Trash or Treasure: How is Produced Water's Economic Value Evolving in the Permian Basin?

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Produced Water Is Evolving From a Liability Into an Asset
Permian daily average frac water use equal to roughly what the City of San Antonio uses. Or, roughly 12 times the average daily water consumption of the City of Midland (CAFR, FY2017).
Putting Oilfield Water Flows in Perspective: Frac Flowback

Source: Well Report Data

**Perspective:**
- This well’s cumulative 90 day flowback volume could fill about 19 Olympic-size swimming pools (660k gallon pool size)
- Now scale this out for a pad drill project with 5, 7, or even 30 wells, with many of them flowing back simultaneously post-completion.
- The resulting water management challenges—from both the perspective of managing peak flow and that of just managing the sheer volume—are substantial.

**Bilbrey 34/27 B2MD #1H: Lea County, NM**
- 502,000 bbl of water pumped in completion
- 2nd Bone Spring, 2-mile lateral
Frac source water: 76,000 metric tons
Produced water: Over 250,000 metric tons
Crude oil and liquids: 68,000 metric tons
Pipe, sand, misc. consumables: Approx. 10,000 metric tons

Long-Lateral Permian Oil Well Inputs and Outputs Weigh ~405,000 metric tons

Empire State Building Weighs ~340,000 metric tons

~400-450 wells completed/month

Water will likely account for approximately 80% of lifetime “mass moved” for many Permian Basin wells.

Source: CME Group, Empire State Realty Trust, FracFocus, TexasBrine.com

This analysis assumes 500,000 barrels of oil produced, with a water-to-oil ratio of 3:1. In many cases, wells will ultimately produce more oil and at a higher water cut.
Permian Oil Production Growth Has Been a Major Global Shock Absorber

The Permian Basin Has Become the World’s Premier Non-OPEC, Non-Middle East Source of Oil Supply Growth

Thought Exercise: What if the Permian Unconventional Space Hadn’t Taken Off?

Source: BP Statistical Review of World Energy 2018, EIA

Source: EIA, OPEC Monthly Oil Market Report

Permian output has grown by 2.5 million bpd from its January 2008 baseline, largely driven by unconventionals. This is more than the total loss in Venezuela’s oil production since Hugo Chavez took power in 1998.

Without the Permian unconventional boom, US oil production would likely be more than 20% lower than its current level.
The molecular endowment of a given block of acreage is geologically fixed, but the other elements of the unconventional oil & gas development equation are highly dynamic. These include drilling and completion costs, materials sourcing, and midstream services to evacuate oil, gas, and produced water. All are subject to cost reduction via technological improvements—and most of all—solutions delivered through more deeply integrated infrastructure and when feasible, economies of scale.

What Management Said Almost 2 Years Ago:
“The majority of these cost savings are expected to be sustainable due to significant enhancements in the power and water-handling infrastructure over the past few years.”
—Devon Q4 2016 Operations Report

What is Happening Now:
The company’s investments in fixed infrastructure like power and pipelines, as well as sand, dedicated rigs, and frac crews appear to be delivering lower operating expenses even as activity heats back up and service cost inflation looms Basin-wide.

Cost savings ultimately accrue to the bottom line, as Devon reported $66 million in free cashflow on $322 million of revenue in 2Q2018 for its Delaware Basin assets.
Integrated Water Services: Scale Drives Value and is Operationally Necessary

**Demand Side**

<table>
<thead>
<tr>
<th>Frac water demand, '000 bpd</th>
<th>3-Rig Program</th>
<th>5-Rig Program</th>
<th>7-Rig Program</th>
<th>10-Rig Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Rig Program</td>
<td>39</td>
<td></td>
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<td>5-Rig Program</td>
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<td></td>
</tr>
<tr>
<td>7-Rig Program</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-Rig Program</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These projections assume 8.0 wells completed per year per rig (based on 9+ wells completed per rig per year implied from annualizing COG’s data from the first three quarters of 2018) and an average volume of 600 thousand barrels of water per frac. Increasing productivity from pad drilling and/or larger frac sizes could significantly increase the water volume demanded per active rig.

