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128th Annual Meeting



Committee on Water

Alternative Project Delivery Case Study: Britannia Mine

Kevin Sonnenberg Business Development

EPC@R

EPCOR Operations



EPCOR Overview

- Builds, owns and operates water, wastewater and electrical transmission distribution infrastructure in Canada and the United States
 - Narrowly-held private corporation with \$6 billion in assets across Canada and the United States
 - Serves over 1.5 million people in 85 communities
 - Largest private water provider in Arizona and New Mexico
 - Sole shareholder is City of Edmonton
 - Became a stand-alone corporation in 1996 and marked 125 years in 2016
 - Independent Board of Directors operates at arm's length from shareholder
 - Raises its own debt without credit support from the City
 - Credit rating is A- (S&P) and A low (DBRS)

Assets: \$6,088 M Revenue:

Revenue: \$1,996 M

Employees: 2,700

Alternative Delivery – Typical Value Proposition



EPC@R

Risk Transfer in Alternative Delivery

Technical & Financial Risk on Owner

Technical & Financial Risk Sharing with Partner



Britannia Mine Project



Britannia Mine

Located 48 km north of the City of Vancouver, British Columbia on the Sea-to-Sky Highway on Howe Sound



Britannia Mine Background



PROVIDING MORE EPC

Project Objectives

- Ensure the quality of treated water is compliant with regulations under the Environmental Management Act
- Minimize any residual potential environmental liabilities to the Province
- Establish public confidence in the treatment of acid rock drainage at the site
- Optimize the Province's life cycle investment
- Protect taxpayers from cost overruns, schedule delays, and costs related to water treatment technology and plant operation
 - Fast track project implementation



Project Sensitivities

- High profile project
- Treatment plant integral part of the overall mine rehabilitation
- Large and diverse group of stakeholders with different visions and values



Alternative project delivery method could be sensitive
Project constructed in and around a residential neighborhood

Risk Analysis and Procurement Method

Risk Analysis Matrix

- Procurement Risks
- Design Risks
- Construction Risks
- Financial Risks
- Operational Risks
- Risk varies with procurement method



- Government selected DBFO procurement for the project based on value for money with strong consideration to risk transfer
 - Procurement undertaken in two steps (RFEOI & RFP)

Project Roles

Partnerships BC

- Assess project delivery methods
- Help select private partner
- BC Ministry of Forests, Lands and Natural Resource Operations (formerly Ministry of Agriculture and Lands)
 - Help select private partner
 - Oversee agreement/ performance of EPCOR
 - EPCOR
 - Finance, design, build, operate treatment plant
 - Partners: Lockerbie Stanley Inc, Stantec Consulting Ltd.

Terms of the Agreement



- Design, build, finance, operate and maintain (DBFOM)
- Build the plant within 1 year and operate for 20 years
- Province provides performance-based payments to EPCOR
- The plant must be in an acceptable condition at the end of the agreement

Project Risk Allocation



Risk Description	EPCOR	Province
Operations, maintenance and repair costs	X	
Construction costs/inflation and schedules	Х	
Water treatment plant discharge compliance	X	
Water treatment plant efficiency	X	
Project financing	X	
Catastrophic events		Х
Internal mine working collapse		Х
Volume of water treated		Х
Liability of disposed sludge		Х
Operating cost inflation		Х
Influent water chemistry within 10/90 percentile	Х	
Influent water chemistry beyond 10/90 percentile		Х
Plant site geotechnical risk	X	
Marine outfall geotechnical risk		Х

Value for Money



	Capital Cost*	Operating Cost*	Total*
EPCOR	\$15.5 M	\$11.6 M	\$27.2 M
Traditional Delivery	\$18.2 M	\$21.5 M	\$39.7 M

* Net Present Value

Source: http://www.partnershipsbc.ca/pdf/Britannia_Value_for_Money_Report_March_05_FINAL.pdf

Environmental Performance



- Plant treats up to 500 million litres (132 million gallons) of contaminated water annually
- Total of 226,000 kg (497,200 lbs) of heavy metal contaminants removed annually
- Significant marine life returning to sensitive inter-tidal zone
- On-site Discovery Centre provides environmental education

Project Success Factors



Well defined scope of work

- Linked payment mechanism and key performance indicators
- Solid, experienced teams
- Shared values everyone "owned" and was committed to the project
- Stakeholder and community engagement (e.g. building design)
- Partnership and relationships

Summary

- Value creation through risk transfer
 - Transfer risk to the partner best able to manage that risk
- Additional value derived from:
 - price certainty, schedule savings, technology performance, environmental compliance, and performance-based payment
- Sound fiscal and risk management
 - Strong accountability
 - Emphasis is on service delivery
 - Competitive and transparent







WATER PARTNERSHIP SOLUTIONS THAT DELIVER

LEARN MORE ABOUT HOW EPCOR DESIGNS, BUILDS, FINANCES AND OPERATES INNOVATIVE WATER SOLUTIONS:

epcorwatersolutions.com 1.877.930.3337 waterdevelopment@epcor.com















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NARUC Annual Meeting November 14, 2016

David J. Spigelmyer President Marcellus Shale Coalition



Marcellus Shale Coalition

About Us

- Nearly 200 diverse members strong.
- Producers, midstream, oilfield services, manufacturers, consulting and downstream users.

