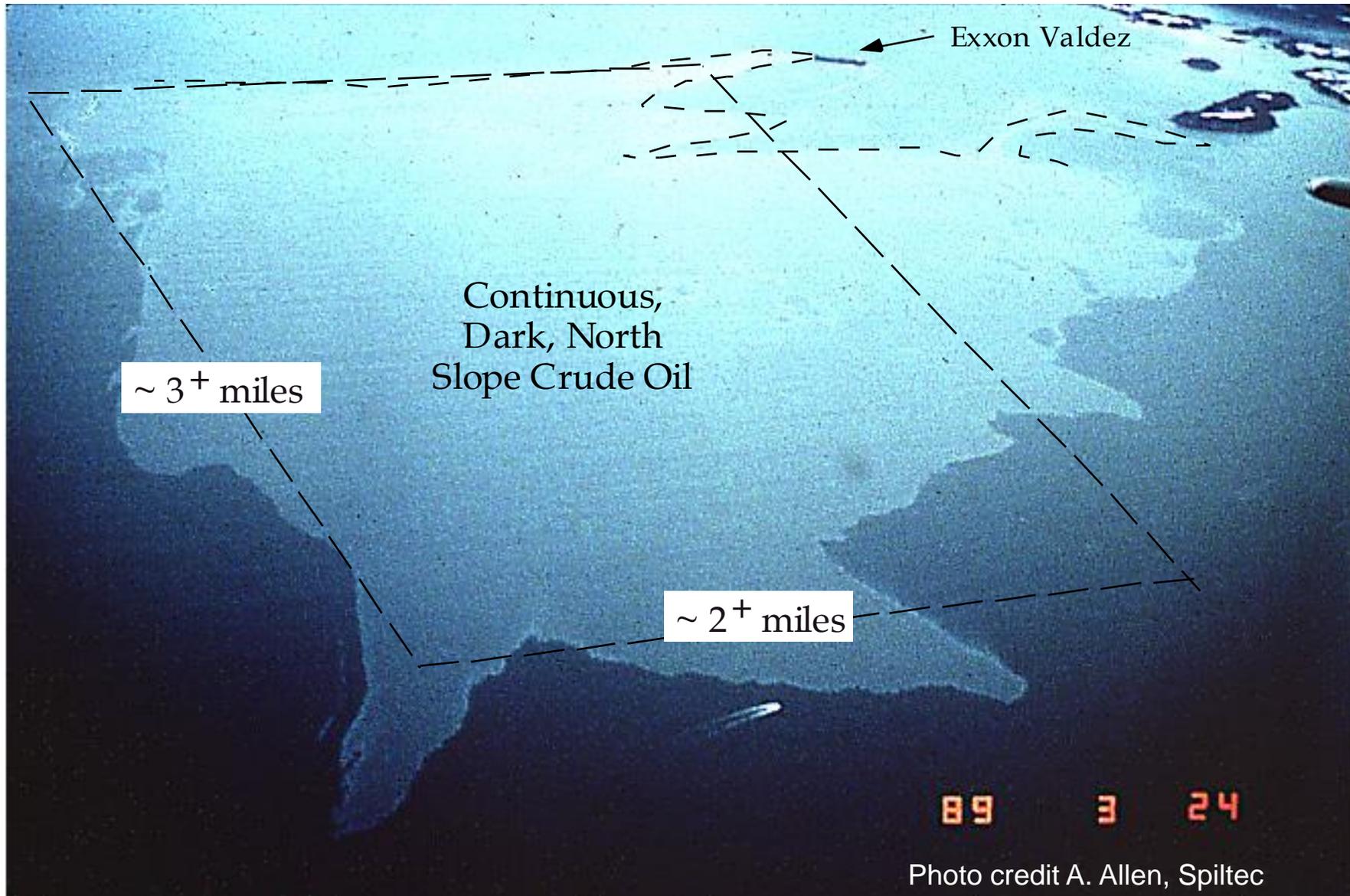


# Development of the Estimated Recovery System Potential (ERSP) Calculator

Dean Dale, Genwest Systems, Inc.  
and  
Alan A. Allen  
Spiltec

Best Achievable Protection Conference  
May 20 and 21, 2015  
Henry M. Jackson Federal Building  
Seattle, Washington



Exxon Valdez

Continuous,  
Dark, North  
Slope Crude Oil

~ 3+ miles

~ 2+ miles

89 3 24

Photo credit A. Allen, Spiltec

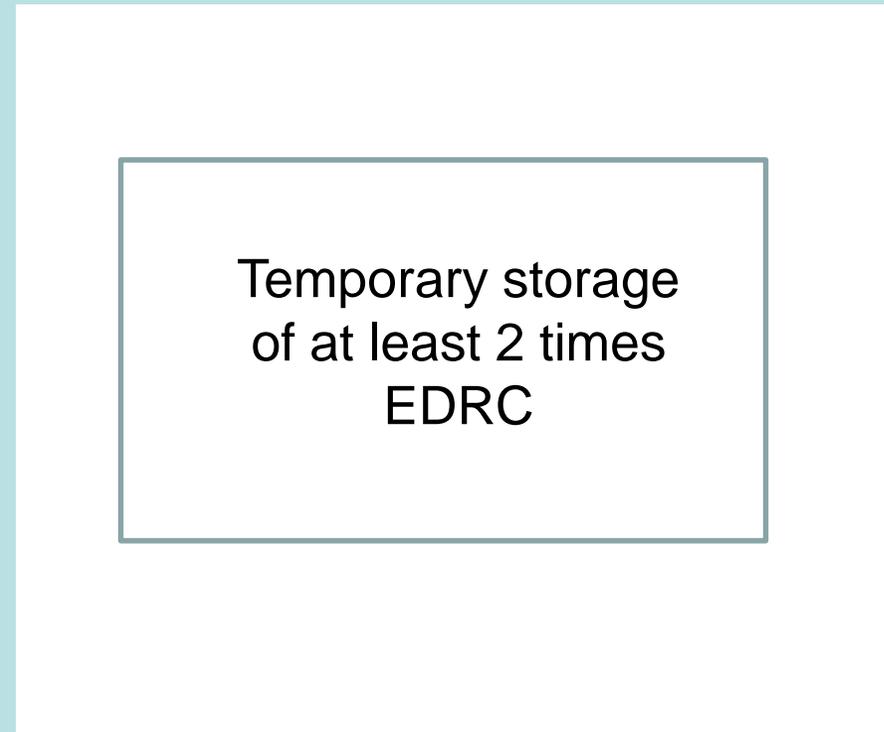
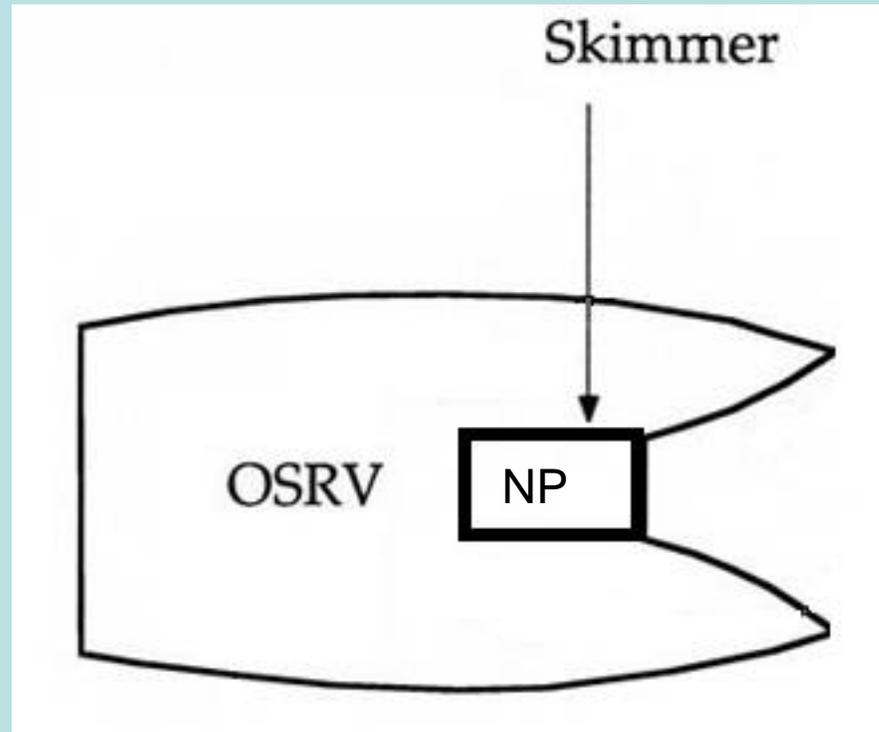
# A Brief Chronology

- Oil Pollution Act of 1990 mandated EDRC
- 1990's – Mechanical Equipment Calculator (MEC) developed as a part of NOAA's "Spill Tools"
- 2009 - Response Options Calculator (ROC)
- 2011 - BSEE Contract to Genwest Systems, Inc
  - Prepare an objective and independent assessment to scientifically validate the most appropriate methodologies for estimating the effective daily recovery capacity (EDRC) of oil skimming systems
  - Provide recommendations for EDRC improvements to inform oil spill planning and preparedness
  - Make recommendations for new EDRC methodologies and guidelines for response systems deployed in nearshore and offshore operating environments.