**Supply Side—For SWDs, Recycling, and in the Future, Re-Purposing**

Source: NM OCD, Author’s Analysis

COG “Vast” Development, 7 Wells, Lea County, NM

3.6 mmbbl cumulative water production, about 31 thousand “truckload equivalents”
Recycled Water Could Now Account for Close to 10% of Permian Frac Sourcewater Supplies

Methodology: Take management statements to investors, any other corporate communications I could locate detailing produced water re-use intentions or actual volumes/proportions, and a Credit Suisse research report on the same topic, apply these numbers to frac water usage data each operator reported to FracFocus and estimate recycling volumes for 2Q2018 and 3Q2018.

Estimated Daily Average Recycled Water Volumes by Selected Permian Operators, Bpd

- Oxy (NM): 84,752
- Cimarex: 29,050
- Pioneer: 55,407
- XTO (Permian): 32,990
- Apache: 29,042
- Concho: 22,298
- EOG (Permian): 38,539
- Laredo: 16,680
- Primexx: 22,003

Estimated Proportion of Recycled Water as % of Total Frac Fluid Stream, 3Q2018

Source: Company Reports, Credit Suisse, Author’s Estimates

- Oxy (NM): 94%
- Cimarex: 92%
- Pioneer: 91%
- XTO (Permian): 90%
- Apache: 87%
- Concho: 86%
- EOG (Permian): 83%
- Laredo: 77%

The yellow-highlighted proportions are the ones where my estimate is likely to be most inaccurate. All estimates intended to err on the low-side.
Companies Are Gearing Up to Recycle More Produced Water

**Apache**—“...by year-end, we feel like we’ll be able to utilize about 80% of recycled water for our fracs [at Alpine High].” (2Q2018 Earnings Call)

**Devon**—“~80% of total water used in operations is recycled” [NM Delaware Basin] (EnergyPlex Presentation, 2018)

**Encana**—“We expect average 40% recycled water use in the basin with some cubes as high as 80%...” (2Q2018 Earnings Call)

**Guidon Energy**—“Once infrastructure was built, we began using 13/87 produced/fresh mix for all fracs.” (May 2018 Presentation)

**Noble**—“And by the end of the year [2018], I’d expect over 30% of the water used in our fracs to be recycled produced water.” (2Q2018 Earnings Call)

**Pioneer Natural Resources**—“Right now, we’re increasing our reuse volumes of our produced water to the point where it’s going to represent 15% to 20% of our water volumes in the fourth quarter this year.” (2Q2018 Earnings Call)

Source: Texas RRC
## Recycle & Re-Sell: “Wellhead to Wellhead” Costs and Value

<table>
<thead>
<tr>
<th>Cost</th>
<th>Low Case</th>
<th>Base Case</th>
<th>High Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of moving PW to recycle center</td>
<td>($0.05)</td>
<td>($0.05)</td>
<td>($0.05)</td>
</tr>
<tr>
<td>Skim oil credit</td>
<td>$0.20</td>
<td>$0.20</td>
<td>$0.20</td>
</tr>
<tr>
<td>Cost of treating PW</td>
<td>($0.30)</td>
<td>($0.30)</td>
<td>($0.30)</td>
</tr>
<tr>
<td>Moving clean brine to customer's frac pit</td>
<td>($0.05)</td>
<td>($0.05)</td>
<td>($0.05)</td>
</tr>
<tr>
<td>Solids disposal</td>
<td>($0.05)</td>
<td>($0.03)</td>
<td>($0.03)</td>
</tr>
<tr>
<td>Freshwater for blending</td>
<td>($0.02)</td>
<td>($0.02)</td>
<td>($0.02)</td>
</tr>
<tr>
<td>Price charged to E&amp;P</td>
<td>$0.40</td>
<td>$0.55</td>
<td>$0.75</td>
</tr>
<tr>
<td>Net value to Recycler</td>
<td>$0.13</td>
<td>$0.30</td>
<td>$0.50</td>
</tr>
</tbody>
</table>

## Economics of Avoiding Disposal Costs

Each million barrels recycled can potentially reduce water-related costs by $250,000 in the most intense phases of an asset’s development cycle.

