Managing a CO₂ Development in a Privately Funded Environment: The GLSAU Project

Tom Thurmond

Presented at the 16th Annual CO₂ Flooding Conference

December 9-10, 2010

Midland, Texas
Legado Resources Background

- Formed in July 2007
  - Funding Commitment from EnCap Partners and Management, et al.

- Business Plan Unique to Private Equity
  - Exclusively Focused on Oil
  - Purchase Oil Properties that have EOR Upside
  - Oil “Resource Play” using techniques of the Gas Resources Plays

- Extensive Experience in Miscible Gas Injection
  - Multiple Basin – West Texas, Oklahoma, Wyoming, Mississippi, Alaska
  - Team Members have worked on over 20% of all CO₂ floods
  - Reservoir Engineering, Geology, Operations, Facilities, Pipelines
  - Business Development
Project Characteristics

Unfamiliar to Private Equity Funding:

- **Technical Aspects**
  - Process – Miscible Displacement, NGL Recovery, Compression etc.
  - Cost – Large Facility Construction, Aging Wells & Infrastructure
  - Performance – Level of Uncertainty in Projections

- **Financing**
  - Timing – Large Up-Front Investment Decisions
  - Maturation – Developments Require Patience
  - Commitment – Long-Term Contractual Ties

- **Other Elements**
  - Price Leverage – Large Reserve Base
  - Talent – Limited Pool of Qualified Professionals
Project Placement

Fraction of Worldwide CO₂ EOR Production

- Permian Basin – San Andres
- Permian Basin – Non SA
- Other Basins

United States CO₂ Pipeline Infrastructure


Placement Alone Addresses Several Management Goals:
Project Placement – GLSAU Background

Timeline
- 1934 – Field Discovery
- 1945 – Completed Initial Development Phase (250 Wells)
- 1948 – Began Gas Cap Re-injection
- 1963 – Unitization and Peripheral Waterflood Install
- 1965 – Begin Phasing into Pattern Waterflood
- 1985 – Stripper Operations and Well Abandonments
- 2008 – Legado Acquires Field Operations
- 2009 – (July) Pilot Operations Commence
- Pres – Phase 1 Development 90% Complete

Goldsmith

<table>
<thead>
<tr>
<th></th>
<th>Disc OOIP (MP)</th>
<th>Disc OOIP (ROZ)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>246 MMSTB</td>
<td>154 MMSTB</td>
<td>400 MMSTB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Oil</th>
<th>Rem OIP (Gas Cap)</th>
<th>Rem OIP (MP)</th>
<th>Rem OIP (ROZ)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>74 MMSTB</td>
<td>22 MMSTB</td>
<td>132 MMSTB</td>
<td>154 MMSTB</td>
<td>308 MMSTB</td>
</tr>
</tbody>
</table>

PV Ratio (ROZ/MP) 1.16
GLSAU EOR Development Plan

- Determine Reserve Base
  - Extensive San Andres Analogs
  - Residual Oil Zone (ROZ) Target

- ROZ Evaluation Questions
  - Consistency Between MPZ/ROZ of:
    - Saturations
    - Petrophysics
    - Quality of Crude
  - Zonal Continuity

- Evaluation Techniques
  - Core Evaluation
  - Petrophysical Analysis
  - Geologic Characterization
  - Pilot Field Operations
Technical Evaluation – Analog Research

Fields with Active ROZ EOR Projects

<table>
<thead>
<tr>
<th>Goldsmith</th>
<th>Wasson</th>
<th>Seminole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formation</td>
<td>San Andres</td>
<td>San Andres</td>
</tr>
<tr>
<td>Discovery (Yr)</td>
<td>1935</td>
<td>1936</td>
</tr>
<tr>
<td>Depth (Ft)</td>
<td>4,200</td>
<td>4,900</td>
</tr>
<tr>
<td>Pinit (psi)</td>
<td>1,712</td>
<td>1,850</td>
</tr>
<tr>
<td>Temperature (Deg)</td>
<td>95</td>
<td>107</td>
</tr>
<tr>
<td>API Gravity (Deg)</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>MMP (psi)</td>
<td>1,150</td>
<td>1,280</td>
</tr>
<tr>
<td>Porosity (Frac)</td>
<td>0.11</td>
<td>0.11</td>
</tr>
</tbody>
</table>
Technical Evaluation – Legado Coring Program

