ECTOR COUNTY

APPRAISAL DISTRICT

2024

MINERAL APPRAISAL PARAMETERS

ECTOR COUNTY, TEXAS

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CONTENTS

I MINERAL PROPERTY APPRAISAL STANDARDS

Mineral Appraisal Parameter Policy……5

Property Tax Code, Sec. 23.175. Oil or Gas Interest……...6

Texas Comptroller of Public Accounts, 2021 Manual for Discounting Oil and Gas Income.....7

Texas Comptroller of Public Accounts, 2023 School District Property Value Study. Discount Rate Range for Oil and Gas Properties…….....33

II MINERAL PROPERTY APPRAISAL PARAMETERS

Producing Mineral Property Present Value of Future Worth Calculations……...42

Constant Rate Present Worth Factors……43

2024 Mineral Pricing PAF/Escalation……...44

2023 Oil Price Data……45

2024 Escalated Gross Oil Prices (Appraisal Years 1-25)……46

2024 Escalated Gross Gas Prices (Appraisal Years 1-25)……47

2024 Lease Equipment Schedule……...48

III COST OF CAPITAL STUDY (PAGES 1-21)

Cost of Capital……1

Cost of Debt……5

Cost of Equity……..7

CAPM Capital Asset Pricing Models……11

IV WEIGHTED AVERAGE COST OF CAPITAL (WACC)

2024 Current Corporate Tax Rates for Tax Year Ended 12-31-2023……71

2024 Current Individual Tax Rates for Tax Year Ended 12-31-2023……72

2024 Conversion to Pre-Tax Rate for Tax Year Ended 12-31-2023 (CAPM)……...73

2024 Discount Rate Schedule……74

V REFERENCES

Bibliography……76

Websites……77

MINERAL PROPERTY
APPRAISAL STANDARDS

ECTOR COUNTY APPRAISAL DISTRICT

MINERAL APPRAISAL PARAMETER POLICY

The Ector County Appraisal District has established policy to develop procedures to identify parametric data in the market that may be used to accurately estimate the market value of taxable mineral property. The established policies are designed to conform to Texas state law and approach the estimate of value in the same manner that potential buyers, sellers, investors, and lending institutions would use in measuring property potential, risk, and prudent value.

In the mass appraisal of mineral properties, like other properties, certain "benchmark" or "typical" properties or property parameters must be developed from significant market data. Since the whole property and not the product is the taxable property, the price of the produced product is useful only in so far as it may be used to estimate an income stream to calculate the present value of the future worth of the property. The first and primary "benchmark" parameter is the market price of the product. The true market of the product is closest measured by the "posted price" as established by Texas state law.

Other "benchmark" or "typical" parameters that are developed in the market value calculation are the discount rate, production decline rates, operating expenses, tax allowances, and specific individual property adjustments.

The "typical" or "benchmark" parameters that are used are developed from comparable properties and then applied with the individual characteristics of each property carefully considered in the appraisal. In addition, a full capitalization rate study applicable specifically to oil and gas investments is produced to formulate a standard base rate and property adjusted discount rate for the mineral appraisals.

Mineral appraisals are developed using the best market data available and generally accepted appraisal practices.

The "Manual for Discounting Oil and Gas Income" is published as a rule by the Texas Comptroller of Public Accounts in Section 9.4031, Comptroller of Public Accounts Property Tax Administration. "Oil and Natural Gas Escalation Forecast" is published in the Texas State Comptroller's Property Tax Division, Statement, annually.