<table>
<thead>
<tr>
<th>Water Sourcing (Cost Delivered into Central Pit)</th>
<th>Flowback Services (spread over first 90 days' est. water volume)</th>
<th>Gathering and Disposal Cost, Commercial SWD (on Pipe)</th>
<th>Gathering and Disposal Cost, Commercial SWD (trucked)</th>
<th>Gathering and Disposal Cost, Proprietary SWD</th>
<th>E&amp;P's Total Lifecycle Cost Per Bbl of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Status Quo” Full-Cycle Permian Water Cost, Trucked Disposal</td>
<td>$0.50</td>
<td>$0.17</td>
<td>X</td>
<td>$2.00</td>
<td>X</td>
</tr>
<tr>
<td>“Status Quo” Full-Cycle Permian Water Cost, Pipe Disposal</td>
<td>$0.50</td>
<td>$0.17</td>
<td>$0.75</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>“Status Quo” Full-Cycle Permian Water Cost, Pipe Disposal via Proprietary SWD</td>
<td>$0.50</td>
<td>$0.17</td>
<td>X</td>
<td>X</td>
<td>$0.30</td>
</tr>
</tbody>
</table>

Total Cost to E&P, Recycled Water | $0.55 | $0.17 | X | X | X | $0.72 |
Can Greater Recycling Help Optimize the Oilfield Water Investment Cycle?

**CAPEX to Dispose of 50 kbd of Produced Water**

**Option 1: Delaware Sands SWD**
2 wells @ 25 kbd per well
$5 million-to-$6.5 million per well
$10 million-to-$13 million

**Option 2: Devonian/Ellenburger SWD**
2 wells @ 25 kbd per well
$8 million-to-$12 million per well
$16 million-to-$24 million

**Option 3: Recycling**
1000 kb pond capacity @ $1.25/bbl of built storage
+$1,000k for process units
$2.25 million

- CAPEX differences favor recycling. OPEX parameters will vary depending on scale and quality of incoming water, as well as E&P customer needs.
- The core question is: do recycling investments early in a play’s development when frac’ing is most intense and the demand for feedstock water is highest help defer SWD investments that can then be made later when PW flows are more predictable and capital and capacity optimization are easier to do?

Examined sample of approximately 600 wells completed in Lea County by Apache, COG, Devon, EOG, and Mewbourne and ranked them according to the cumulative oil volume produced in their first 6 months of reported production. Curve built from average of data from the 10 wells clustered around the 75th and 50th percentiles, respectively.

**Water Production Profile of Top-Tier Wells in Lea County, NM**

Peaky, front-loaded flows.

These impacts would become especially strong in an injection-constrained environment.
Valuation From The Investor Perspective
Permian Basin Oilfield Water Space Increasingly Popular

| Permian Crude Output, Kbd | 1Q11 | 2Q11 | 3Q11 | 4Q11 | 1Q12 | 2Q12 | 3Q12 | 4Q12 | 1Q13 | 2Q13 | 3Q13 | 4Q13 | 1Q14 | 2Q14 | 3Q14 | 4Q14 | 1Q15 | 2Q15 | 3Q15 | 4Q15 | 1Q16 | 2Q16 | 3Q16 | 4Q16 | 1Q17 | 2Q17 | 3Q17 | 4Q17 | 1Q18 | 2Q18 | 3Q18 | 4Q18 | 1Q19 |
|--------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Mesquite SWD              | 992  | 1,001| 1,041| 1,095| 1,139| 1,167| 1,202| 1,265| 1,290| 1,342| 1,408| 1,444| 1,545| 1,590| 1,670| 1,807| 1,886| 1,897| 1,935| 1,983| 1,997| 2,042| 2,121| 2,270| 2,414| 2,592| 2,859| 3,161| 3,377| 3,641| 3,800|
| Fountain Quail            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Wilson Systems            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Pyote Disposal Company    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| West Texas H2O (now GlobeLTR) |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Hydrozoonix               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| FD                       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Select Energy Services    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| MTN Energy                |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Trinity Environmental Services |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| DACO                      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Waterfield Midstream, LLC |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Layne Water Midstream     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

