Empirical Analysis of the OCS Pipeline Network in the GoM

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Information Technology Meeting

DIRECTIONS in SOCIAL SCIENCE RESEARCH

New Orleans, LA

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Outline

Terminology

Task

“Talking About Pipelines”

GoM Statistics

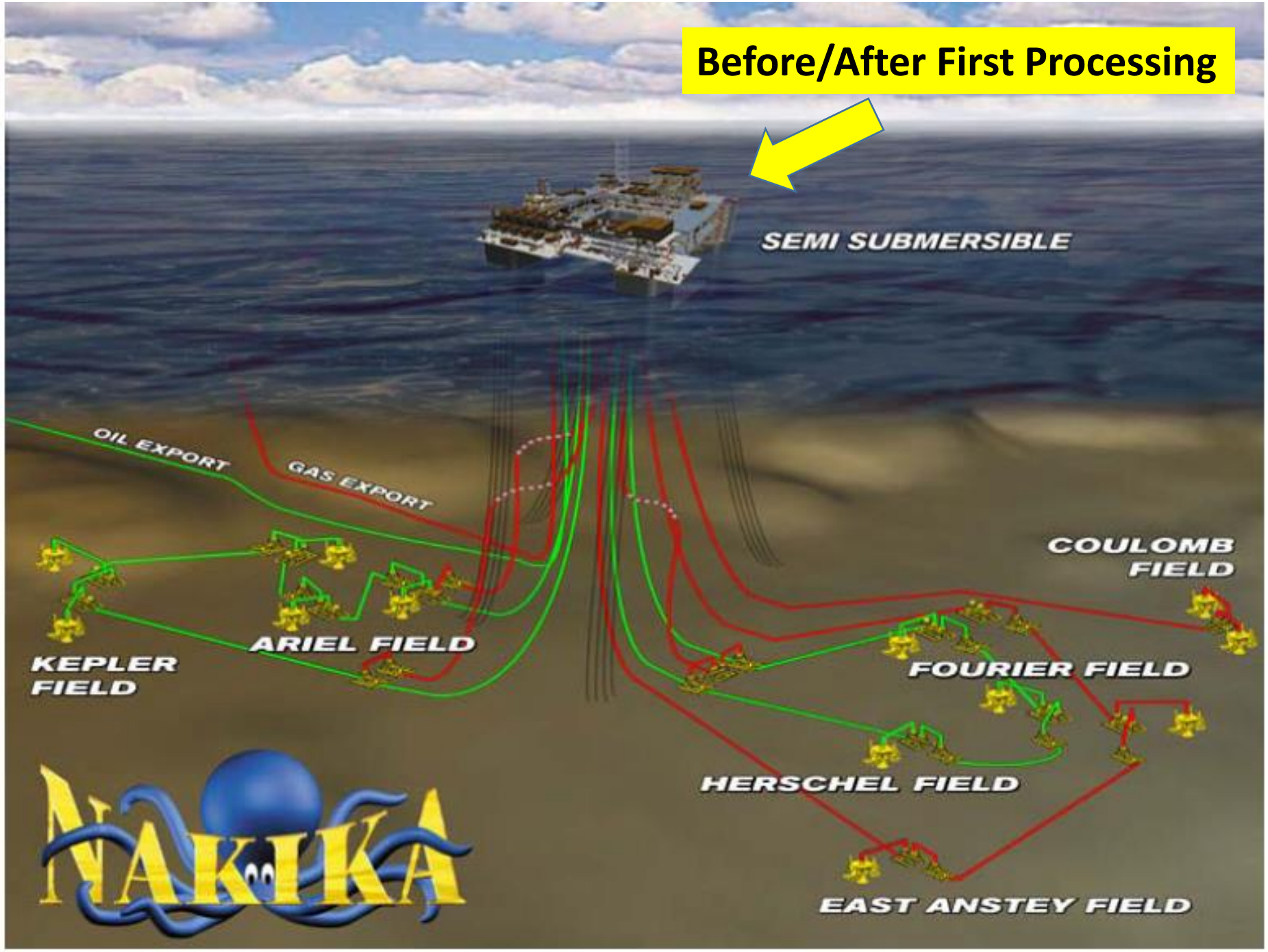
Correlations

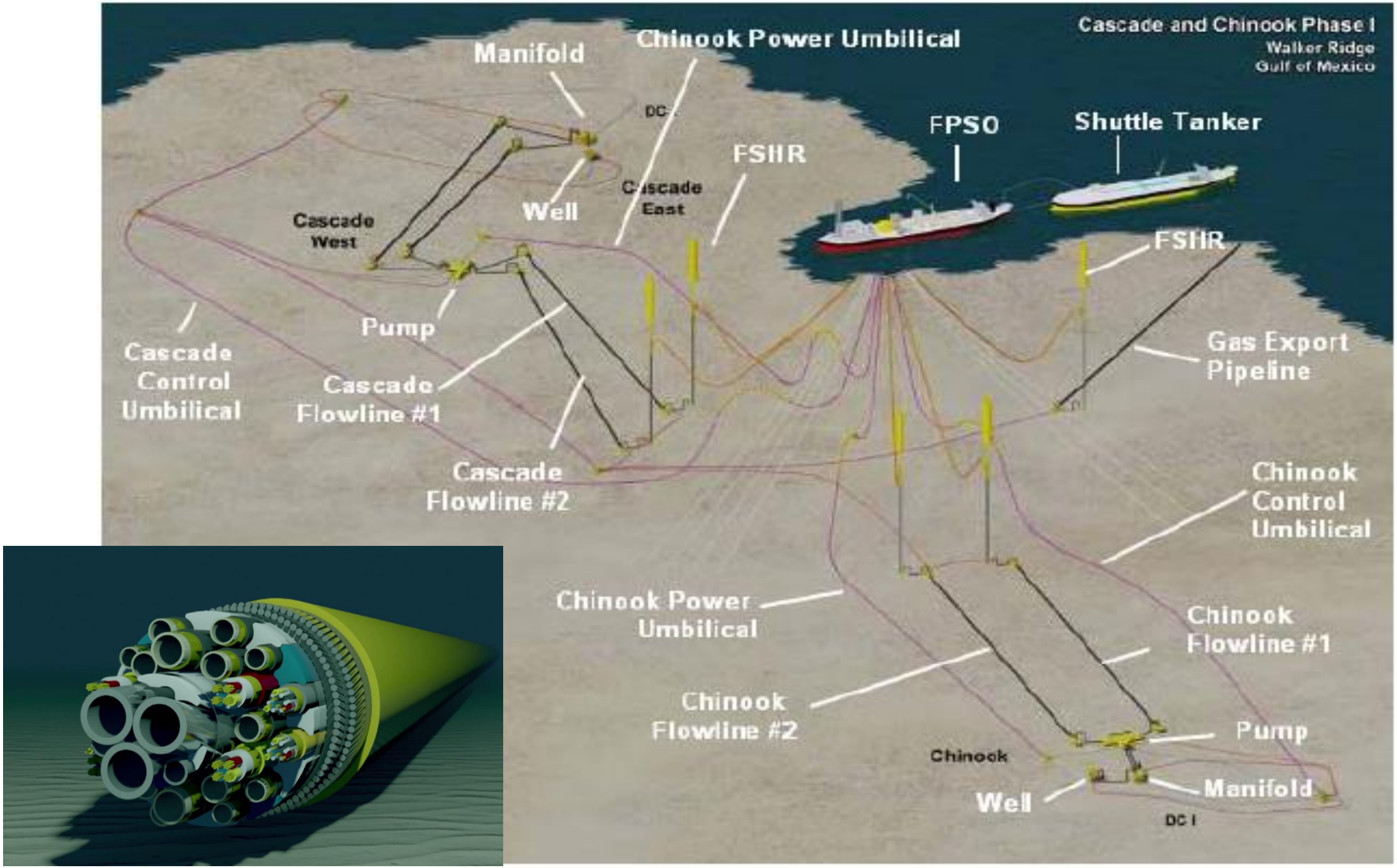
Terminology

Pipeline Type

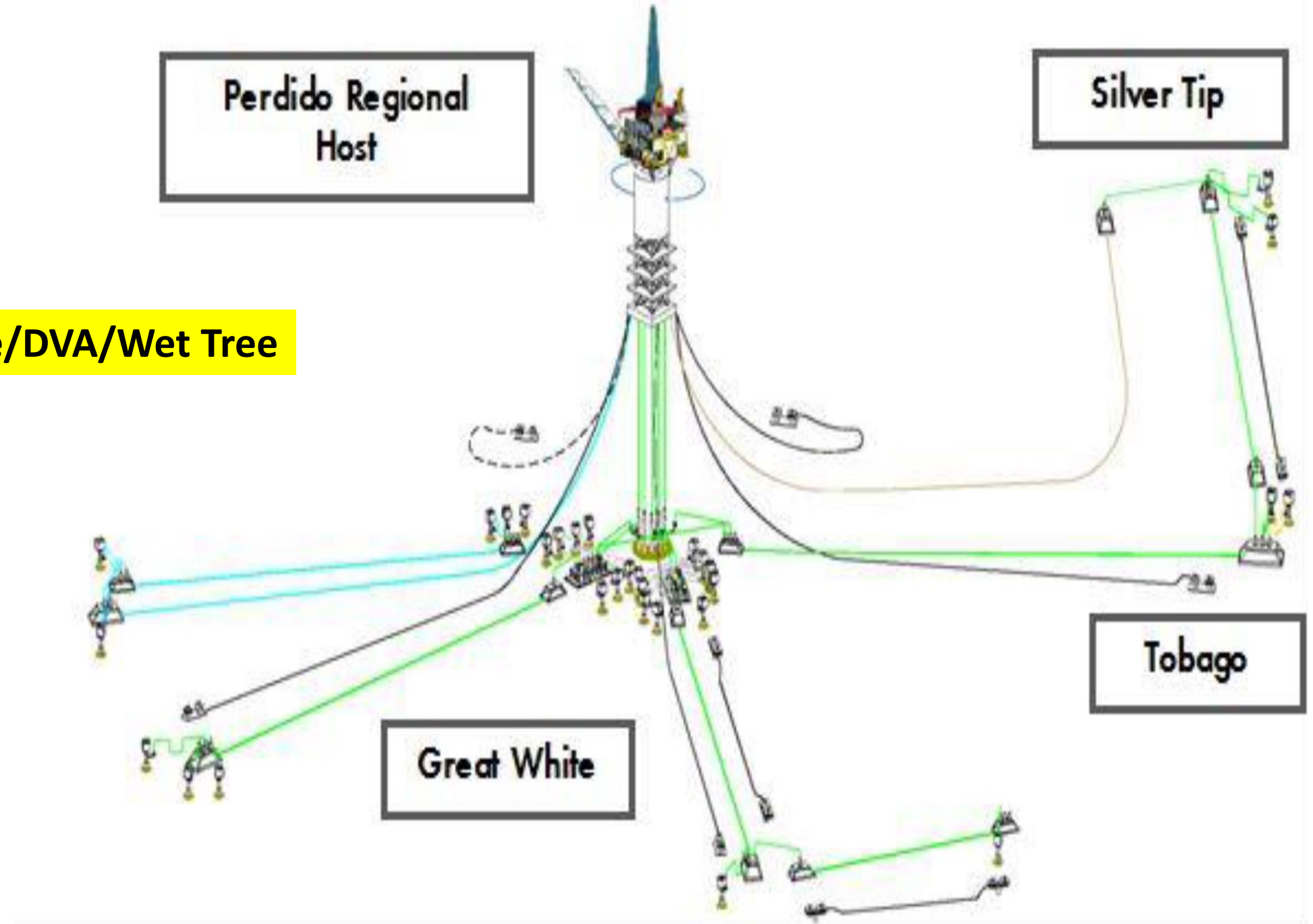
Well Type

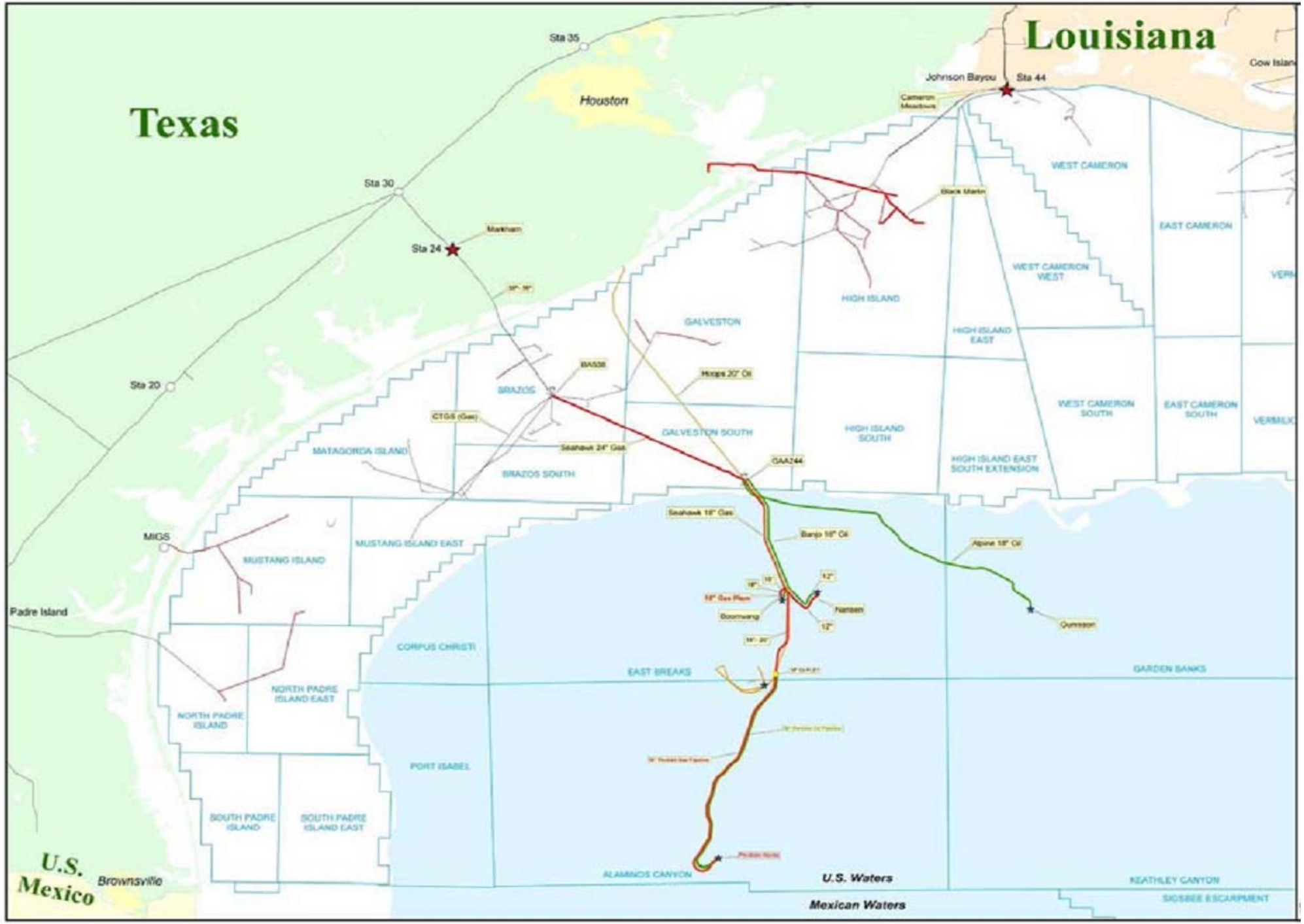
Water Depth