Our Focus

- Protecting and enhancing our environment.
- Addressing landowner and public issues.
- Maximizing benefits for our region.





PA's History of Oil and Gas

- Long history of producing natural gas in Appalachia
- Fueling American homes and businesses since the mid 1800s
- Steel industry took root in western PA/along the Great Lakes in part due to natural gas availability
- All steel, glass, plastics, chemicals, fertilizers, powdered metals, & pharmeuseudicals require natural gas
- Edwin Drake Titusville, 1859
- More than 350,000 oil and natural gas wells since
- 2009 PA > 57,000 active natural gas wells and ~ 20,000 active oil wells
- A solid foundation



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Where are we?

- 9166 unconventional wells*
 - 641 shut in
 - 662 drilling not completed
 - 647 inactive
- 7165 unconventional wells producing natural gas
- From 15th to 2nd largest natural gas producer in nation ('08-'16)
- 420 billion cubic feet/month
 - 5 trillion+ cubic feet/year
 - 37% of total U.S. shale gas production Historic levels of environmental compliance

Drilling Activity in PA



Why Marcellus Shale Now?



- Marcellus Shale known for more than 100 years
- Number of factors make it economically feasible
 - Horizontal drilling
 - Proximity to northeast population centers
 - Energy cost trends
 - More than 500 trillion cubic feet of natural gas



Shale Gas Revolution Across the U.S.



Source: Energy Information Administration



Shale Gas – Global Opportunity

An Elusive Prize | Many nations are believed to have large shale deposits







Reported values are calculated as percentage of fracturing fluid by VOLUME

For more information, see the Marcellus Shale Hydraulic Fracturing Fact Sheet on http://www.hydraulicfracturing.com

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Water Usage in the Marcellus:



General approximation for illustrative purposes Susquehanna River Basin total water demand *According to the Gas Technology Institute*



Raw Fuel Source Water Efficiency

How well are we using our water resources for all energy?

Energy resource	Range of gallons of water used per MMBtu of energy produced
Deep shale natural gas – Marcellus Shale	1
Conventional natural gas	1 – 3
Coal (no slurry transport) (with slurry transport)	2 - 8 13 - 32
Nuclear (processed uranium ready to use in plant)	8 – 14
Conventional oil	8 – 20
Synfuel - coal gasification	11 – 26
Oil shale petroleum	22 – 56
Tar sands petroleum	27 – 68
Synfuel - Fisher Tropsch (Coal)	41 – 60
Enhanced oil recovery (EOR)	21 – 2,500
Biofuels (Irrigated Corn Ethanol, Irrigated Soy Biodiesel)	> 2,500

Source: USDOE 2006 (other than CHK data)

*Does not include processing which can add from 0 - 2 gallons per MMBtu

Solar and wind not included in table (require virtually no water for processing)

Values in table are location independent (domestically produced fuels are more water efficient than imported fuels)



Water Intensity of Transportation Fuels



Average Consumption: Gallons of Water Per 100 Miles Driven

Compressed Natural Gas (CNG) Source: Adapted from King and Webber 2008a; *Adapted from King and Webber 2008b, combined with data from USDOE 2006



What happens to the water?



Aqua Renew water recycling initiative

Process

Currently recycling / reusing nearly 100% of produced water via improved filtering processes Produced water during frac flowback process collected and stored in holding tanks onsite Produced water pumped from the tanks through 20-micron filter Filtered fluid is pumped into a clean storage tank Prior to re-use in frac, the water is tested for remaining chlorides not removed in filtration process Test results determine the rate at which the filtered water can be blended with fresh water during the frac job

Benefits

Reduction in the volume of wastewater means less water sent offsite for disposal Less fresh water needed for fracturing operations means reduced impact on local supplies Reduced truck traffic (less water hauled) means lower impact on roads, noise and air Filtration process does not require substantial amounts of energy like other processes that remove salts (i.e. reverse osmosis membranes, distillation) Helps reduce the cost of operations

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Recycled Water Impoundment





Fresh Water Impoundment



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THANK YOU!



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www.anadarko.com | NYSE: APC

ANADARKO PETROLEUM CORPORATION

ANADARKO AND WATER MANAGEMENT

Jill Cooper

HSE Manager Data Advocacy & Reporting

October 27, 2016

Anadarko's Mission & Values

WE LIVE OUR VALUES

- Integrity and Trust: We will act with the highest ethical standards and honor our promises and obligations to work, family, faith and community.
- Servant Leadership: We will place the success of others above our own, as we pledge to exhibit personal humility and professional courage.
- People and Passion: We will recognize and reward strong performance and respect diversity in thought, practice and culture.
- Commercial Focus: We will safeguard the long-term interest of our shareholders and maintain high standards for health, safety and the environment.
- Open Communication: We will listen for understanding, communicate freely and clearly, as well as encourage diverse opinions and constructive debate.