TEXAS PROPERTY TAX CODE

Sec. 23.175. OIL OR GAS INTEREST. (a) If a real property interest in oil or gas in place is appraised by a method that takes into account the future income from the sale of oil or gas to be produced from the interest, the method must use the average price of the oil or gas from the interest for the preceding calendar year multiplied by a price adjustment factor as the price at which the oil or gas produced from the interest is projected to be sold in the current year of the appraisal. The average price for the preceding calendar year is calculated by dividing the sum of the monthly average prices for which oil and gas from the interest was selling during each month of the preceding calendar year by 12. If there was no production of oil or gas from the interest during any month of the preceding calendar year, the average price for which similar oil and gas from comparable interests was selling during that month is to be used. Except as otherwise provided by this subsection, the chief appraiser shall calculate the price adjustment factor by dividing the spot price of West Texas Intermediate crude oil in nominal dollars per barrel or the spot price of natural gas at the Henry Hub in nominal dollars per million British thermal units, as applicable, as projected for the current calendar year by the United States Energy Information Administration in the most recently published edition of the Annual Energy Outlook by the spot price of West Texas Intermediate crude oil in nominal dollars per barrel or the spot price of natural gas at the Henry Hub in nominal dollars per million British thermal units, as applicable, for the preceding calendar year as stated in the same report. If as of March 1 of the current calendar year the most recently published edition of the Annual Energy Outlook was published before December 1 of the preceding calendar year, the chief appraiser shall use the projected current and preceding calendar year spot price of West Texas Intermediate crude oil in nominal dollars per barrel or the spot price of natural gas at the Henry Hub in nominal dollars per million British thermal units, as applicable, as stated in the Short-Term Energy Outlook report published in January of the current calendar year by the United States Energy Information Administration in the price adjustment factor calculations. The price for the interest used in the second through the sixth calendar year of the appraisal may not reflect an annual escalation or de-escalation rate that exceeds the average annual percentage change from 1982 to the most recent year for which the information is available in the producer price index for domestically produced petroleum or for natural gas, as applicable, as published by the Bureau of Labor Statistics of the United States Department of Labor. The price for the interest used in the sixth calendar year of the appraisal must be used in each subsequent year of the appraisal.

(b) The comptroller by rule shall develop and distribute to each appraisal office appraisal manuals that specify the formula to be used in computing the limit on the price for an interest used in the second through the sixth year of an appraisal and the methods and procedures to discount future income from the sale of oil or gas from the interest to present value.

(c) Each appraisal office shall use the formula, methods, and procedures specified by the appraisal manuals developed under Subsection (b).

Added by Acts 1993, 73rd Leg., ch. 998, Sec. 1, eff. Sept. 1, 1993.
Amended by:
Acts 2007, 80th Leg., R.S., Ch. 911 (H.B. 2982), Sec. 2, eff. January 1, 2008.
Acts 2011, 82nd Leg., R.S., Ch. 144 (S.B. 1505), Sec. 1, eff. January 1, 2012.
Acts 2015, 84th Leg., R.S., Ch. 4 (S.B. 1985), Sec. 1, eff. January 1, 2016.

Glenn Hegar
Texas Comptroller of Public Accounts

Manual for Discounting Oil and Gas Income

as of

June 2021

Table of Contents

Introduction 1

History of Oil and Gas in Texas 3

Major Oil and Gas Formations 3

Permian Basin 3

East Texas 3

Barnett Shale 4

Eagle Ford Shale 4

Granite Wash 4

Haynesville/Bossier 4

Fracking 4

Discounted Cash Flow 7

Discounting 7

Discounted Cash Flow (DCF) Appraisal 8

Discount Rate Components 8

DCF Method Techniques 9

Market Surveys 9

Oil and Gas Sales Analysis 9

Weighted Average Cost of Capital (WACC) 10

Final Discount Rate Selection 12

Appendix A: Discounted Cash Flow Examples 13

Appendix B: Escalation or De-escalation Formula 21

Introduction

The Texas oil and gas industry is an important and significant contributor to the diversity of the state's economy, providing jobs at all levels and investment in exploration, production and refining. Petroleum is a principal driver of the Texas economy. The Texas Railroad Commission (RRC) is the primary state agency responsible for permitting, monitoring and regulating aspects of the industry.

In 1993, the Texas Legislature enacted Tax Code Section 23.175. It requires the Comptroller's office to develop and distribute to each appraisal district an appraisal manual specifying the methods and procedures to calculate the present value of oil and gas properties using discounted future income.[1]

In 2011, the Texas Legislature required the Comptroller's office to specify the formula used to limit the price applied in the second through the sixth years of an appraisal. It also revised the formula used when calculating the price adjustment factor in 2015.[2] [3]

This manual explains discounting, the discounted cash flow (DCF) equation, DCF appraisal and three acceptable techniques for estimating a discount rate in the DCF method, which include market surveys, oil and gas sales analysis and weighted average cost of capital (WACC), also called band of investment.

