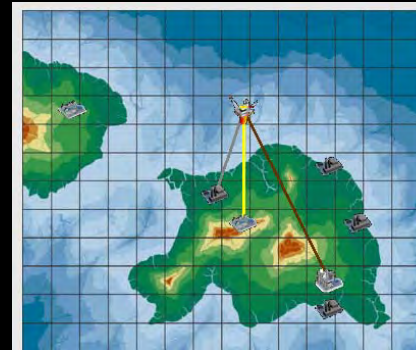
- You can update your well plan according to this, but do it before the facilities plan

# Fourth task

- Choose production platform and plan the necessary capacities and connections
  - CO<sub>2</sub> separation and compression capacities
  - Connect to external CO<sub>2</sub> sources
- Procedure
  - Study the detailed production profile and the environmental surveys
  - Examine oil and gas terminals and potential onshore sources of CO<sub>2</sub>
  - Choose platform type, capacities, connections
  - Complete worksheet 4

# 6 tools to solve the task

- Onshore facilities to connect to
- Environmental maps
- Detailed production profile
- Platform parameters
- Pipeline and flowline capacities
- Platform capacities and connections



Parameters	
Max seabed depth in meters	2400 m
Max separation & compression capacity	500 mbbbl/d
Earthquake resistance	MEDIUM
Hurricane resistance	HIGH
Waveheight resistance	MIDH
CAPEX min cost of rig	\$100,000,000
Opex operating cost per year	\$50,000,000
Max water treatment capacity for rig	150 mbbbl/d
Max oil stabilization capacity for rig	100 mbbbl/d
Max gas compression capacity for rig	500 mbbbl/d
Max condensate stabilization capacity for rig	100 mbbbl/d

Water treatment capacity(\$1,000 bbl/d)	4	mbbl/d
Oil stabilizing capacity(\$5,000 bbl/d)	0	mbbl/d
Gas compression capacity(\$5,000 bbl/d)	60	mbbl/d
Condensate stabilizing capacity(\$5,000 bbl/d)	8	mbbl/d
CO2 compression & separation(\$36,000 mt/d)	18	mt/d
Flowline diameters	13 3/8" Count: 7	
Gas terminal Block No.: 606 Pipeline diameter	100" <input checked="" type="checkbox"/>	
Oil storage facility Block No.: 637	13 3/8" <input checked="" type="checkbox"/>	
Oil-fired power plant Block No.: 591 Pipeline diameter	40" <input checked="" type="checkbox"/>	
Gas-fired power plant Block No.: 610 Pipeline diameter	7" <input type="checkbox"/>	
Oil-fired power plant Block No.: 651	7" <input type="checkbox"/>	


Approximate Capital Expenses: \$ 474,452,339  
 Approximate Operational Expenses: \$ 53,729,293

Transport Information			
On the page below there is information			
Clonis	5"	125mm	3,927 bbl/d
Cryses	5 1/2"	137.5mm	4,304 bbl/d
Clio	7"	175mm	5,498 bbl/d
Clytia	9 5/8"	241mm	7,571 bbl/d
Crenus	13 3/8"	334.375mm	10,493 bbl/d

Pipeline Catalogue			
Name	Size	Size	Estimated Rate
	7"	177.8mm	5,586 bbl/d
	9 5/8"	193.675mm	6,084 bbl/d
	13 3/8"	339.725mm	10,673 bbl/d
	36"	914.4mm	28,727 bbl/d
	40"	1000mm	31,416 bbl/d
	50"	1250mm	39,270 bbl/d
	60"	1500mm	47,124 bbl/d
	100"	2500mm	78,540 bbl/d

# Worksheet 4



**OilSim CCS Worksheet 4**

Team name: \_\_\_\_\_ Time: \_\_\_\_\_

*Risk adjustment*

	Hurricanes	Earthquakes	Waveheight	Total
Environmental risk				
Chosen platform risk				
Risk adjustment	%	%	%	