Initial registration date for corporate entity

Source: Company Reports, Corporation Wiki, EIA (Permian crude data)
<table>
<thead>
<tr>
<th>Announced Date</th>
<th>Basin</th>
<th>Acquirer</th>
<th>Asset</th>
<th>Seller</th>
<th>Price (Million USD)</th>
<th>EV/EBITDA Multiple</th>
<th>Contract Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 2015</td>
<td>Appalachia</td>
<td>Antero Midstream Partners, L.P.</td>
<td>integrated water services system, dropdown</td>
<td>Antero Resources</td>
<td>$1,050</td>
<td>8.5-9.0X</td>
<td>20 yrs + MVC+ ROFR on future drilling areas</td>
</tr>
<tr>
<td>June 2017</td>
<td>DJ, Permian</td>
<td>NBLX/affiliated DevCos</td>
<td>multiple asset dropdown</td>
<td>NBL</td>
<td>$270</td>
<td>8.2-9.2X</td>
<td>15-yr fee-based</td>
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<tr>
<td>July 2017</td>
<td>Multiple</td>
<td>Select Energy</td>
<td>Rockwater services</td>
<td>SCF Partners</td>
<td>$516</td>
<td>7.2X</td>
<td>-</td>
</tr>
<tr>
<td>February 2018</td>
<td>Permian</td>
<td>TETRA Technologies</td>
<td>SwiftWater Energy Services</td>
<td>SwiftWater</td>
<td>$85 (including $15 million in potential earnout payments)</td>
<td>4.3-5.3X</td>
<td>(based on NTM expected EBITDA)</td>
</tr>
<tr>
<td>October 2018</td>
<td>Permian</td>
<td>Waterbridge</td>
<td>Halcón Delaware water infrastructure</td>
<td>Halcón</td>
<td>$200 million (not counting potential $125 million of incentive payments)</td>
<td>~9X</td>
<td>-</td>
</tr>
</tbody>
</table>

Simple rule of thumb: at $0.75/bbl, an enterprise handling 500 kbd of produced water could potentially justify a billion dollar valuation.

Private equity funds generally target a 2.5 times multiple of invested capital ("MOIC") when they sell a business.

2015 HBS Study

What Do Private Equity Firms Say They Do?

Paul Gompers
Steven N. Kaplan
Vladimir Matzkin

Table 9: MOIC
The target value of gross MOIC used by PE investors.

<table>
<thead>
<tr>
<th>Multiple</th>
<th>Mean</th>
<th>Median</th>
<th>AUM</th>
<th>Low</th>
<th>High</th>
<th>IRR</th>
<th>Low</th>
<th>High</th>
<th>Age</th>
<th>Old</th>
<th>Young</th>
<th>Offices</th>
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<tbody>
<tr>
<td></td>
<td>2.85</td>
<td>2.50</td>
<td>3.16</td>
<td>2.54</td>
<td>**</td>
<td>2.51</td>
<td>2.56</td>
<td>**</td>
<td>2.50</td>
<td>3.14</td>
<td>**</td>
<td>2.98</td>
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<tr>
<td>Number of responses</td>
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<td>62</td>
<td>31</td>
<td>31</td>
<td>24</td>
<td>21</td>
<td>28</td>
<td>34</td>
<td>36</td>
<td>26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This matters because... ~$200 million/system x 2 systems = $400 million invested. A 2.5X MOIC thus equals approx. $1 billion—roughly the enterprise valuation of our hypothetical system at a 7.0X EBITDA multiple.
Where might the financial profile of integrated water services eventually head?

Important Adjustment Factors to Consider

1. Strength of contracts
2. Diversity of customer base
3. Hydrogeological trends in market area
4. Potential for tie-ins with other pipeline operators’ systems
5. Infrastructure integrity
   a. In particular, what are the SWDs’ downhole conditions like?
   b. Potential buyers of water midstream firms would be wise to conduct full downhole and engineering diligence to make sure they aren’t buying a set of components intended for 5 years of use that are now in their 4th year of operation.