Appraisal districts must use the methods, procedures and formulas specified in this manual, which is adopted by Comptroller Rule 9.4031.[4]

[1] Tex. Tax Code §23.175
[2] Tex. Tax Code §23.175(b)
[3] Tex. Tax Code §23.175(a)
[4] Tex. Tax Code §23.175(c)

History of Oil and Gas in Texas

The earliest discoveries of oil and gas formations in Texas happened in the late 19th century. On Sept. 12, 1866, Lyne Taliaferro Barret drilled the first oil-producing well at Melrose in Nacogdoches County at 106 feet. The first well-equipped refinery in Texas was built in Corsicana in 1898 and shipped its first production in 1899.[5]

On Jan. 10, 1901, Capt. A.F. Lucas discovered a salt dome of oil and produced a "gusher" at Spindletop, near Beaumont.[6] In 1908, the Goose Creek Field was the first offshore discovery, located in Galveston Bay 21 miles southeast of Houston. A gusher in 1916 created a boom that reached a peak annual production of 8,923,635 barrels by 1918 with onshore and offshore wells.[7] **Exhibit 1** lists other significant oil and gas discoveries in Texas. [8]

Major Oil and Gas Formations

Texas has some of the largest oil and gas formations in the US, including the Permian Basin, East Texas Field, Barnett Shale, Eagle Ford Shale, Granite Wash and Haynesville/Bossier.

Permian Basin

The first well drilled in the Permian Basin was in Mitchell county in 1921. The Permian Basin is approximately 250 miles by 300 miles, stretching to southern New Mexico, with more than 7,000 fields in West Texas. Well depths range from a few hundred feet to five miles deep. This area provides almost 40 percent of U.S. domestic crude oil and 15 percent of natural gas, according to the Federal Reserve Bank of Dallas.[9]

EXHIBIT 1

Oil and Gas Discovery	County	Year
Electra Field	Wichita	1911
Damon Mound	Brazoria	1915
Barbers Hill	Chambers	1916
Ranger Field	Eastland	1917
Burkburnett Townsite Field	Wichita	1918
Blue Ridge	Fort Bend	1919
Mexia	Limestone	1920
Panhandle	Hutchinson	1921
Luling Field	Caldwell	1922
Howard-Glasscock Field	Howard	1925
Hendricks	Winkler	1926
Raccoon Bend	Austin	1927
Sugar Land	Fort Bend	1928
Darst Creek Field	Guadalupe	1929
Van	Van Zandt	1929
Pettus	Bee	1929

East Texas

The East Texas field in Rusk County was discovered by wildcatter C.M. Joiner in October 1930. It is still active and has produced more than 5.2 billion barrels of oil. The field covers more than 140,000 acres in Gregg, Rusk, Upshur, Smith and Cherokee counties in the northeastern part of Texas, with well depths primarily below 3,500 feet. The East Texas field created overproduction and prices quickly dropped. To enforce production restrictions, Governor Ross S. Sterling declared martial law on Aug. 17, 1931 and sent the National Guard to shut down the entire field. The Legislature enacted

[5] Texas State Historical Association, 2018, *"History of Oil Discoveries In Texas"*, https://texasalmanac.com/topics/business/history-oil-discoveries-texas (last visited Feb. 3, 2021).

[6] Robert Wooster, "Lucas, Anthony Francis," *Handbook of Texas Online*, https://www.tshaonline.org/handbook/entries/lucas-anthony-francis (last visited Feb. 03, 2021).

[7] Priscilla Myers Benham, *"Goose Creek Oilfield"*, Handbook of Texas Online, https://www.tshaonline.org/handbook/entries/goose-creek-oilfield (last visited Feb. 3, 2021).

[8] Texas State Historical Association, 2018, *"History of Oil Discoveries In Texas"*, https://texasalmanac.com/topics/business/history-oil-discoveries-texas (last visited Feb. 3, 2021).