[www.bsee.gov/Technology-and-Research/Oil-Spill-Response-Research/Projects/Project-673/](http://www.bsee.gov/Technology-and-Research/Oil-Spill-Response-Research/Projects/Project-673/)

- EDRC Final Report, December 7, 2012
- Estimated Recovery System Potential (ERSP) Calculator, revised February 2015
- Estimated Recovery System Potential (ERSP) User Manual, revised February 2015
- National Academy of Sciences Review of Genwest's Final Report on EDRC, 2013
- Federal Register Notice Providing BSEE Comments on the EDRC Study and NAS Letter Report and Requesting Public Comment on ERSP

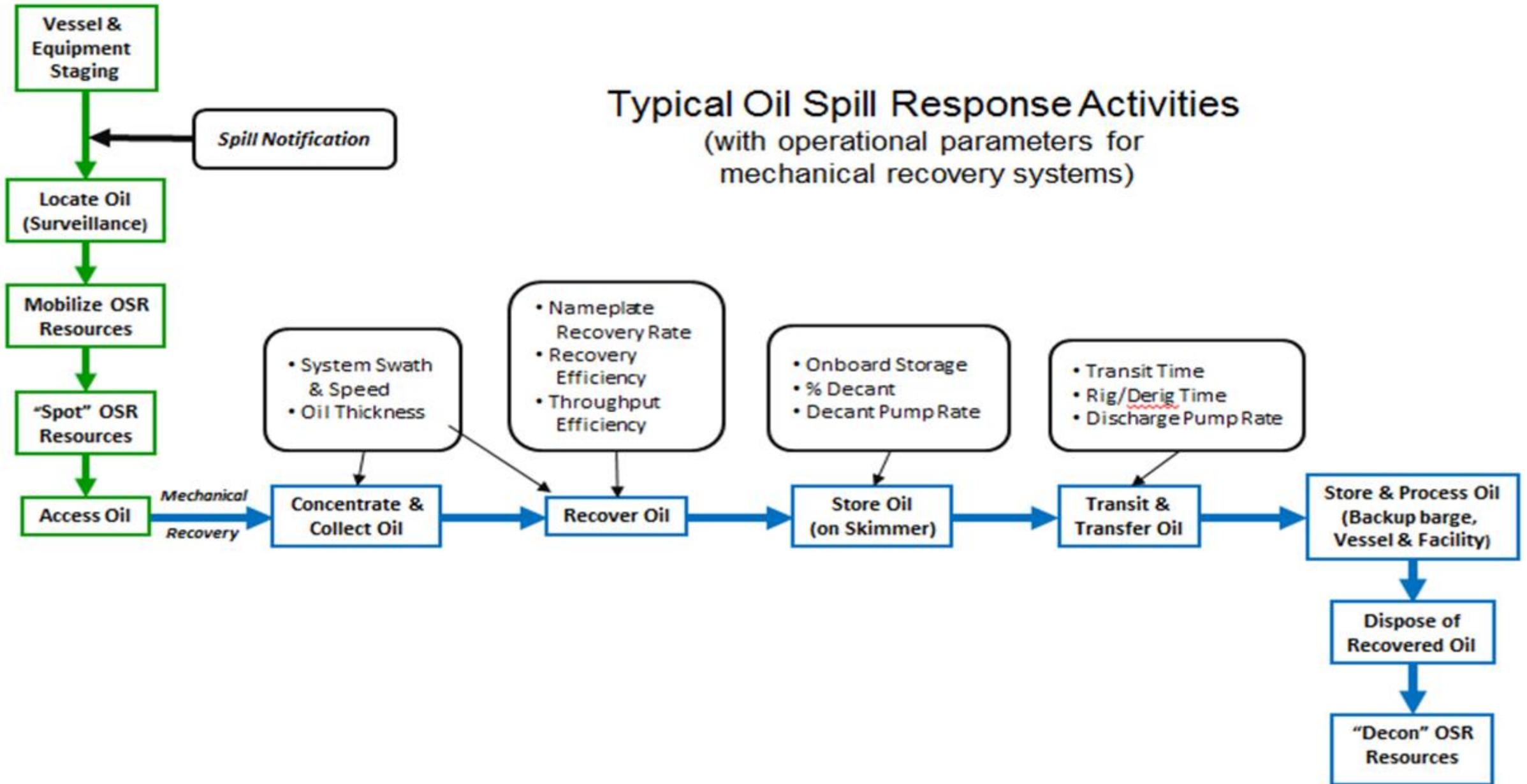
# Oil Recovery Device from 33 CFR 155 Appendix B



$$\text{EDRC} = \text{Manufacturer's Nameplate Capacity (bbl/hr)} \times 24 \text{ (hrs/day)} \times 20\%$$

# Typical Oil Spill Response Activities

(with operational parameters for mechanical recovery systems)

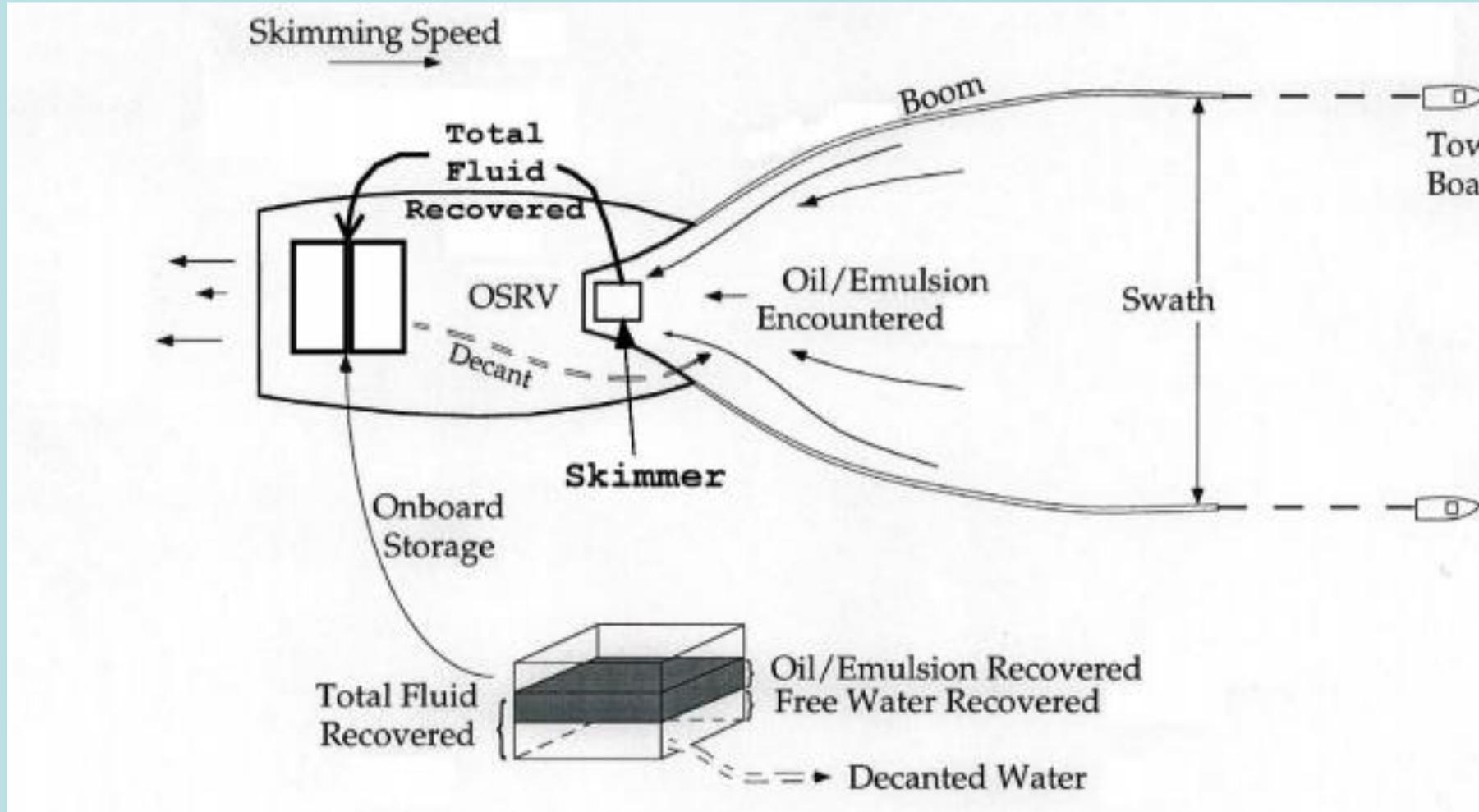


# The ERSP Calculator

The ERSP Calculator was developed to provide an encounter-rate based estimate of daily recovery potential for advancing skimming systems operating in open waters, in warm or cold climates, without the effects of ice, debris or extreme weather conditions.

The Calculator is a planning tool, not an incident-specific response model. During an actual response, consider using models that account for oil type, oil weathering, environmental conditions, and other factors specific to that incident. ERSP is not designed for use as a measure of actual performance, but rather, recovery potential.

# ERSP Skimming System



# Advancing Skimmer Recovery System Components

- Supporting Platform Vessel – Labeled as OSRV in the diagram. This is the supporting platform for all the basic components of a skimming system
- Containment Boom – Encounters and concentrates the oil/emulsion from the oil slick.
- Skimmer Device – Captures oil, emulsion, and free water (a measure of the Recovery Efficiency) and transfers the Total Fluid Recovered to Onboard Storage. A portion of the oil/emulsion encountered is lost behind the system. A measure of the Throughput Efficiency is the portion taken onboard.
- Onboard Storage – Includes tankage built into the OSRV to receive the total fluids recovered.
- Pumps – Decant and discharge.
- Secondary Storage - While not shown in the diagram, secondary storage is considered a component of each skimming system.

# ERSP Assumptions

- Planning tool for significant continuous or “batch” spills
- Three day window for ERSP batch spill scenario
- Ambient Conditions
- Default Values
- No skimmer downtime
- Oil Type not considered
- Use of constant TFRR values
- No distinction between ocean, offshore, or inshore
- Oil spreading and thickness values
- Use of best practices
- Emulsification
- Asset mobilization
- Offloading in between Operating Periods

# Encounter Rate

- Speed
- Swath
- Oil/Emulsion Average Thickness

Encounter Rate can be enhanced by:

- Keeping skimmers in the heaviest oil.
- Increasing the skimming speed.
- Increasing the swath width.

# ERSP Oil/Emulsion Thickness Values

## Progression of Oil Slick Thickness Input



Manual thickness entry based on user choice. One thickness for entire simulation.

Time-dependent thickness derived every hour from model, based on oil type & Environment.