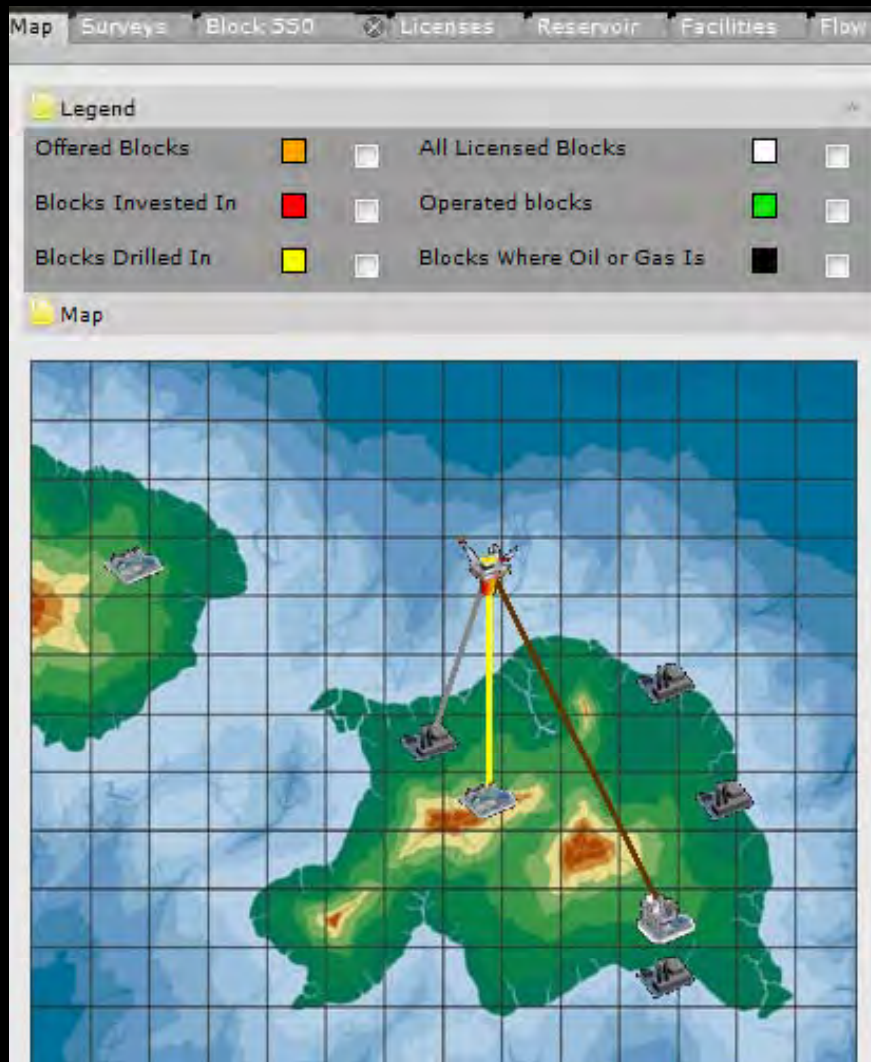
*Facilities cost*

		CAPEX	OPEX
Base cost of platform		\$	\$
Platform capacities	Oil	\$	\$
	Gas		
	Cond		
	Water		
	CO <sub>2</sub>		
Flowline length	km	\$	\$
Pipeline length	km	\$	\$
Total		\$	\$

- Specify capacities chosen and calculate facilities costs



# Onshore facilities



- Gas terminals
  - To receive any gas
- Oil storage
  - To receive any oil and condensate
- Power plants
  - Need to store CO<sub>2</sub> and are willing to pay




# Power plant prices and volumes

**Select Onshore Facility**

Select between all the onshore facilities within block 591, you can make changes to the facilities that belong to your team, and view information about facilities belonging to other teams.

Oil-fired power plant



This power plant is fired by oil (which is supplied from elsewhere), and they need a solution to store the CO<sub>2</sub> which comes from burning the oil.

**CO<sub>2</sub> Price:** \$50

**CO<sub>2</sub> Production:** 120000 t/y

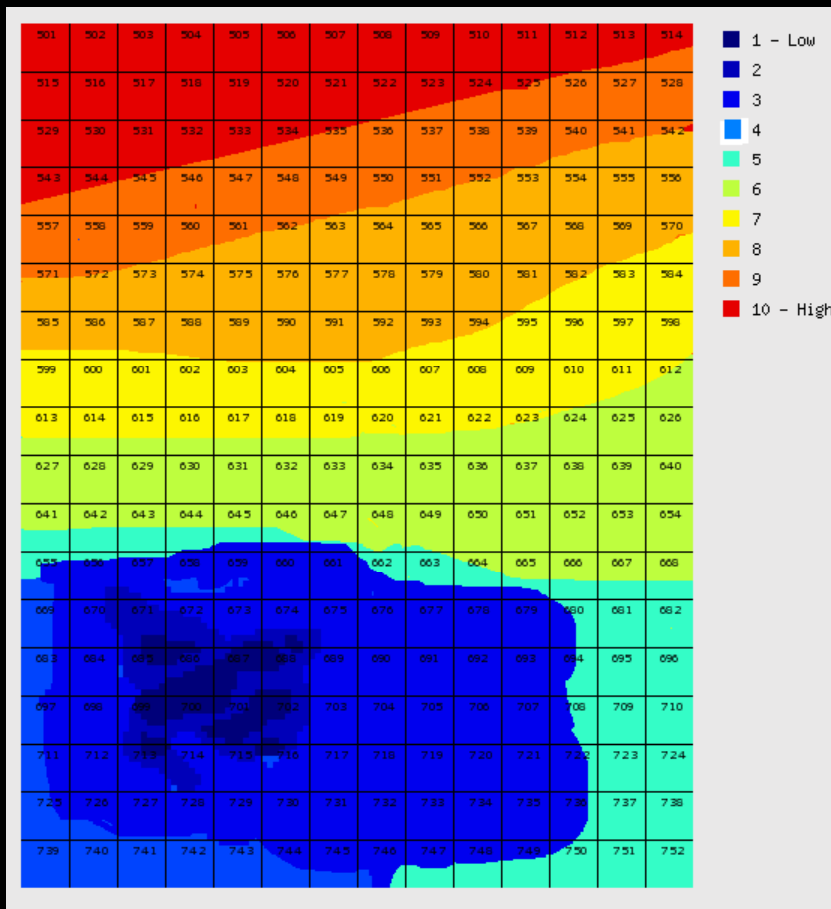
**Teams connected to facility:**

team 1 is storing: 120000 t/y

- Each plant has a yearly production and is offering you a premium to store their CO<sub>2</sub>
- CO<sub>2</sub> is distributed evenly between all teams that connect to a given plant