[9] Railroad Commission of Texas, *"Permian Basin,"* https://www.rrc.state.tx.us/oil-and-gas/major-oil-and-gas-formations/permian-basin/ (last visited Feb. 3, 2021).

legal proration to regulate how much oil could be produced. This system of regulation is still utilized today.[10]

Barnett Shale

During a mapping exercise in the early 20th century, geologists noted thick, black, organic-rich shale in a rock outcropping close to a stream. The Barnett Shale consists of sedimentary rocks near 8,000 feet. It was named for John W. Barnett who settled in San Saba County during the late 19th century. It is one of the largest onshore natural U.S. gas fields, covering an estimated 5,000 square miles, extending from Dallas to the west and south.[11]

The Barnett Shale is where George Mitchell first successfully implemented hydraulic fracturing ("fracking") technology to unlock shale gas in 1997.[12]

Eagle Ford Shale

The Eagle Ford Shale is a band roughly 50 miles wide and 400 miles long with an average thickness of 250 feet that extends across Texas from the Mexico border into East Texas. It is up to 70 percent carbonate and produces more oil than other traditional shale plays. It also produces natural gas. Fracking is beneficial in producing gas from the brittle, carbonate-rich shale rock. Most of the current production is between 4,000 and 14,000 feet below sea level. It is the source rock for the Austin Chalk and the East Texas Field.[13]

Granite Wash

The Granite Wash produces both oil and gas through a tight sand play located in the Texas Panhandle and Western Oklahoma. It is several washes of rock fragments and organic particles about 160 miles long and 30 miles wide with a depth from 11,000 to 15,400 feet. On average, the play is 3,000 feet thick.[14]

Haynesville/Bossier

The Haynesville/Bossier Shale is in East Texas and Western Louisiana along the Gulf Coast. It can produce from 3 to 7 billion cubic feet of gas per well in each formation. It produces hundreds of trillions of cubic feet of gas. The shale thickness ranges from 200 to 305 feet, with depths of 10,000 to 14,000 feet.[15]

Fracking

In 1862, at the Battle of Fredericksburg, Virginia, Col. Edward A.L. Roberts observed artillery rounds exploding in a small canal that was blocking the battleground. The ensuing fractures in the canal's walls prompted him to apply explosives to oil exploration after the Civil War. It led to drillers pouring liquid nitroglycerin down well bores to perforate the casing. On March 17, 1949, fracking began about 12 miles east of Duncan, Oklahoma and Halliburton and Stanolind Co. fractured another oil well near Holliday, Texas.[16]

In 1967, the U.S. government used a 13 foot by 18-inch nuclear device to fracture a gas well in New Mexico at a depth of 4,240 feet. "The reasoning was that the relatively inexpensive energy available from nuclear explosions could prove useful for a wide variety of peaceful purposes," notes a report later prepared for the U.S. Department of Energy.[17]

In Texas during the 1980s, gas producer and geologist George Mitchell worked on refining fracking in the Barnett Shale. A mixture of water, sand and chemicals was forced down the well at high pressure to fracture the shale rock. The porous sand wedged into the cracks allowing the gas to flow. The combination of horizontal drilling and fracking in the 1990s unlocked the oil and gas hydrocarbon resources in the tight shale rock.

Environmental and health issues are a concern because fracking requires millions of gallons of water for each well. New

[10] Texas State Historical Association, 2018, *"History of Oil Discoveries In Texas,"* https://texasalmanac.com/topics/business/history-oil-discoveries-texas (last visited Feb. 3, 2021).

[11] Railroad Commission of Texas, *"Barnett Shale,"* https://www.rrc.state.tx.us/oil-and-gas/major-oil-and-gas-formations/barnett-shale/ (last visited Feb. 3, 2021).

[12] *The New York Times Magazine*, "The Lives They Lived: George Mitchell," https://www.nytimes.com/news/the-lives-they-lived/2013/12/21/george-mitchell/ (last visited Feb. 3, 2021).

[13] Railroad Commission of Texas, *"Eagle Ford Shale,"* https://www.rrc.state.tx.us/oil-and-gas/major-oil-and-gas-formations/eagle-ford-shale/ (last visited Feb. 3, 2021).

[14] Railroad Commission of Texas, *"Granite Wash,"* https://www.rrc.state.tx.us/oil-and-gas/major-oil-and-gas-formations/granite-wash/ (last visited Feb. 3, 2021).