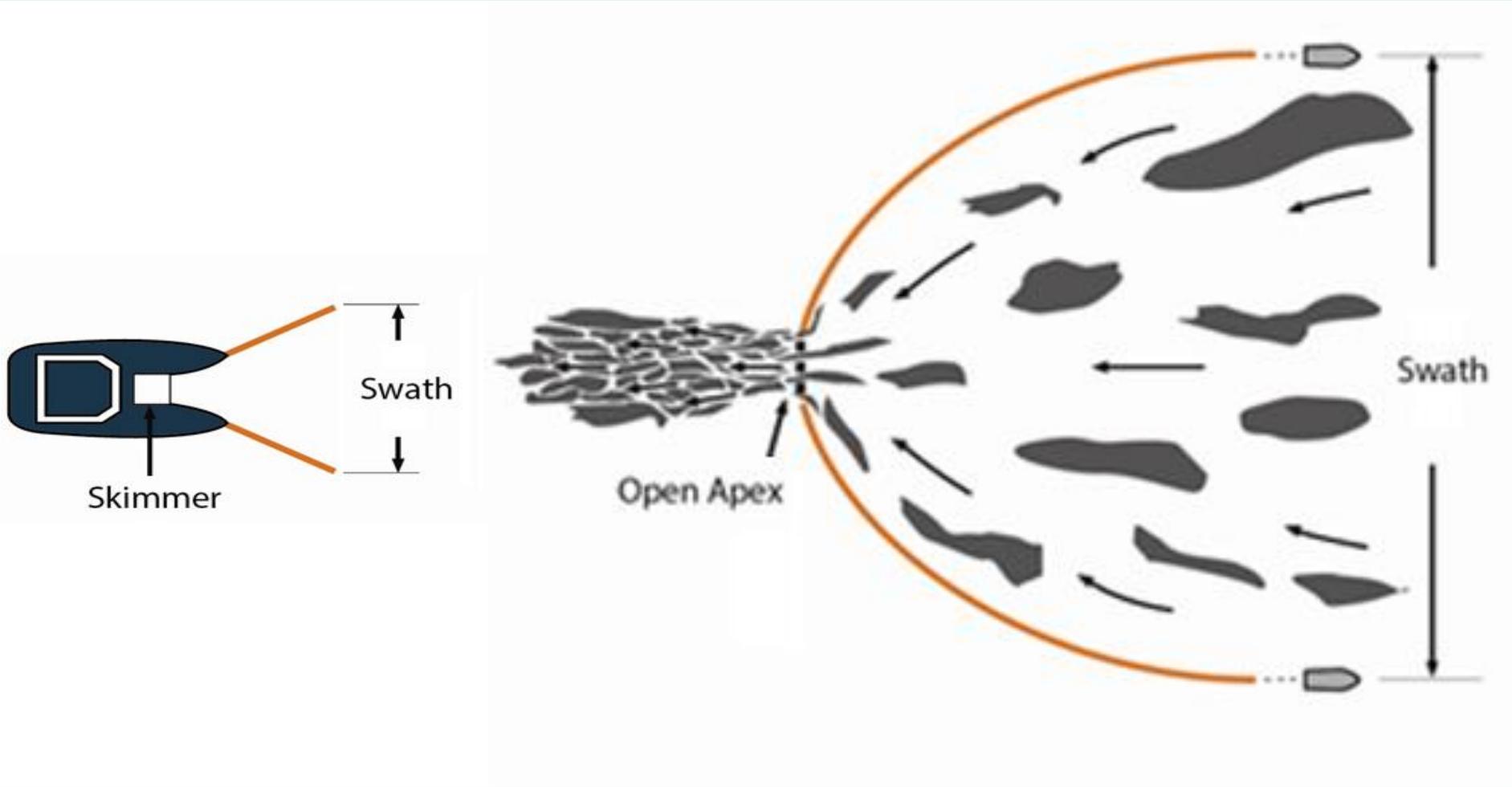
Three recommended nominal average thicknesses based on ROC and other model simulation results for 12 hours, 36 hours, and 60 hours after a batch release.

# Total Fluid Recovery Rate

- Encounter Rate
- Throughput Efficiency - The percentage of oil/emulsion recovered compared to the oil/emulsion encountered.
- Recovery Efficiency - The percentage of the volume of oil/emulsion recovered compared to the total volume of fluids recovered.

The Total Fluid Recovery Rate is limited by the Nameplate Recovery Rate (Maximum Fluid Recovery Rate), the maximum skimming capacity of a device as stated by the manufacturer.

# Enhanced Swath



# Maximum Effective Swath

That Swath where the Encounter Rate is equal to the Maximum Fluid Recovery Rate (Nameplate Recovery Rate).

# ERSP Calculator

Name of System:

Discharge Type:

Continuous Spill

Batch Spill

Skimmer Details:

## Encounter Rate

Operating Period [hrs]:

Speed [kts]:

Swath [ft]:

## Recovery

Maximum Total Fluid Recovery  
Rate [gpm]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:

## Storage

On-Board Storage [bbf]:

Percent Decant [%]

Decant Pump Rate [gpm]:

Rig + Derig Time [min]:

One Way Transit Time [min]:

Discharge Pump Rate [gpm]:

Calculate

# ERSP Output

## Simulation Notes

Simulation Notes are generated by the Calculator to alert the user that adjustments to input data may be necessary.

- If the entered Swath > MES, the calculator uses the Swath = MES for that day.
- Swath used for calculation may not be achievable.
- Calculated Decant Rate is greater than Decant Pump Rate – Reduce Percent Decant [%] value.
- Offload not achievable between Operating Periods - Reduce Operating Period [hrs].

# ERSP Output

## Summary and Bar Charts

**Estimated Recovery System Potential (ERSP)**  
(Total Volume of Oil Recovered in Operating Period)

**Operating Period 1**  
2,172 bbl

**Operating Period 2**  
1,369 bbl

**Operating Period 3**  
625 bbl

**3-day Total**  
4,167 bbl

Operating Period 1    Thickness = 0.1 in.    Emulsion = 35%    Total Recovered and Retained Fluids = 4,011 bbl

Oil = 2,172 bbl (54%)    Water in Emulsion = 1,170 bbl (29%)    Retained Free Water = 669 bbl (17%)



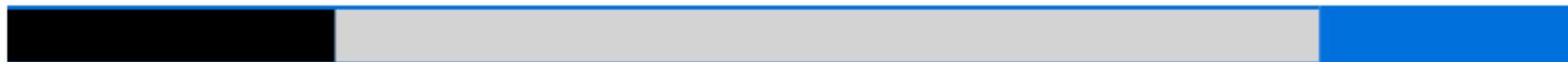
Operating Period 2    Thickness = 0.05 in.    Emulsion = 55%    Total Recovered and Retained Fluids = 3,653 bbl

Oil = 1,369 bbl (37%)    Water in Emulsion = 1,674 bbl (46%)    Retained Free Water = 609 bbl (17%)



Operating Period 3    Thickness = 0.025 in.    Emulsion = 75%    Total Recovered and Retained Fluids = 3,000 bbl

Oil = 625 bbl (21%)    Water in Emulsion = 1,875 bbl (62%)    Retained Free Water = 501 bbl (17%)



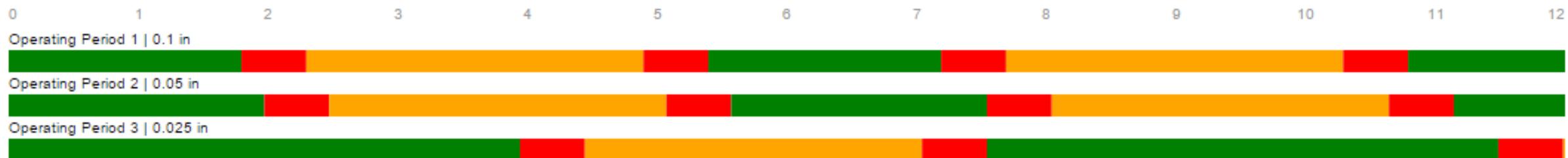
# ERSP Output

## Recovery Cycle Timeline

### Recovery Cycle Timeline



Operating Period [hrs]



# Enhancement of Response Systems

(using the Response System Calculator)

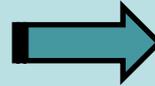
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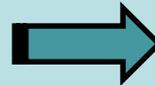
# Enhancement of Response System Performance Using the Response System Calculator (RSC)

## Objective

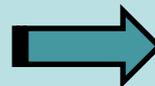
Familiarization with the Response System Calculator



Identification of “Key” System Performance Calculations



Calculation & Assessment of System Performance “Drivers”



## Topic

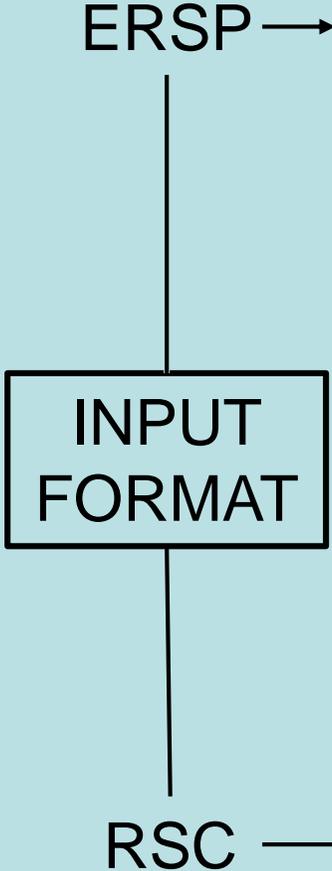
Access and Use of RSC  
Input & Output parameters  
(compared to those of the ERSP Calculator)

Areal Coverage Rate  
Oil Encounter Rate  
Total Fluid Recovery Rate  
Maximum Effective Swath

Maximum Effective Swath vs. Speed  
ERSP vs. On-board Storage  
ERSP vs. Emulsion & Decant

To access and download the Recovery  
System Calculator go to:

<http://www.genwest.com/RSC.html>



### ERSP Calculator

Name of System:

Skimmer Details:

Discharge Type:  Continuous Spill  
 Batch Spill

#### Encounter Rate

Operating Period [hrs]:

Speed [kts]:

Swath [ft]:

#### Recovery

Maximum Total Fluid Recovery Rate [gpm]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:

#### Storage

On-Board Storage [bb]:

Percent Decant [%]:

Decant Pump Rate [gpm]:

Rig + Derig Time [min]:

One Way Transit Time [min]:

Discharge Pump Rate [gpm]:

### Recovery System Calculator

Thickness [in]:

Emulsion [%]:

Speed [kts]:

% Decant [%]:

Swath [ft]:

On-Board Storage [bb]:

Nameplate Recovery Rate [gpm]:

Decant Pump Rate [gpm]:

Discharge Pump Rate [gpm]:

Transit Time [min]:

Rig/Derig Time [min]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:

Variable to Isolate:  Iterations:  Increment:

Operating Period [hrs]:

## ERSP Calculator

**Name of System:**

**Discharge Type:**  Continuous Spill  
 Batch Spill

**Skimmer Details:**

**Encounter Rate**

Operating Period [hrs]:

Speed [kts]:

Swath [ft]:

**Recovery**

Maximum Total Fluid Recovery Rate [gpm]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:

**Storage**

On-Board Storage [bb]:

Percent Decant [%]:

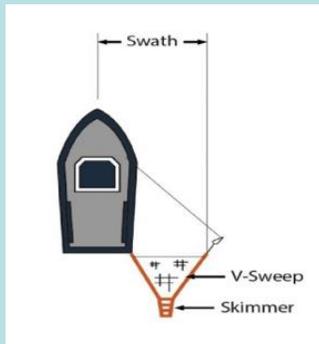
Decant Pump Rate [gpm]:

Rig + Derig Time [min]:

One Way Transit Time [min]:

Discharge Pump Rate [gpm]:

Selected Skimmer: "X"



- Choice of Continuous or Batch Spill
- Batch Spill: Thickness of Oil & % Emulsion are set by the calculator for each of Days 1, 2 and 3.
- Continuous Spill: Oil Thickness and % Emulsion for Day 1 remain unchanged for each day of spillage.