# Hurricane maps

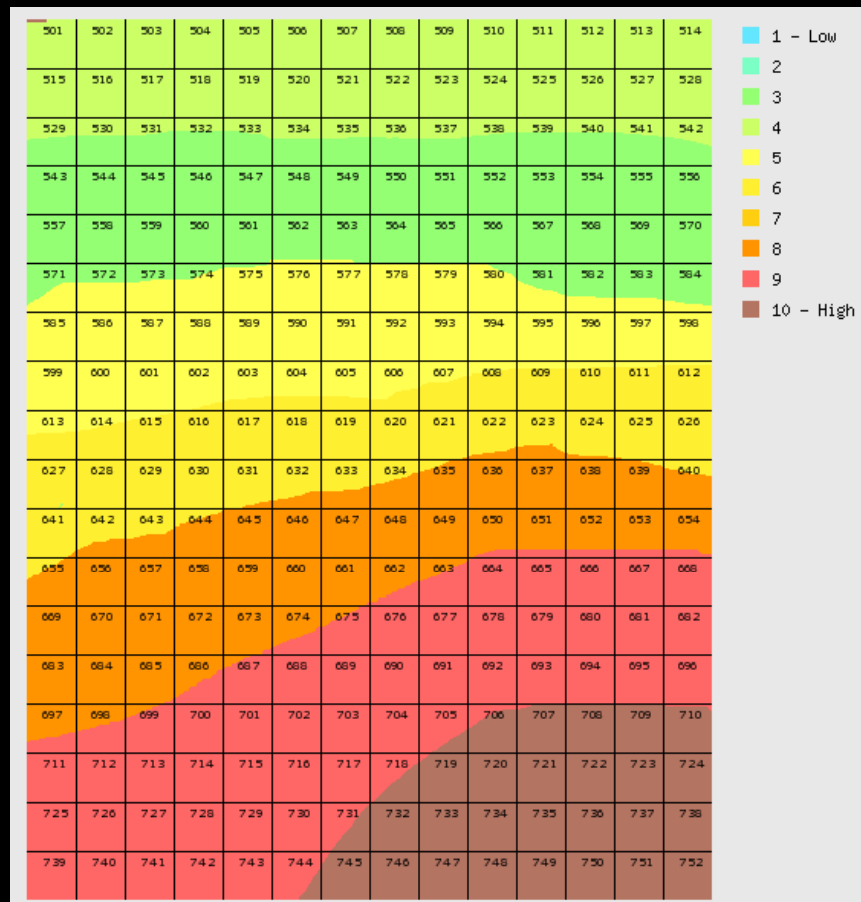
- Three risk groups



1-3 Low  
4-7 Medium  
8-10 High

# Earthquake maps

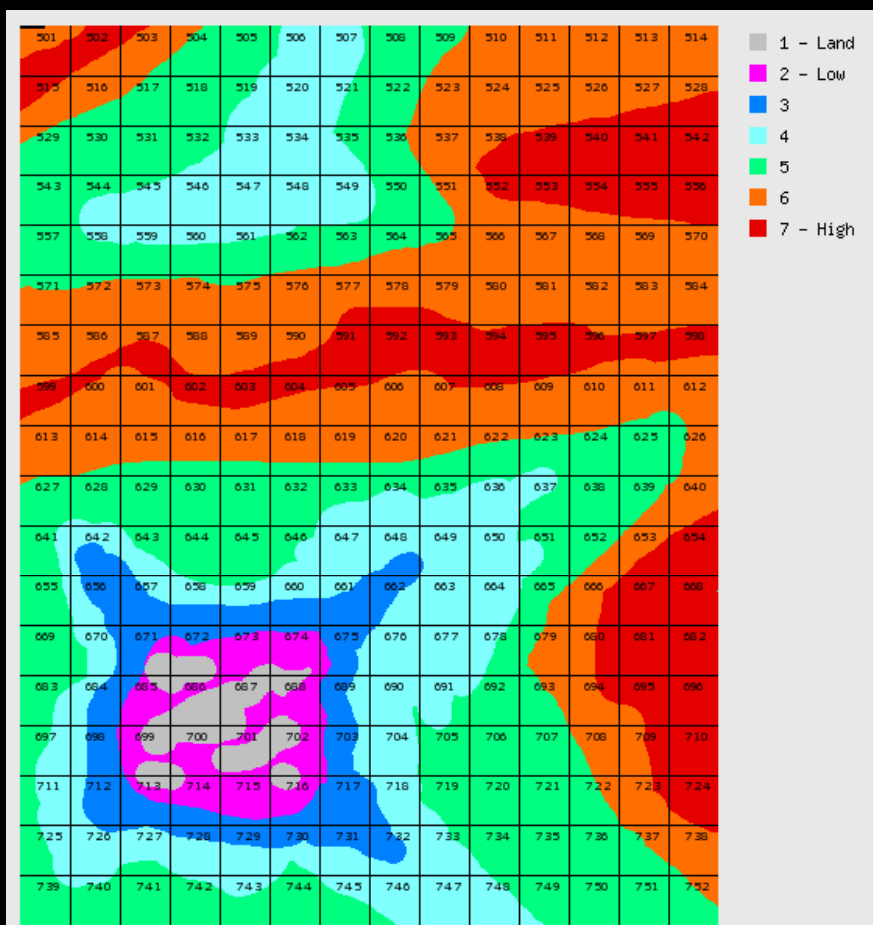
- Three risk groups



1-3 Low  
4-7 Medium  
8-10 High

# Waveheight map

- Three risk groups



2-3 Low  
4-5 Medium  
6-7 High

# Platform types and resistance

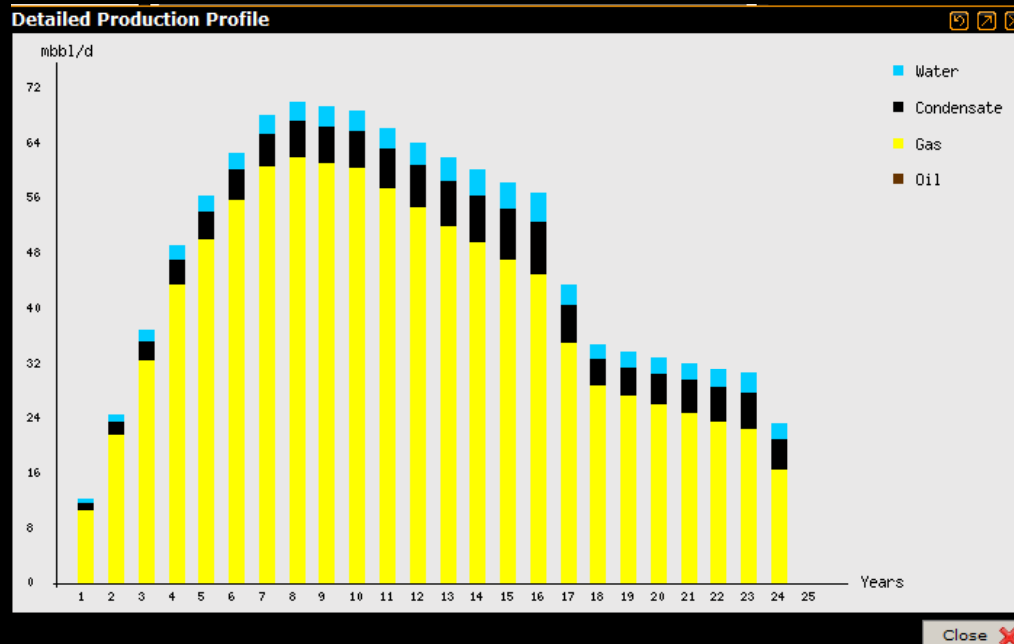
	Hurricane	Earthquake	Waveheight
Jack-up	medium	low	Medium
Semi-submersible	medium	high	Medium
FPSO	medium	high	Medium
Spar	high	medium	High
Tension Leg	medium	medium	Medium
Steel Jacket	low	low	high
Compliant Tower	high	medium	high
Gravity-based	medium	high	high

# Consequences of choices

- If you choose a platform that is not suitable for the water depth, there will be no production
- The discount rate is an expression of the risk in the project
  - The base discount rate is 10%