Before/After First Processing
SEMI SUBMERSIBLE
OIL EXPORT
GAS EXPORT
KEPLER FIELD
ARIEL FIELD
COULOMB FIELD
FOURIER FIELD
HERSCHEL FIELD
EAST ANSTEY FIELD
NAKIKA

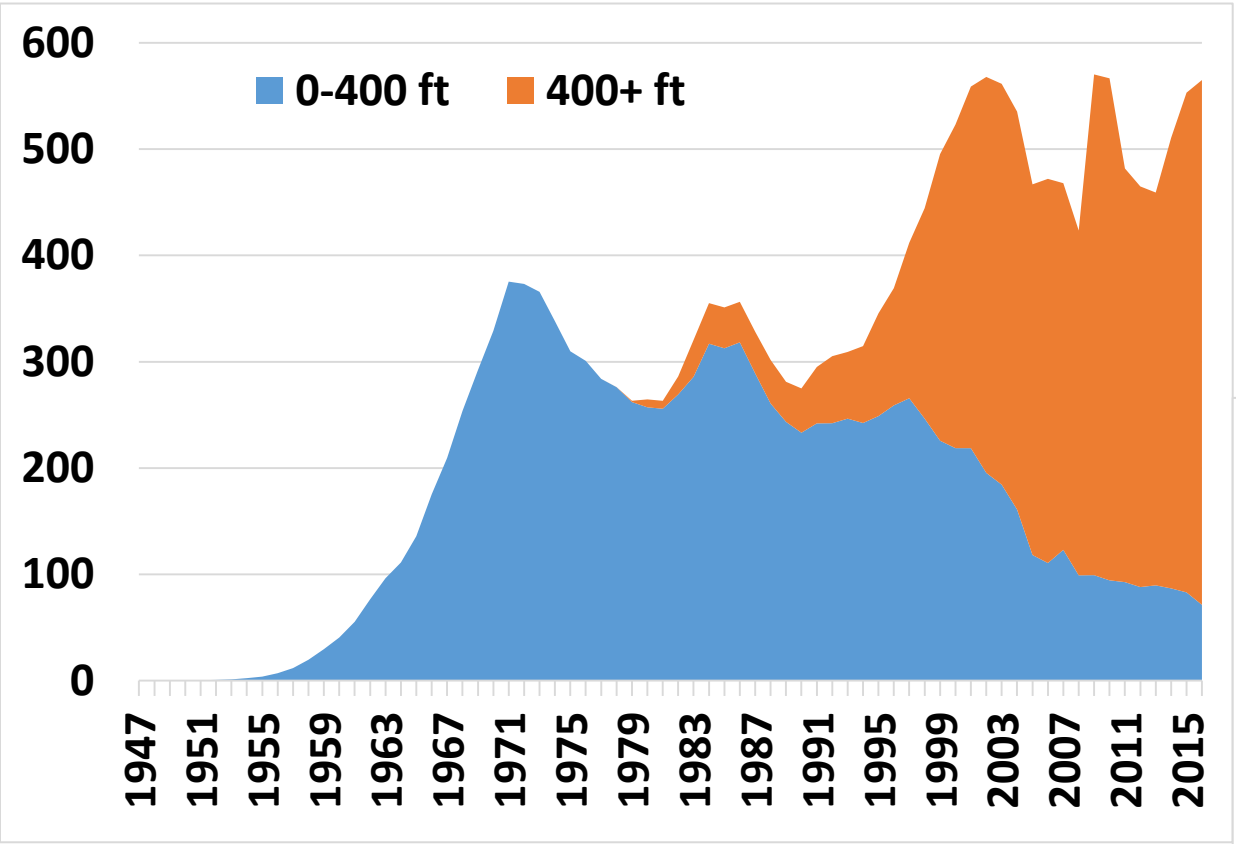

Cascade and Chinook Phase I
Walker Ridge
Gulf of Mexico
Manifold
Chinook Power Umbilical
DC
FPSO
Shuttle Tanker
FSHR
Cascade East
Well
Cascade West
FSHR
Pump
Gas Export Pipeline
Cascade Control Umbilical
Cascade Flowline #1
Cascade Flowline #2
Chinook Control Umbilical
Chinook Power Umbilical
Chinook Flowline #1
Chinook Flowline #2
Pump
Chinook
Manifold
Well
DC I