# Sample Graphic Output from ERSP

Estimated Recovery System Potential (ERSP) (Total Volume of Oil Recovered in Operating Period)	Operating Period 1	Operating Period 2	Operating Period 3	3-day Total
	1,381 bbl	943 bbl	387 bbl	2,711 bbl

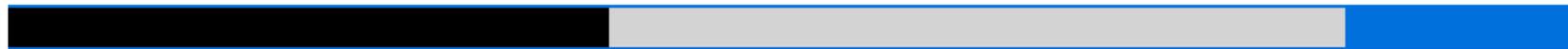
Operating Period 1    Thickness = 0.1 in.    Emulsion = 35%    Total Recovered and Retained Fluids = 2,500 bbl

Oil = 1,381 bbl (55%)    Water in Emulsion = 744 bbl (30%)    Retained Free Water = 375 bbl (15%)



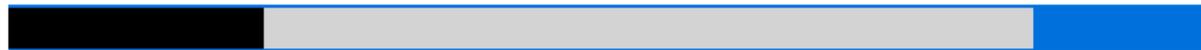
Operating Period 2    Thickness = 0.05 in.    Emulsion = 55%    Total Recovered and Retained Fluids = 2,467 bbl

Oil = 943 bbl (38%)    Water in Emulsion = 1,153 bbl (47%)    Retained Free Water = 370 bbl (15%)

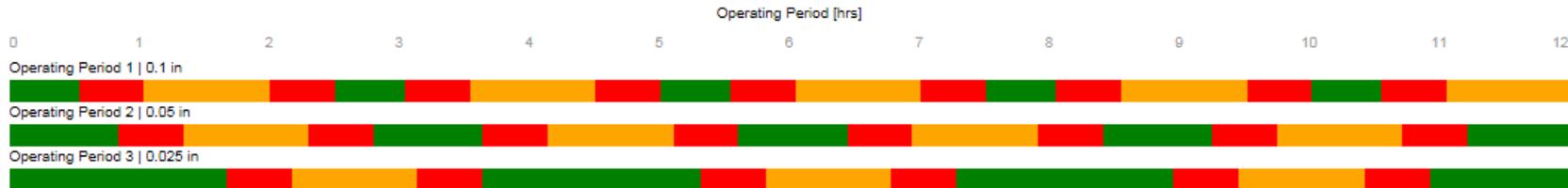


Operating Period 3    Thickness = 0.025 in.    Emulsion = 75%    Total Recovered and Retained Fluids = 1,820 bbl

Oil = 387 bbl (21%)    Water in Emulsion = 1,160 bbl (64%)    Retained Free Water = 273 bbl (15%)

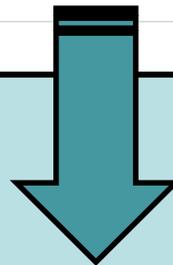


## Recovery Cycle Timeline



# Sample Data Output from ERSP

	Operating Period: Encountered Product (Oil/Emulsion) Thickness: % of Water in Oil/Water Emulsion:	Op. Period 1 0.1 in 35%	Op. Period 2 0.05 in 55%	Op. Period 3 0.025 in 75%
<b>Encounter Rate Results</b>				
Maximum Effective Swath (MES)		58 ft	117 ft	233 ft
Swath Used For Calculation		58 ft	75 ft	75 ft
Oil/Emulsion Encounter Rate		737 gpm	473 gpm	237 gpm
Areal Coverage Rate		0.27 acres/min	0.35 acres/min	0.35 acres/min
Area Covered in Operating Period (Acres)		44 acres	87 acres	128 acres
Area Covered in Operating Period (Sq. Miles)		0.07 sq mi	0.14 sq mi	0.2 sq mi
<b>Recovery Results</b>				
Total Fluid Recovery Rate		650 gpm	418 gpm	209 gpm
Emulsion Recovery Rate		553 gpm	355 gpm	178 gpm
Oil Recovery Rate		359 gpm	160 gpm	44 gpm
Free Water Recovery Rate		98 gpm	63 gpm	31 gpm



etc.

## Recovery System Calculator

Thickness [in]: <input type="text"/>	Nameplate Recovery Rate [gpm]: <input type="text"/>
Emulsion [%]: <input type="text"/>	Decant Pump Rate [gpm]: <input type="text"/>
Speed [kts]: <input type="text"/>	Discharge Pump Rate [gpm]: <input type="text"/>
% Decant [%]: <input type="text"/>	Transit Time [min]: <input type="text"/>
Swath [ft]: <input type="text"/>	Rig/Derig Time [min]: <input type="text"/>
On-Board Storage [bbl]: <input type="text"/>	Throughput Efficiency [%]: <input type="text"/>
	Recovery Efficiency [%]: <input type="text"/>

Variable to Isolate:   Iterations:  Increment:

Operating Period [hrs]:

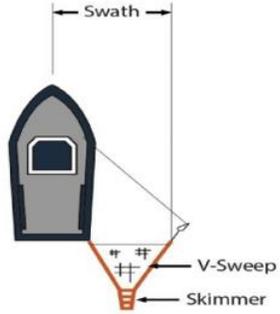


Example: Input for Skimmer "X" (running 4 iterations of oil thickness with 0.02 in. increments)



## Recovery System Calculator

Thickness [in]: <input type="text" value="0.02"/>	Nameplate Recovery Rate [gpm]: <input type="text" value="650"/>
Emulsion [%]: <input type="text" value="20"/>	Decant Pump Rate [gpm]: <input type="text" value="0"/>
Speed [kts]: <input type="text" value="2"/>	Discharge Pump Rate [gpm]: <input type="text" value="750"/>
% Decant [%]: <input type="text" value="0"/>	Transit Time [min]: <input type="text" value="30"/>
Swath [ft]: <input type="text" value="75"/>	Rig/Derig Time [min]: <input type="text" value="30"/>
On-Board Storage [bbl]: <input type="text" value="500"/>	Throughput Efficiency [%]: <input type="text" value="75"/>
	Recovery Efficiency [%]: <input type="text" value="85"/>



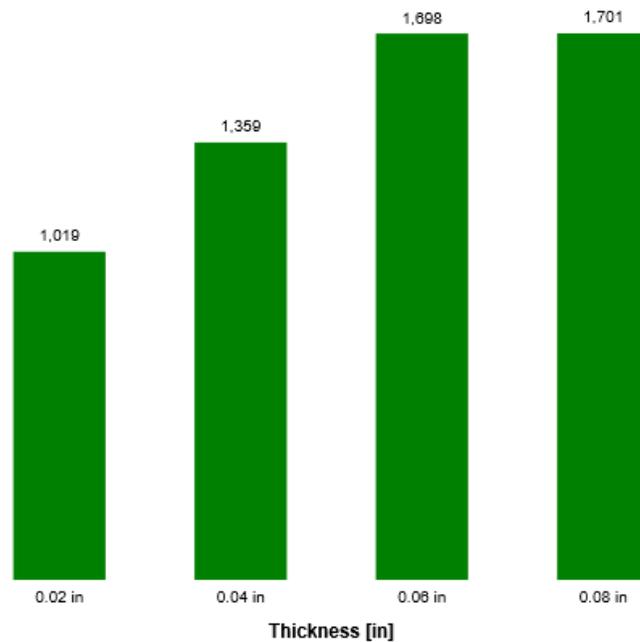
Variable to Isolate:   Iterations:  Increment:

Operating Period [hrs]:

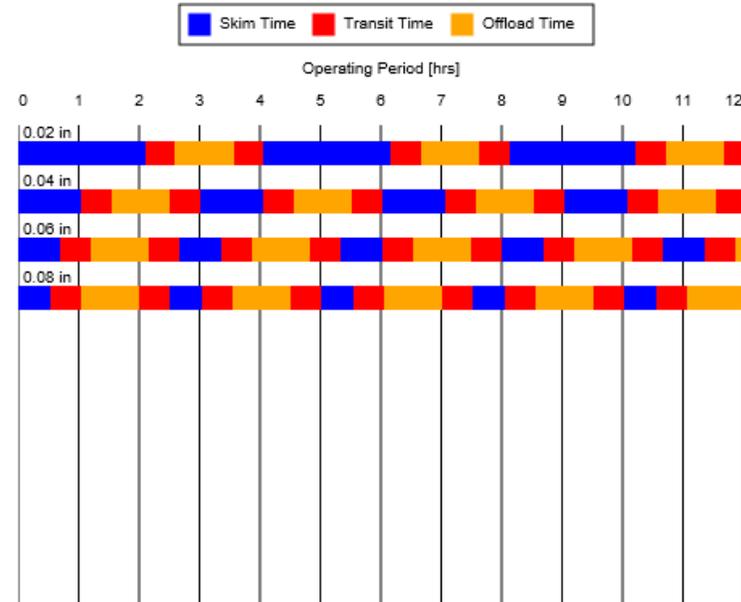
# Sample Format for Output Data & Charts

Time for 1 Full Cycle (includes offload & 2 transits)	4.1 hr	3 hr	2.7 hr	2.5 hr
Skimming Time in Op Period	6.3 hr	4.2 hr	3.5 hr	2.7 hr
Skimming Time in Op Period %	52 %	35 %	29 %	22 %
Area Covered (acre) in Op Period	132 acres	88 acres	73 acres	55 acres
Area Covered (sq mi) in Op Period	0.21 sq mi	0.14 sq mi	0.11 sq mi	0.09 sq mi
Total Volume Oil/Emulsion + Free Water Recovered/Op Period	1,500 bbl	2,000 bbl	2,500 bbl	2,500 bbl
Total volume of Oil/Emulsion Recovered/Op Period	1,274 bbl	1,698 bbl	2,123 bbl	2,126 bbl
Total # of Fills/Op Period	3	4	5	5
<b>ERSP (Total Volume Oil Recovered/Op Period)</b>	<b>1,019 bbl</b>	<b>1,359 bbl</b>	<b>1,698 bbl</b>	<b>1,701 bbl</b>

### ERSP vs Thickness [in]



### Response Timeline



# Key System Performance Equations

$$\text{Areal Coverage Rate (acres/min)} = W \text{ (ft)} \times V \text{ (kt)} / 430$$

$$\text{Encounter Rate (gpm)} = 63.13 \times W \text{ (ft)} \times V \text{ (kt)} \times T_o \text{ (in.)}$$

$$\text{Total Fluid Recovery Rate (gpm)} = \frac{\text{Encounter Rate (gpm)} \times \text{TE}}{\text{RE}}$$

$$\text{Maximum Effective Swath (gpm)} = \frac{\text{Max. Fluid Recovery Rate}^* \text{ (gpm)} \times \text{RE}}{63.13 \times V \text{ (kt)} \times T_o \times \text{TE}}$$

Where:  $W$  = Swath of system     $V$  = Speed of system     $T_o$  = Avg. Oil Thickness  
 $\text{TE}$  = Throughput Efficiency     $\text{RE}$  = Recovery Efficiency

\* Note: Max. Fluid Recovery Rate (some call “Nameplate” Recovery Rate) includes all oil and/or emulsion plus free water removed from the surface and placed in on-board storage.