- The environmental risk groups are compared to the rig's capabilities, and adjustments are made to the financial discount rate. For each of the 3 environmental maps:

	Low risk area	Medium risk area	High risk area
Low rig capability	-2%	0%	+5%
Medium rig capability	-2.5%	-2%	0%
High rig capability	-3%	-2.5%	-2%


# Detailed production profile



- Determine the maximum production for each component (oil, gas, condensate, water)



# Study flow capacities

 <b>Transport Information</b> On the page below there is information			
Cloris	5"	125mm	3,927 bbl/d
Cryses	5 1/2"	137,5mm	4,304 bbl/d
Clio	7"	175mm	5,498 bbl/d
Clytia	9 5/8"	241mm	7,571 bbl/d
Cronus	13 3/8"	334,375mm	10,493 bbl/d

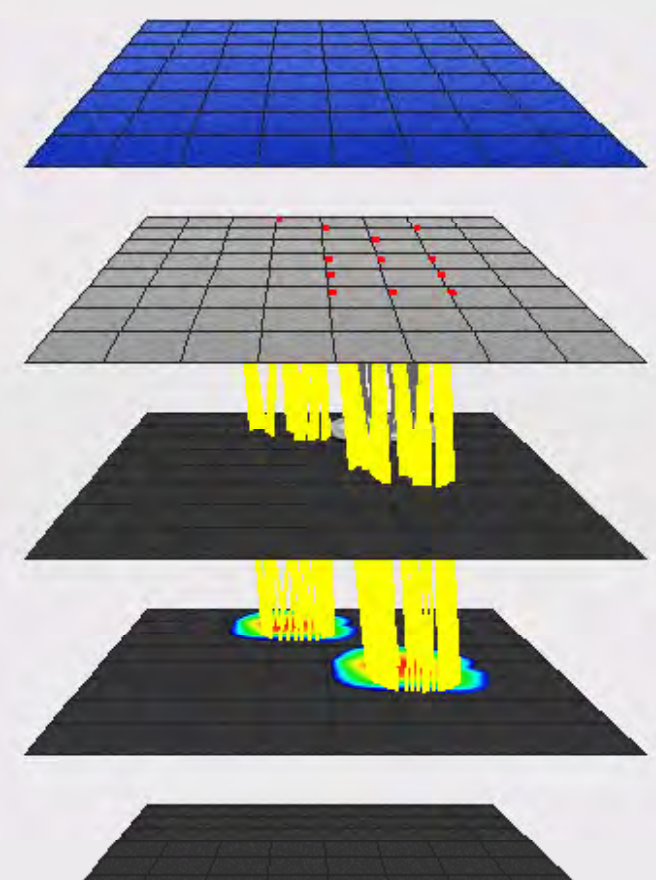
  

Pipeline Catalogue			
Name	Size	Size	Estimated Rate
	7"	177.8mm	5,586 bbl/d
	9 5/8"	193.675mm	6,084 bbl/d
	13 3/8"	339.725mm	10,673 bbl/d
	36"	914.4mm	28,727 bbl/d
	40"	1000mm	31,416 bbl/d
	50"	1250mm	39,270 bbl/d
	60"	1500mm	47,124 bbl/d
	100"	2500mm	78,540 bbl/d