Source: Bloomberg, Waste Management
Valuation From The E&P a/k/a “Customer” Perspective
Valuing Produced Water Assets: Cost-Avoidance Perspective

For Big, Blocky Acreage Firms, In-House Water Systems May Offer Market Optionality As Well

Cumulative OPEX at $0.50/bbl Disposal Cost

- Permian M&A is already creating companies with 500 kbd+ levels of water activity
- Likely CAPEX cost range for a PXD-scale water system

Important Decision for E&Ps: Is Water Better Handled as a CAPEX Item or an OPEX Item?
Takeover Logic Hypothetical Example: Capturing Scale Up Opportunities

1. Potential Acquirer is Scaling Up

Lateral Length, ft

Drilling longer laterals

Source: NM OCD, Author’s Analysis (Research assistance provided by Nosa James)

2. Potential Acquiree (Ideally Adjacent) Has Proven Acreage But Not Yet Scaled Up

Potential upsizing opportunity
“Imagination is not to be divorced from the facts: it is a way of illuminating the facts.”

—Alfred North Whitehead, 1927
At least one Texas-focused operator has already contemplated a world in which produced water carries a commercial price tag. Significant chemical, legal, and physical barriers to tradability remain, but the proper set of financial and legislative incentives would greatly facilitate produced water trading.
Oilfield Input Transitions Can Happen *Fast*

- Consider the velocity at which E&Ps are adopting In-Basin frac sand.
- It took a while for the transition to reach a tipping point, but now sand suppliers are scaling up at warp speed to meet demand.

*The Dunes at Kermit: March 2015*

*The Dunes at Kermit: September 2017*

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**Industrial Water Well Drilling in Winkler County Reflects Intensity and Speed of Sand Mine Development**

Source: TWDB, Author’s Analysis
Produced Water Repurposing: Thinking Beyond the Oilfield

Large-scale midstream infrastructure has the potential to enable creative new uses of water that go beyond disposal and recycling alone. Here we are talking utility-scale systems with pipelines that could be 36” diameter or larger. These ideas also presuppose two other developments: (1) a higher degree of interconnection between oilfield water handling footprints, which at this point in time are highly fragmented and (2) lower-cost treatments that can provide “upgraded” produced water at scale.

It is also important to start thinking intensively now about re-purposing part of the produced water stream, so that the practices and technologies have a better chance of being in place when oilfield recycling demand begins to slow several years down the road as many parts of the Delaware and Midland Basins begin to mature.

A Few Potential Applications

- Non-food crops
- Pipeline to Gulf of Mexico
- Power plant cooling/industrial use
- Fuel algae

At What Price Would Treated Produced Water Become Practically Useful to Farmers?

**For Biofuel Crops**

*Probably $0.10/bbl or less, assuming a 75% freshwater/25% treated PW irrigation blend*

Alamo switchgrass grows well in TX climates and can be a feedstock for cellulosic ethanol production.

**For the Highest Value “Non-Food” Crops**

*Approximately $0.40/bbl, assuming a 75% freshwater/25% treated PW irrigation blend*

Opium cultivation assuming that farmer sells morphine base instead of raw opium, such as that being harvested below by a farmer in southern Afghanistan.

Disclaimer: The opium example is for illustrative purposes only.
At What Price Would Treated Produced Water Become Practically Useful to Farmers?

Data Breakdown

### Revenue

<table>
<thead>
<tr>
<th>Crop</th>
<th>Quantity</th>
<th>Units</th>
<th>$/Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgrass</td>
<td>5.668016</td>
<td>ton</td>
<td>$140.00</td>
<td>$793.52</td>
</tr>
<tr>
<td><strong>Enterprise Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$396,761.13</strong></td>
</tr>
</tbody>
</table>

### Variable Costs

#### Fertilizer

- N-32 in water: 20 lb, $0.39/lb, $7.80
- Urea, Solid (46% N): 45 lb, $0.20/lb, $8.89

#### Herbicide

- 2,4-D Amine 4: 40 ounce, $0.14/ounce, $5.60

#### Other Labor

- Hand labor: 0.14 hr, $15.00/hr, $2.10

#### Irrigation

- Irrigation Labor: 0.03 hr, $15.00/hr, $0.45

#### Repairs & Maintenance

- Irrigation Equipment: 1 acre, $12.02, $12.02
- Tractors: 1 acre, $24.68, $24.68
- Implements: 1 acre, $3.87, $3.87