Dry Tree/DVA/Wet Tree

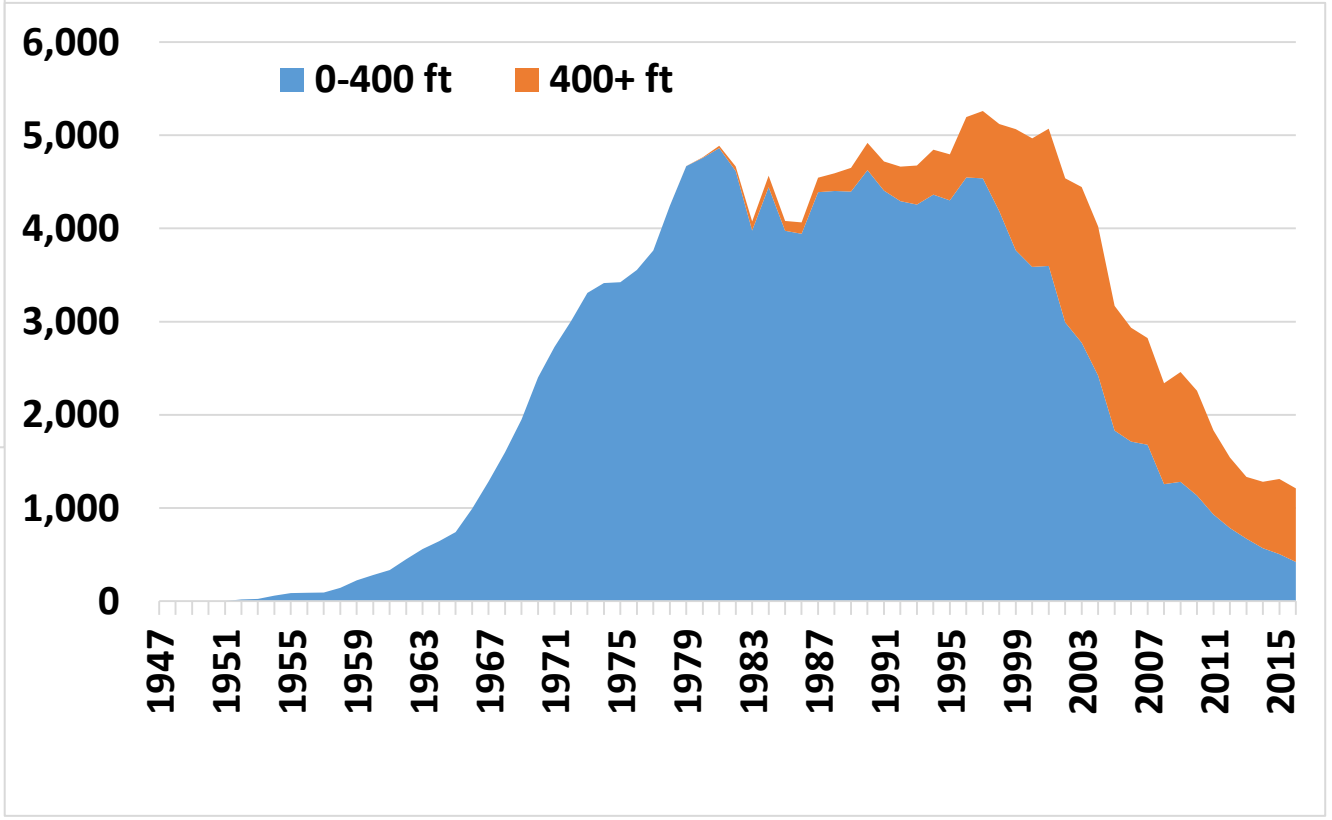


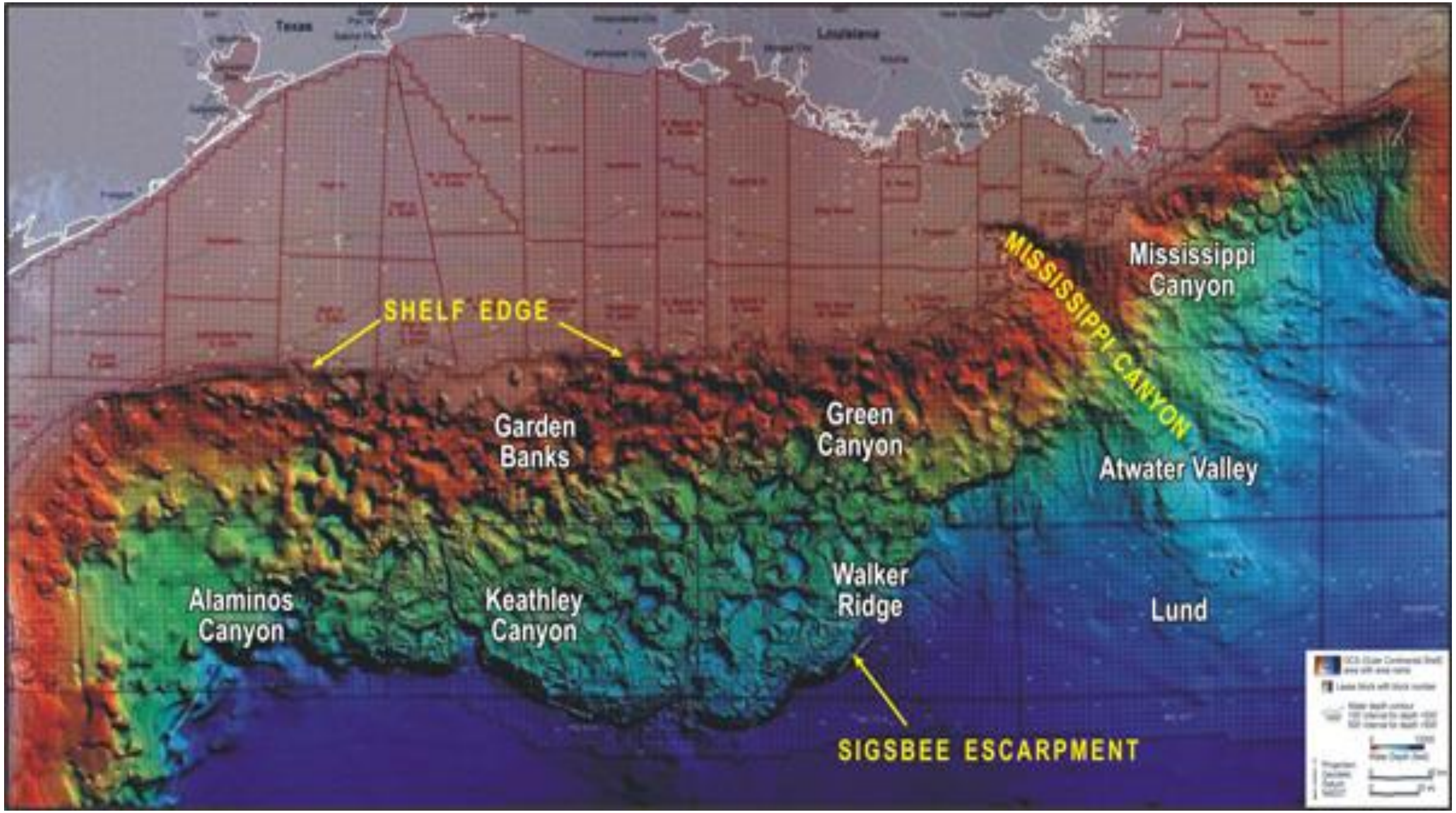

Texas
Louisiana
Houston
Sta 35
Sta 30
Sta 24
Markham
Sta 20
Johnson Bayou
Sta 44
Cameron Meadows
Black Marlin
WEST CAMERON
EAST CAMERON
WEST CAMERON WEST
HIGH ISLAND
GALVESTON
HIGH ISLAND EAST
BA538
Hioga 20" Oil
BRAZOS
ICTGS (Gas)
WEST CAMERON SOUTH
EAST CAMERON SOUTH
GALVESTON SOUTH
HIGH ISLAND SOUTH
MATAGORDA ISLAND
Seahawk 24" Gas
BRAZOS SOUTH
GAA244
HIGH ISLAND EAST SOUTH EXTENSION
Seahawk 18" Gas
Banjo 18" Oil
Alpine 18" Oil
MIGS
MUSTANG ISLAND
MUSTANG ISLAND EAST
18" Gas Riser
Boomerang
Harrison
Quinnson
Padre Island
CORPUS CHRISTI
EAST BREAKS
GARDEN BANKS
NORTH PADRE ISLAND EAST
NORTH PADRE ISLAND
PORT ISABEL
SOUTH PADRE ISLAND
SOUTH PADRE ISLAND EAST
ALAMINOS CANYON
KEATHLEY CANYON
SIGSBEE ESCARPMENT
U.S.
Mexico
Brownsville
U.S. Waters
Mexican Waters

Oil Production (MMbbl)

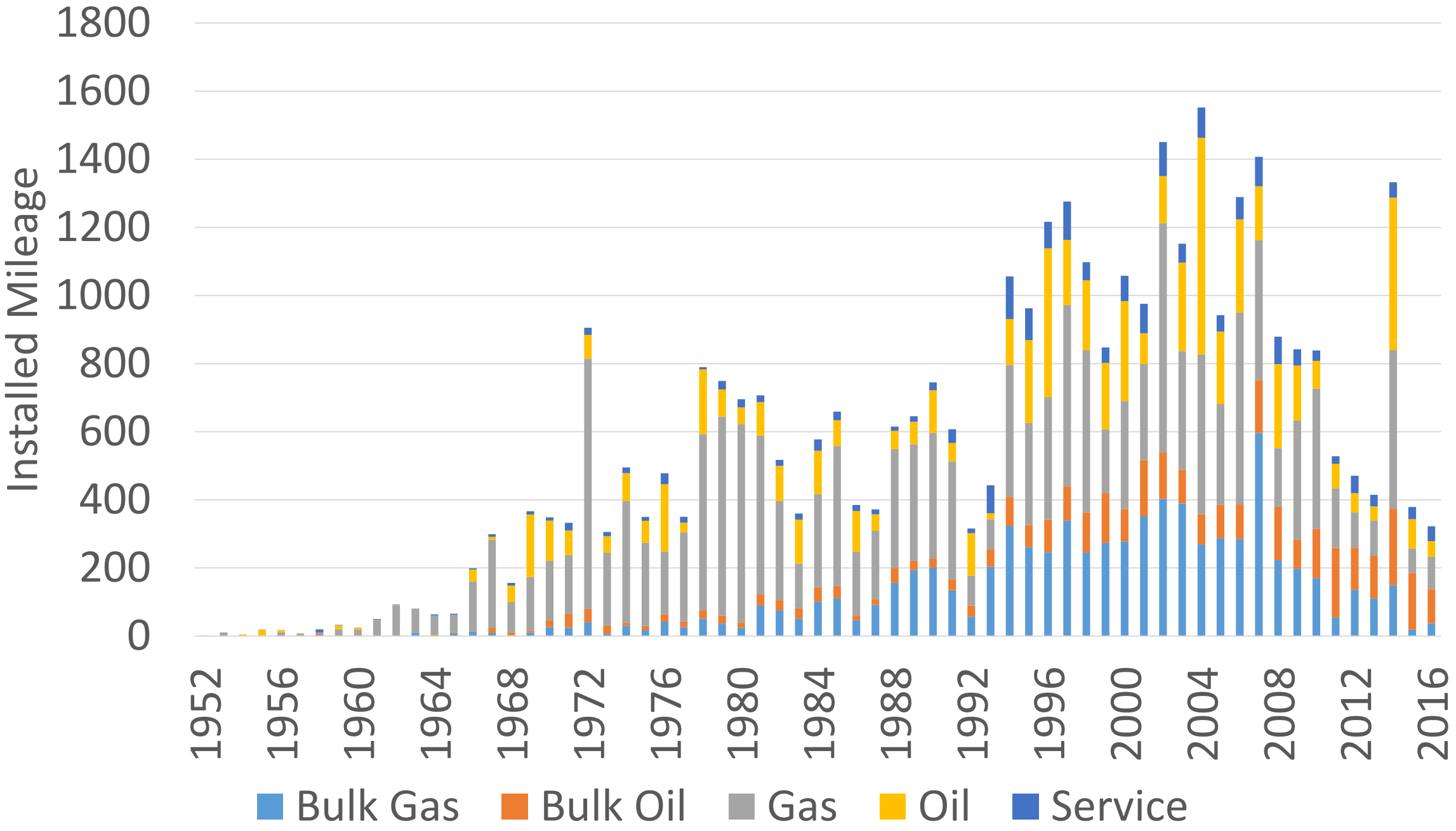


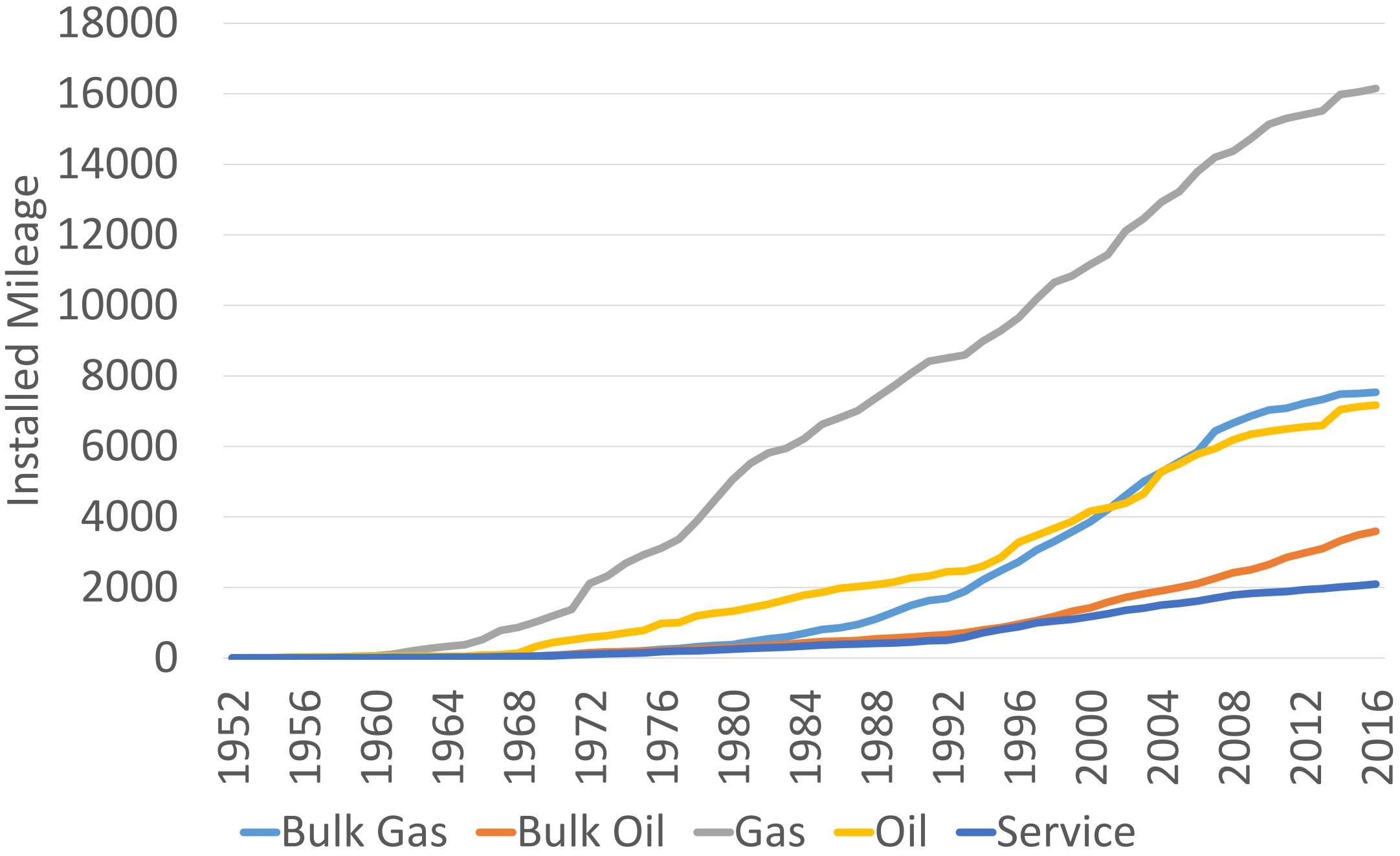
Gas Production (Bcf)




Texas
Louisiana
SHELF EDGE
MISSISSIPPI CANYON
Mississippi Canyon
Garden Banks
Green Canyon
Atwater Valley
Alaminos Canyon
Keathley Canyon
Walker Ridge
Lund
SIGSBEE ESCARPMENT

Task


Installed Mileage
1800
1600
1400
1200
1000
800
600
400
200
0
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
Bulk Gas
Bulk Oil
Gas
Oil
Service