- Click on Transport Information
- Flowline = connection from wellhead to platform
- Pipeline = connection from platform to onshore terminal

# Choose platform type

Map Surveys Block 550 ✕ Licenses Reservoir Facilities Plan Flow



**Tools**

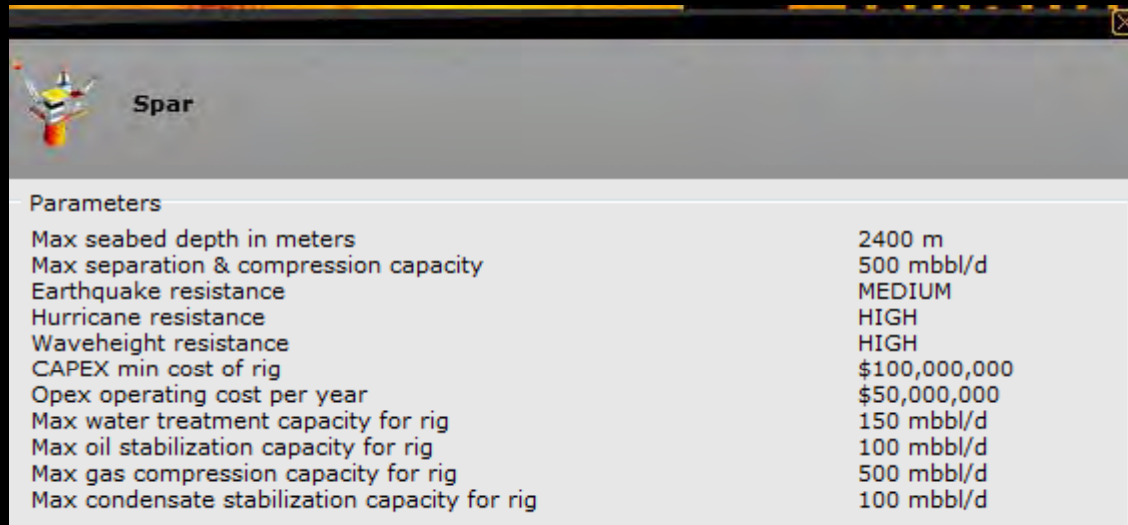
- Jack-up Platform
- Semi-submersible Platform
- Spar
- Gravity-based Production Platform
- Steel-jacket Production Platform
- Tension Leg Production Platform
- CTP Platform
- FPSO

**Current Task**

5. Field Infrastructure

- Task Information
- Task Form
- Solution Submitted
- 328 - Version: 1
- Solution Draft
- 4. Drainage plan
- 3. Partnering & Drilling
- 2. Bid for Licenses






# Study platform characteristics



Parameters	
Max seabed depth in meters	2400 m
Max separation & compression capacity	500 mbb/d
Earthquake resistance	MEDIUM
Hurricane resistance	HIGH
Waveheight resistance	HIGH
CAPEX min cost of rig	\$100,000,000
Opex operating cost per year	\$50,000,000
Max water treatment capacity for rig	150 mbb/d
Max oil stabilization capacity for rig	100 mbb/d
Max gas compression capacity for rig	500 mbb/d
Max condensate stabilization capacity for rig	100 mbb/d

- Each platform type has a maximum water depth, a risk profile, and maximum capacities for separation and compression