#### Interest on Credit Line

- 6.5%, $225.00

#### Total Variable Costs, Ex-irrigation

- $599.49

### Planned Returns Above Variable Costs

- $105.77 ton

### Fixed Costs

#### Machinery Depreciation

- Irrigation Equipment: 1 acre, $48.64, $48.64
- Tractors: 1 acre, $24.68, $24.68
- Implements: 1 acre, $3.87, $3.87

#### Equipment Investment

- Irrigation Equipment: $364.78, $364.78
- Tractors: $122.60, $122.60
- Implements: $50.54, $50.54

#### Allocated Establishment Cost

- Irrigation Equipment: $41.84, $41.84
- Trans-Pecos Irrigated Land: $40.00, $40.00

#### Total Fixed Costs

- $1,730.00

### Total Specified Costs

- $796.08

### Returns Above Specified Costs

- $2.56

### Breakeven Price to Cover Total Costs

- $140.45/ton

---

**Opium poppy cultivation**

### Crop Acres

- 500

### Revenue

<table>
<thead>
<tr>
<th>Crop</th>
<th>Quantity</th>
<th>Units</th>
<th>$/Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td>5.80</td>
<td>Pound</td>
<td>$1,125.23</td>
<td>$6,526.32</td>
</tr>
<tr>
<td><strong>Enterprise Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$3,263,157.89</strong></td>
</tr>
</tbody>
</table>

### Production Costs

- **$/Acre**
  - Seed: $4.05
  - Sowing: $23.76
  - Fertilizer: $207.92
  - Weeding: $99.34

- **$/bbl**
  - Water: $5,689.59

### Irrigation Water

- **Estimated Acre-Feet**
  - Seed: 22.28 ac-inches
  - Sowing: 14,404 bbl/ac

### Total Costs

- $6,513.33

### Net Income

- $12.98

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**Source:**

Accommodating Future PW Volumes Might Require Unorthodox Solutions

Example: *What might the economics of piping produced water down to the Gulf Coast and discharging treated PW into the ocean or disposing of it in depleted offshore fields look like?*

Initial model based on Vista Ridge water pipeline to San Antonio.

- 142 miles
- $930 million project cost
- 54-inch steel line
- Projected to move ~1 million bwpd.

Using Vista Ridge’s economics as a baseline, installing 5 X 54-Inch, 650-mile long water pipelines between Orla and Corpus Christi would cost about $16 billion and financed at a 4.5% interest rate over 20-years, would yield an estimated CAPEX cost of $0.66/bbl and OPEX cost of $0.23/bbl, for a delivered cost to the Gulf Coast of $0.89/bbl.
Permian Oilfield Water Predictions

A. Within 12 months from today (start date August 2018)
   - A major Permian-focused water midstream firm goes public or has a similarly large liquidity event
   - At least 3 additional large private equity companies enter the space
   - At least 3 sizeable (80 kbd+ avg. actual volume handled) water midstream firms in the Permian will be acquired by a larger player
   - Treated co-mingled produced water will began to be re-sold at a commercial price

B. Within the next 24 months (by August 2020)
   - There will have been a billion-dollar oilfield water transaction in the Permian
   - At least five Permian-focused entities other than Pioneer Water Management will be transporting and injecting 500 kbd or more of produced water

C. Within the next 36 months (i.e. by August 2021)
   - At least 4 million bpd of incremental produced water (relative to August 2018) must be handled
Cutting-Edge Texas Groundwater and Oilfield Water Research

Appendix
Monetizing Oilfield Water

- Sell fresh water
- Sell brackish water
- Sell the groundwater rights
  - New Mexico: NGL Beckham and McCloy Ranch purchase in September 2018 (122 thousand acres for $93 million)
- Sell the groundwater estate (Texas)
- Charge royalties for saltwater disposal
- Sell a broader package of disposal rights
- Charge “trespass fees”
- Charge for pipeline transport of water and subsequent injection services
- Sell water gathering and handling dedications (E&Ps)
- Recycle and sell produced water
  - In practice, likely to be a blend of produced water and fresh/brackish groundwater or treated municipal effluent.
- Provide an integrated water services package that does all this and also includes transfer and chemical expertise