ANADARKO PETROLEUM CORPORATION



ANADARKO Corporate Responsibility

Our Mission: To provide a competitive and sustainable rate of return to shareholders by exploring for, acquiring and developing oil and natural gas resources vital to the world's health and welfare.

What Differentiates Anadarko?

- Proven Successful Track Record
- Deep and Balanced Portfolio
- Best-in-Class Capital Allocation
- Distinct Competitive Advantages
- Active Portfolio Management



Life Cycle of Water in Upstream Operations



Putting Industry Water Use in Context

- Wells will typically produce energy for 30 years
- Colorado OGCC projected that water usage for oil and natural gas industry is about 0.08% of total water use in Colorado
- US EPA projected nationwide upstream water use is <1% of total water use</p>



Produced Water Management

- Produced water is generated from most actively producing oil and natural gas wells in the United States
- Every play has a different "water profile"
- We "get what nature gives us"



Water as a Product

Oil was King natural gas was considered a waste product from an oil well

Both Oil & Natural Gas

became a profitable commodity



Produced or Formation Water can it also become a useable by-product?

Oil & Natural Gas – Part of the Water Solution

Opportunities

- Water sourcing, management and disposal
- Not a significant user of water compared to other sectors
- Can bring "trapped water" to the surface net gain to the system
- Collaboration is important to achieve progress

Actions necessary to maximize opportunities

- Invest in improvements in water treatment technologies
- Reduce the cost of water treatment
- Support laws and regulations that allow the beneficial reuse of water
- Identify entities interested in accepting the treated water
- Inform the general public around water in general

Energy Water Initiative

 18 upstream oil and natural gas companies sharing water solutions and best practices

Energy Water Initiative (EWI)

- EWI is a collaborative effort to study, communicate and improve lifecycle water use and management in onshore oil and natural gas exploration and production
 - Technology and knowledge-sharing
 - Recommended management practices and technologies
 - Fact-based information to stakeholders
 - Follows API's anti-trust provisions during all meetings and discussions

Apache CorporationDevon EnergyQEP Resources, Inc.BG GroupHess CorporationRoyal Dutch Shell PlcBP PlcMarathon Oil CorporationSouthwestern EnergyChesapeake EnergyNewfield Exploration Co.Talisman Energy USA, Inc.Chevron CorporationNoble EnergyXTO Energy, Inc.	Anadarko Petroleum Corp.	ConocoPhillips Co.	Pioneer Natural Resources Co.
BG GroupHess CorporationRoyal Dutch Shell PlcBP PlcMarathon Oil CorporationSouthwestern EnergyChesapeake EnergyNewfield Exploration Co.Talisman Energy USA, Inc.Chevron CorporationNoble EnergyXTO Energy, Inc.	Apache Corporation	Devon Energy	QEP Resources, Inc.
BP PlcMarathon Oil CorporationSouthwestern EnergyChesapeake EnergyNewfield Exploration Co.Talisman Energy USA, Inc.Chevron CorporationNoble EnergyXTO Energy, Inc.	BG Group	Hess Corporation	Royal Dutch Shell Plc
Chesapeake EnergyNewfield Exploration Co.Talisman Energy USA, Inc.Chevron CorporationNoble EnergyXTO Energy, Inc.	BP Plc	Marathon Oil Corporation	Southwestern Energy
Chevron Corporation Noble Energy XTO Energy, Inc.	Chesapeake Energy	Newfield Exploration Co.	Talisman Energy USA, Inc.
	Chevron Corporation	Noble Energy	XTO Energy, Inc.

Energy Water Initiative (EWI) 2015 Case Study Findings

INDUSTRY TRENDS	BENEFITS
Improving Fracturing Chemistry	Increasing use of non-fresh water
Innovation in Treatment Technology	Increasing feasibility of produced water reuse
Increasing Water Conveyance Systems	Reducing truck traffic
New Water Storage Designs	Provides flexibility and reliability when using non-fresh water
Increasing Transparency	Improves relationships with stakeholders
Dedicated Water Staff	Improves water management, planning technical support and performance

ANADARKO PETROLEUM CORPORATION

Anadarko's Water Strategy

Strategic Water Committee – Five-part strategy



Time Line of Water Strategy



Anadarko Water Management Objectives: Colorado

- 1. Make responsible use of flowback and produced water
- 2. Ensure water management issues do not impact oil production
- 3. Decrease dependence on saltwater disposal (UIC) wells
- 4. Reduce demand for fresh water supplies
- 5. Reduce trucking traffic
- 6. Maximize use of existing field infrastructure
- 7. Improve stakeholder relationships within the region



Water Programs Can Include:

- Outreach to build stakeholder confidence
- Collaboration with other operators, universities, and agencies
- Building infrastructure improvements to meet partner needs
- Innovating for regional water benefits
- Recycling and using produced water to conserve and maximize fresh water
- Building efficient redundancy and reliability into the system



Questions





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