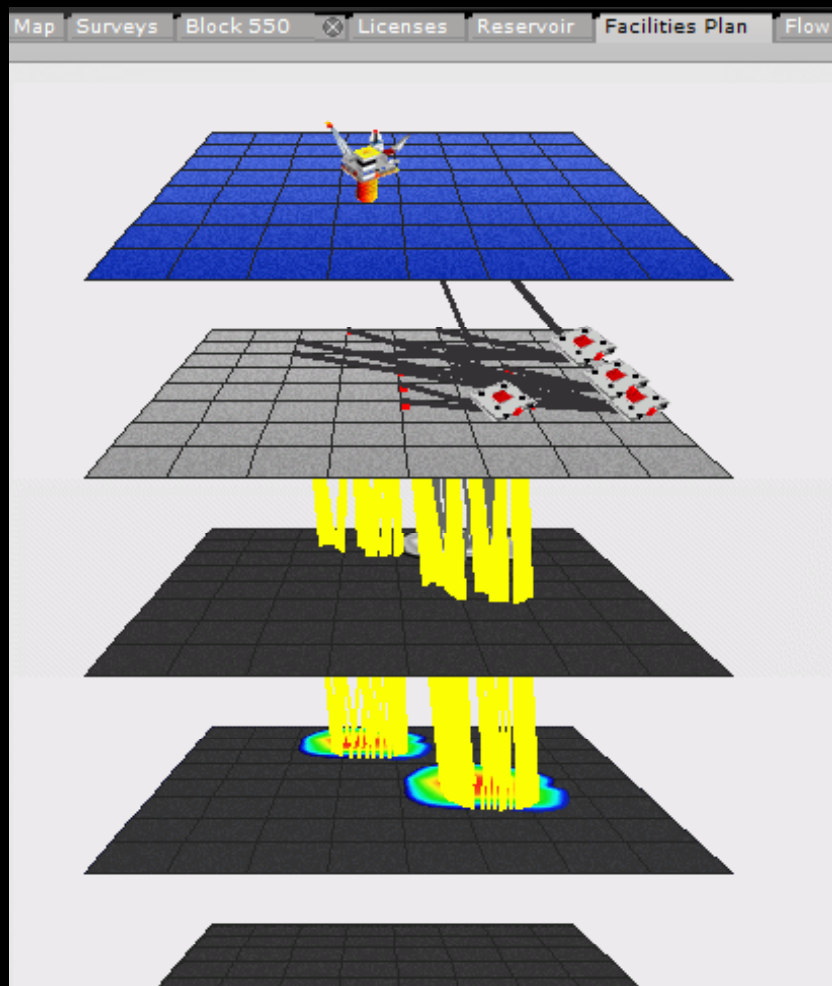
# Specify capacities and diameters

Water treatment capacity(\$1,000 bbl/d)	<input type="text" value="4"/>	mbbl/d
Oil stabilizing capacity(\$5,000 bbl/d)	<input type="text" value="0"/>	mbbl/d
Gas compression capacity(\$5,000 bbl/d)	<input type="text" value="60"/>	mbbl/d
Condensate stabilizing capacity(\$5,000 bbl/d)	<input type="text" value="8"/>	mbbl/d
CO2 compression & separation(\$36,000 mt/d)	<input type="text" value="18"/>	mt/d
Flowline diameters	<input type="text" value="13 3/8"/> Count: <input type="text" value="7"/>	
 Gas terminal Block No.: 606 Pipeline diameter	<input type="text" value="100"/>	<input checked="" type="checkbox"/>
 Oil storage facility Block No.: 637	<input type="text" value="13 3/8"/>	<input checked="" type="checkbox"/>
 Oil-fired power plant Block No.: 591 Pipeline diameter	<input type="text" value="40"/>	<input checked="" type="checkbox"/>
 Gas-fired power plant Block No.: 610 Pipeline diameter	<input type="text" value="7"/>	<input type="checkbox"/>
 Oil-fired power plant Block No.: 651	<input type="text" value="7"/>	<input type="checkbox"/>

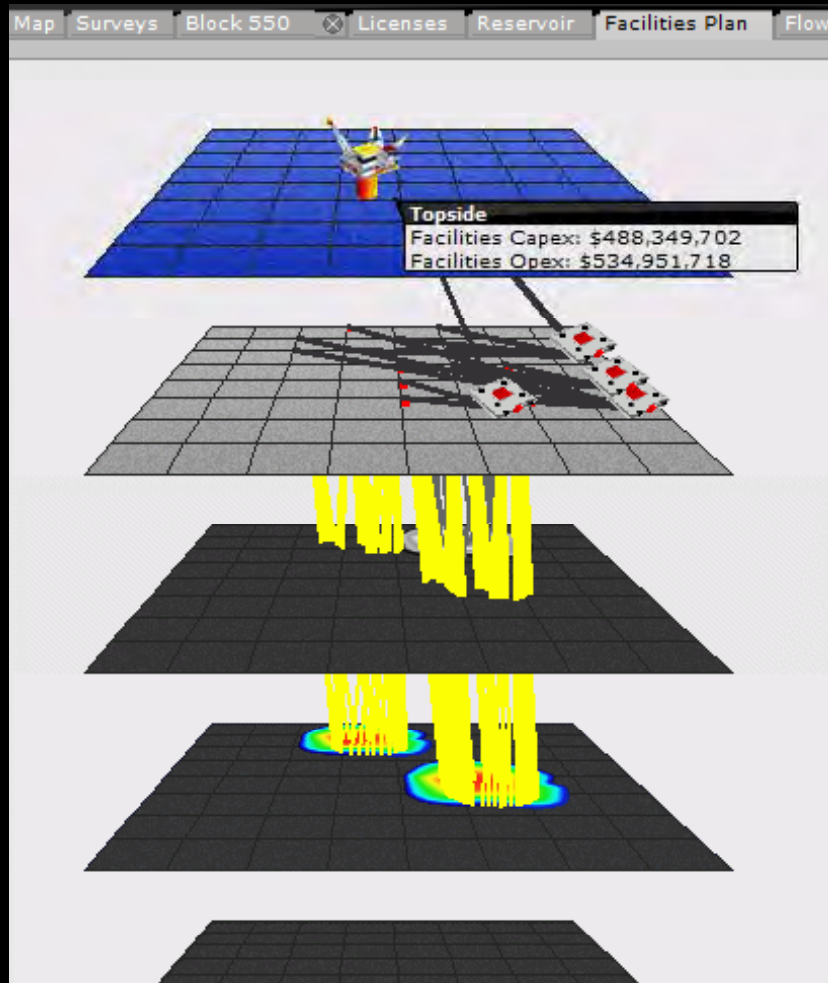
Approximate Capital Expenses: \$ 474,482,339  
Approximate Operational Expenses: \$ 53,729,293

- Capacities are measured in 1000 bbl/d and 1000 t/d
- Diameters are in inches
- Tick the checkboxes for each onshore facility that you want to connect to