Derivation of Total Fluid Recovery Rate (TFRR):

$$RE (\%) = (OR/TFR) \times 100 = (ORR/TFRR) \times 100$$

$$TE (\%) = (OR/En) \times 100 = (ORR/EnR) \times 100$$

Therefore,

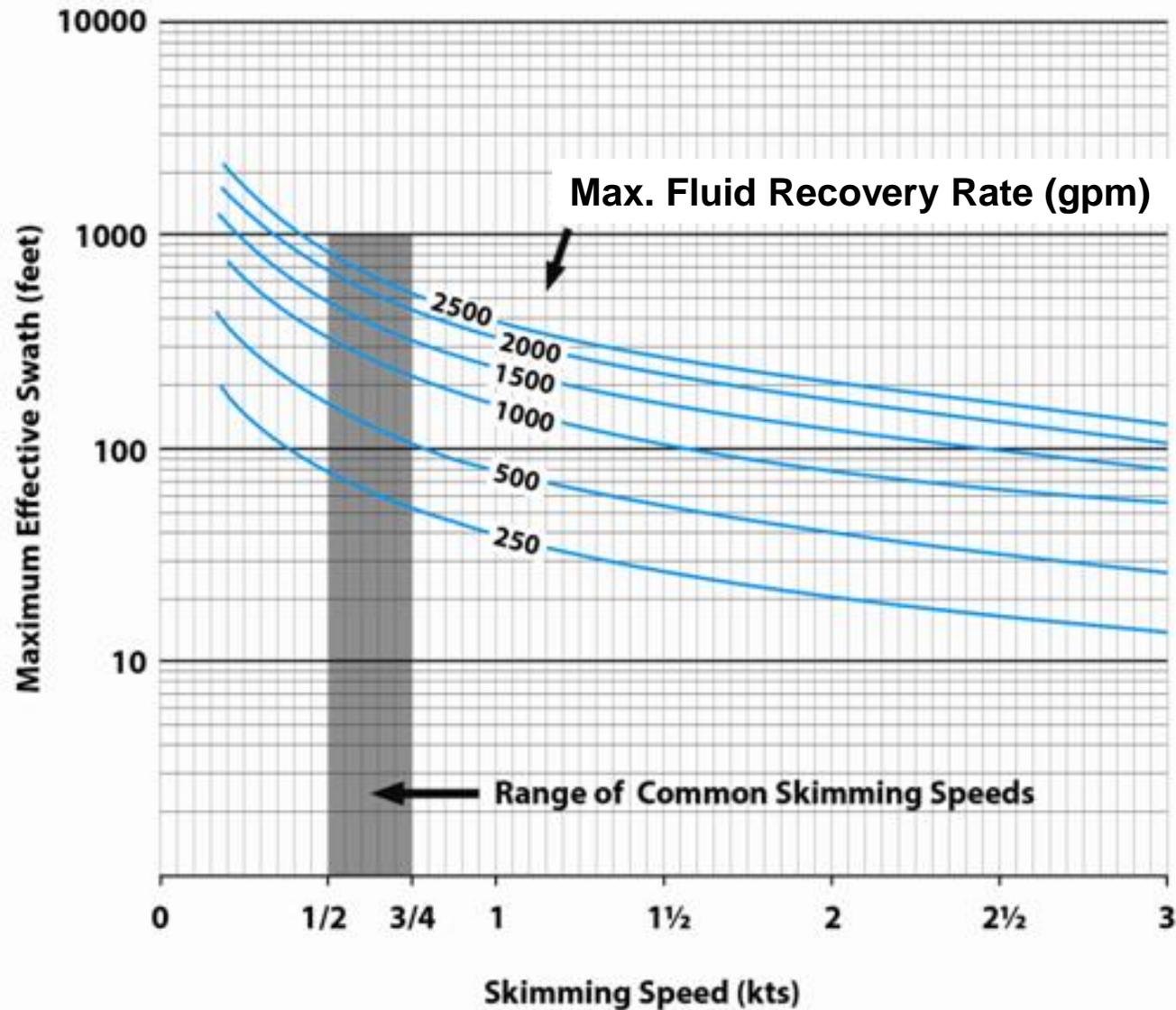
$$ORR = TFRR \times RE (\%)/100$$

$$ORR = EnR \times TE (\%) /100$$


$$TFRR = EnR (TE/RE)$$

# Maximum Effective Swath (MES) vs. Speed (V)

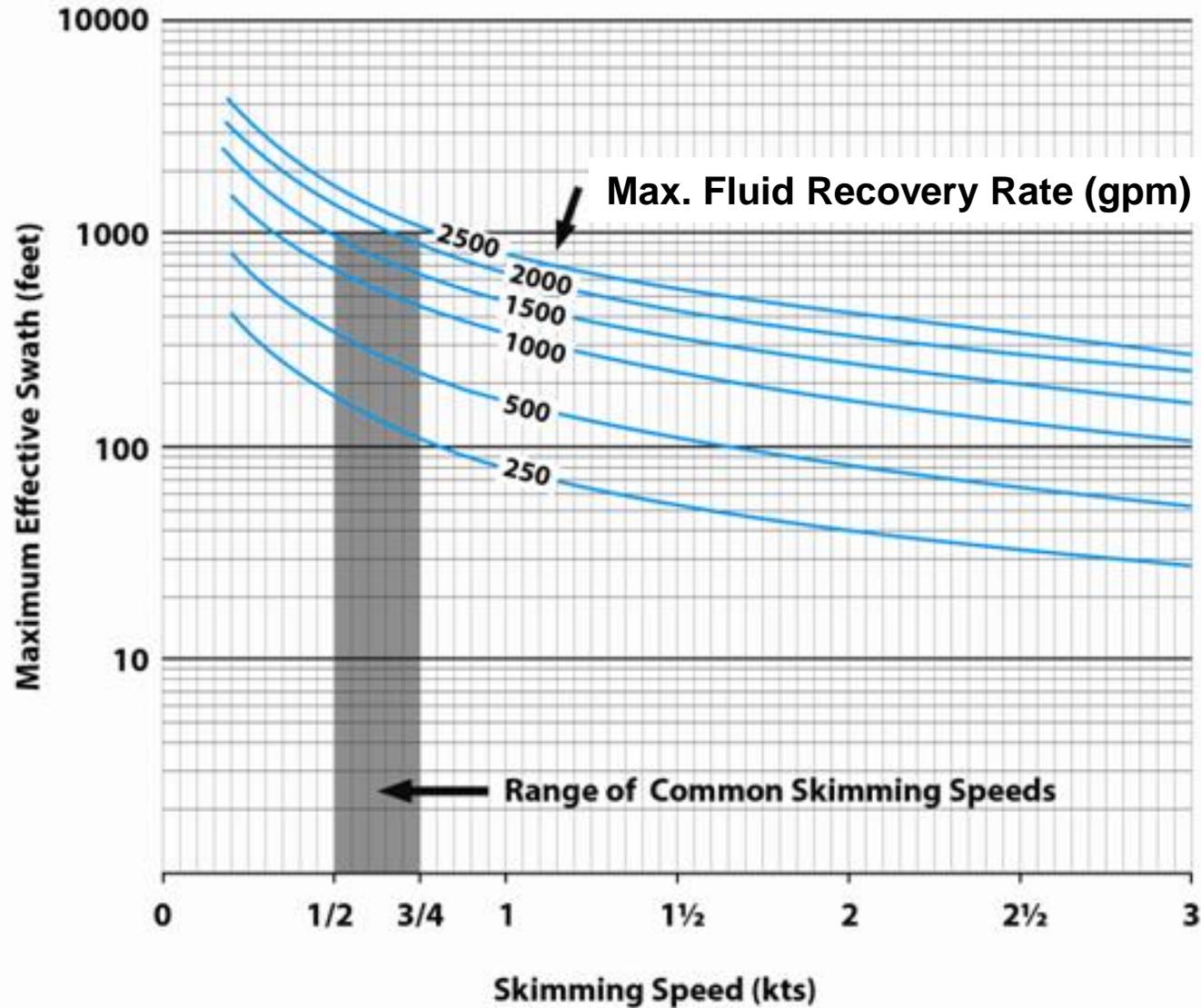
Avg. Oil Thickness ( $T_o$ ) = 0.1 inch



For Max. Fluid  
Recovery Rates  
&  
with  $TE = RE$

# Maximum Effective Swath (MES) vs. Speed (V)

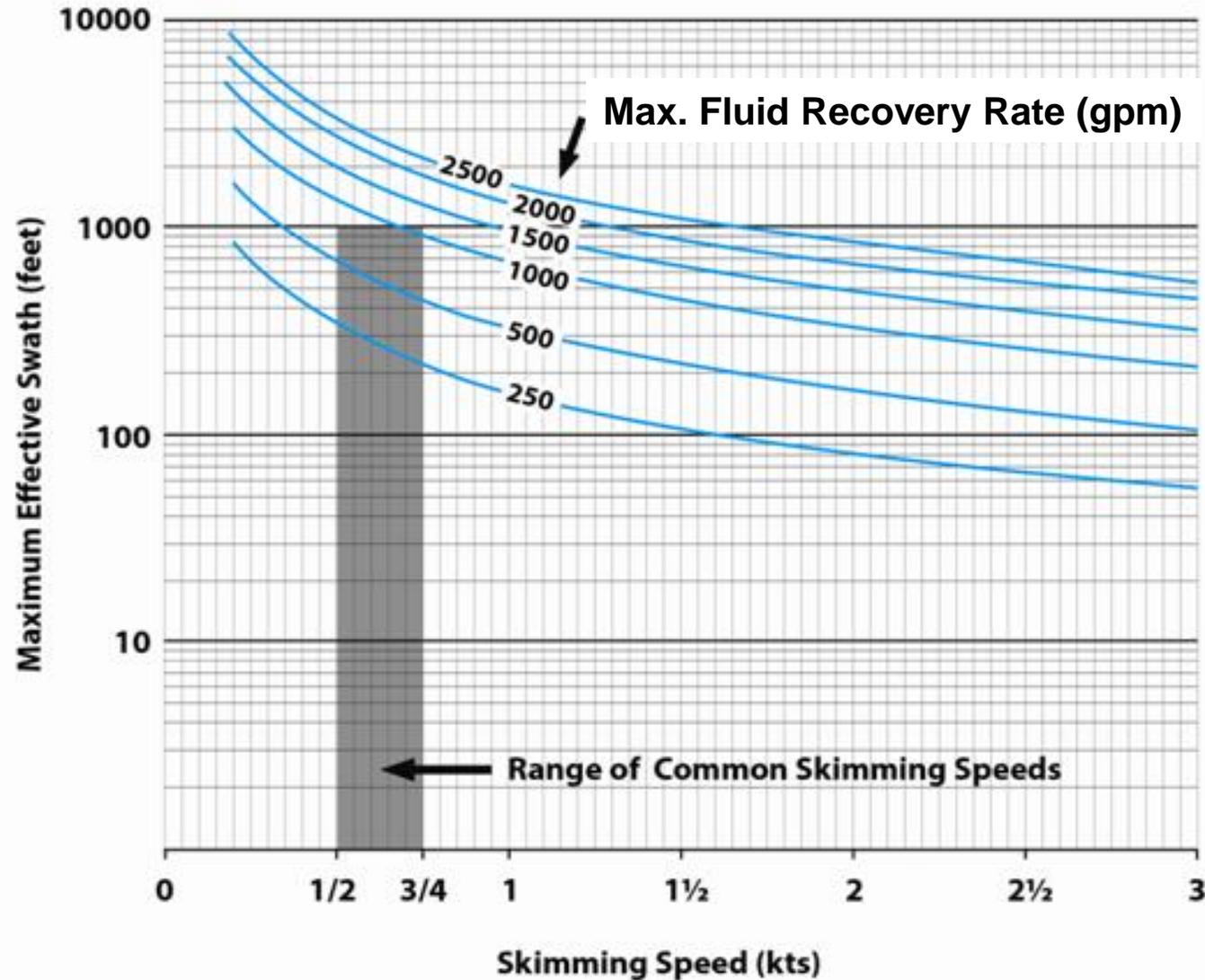
Avg. Oil Thickness ( $T_o$ ) = 0.05 inch



For Max. Fluid  
Recovery Rates  
&  
with  $TE = RE$

# Maximum Effective Swath (MES) vs. Speed (V)

Avg. Oil Thickness ( $T_o$ ) = 0.025 inch



For Max. Fluid Recovery Rates & with  $TE = RE$

**Example: Variable Storage  
(with  $T_o = 0.05$  in.)**

# Recovery System Calculator

Thickness [in]:

Emulsion [%]:

Speed [kts]:

% Decant [%]:

Swath [ft]:

On-Board Storage [bbl]:

Nameplate Recovery Rate [gpm]:

Decant Pump Rate [gpm]:

Discharge Pump Rate [gpm]:

Transit Time [min]:

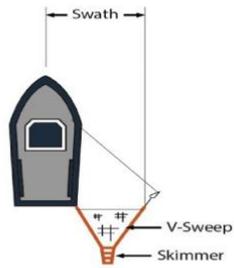
Rig/Derig Time [min]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:

**Simulation Notes:**

\*If the entered Swath > MES, the calculator uses the Swath = MES for that day.



Variable to Isolate:  Iterations:  Increment:

Operating Period [hrs]:

## Performance with 500 bbl On-Board Storage

<b>On-Board Storage</b>	<b>500 bbl</b>
Maximum Effective Swath	117 ft