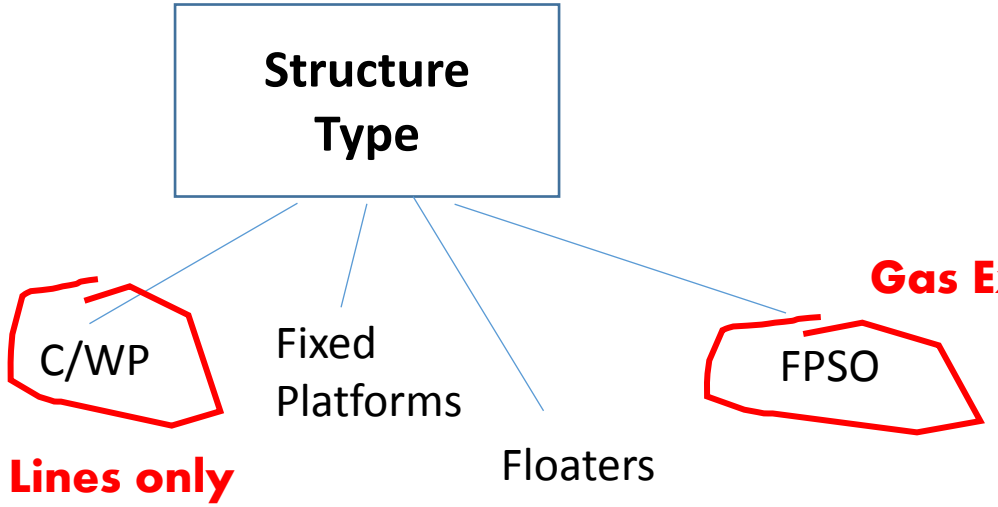

18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Installed Mileage
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
Bulk Gas
Bulk Oil
Gas
Oil
Service

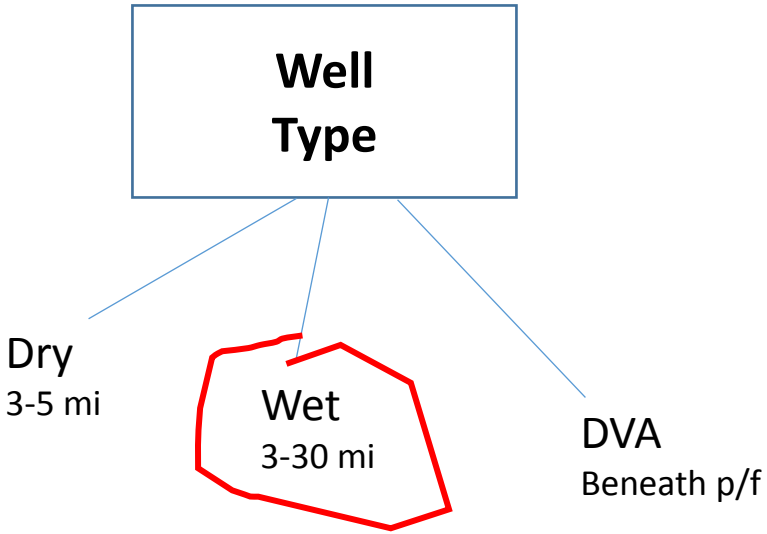
“Talking About Pipelines”

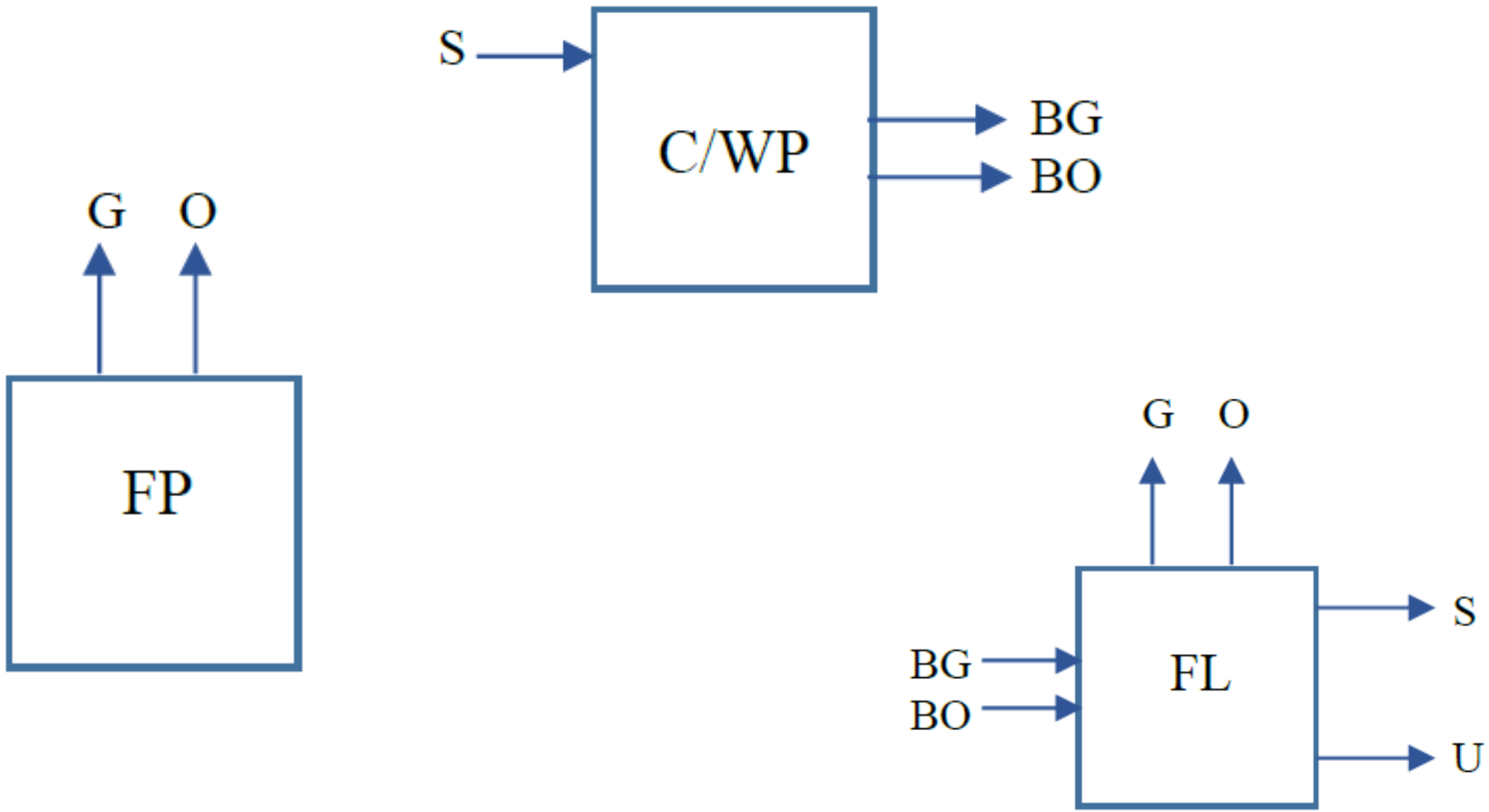
(Or, Why Pipeline Modeling is So Difficult)

1. Magnitude
2. Causal Relations
3. Complex Dependencies
4. Ownership Issues
5. Regulatory Requirements
6. Field Development