# Diagram of selected solution

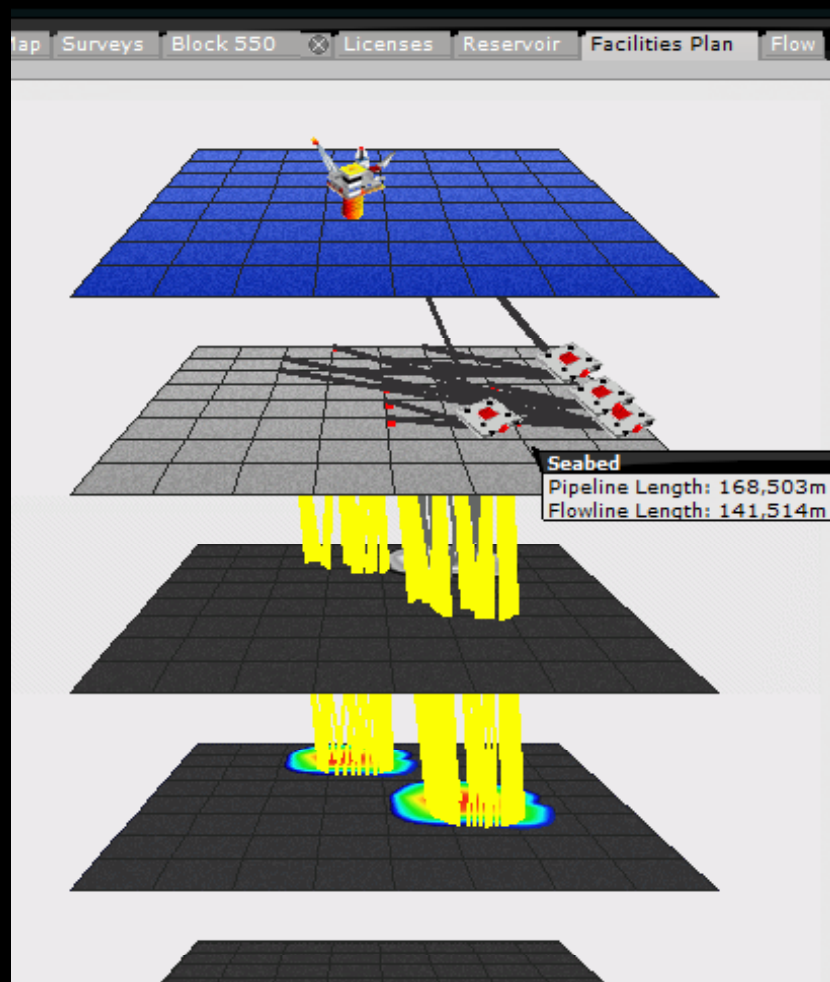


# Facilities cost



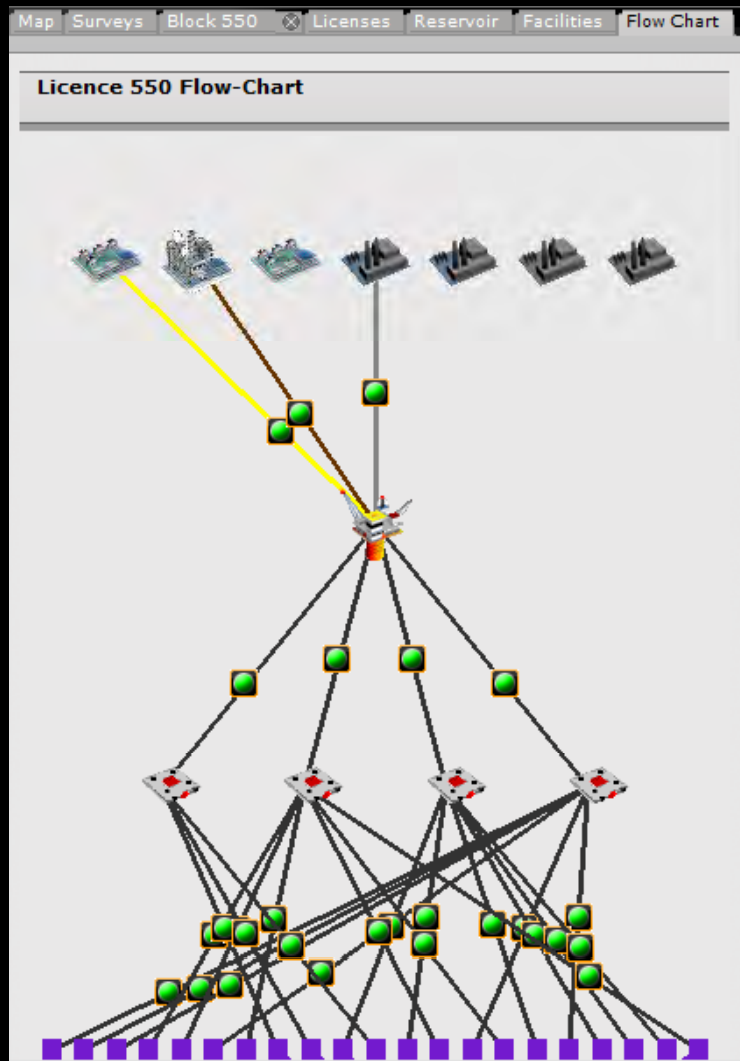


# Flowline and pipeline length



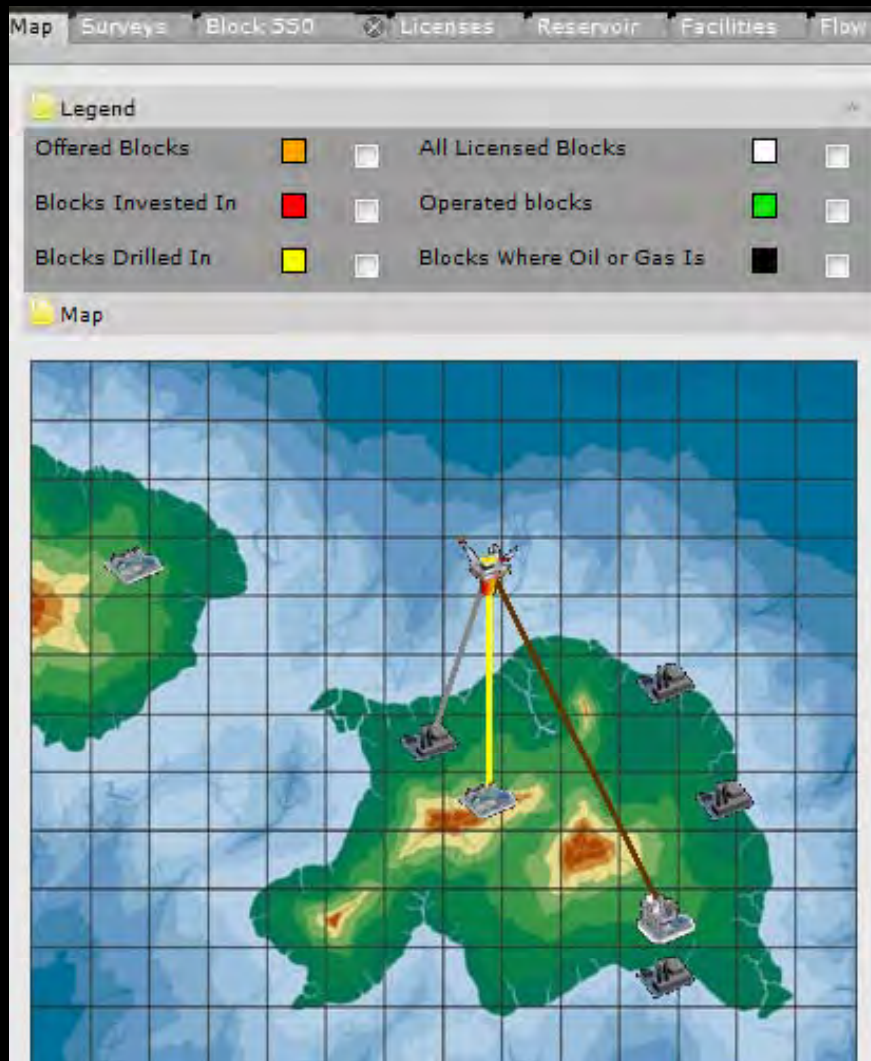


# Flow-chart of the solution



- Green means that the fluid or gas is flowing as it should
- Yellow means that there are limitations to the flow
- Red means that the flow is practically stopped

# Overview map



- See full infrastructure for all teams in the Map tab

# Solve task 4

- Choose platform type, capacities, connections
- Complete worksheet 4

# Review of task 4

- Credibility Points
- Adjusted license value
- To what extent did it make sense to connect to external sources?
- Were the pipeline costs prohibitive?

## Field Infrastructure Evaluation

From: System, Sent: 24 September 16:43:46

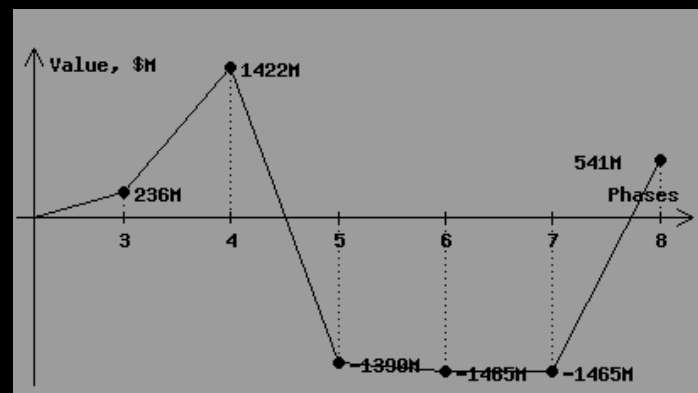
The solution that your team has submitted the result for the I the result for the credibility points awarded are below.

credibility point acquired for your solution:

Optimal flow-line capacity: 5 / 10 KP  
 Oil Stabilizing Capacity: 10 / 10 KP  
 Gas Processing Capacity: 10 / 10 KP  