[15] Shale Experts, *"Haynesville-Bossier-Cotton Valley Overview,"* https://www.shaleexperts.com/plays/haynesville-bossier-cotton-valley/Overview (last visited Feb. 3, 2021).

[16] American Oil & Gas Historical Society, aoghs.org, *"Shooters – A Fracking History,"* https://aoghs.org/technology/hydraulic-fracturing, Original: Sept. 1, 2007, last updated April 20, 2020 (last visited Feb. 3, 2021).

[17] American Oil & Gas Historical Society, aoghs.org, *"Project Gasbuggy tests Nuclear Fracking,"* https://www.aoghs.org/technology/project-gasbuggy, original: Dec. 10, 2013, last updated Dec. 7, 2020 (last visited Feb. 3, 2021).

technologies and processes are being developed to reduce or eliminate water used to fracture shale rock including:

- water additives that allow for water recycling and reuse;
- foams and gels from pressurized gases (such as propane or carbon dioxide) that replace the water;
- environmentally friendly fracking fluids that use less water and chemicals;
- acoustic energy fracking, which can potentially improve the penetrating power of fracking and reduce required water and chemicals;
- microwave fracking, which uses almost no water (but requires a lot of electricity); and
- solar- and natural gas-powered equipment to replace diesel equipment and reduce poisonous pollutants and greenhouse gases.

Discounted Cash Flow

Discounted cash flow (DCF) appraisal is the most common method for valuing oil and gas property. The underlying concept of discounting future income to a present-day value applies a discount rate to the future income. Discount rate components include historic, current and future market expectations. An appraiser uses DCF method techniques such as market surveys, sales analysis and weighted average cost of capital to determine a discount rate range. The appraiser's final discount rate selection will typically fall within this discount rate range.

Appendix A provides a description of property-specific risk factors and examples to illustrate DCF appraisal, weighted average cost of capital (WACC) estimating and standard deviation analysis.

Discounting

Because investors prefer immediate cash over future cash returns, they "discount" them —paying less now for future cash flows. The discount amount depends on:

- the length of time until the cash is due;
- the level of risk that the cash will not be tendered when due; and
- the rate of return available from other comparably risky investments.

Typically, discounting converts future income to present value using annual discount factors. The discount factor declines for each successive year to reflect the reduced value of revenue received in the future. The appraiser calculates the present worth of the forecast revenue stream by multiplying the projected net income (cash flow) for each year by the calculated discount factor for that year. DCF analysis is the process of deriving discount factors from the discount rate (also known as the yield rate).

The International Association of Assessing Officers (IAAO) defines discount rate as:

> The rate of return on investment; the rate an investor requires to discount future income to its present worth. It is made up of an interest rate and an equity yield rate. Theoretical factors considered in setting a discount rate are the safe rate earned from a completely riskless investment (this rate may reflect anticipated loss of purchasing power due to inflation) and compensation for risk, lack of liquidity and investment management expenses. The discount rate is most often estimated by band-of-investment analysis or a sales comparison analysis that estimates typical internal rates of return.[18]

The discount rate is a key variable in DCF analysis, making correct rate selection crucial. The market's expectations are critical when choosing a discount rate. The Appraisal Institute's Appraisal of Real Estate states:

> "The estimation of an appropriate discount rate is critical to DCF analysis. (A yield rate is a generic term used to describe many rates. When anticipated cash flows are used, it is called a discount rate. When actual past cash flows are used, it is called an internal rate of return.) To select an appropriate discount rate, an appraiser must verify and interpret the attitudes and expectations of market participants, including buyers, sellers, advisers and brokers. Although the actual yield on an investment cannot be calculated until the investment is sold, an investor may set a target yield for the investment before or during ownership. Historical yield rates derived from comparable sales may be relevant, but they reflect past, not future, benefits in the mind of the investor and may not be reliable indicators of the current required yield. Therefore, the estimation of yield rates for discounting cash flows should focus on the prospective or forecast yield rates anticipated by typical buyers and sellers of comparable investments. An appraiser can verify

[18] International Association of Assessing Officers, *Property Appraisal and Assessment Administration*, (1990) Pp. 641-642.

investor expectations by interviewing the parties to comparable sales transactions or reviewing marketing materials for comparable properties recently offered for sale."[19]

Discounted Cash Flow (DCF) Appraisal

The DCF method is versatile and widely used to appraise income-producing property. An appraiser using DCF projects an anticipated net income for each year of the property's remaining economic life; discounts each annual cash flow to present value; then adds all the present values to obtain the total market value of the real property interest being appraised. **Exhibit 2** shows the DCF equation, including the variable definitions.