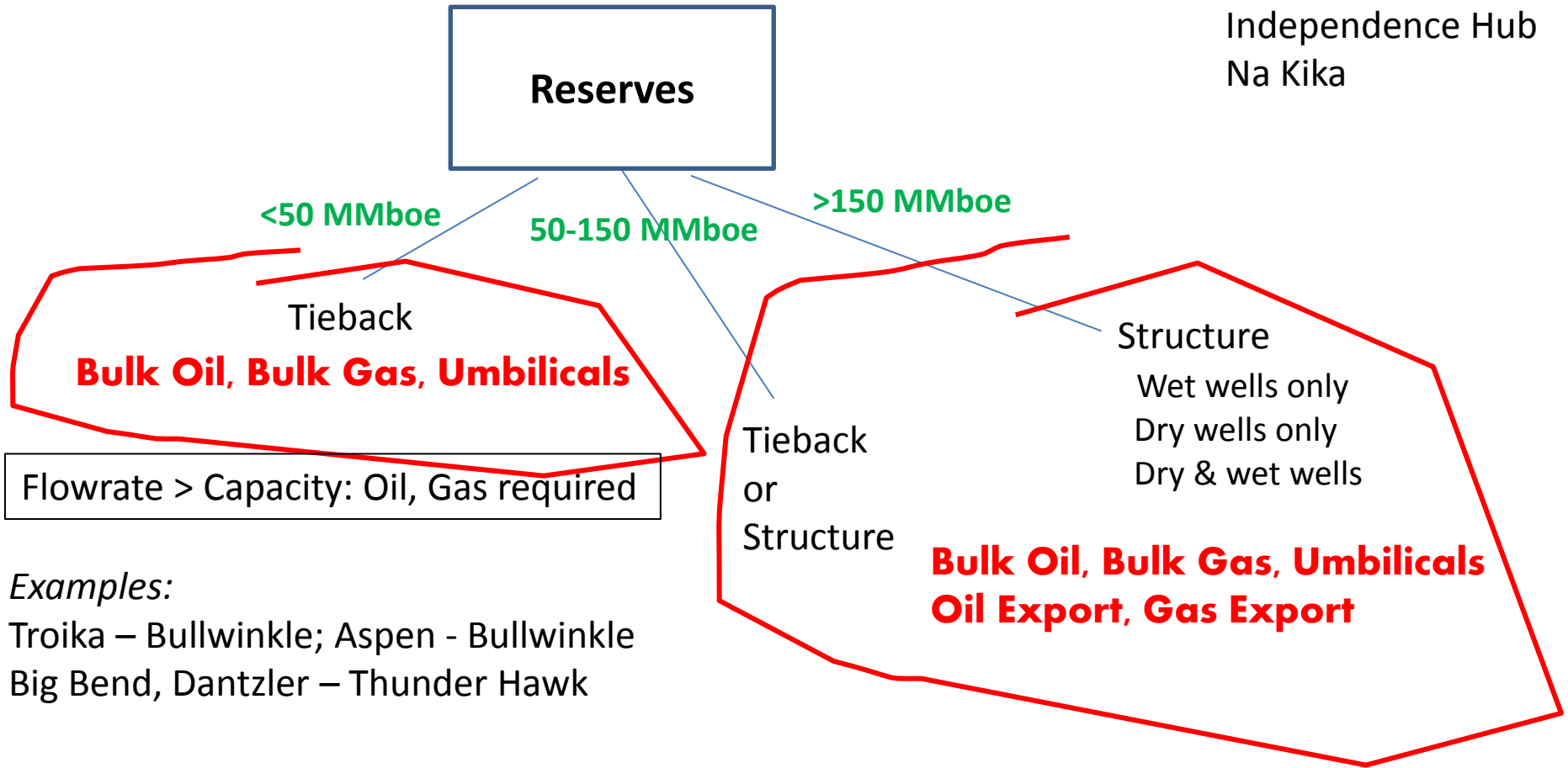
Causal Relations, Usually






S
C/WP
BG
BO
G
O
FP
G
O
BG
BO
FL
S
U

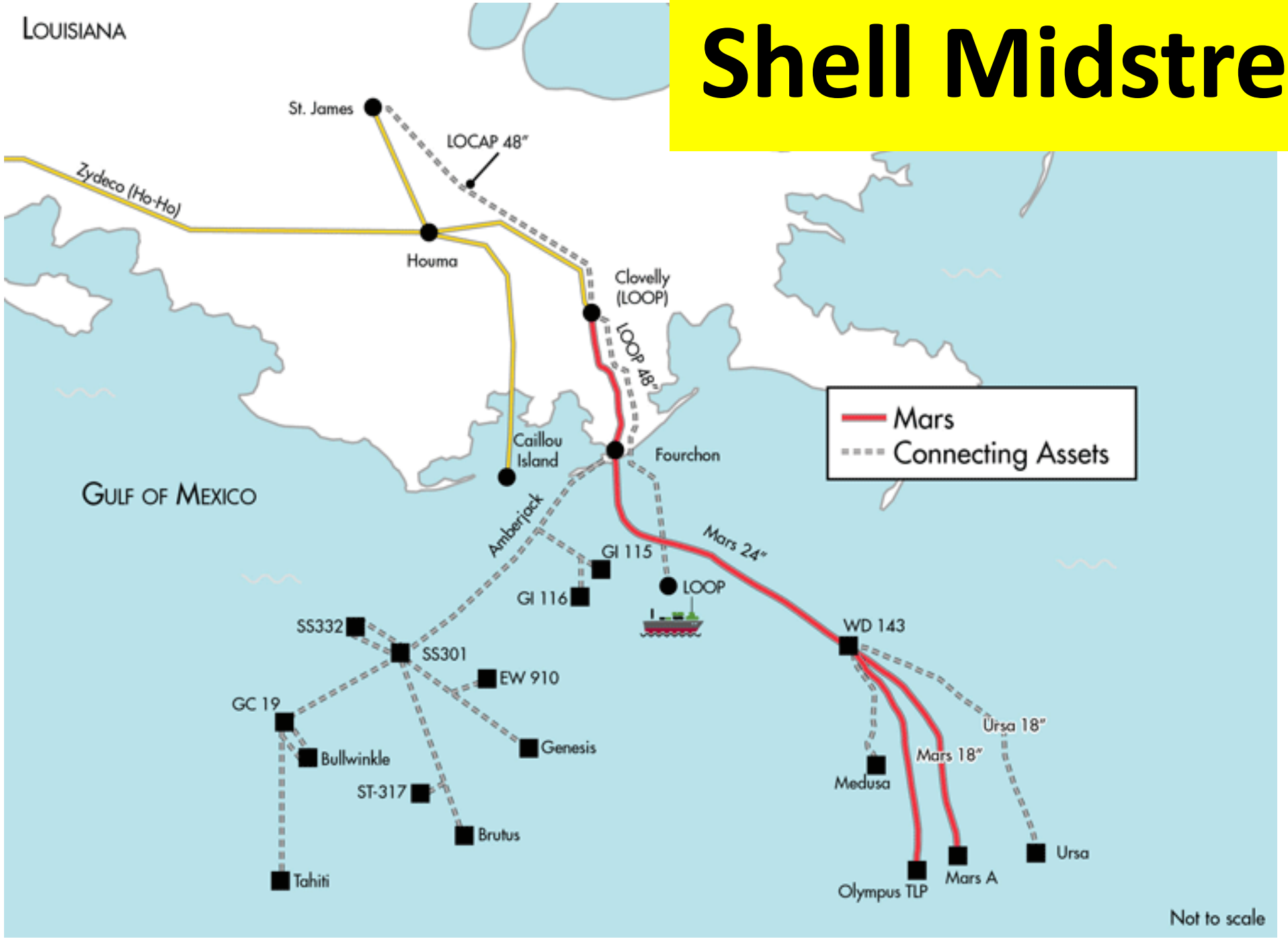
Development Strategy is Key



Examples:
Canyon Express
Independence Hub
Na Kika

Examples:
Troika – Bullwinkle; Aspen - Bullwinkle
Big Bend, Dantzler – Thunder Hawk

Shell Midstream

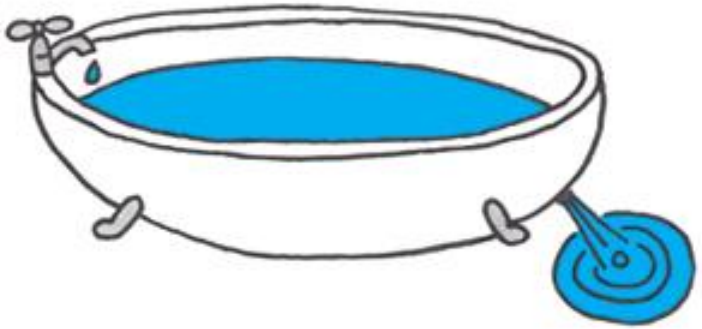


Statistics

GoM Statistics circa 2016

Cum Installed	**45,310 miles**
Cum Decommissioned	**19,236 miles**
Active	**21,872 miles**
Out-of-Service (Idle)	**4,032 miles**

Radius ~ 4000 miles

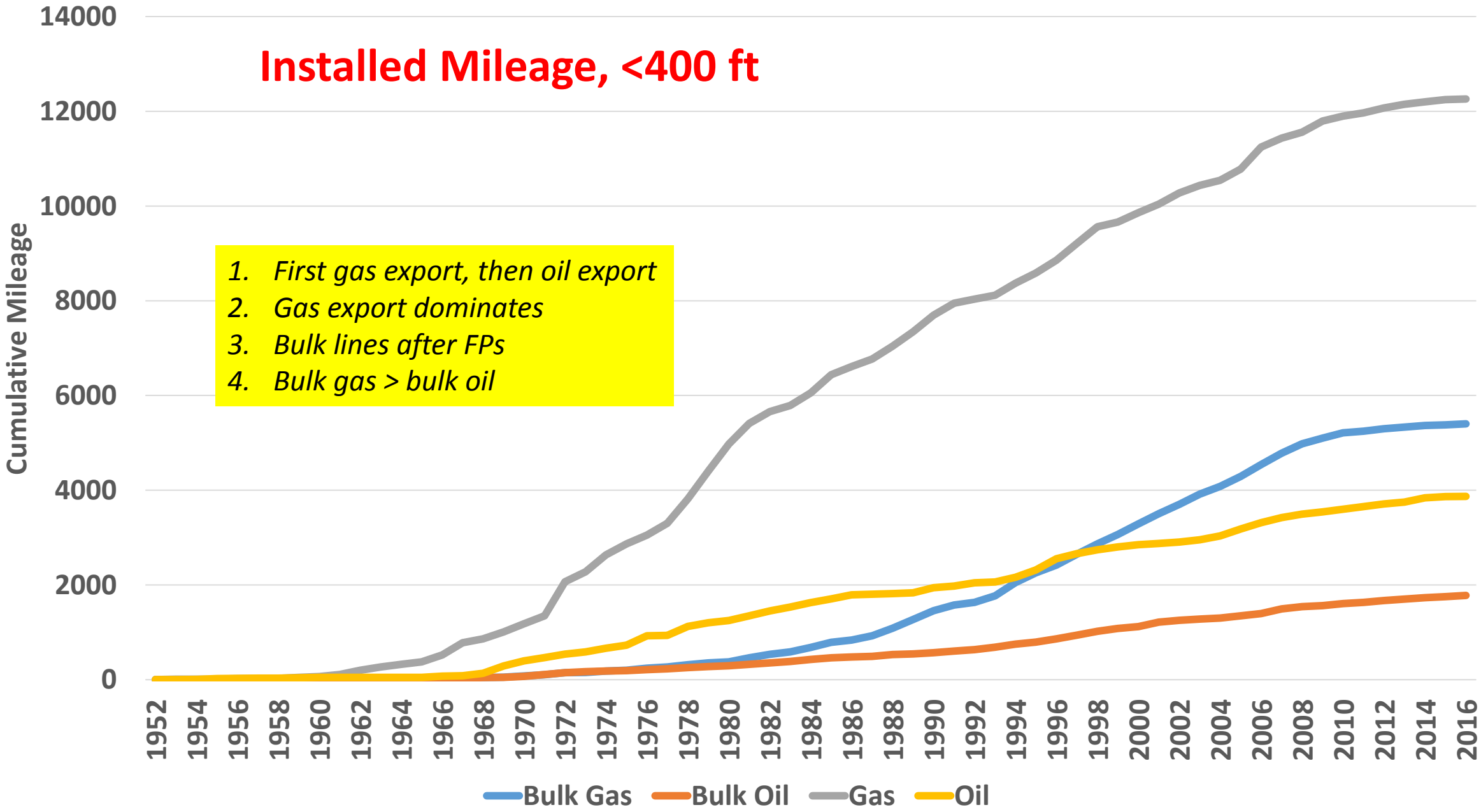


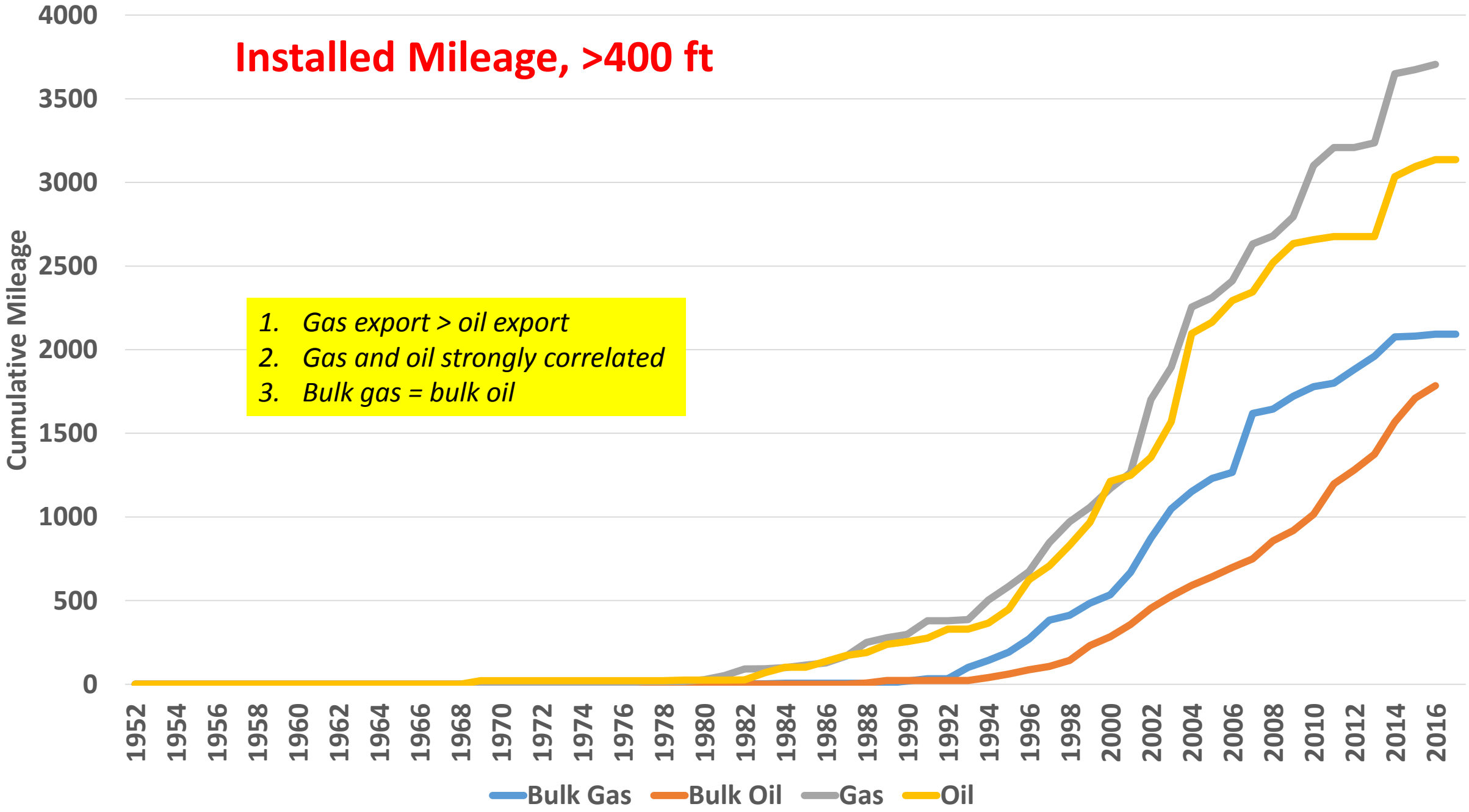
CumInstalled = Active + Idle + CumDecommissioned