 Water Treatment Capacity: 10 / 10 KP  
 Condensate Stabilizing Capacity: 10 / 10 KP  
 Gas Pipeline Capacity: 3 / 5 KP  
 Oil Pipeline Capacity: 0 / 5 KP  
 Functional Platform: 10 / 10 KP  
 Hurricane Resistance: 10 / 10 KP  
 Earthquake Resistance: 5 / 10 KP  
 Waveheight Resistance: 10 / 10 KP

Total: 83 / 100 KP

Team	Credibility points
team 1	83



# Worksheet 5

- What were the two main sources of CO<sub>2</sub> in the OilSim exercise?
- Why did it make sense to store the CO<sub>2</sub>?
- What do you think are the real-life challenges in capturing the CO<sub>2</sub> in these cases?
- What were the two main CO<sub>2</sub> storage options in the OilSim exercise?
- What are the economical limits when storing CO<sub>2</sub>?
- What real-life challenges do you envisage when storing CO<sub>2</sub> in these cases?

# Debriefing

- Carbon sources
  - Associated CO<sub>2</sub> in natural gas
  - CO<sub>2</sub> from power plants and other sources
- Carbon storage options
  - Dry but tight reservoirs
  - Enhanced Oil Recovery
- CO<sub>2</sub> tax and CO<sub>2</sub> thresholds
- Other issues
  - Monitoring