Swath Used For Calculation	75 ft
Encounter Rate	473 gpm 677 bbl/hr
Areal Coverage Rate	0.35 acres/min
Total Fluid Recovery Rate	418 gpm 597 bbl/hr
Emulsion Recovery Rate	355 gpm 507 bbl/hr
Oil Recovery Rate	231 gpm 330 bbl/hr
Rate Water Taken Onboard	63 gpm 89 bbl/hr
Water Retained Rate	63 gpm 89 bbl/hr
Decant Rate	0 gpm 0 bbl/hr

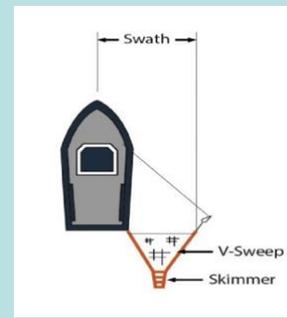
Time To Fill Onboard Storage	0.8 hr
Time to Offload Full Tank(s)	58 min
Time for 1 Full Cycle (includes offload & 2 transits)	2.8 hr
Skimming Time in Op Period	4.1 hr
Skimming Time in Op Period %	34 %
Area Covered (acre) in Op Period	87 acres
Area Covered (sq mi) in Op Period	0.14 sq mi
Total Volume Oil/Emulsion + Free Water Recovered/Op Period	2,467 bbl
Total volume of Oil/Emulsion Recovered/Op Period	2,095 bbl
Total # of Fills/Op Period	4.9
<b>ERSP (Total Volume Oil Recovered/Op Period)</b>	<b>1,362 bbl</b>

**Example: Variable Storage**  
 ( $T_o = 0.05$  in.)

## System "X" ERSP vs. On-Board Storage

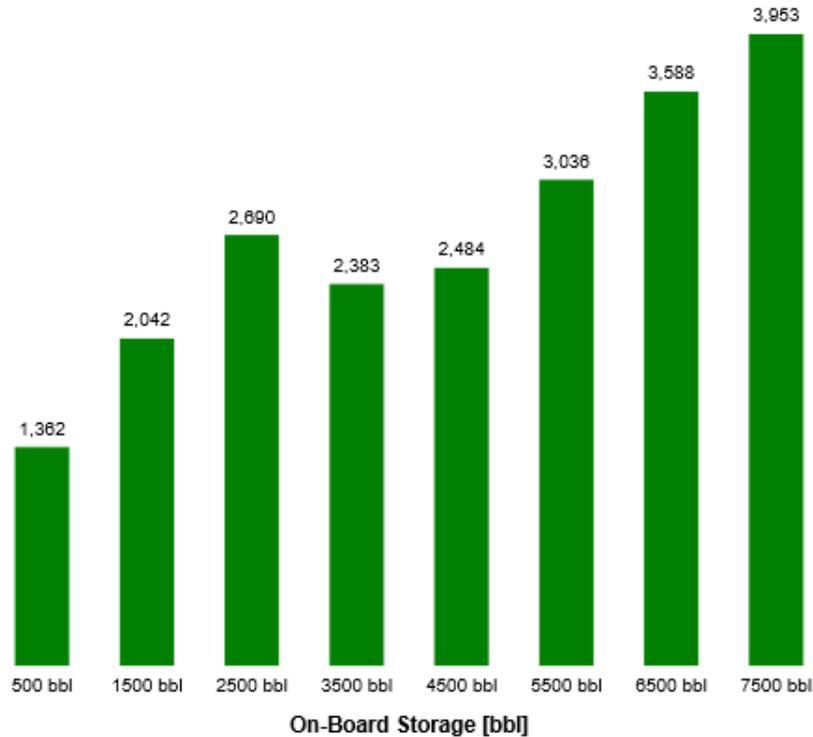
Average Oil Thickness = 0.05 in. (1.27 mm)

Encountered Oil Emulsion at 35 % water

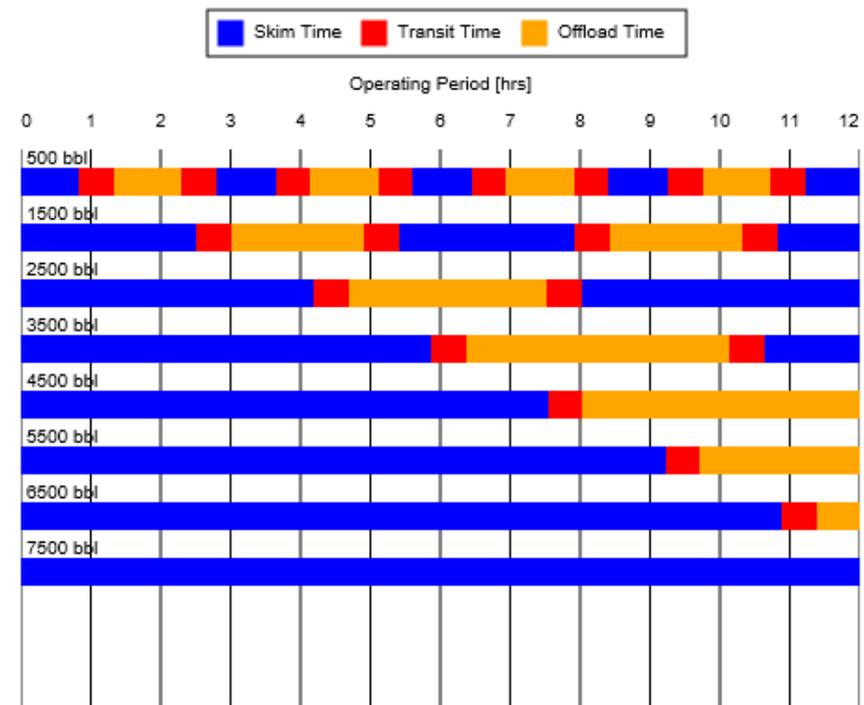


On-Board Storage	500 bbl	1500 bbl	2500 bbl	3500 bbl	4500 bbl	5500 bbl	6500 bbl	7500 bbl
ERSP (Total Volume Oil Recovered/Op Period)	1,362 bbl	2,042 bbl	2,690 bbl	2,383 bbl	2,484 bbl	3,036 bbl	3,588 bbl	3,953 bbl

**ERSP vs On-Board Storage [bbl]**



**Response Timeline**



**Example: Variable Storage  
(with  $T_o = 0.025$  in.)**

## Recovery System Calculator

Thickness [in]:

Emulsion [%]:

Speed [kts]:

% Decant [%]:

Swath [ft]:

On-Board Storage [bbl]:

Nameplate Recovery Rate [gpm]:

Decant Pump Rate [gpm]:

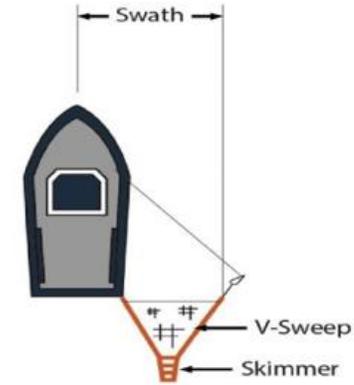
Discharge Pump Rate [gpm]:

Transit Time [min]:

Rig/Derig Time [min]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:



Variable to Isolate:  Iterations:  Increment:

Operating Period [hrs]:

<b>On-Board Storage</b>	<b>500 bbl</b>
Maximum Effective Swath	233 ft
Swath Used For Calculation	75 ft
Encounter Rate	237 gpm 338 bbl/hr
Areal Coverage Rate	0.35 acres/min
Total Fluid Recovery Rate	209 gpm 298 bbl/hr
Emulsion Recovery Rate	178 gpm 253 bbl/hr
Oil Recovery Rate	115 gpm 165 bbl/hr
Rate Water Taken Onboard	31 gpm 44 bbl/hr
Water Retained Rate	31 gpm 44 bbl/hr
Decant Rate	0 gpm 0 bbl/hr

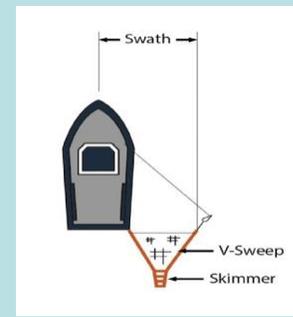
Time To Fill Onboard Storage	1.7 hr
Time to Offload Full Tank(s)	58 min
Time for 1 Full Cycle (includes offload & 2 transits)	3.6 hr
Skimming Time in Op Period	6.1 hr
Skimming Time in Op Period %	51 %
Area Covered (acre) in Op Period	128 acres
Area Covered (sq mi) in Op Period	0.2 sq mi
Total Volume Oil/Emulsion + Free Water Recovered/Op Period	1,820 bbl
Total volume of Oil/Emulsion Recovered/Op Period	1,546 bbl
Total # of Fills/Op Period	3.6
<b>ERSP (Total Volume Oil Recovered/Op Period)</b>	<b>1,005 bbl</b>

**Example: Variable Storage**  
 ( $T_o = 0.025$  in.)

## System "X" ERSP vs. On-Board Storage

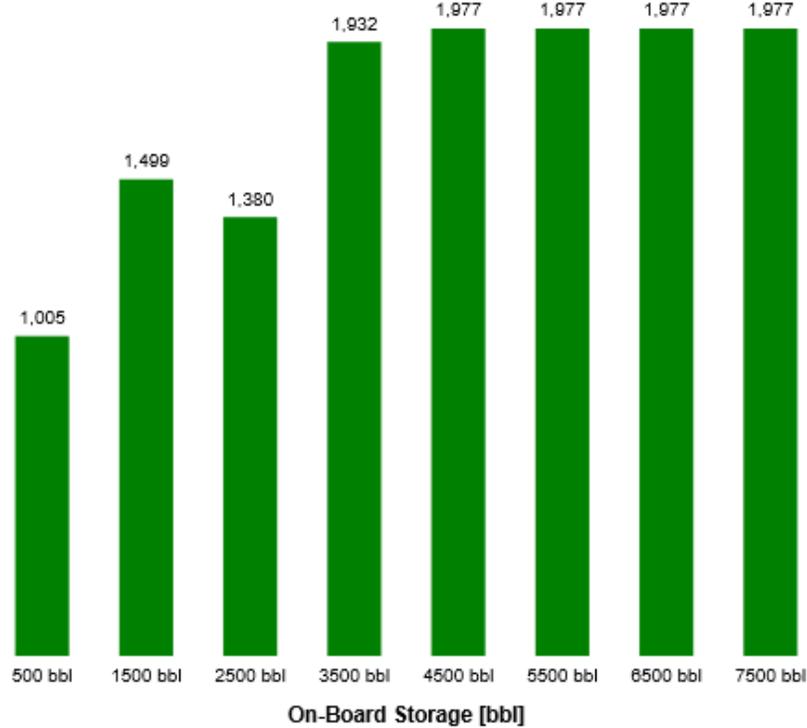
Average Oil Thickness = 0.025 in. (0.64 mm)

Encountered Oil Emulsion at 35 % water

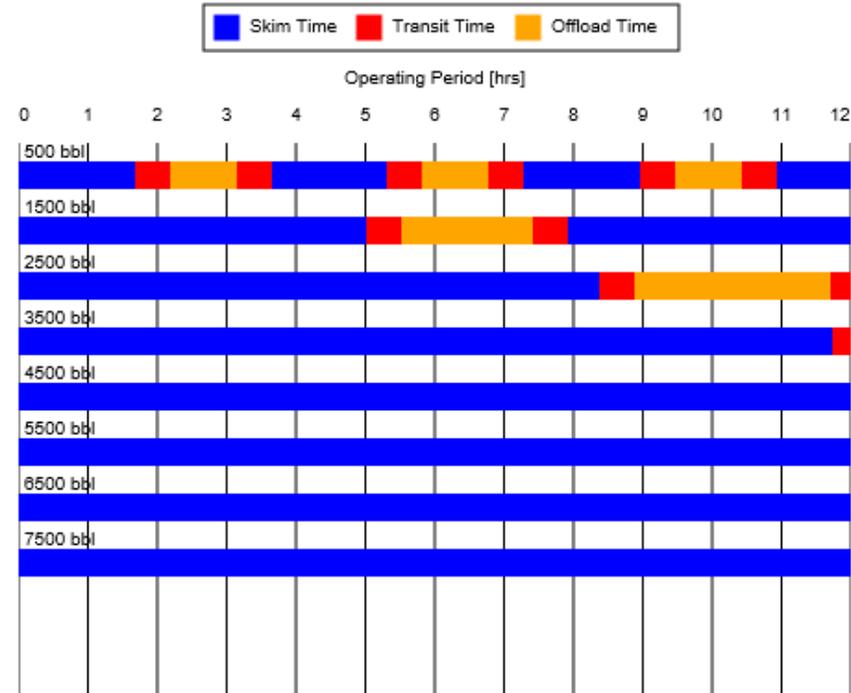


On-Board Storage	500 bbl	1500 bbl	2500 bbl	3500 bbl	4500 bbl	5500 bbl	6500 bbl	7500 bbl
ERSP (Total Volume Oil Recovered/Op Period)	1,005 bbl	1,499 bbl	1,380 bbl	1,932 bbl	1,932 bbl	1,977 bbl	1,977 bbl	1,977 bbl

**ERSP vs On-Board Storage [bbl]**



**Response Timeline**



**Example: Variable % Emulsion**  
**( $T_o = 0.05$  in.)**

# Recovery System Calculator

Thickness [in]:

Emulsion [%]:

Speed [kts]:

% Decant [%]:

Swath [ft]:

On-Board Storage [bbl]:

Nameplate Recovery Rate [gpm]:

Decant Pump Rate [gpm]:

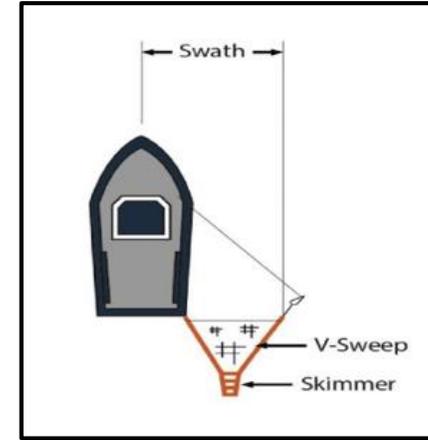
Discharge Pump Rate [gpm]:

Transit Time [min]:

Rig/Derig Time [min]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:



Variable to Isolate:  Iterations:  Increment:

Operating Period [hrs]:  Performance the same for all emulsion values (only ERSP changes)

Maximum Effective Swath	117 ft
Swath Used For Calculation	75 ft
Encounter Rate	473 gpm 677 bbl/hr
Areal Coverage Rate	0.35 acres/min
Total Fluid Recovery Rate	418 gpm 597 bbl/hr
Emulsion Recovery Rate	355 gpm 507 bbl/hr
Oil Recovery Rate	302 gpm 431 bbl/hr
Rate Water Taken Onboard	63 gpm 89 bbl/hr
Water Retained Rate	63 gpm 89 bbl/hr
Decant Rate	0 gpm 0 bbl/hr

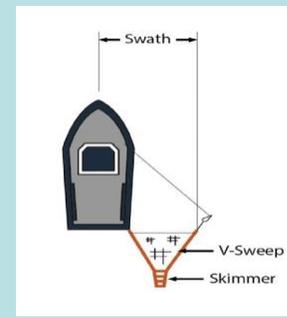
Time To Fill Onboard Storage	0.8 hr
Time to Offload Full Tank(s)	58 min
Time for 1 Full Cycle (includes offload & 2 transits)	2.8 hr
Skimming Time in Op Period	4.1 hr
Skimming Time in Op Period %	34 %
Area Covered (acre) in Op Period	87 acres
Area Covered (sq mi) in Op Period	0.14 sq mi
Total Volume Oil/Emulsion + Free Water Recovered/Op Period	2,467 bbl
Total volume of Oil/Emulsion Recovered/Op Period	2,095 bbl
Total # of Fills/Op Period	4.9