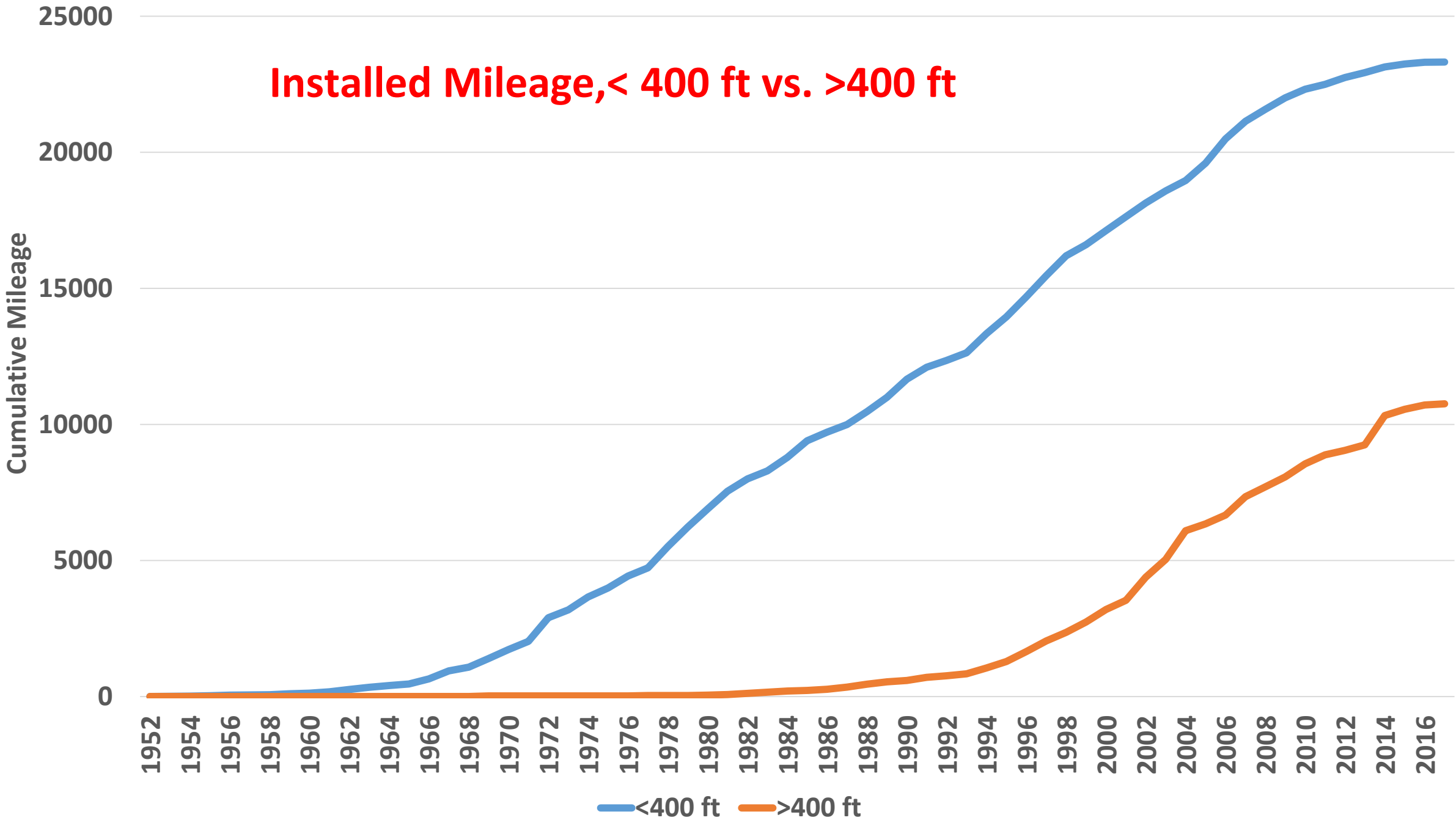
~1 in 10,000

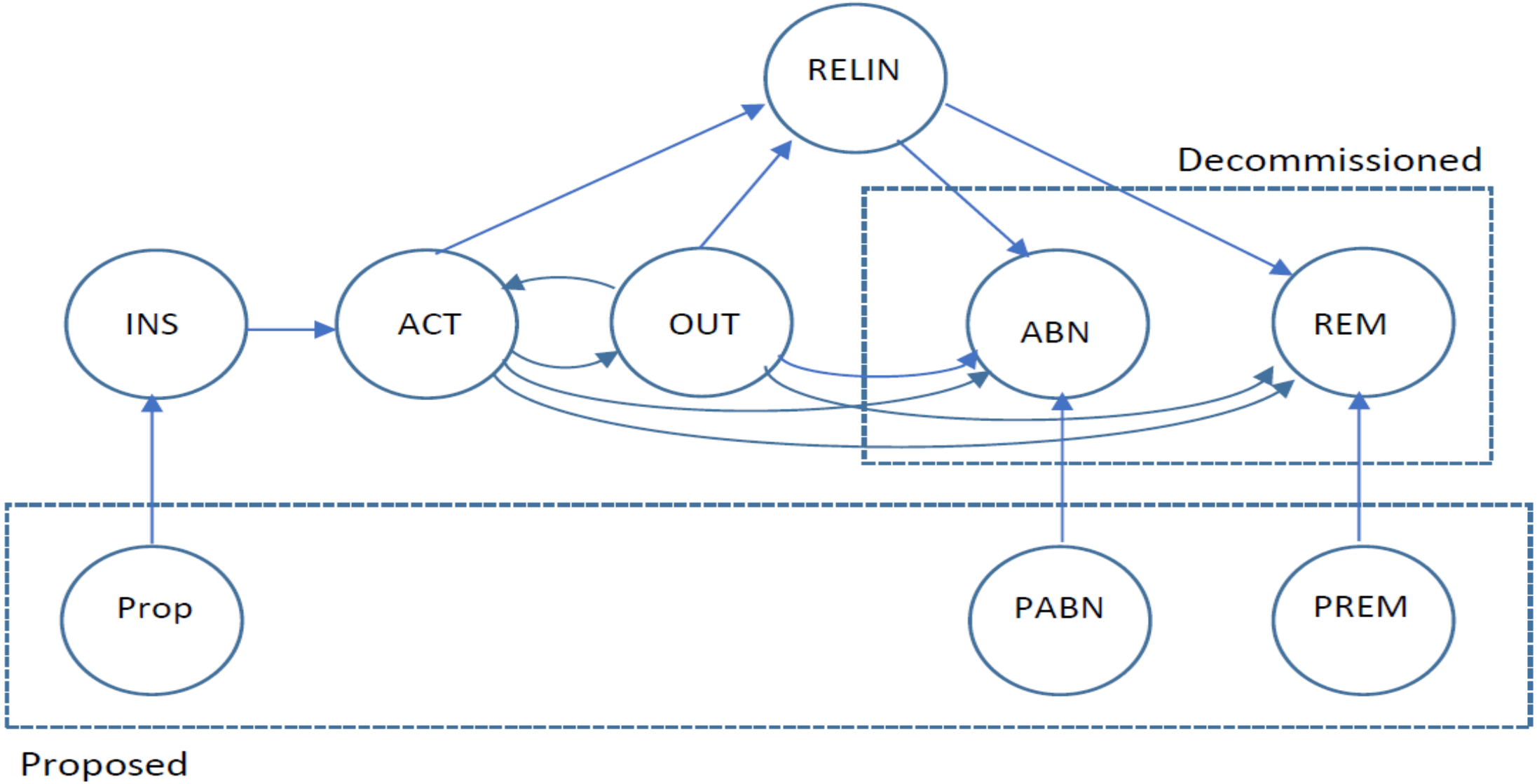
Installed pipeline areal coverage percentage