- Spaced to Investigate Distribution Across Unit
- Operational Activity
  - Deepen and Core Thru ROZ
  - Production Test ROZ
  - Obtain Oil/Fluid Sample
- Fluorescent Photos and Saturation Measurements
Core Analysis Shows Similar Saturation Values Between the Main Pay and the ROZ
Technical Evaluation – Core Fluorescence

Gas Cap
(Resaturated)

Main Pay Oil Zone
(MPZ)

Residual Oil Zone
(ROZ)

Below ROZ

TOP

BASE

TOP

BASE

TOP

BASE

TOP

BASE
Technical Evaluation – Petrophysics

- Petrophysics
- Core Observation
- Core Analysis
Continuity of ROZ Matches Continuity of Main Pay Zone Even at 3000’ Spacing (320 Acres)
Analysis Has Revealed that the MPZ and ROZ have Consistent Properties:

- Core Oil Saturation is Consistent
- Reservoir Quality is Consistent
- Bulk Oil Properties are Consistent
- Chemical Process Behavior is Consistent

Questions of Economic Importance:

- How Efficiently Can the MPZ and ROZ be Flooded Concurrently?
- How Quickly Can the Total Interval be Processed?
- What Capital Investment is Required for Concurrent Development?

These Questions Guide Pilot Design
Pilot Operations – Design

- Well Utility ($3.8 MM)
  - 15 Deepen and Equip
  - 7 Re-entry and Deepen
  - 3 Drill Wells

- Facilities ($4.5 MM)
  - 3.5 Mile 8’’ CO₂ Service Pipeline
  - 700 HP Recycle Compressor (~3.2 MMCFD)
  - Separation and Test Satellite

Goldsmith-Landreth San Andres Unit: Jun-2010

All Wells Require Deepening to ROZ

16 MP/ROZ Producers
25 MP/ROZ Injectors
4 ROZ Pilot Injectors

LEGADO resources

LEGADO resources
Pilot Operations – Performance

- 260 BOPD Incremental Production
- 7 Fold Increase in Oil Cut
- Stable GOR
- Added 2 Pilot CO2 Injectors: March 2010
- Added 2 Additional CO2 Injectors: October 2010
Pilot Operations – Performance

Fully CO₂ Confined
Producer Pattern #190

Surveillance Activities
- Material Balance & Performance
- Injection Tests and Profiles
- Production Logs
- Pressure Observation
Pilot Operations – Performance

Goldsmith-Landreth Unit Production

- Oil
- Water
- HC Gas-Oil Ratio

Key Dates:
- 1963 – Unitize
- 1985 – SI Wells
- 2009 – CO2 Pilot
Successful Project Management

- Achieving Project Confidence
  - Leverage Industry Experience and Tangible Performance
  - Clearly Define Reserve Base
  - Demonstrate Specific Project Capabilities (Pilot)
  - Attain Reasonable Certainty in Investment Requirements (Pilot)

- Economic/Management Considerations
  - Technical Clarity → Confidence in Future Production Schedule
  - Patience in Cashflow Generation and Project Maturity
  - Flexibility to Commit to Required Resources (CO₂ Supplies etc.)

- Execution
  - Large, Low-Margin Projects
  - Can’t Overstate Value of Talented Team
Looking Ahead

Well Utility
124 EOR Injectors
146 EOR Producers
19 Water Injectors

Phase Development
~20 Pats Per Phase
~ 1 Phase Per Year

CPF Under Construction
Construction and Development 90% Complete
Acknowledgement & Contact Information

**Our GLS”A”U Team:**

- Marinos Baghdadi
- Adrian Berry
- Rodney Garcia
- Garron Halterman
- Gabriel Jones
- Bobby Lord

- Larry Pickerel
- Jennifer Radle
- Dan Victor
- Steven White
- Shawn Young

**Legado Resources, LLC**

**Tom Thurmond**

Engineering Manager

(832) 482-3906

Tom.Thurmond@legadoresources.com

GLSAU Field Office