**Example: Variable % Emulsion**  
 ( $T_o = 0.05$  in.)

## System "X" ERSP vs. Emulsion

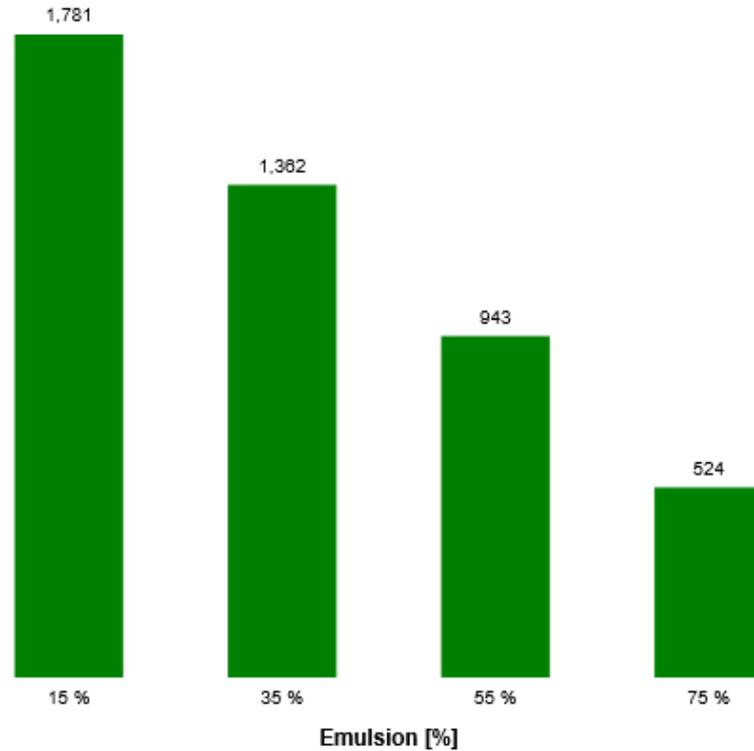
Average Oil Thickness = 0.05 in. (1.27 mm)

On-Board Storage = 500 bbl

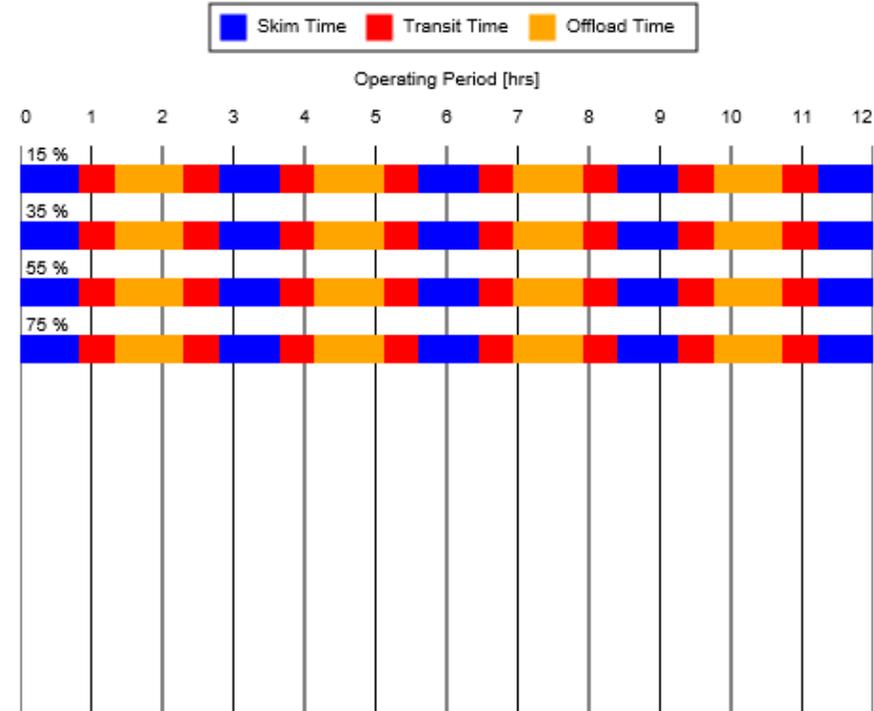


Emulsion	15 %	35 %	55 %	75 %
ERSP (Total Volume Oil Recovered/Op Period)	1,781 bbl	1,362 bbl	943 bbl	524 bbl

**ERSP vs Emulsion [%]**



**Response Timeline**



## Example: Variable % Decant

( $T_o = 0.05$  in.)

Thickness [in]:

Emulsion [%]:

Speed [kts]:

% Decant [%]:

Swath [ft]:

On-Board Storage [bbl]:

## Recovery System Calculator

Nameplate Recovery Rate [gpm]:

Decant Pump Rate [gpm]:

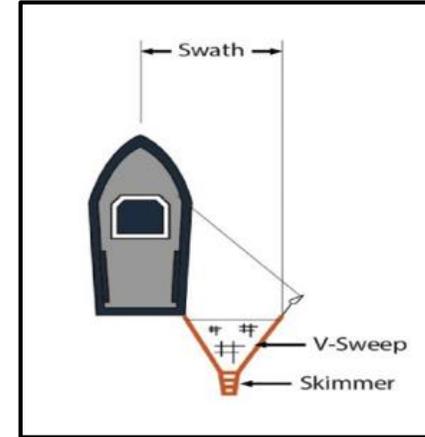
Discharge Pump Rate [gpm]:

Transit Time [min]:

Rig/Derig Time [min]:

Throughput Efficiency [%]:

Recovery Efficiency [%]:



Variable to Isolate:  Iterations:  Increment:

Operating Period [hrs]:

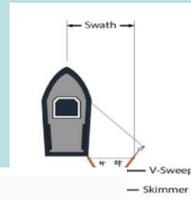
Only change below involves water decanted and retained.

% Decant	0 %	20 %	40 %	60 %	80 %
Maximum Effective Swath	117 ft				
Swath Used For Calculation	75 ft				
Encounter Rate	473 gpm 677 bbl/hr				
Areal Coverage Rate	0.35 acres/min				
Total Fluid Recovery Rate	418 gpm 597 bbl/hr				
Emulsion Recovery Rate	355 gpm 507 bbl/hr				
Oil Recovery Rate	231 gpm 330 bbl/hr				
Rate Water Taken Onboard	63 gpm 89 bbl/hr				
Water Retained Rate	63 gpm 89 bbl/hr	50 gpm 71 bbl/hr	38 gpm 53 bbl/hr	25 gpm 35 bbl/hr	13 gpm 17 bbl/hr
Decant Rate	0 gpm 0 bbl/hr	13 gpm 17 bbl/hr	25 gpm 35 bbl/hr	38 gpm 53 bbl/hr	50 gpm 71 bbl/hr

**Example: Variable % Decant**  
 ( $T_o = 0.05$  in.)

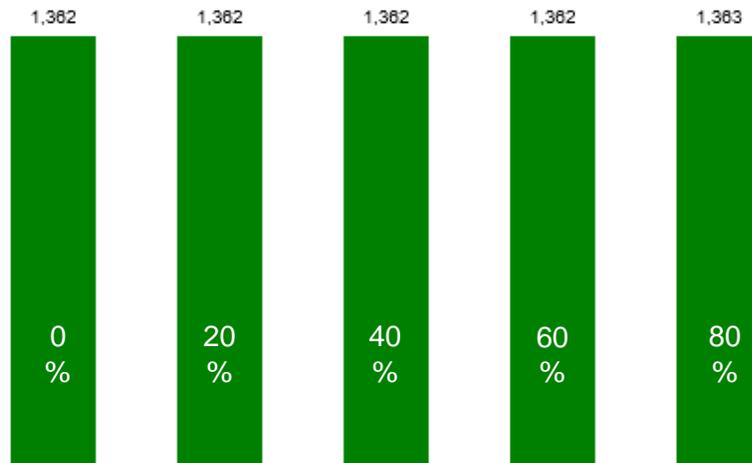
# System "X" ERSP vs. % Decant

Average Oil Thickness = 0.05 in. (1.27 mm)

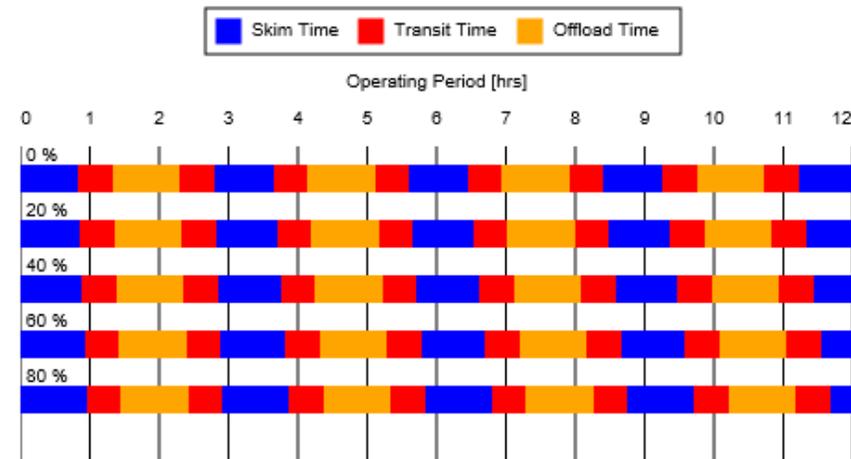


% Decant	0 %	20 %	40 %	60 %	80 %
Time To Fill Onboard Storage	0.8 hr	0.9 hr	0.9 hr	0.9 hr	1 hr
Time to Offload Full Tank(s)	58 min				
Time for 1 Full Cycle (includes offload & 2 transits)	2.8 hr	2.8 hr	2.9 hr	2.9 hr	2.9 hr
Skimming Time in Op Period	4.1 hr				
Skimming Time in Op Period %	34 %	34 %	34 %	34 %	34 %
Area Covered (acre) in Op Period	87 acres				
Area Covered (sq mi) in Op Period	0.14 sq mi				
Total Volume Oil/Emulsion + Free Water Recovered/Op Period	2,467 bbl	2,393 bbl	2,319 bbl	2,245 bbl	2,171 bbl
Total volume of Oil/Emulsion Recovered/Op Period	2,095 bbl	2,095 bbl	2,096 bbl	2,096 bbl	2,096 bbl
Total # of Fills/Op Period	4.9	4.8	4.6	4.5	4.3
<b>ERSP (Total Volume Oil Recovered/Op Period)</b>	<b>1,362 bbl</b>	<b>1,362 bbl</b>	<b>1,362 bbl</b>	<b>1,362 bbl</b>	<b>1,363 bbl</b>

**ERSP vs % Decant [%]**



**Response Timeline**



# Summary

- ✓ ERSP is a significant improvement over EDRC.
- ✓ Full “System” response is essential for meaningful performance estimates and planning standards.
- ✓ Optimized recovery potential for any skimming system involves the matching of possible oil encounter rates with on-board storage and processing capability.
- ✓ The recovery potential of each skimming system is uniquely tied to specific operating characteristics that can be quantified to enhance overall performance.
- ✓ “Bigger isn’t always better!” System swath, speed and storage should work within the constraints of throughput and recovery efficiency, pump capacity, and the type and proximity of backup support.