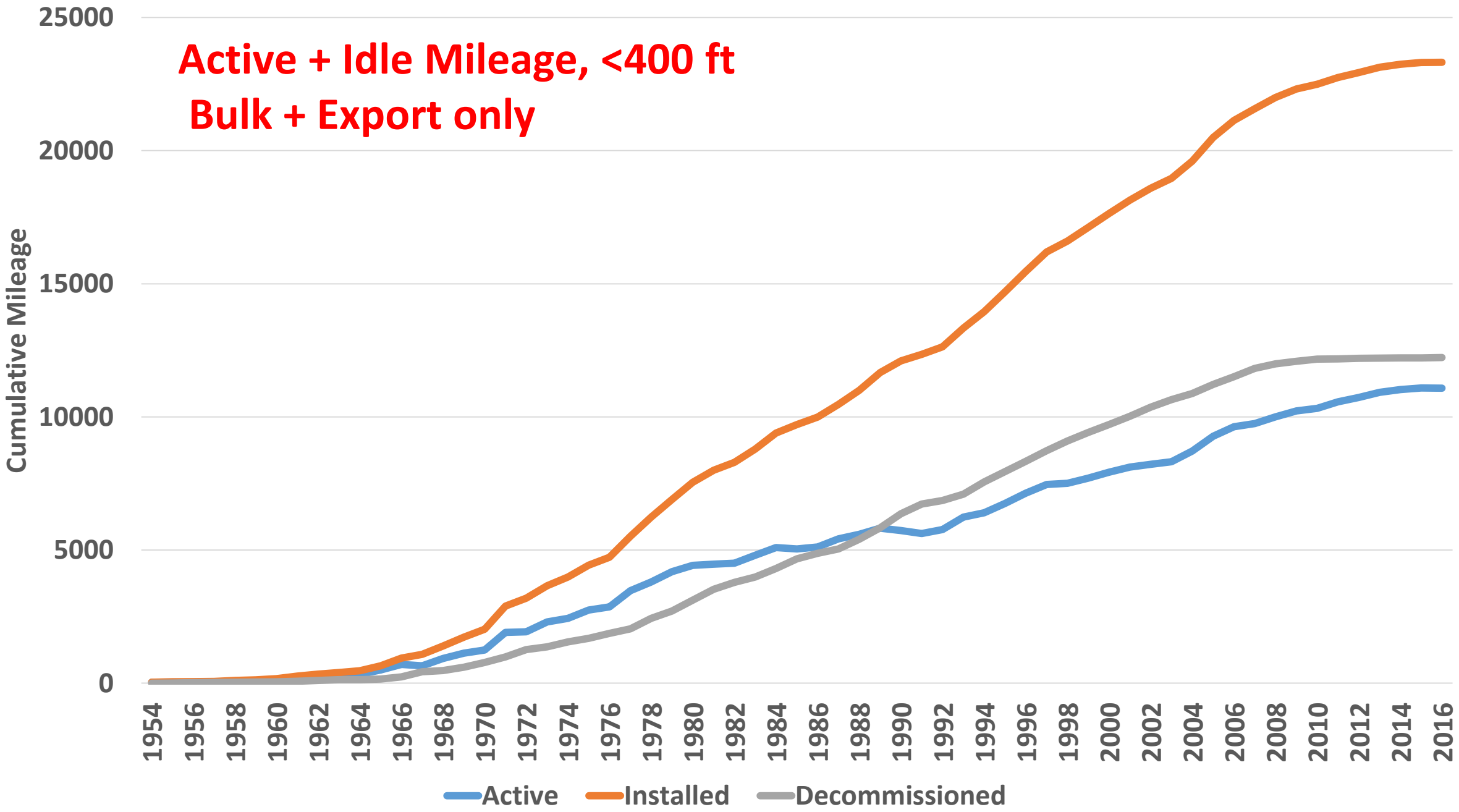
Trends

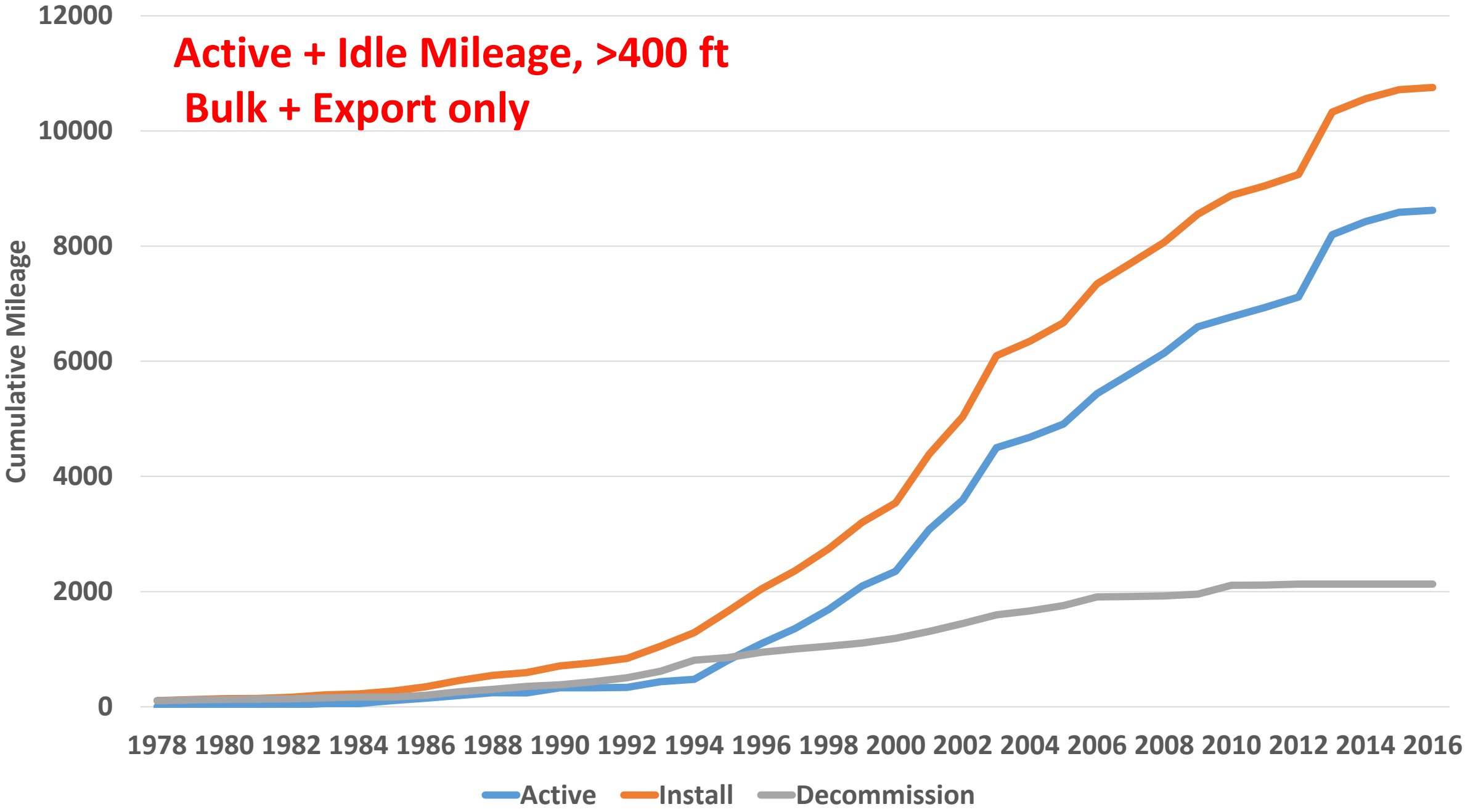

Installed Mileage, <400 ft
1. First gas export, then oil export
2. Gas export dominates
3. Bulk lines after FPs
4. Bulk gas > bulk oil
Cumulative Mileage
14000
12000
10000
8000
6000
4000
2000
0
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Bulk Gas
Bulk Oil
Gas
Oil


Installed Mileage, >400 ft
1. Gas export > oil export
2. Gas and oil strongly correlated
3. Bulk gas = bulk oil
Cumulative Mileage
4000
3500
3000
2500
2000
1500
1000
500
0
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Bulk Gas
Bulk Oil
Gas
Oil


Installed Mileage,< 400 ft vs. >400 ft
Cumulative Mileage
25000
20000
15000
10000
5000
0
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
<400 ft
>400 ft

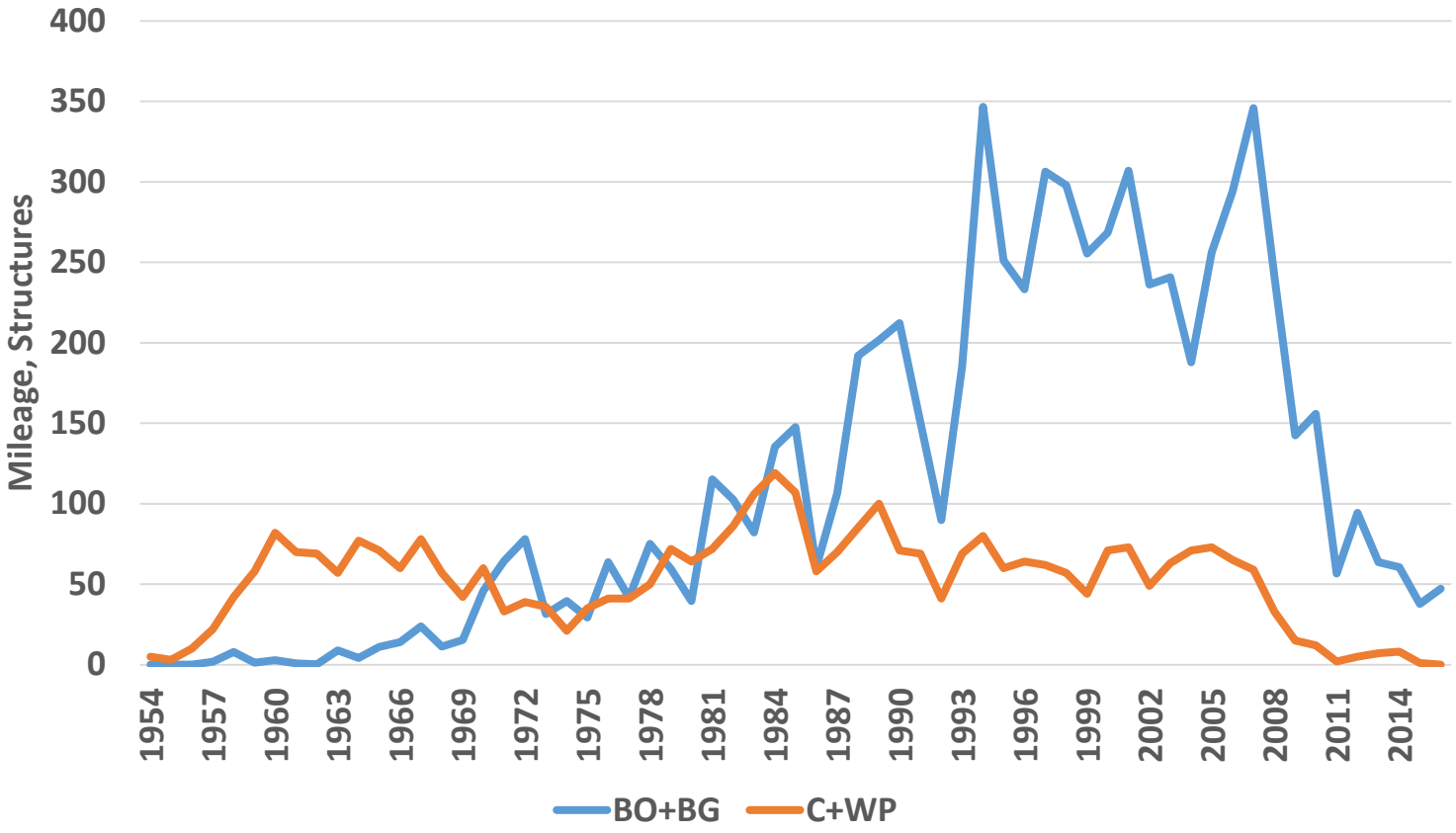

RELIN
Decommissioned
INS
ACT
OUT
ABN
REM
Prop
PABN
PREM
Proposed


Active + Idle Mileage, <400 ft
Bulk + Export only
Cumulative Mileage
25000
20000
15000
10000
5000
0
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Active
Installed
Decommissioned

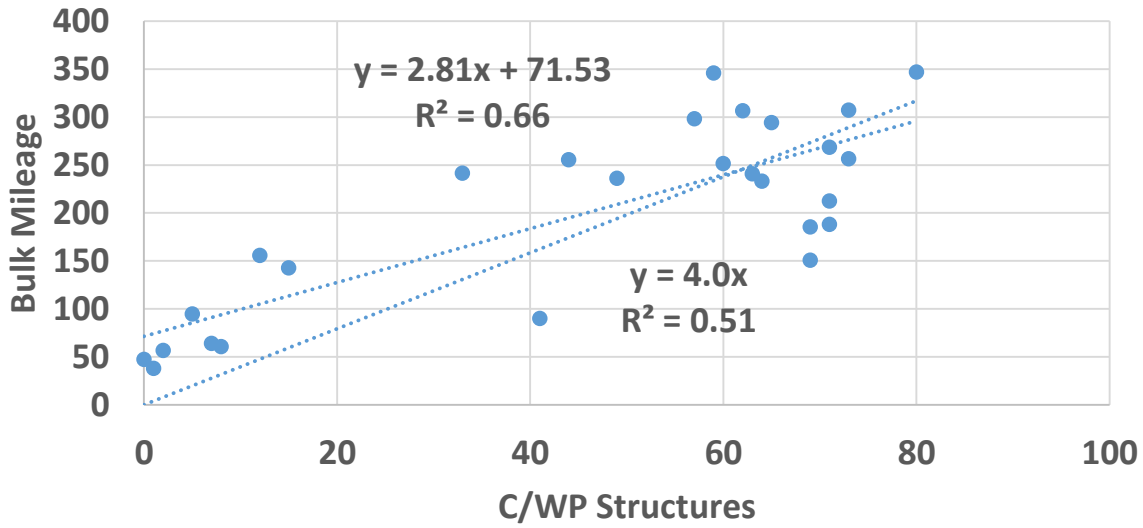

Active + Idle Mileage, >400 ft
Bulk + Export only
Cumulative Mileage
12000
10000
8000
6000
4000
2000
0
1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Active
Install
Decommission

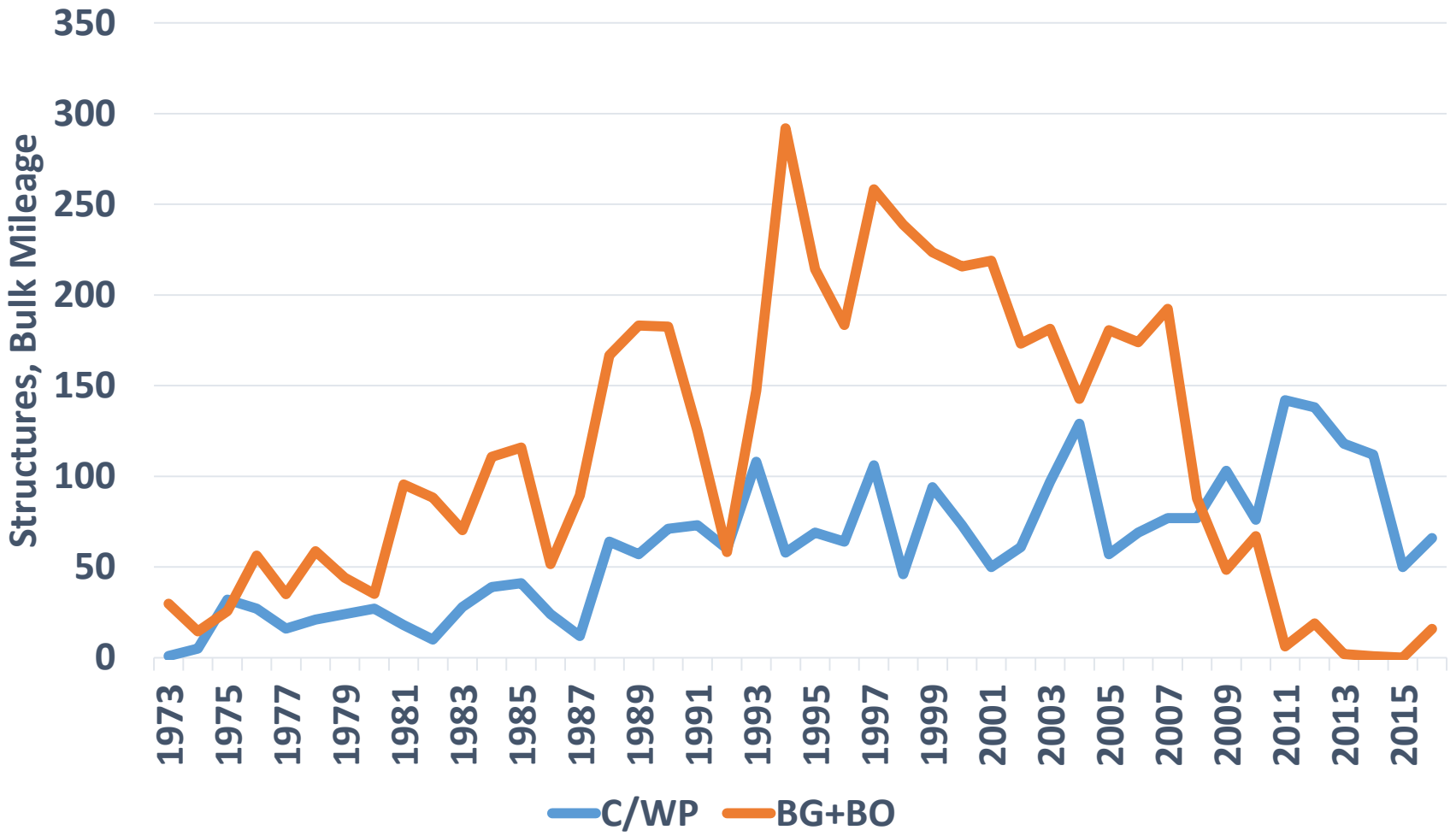
Correlations

(Sample)



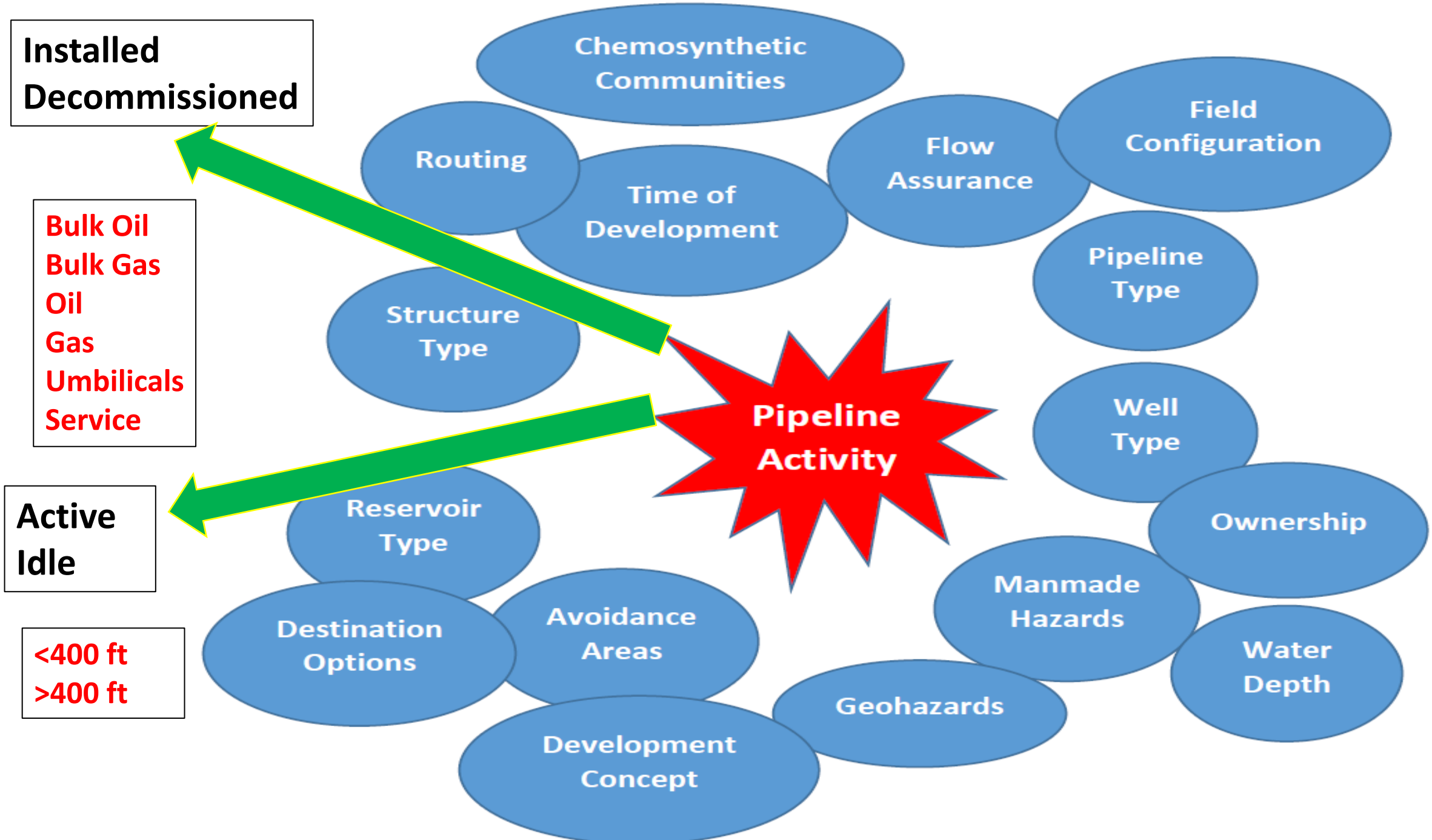
Installation, 1990-2016, <400 ft:
[BG+BO] = 2.81*C/WP + 71,
R^2 = 0.66



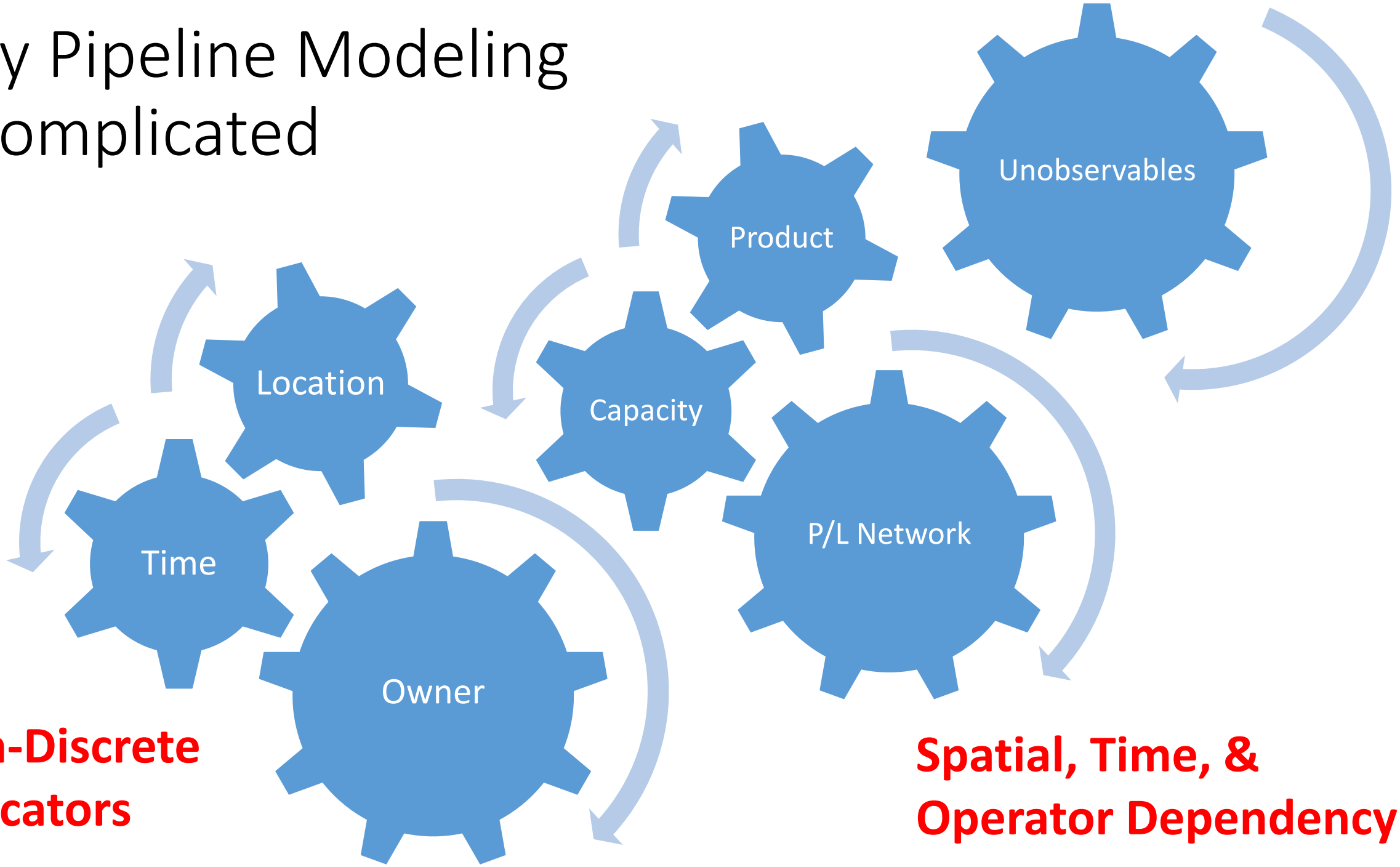


Decommissioning, 1990-2016, <400 ft:
[BG+BO] = 1.6*C/WP + 48.6, R^2 = 0.47

Extra Slides


Installed
Decommissioned
Bulk Oil
Bulk Gas
Oil
Gas
Umbilicals
Service
Active
Idle
<400 ft
>400 ft
Chemosynthetic Communities
Routing
Time of Development
Flow Assurance
Field Configuration
Pipeline Type
Structure Type
Pipeline Activity
Well Type
Ownership
Reservoir Type
Destination Options
Avoidance Areas
Manmade Hazards
Water Depth
Geohazards
Development Concept

Why Pipeline Modeling is Complicated



Non-Discrete Indicators

Spatial, Time, & Operator Dependency

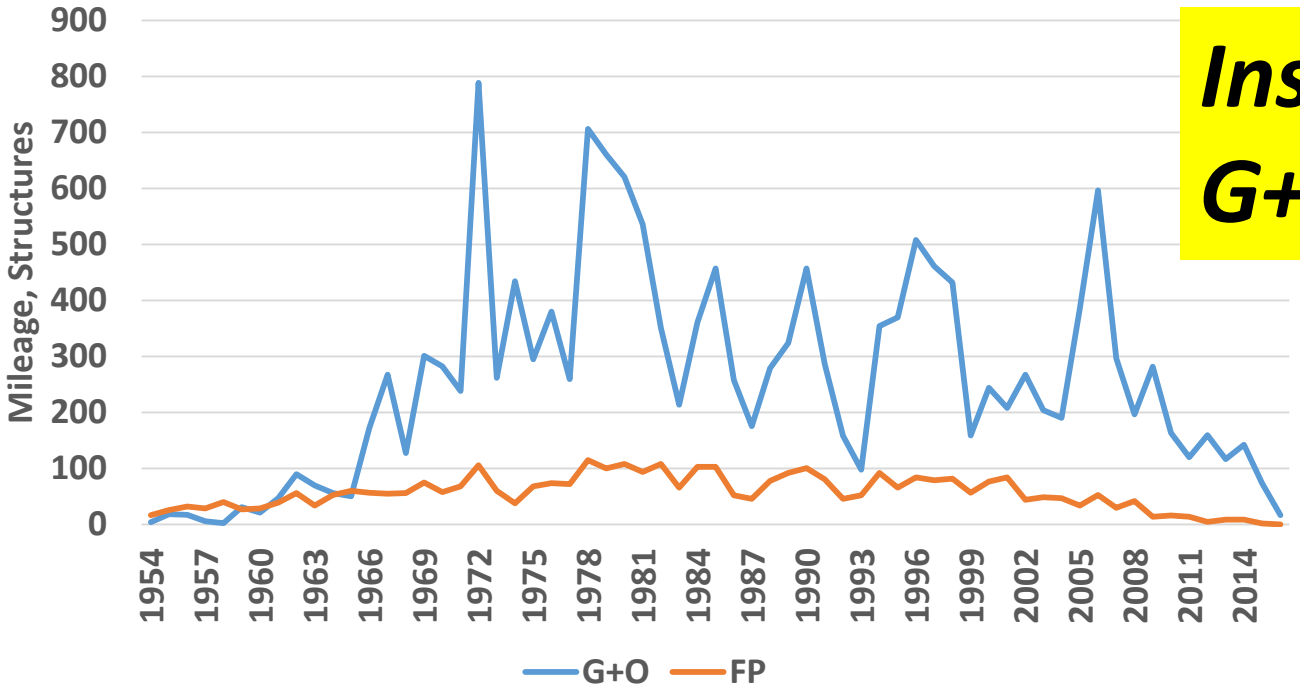
Time Normalization

Installation, >400 ft:

[G+O] = 54.8*DWS + 52, R^2 = 0.32 (1990-2016)

[G+O] = 61.1*DWS + 137, R^2 = 0.56 (5-yr TB, 1990-2016)

[G+O] = 80.1*DWS + 163, R^2 = 0.87 (5-yr TB, 2000-2016)



Installation, 1990-2016, <400 ft

G+O = 3.04*FP + 114, R^2 = 0.42