EXHIBIT 2

DCF Equation PV = CF1 × (PWF1) + CF2 × (PWF2) + ... CFn × (PWFn)	
PV	Present value $
CF	Cash flow or income for the period specified $
PWF	End of period present worth factor, equals $1/((1+i)^n)$
i	Discount rate (the period compound interest rate)
n	Period for the present worth factor being calculated

An estimate of each year's expected income (cash flow) is necessary to estimate the present value (PV). The number of periods – n (usually years) – used in the analysis is the number of years that the mineral property is expected to produce a positive net income.

DCF formulas vary based on when the money is received; i.e., continuously, beginning of period, middle of period or end of period. The period may be continuous, daily, monthly, quarterly, biannual or annual. Many oil properties are evaluated using an annual mid-period discounting variation of the DCF formula shown in **Exhibit 3**.

EXHIBIT 3

Present Worth Factor for Mid-year DCF $PWFMY = 1/((1 + i)^{(n - .5)})$	
PWFMY	Mid-year present worth factor
i	Discount rate (the period compound interest rate)
n	Period for the present worth factor being calculated

[19] Appraisal Institute, *The Appraisal of Real Estate*, 15th ed. (Chicago: Appraisal Institute, 2020), Pp. 478-479.

Appendix A, Figure 2 illustrates how a DCF is calculated for a mineral property using a mid-year factor.

Discount Rate Components

The discount rate components used in DCF analysis are the inflation rate, risk-free component, general risk premium and property-specific risk premium.

Inflation rate: the annual rate of price change for a basket of consumer goods.

Inflation is normally measured by the Consumer Price Index for All Urban Consumers (CPI-U), calculated by the U.S. Bureau of Labor Statistics. The inflation rate is the most basic component of a discount rate. An investor's rate of return must equal the inflation rate just to break even in real dollar terms.

Risk-free component: a return to compensate the investor for a loss of liquidity (risk-free rate minus the inflation rate).

The risk-free rate is the inflation rate plus a return to reimburse the investor for a loss of liquidity. It is measured by the yield to maturity on U.S. government securities with a maturity period comparable to the investment under consideration (oil or gas reserves). The market perceives U.S. government securities as risk-free for all practical purposes.

General risk premium: a return to compensate the investor for assuming diversified company-wide risk.

The general risk premium is the WACC minus the risk-free rate. To measure WACC, weight the typical oil company debt and equity costs by the typical oil company debt and equity capital structure percentages, and then add the weighted costs. When appraising companies, the WACC is the discount rate, because it reflects the market's expected yields from the stock and debt of a company.

For property tax purposes, appraisers estimate the value of a real property interest in oil or gas in place, not the value of oil companies. Buyers of mineral interests usually perceive individual interests as riskier than the stock and debt of an entire company. Companies can spread their risk over many individual mineral interests and often over several kinds of assets (some may be unrelated to oil or gas). This asset diversification reduces the company's risk and, as a result, the

WACC derived from company financial data is usually lower than an individual producing property's discount rate. The WACC, however, is always higher than the risk-free rate. This rate increase is a general risk premium to reward investors for assuming the diversified company-wide risk.

Property-specific risk premium: a return that compensates the investor for assuming the unique risks associated with a mineral-producing property.

The property-specific risk premium is the discount rate minus WACC. Investors demand a premium above the WACC to compensate them for individual property risk. This premium can be quite high for high-risk property.

EXHIBIT 4

Discount Rate Component Summary	
	Inflation rate
+	Risk-free component
+	General risk premium
+	Property-specific risk premium
=	Discount rate

Exhibit 4 summarizes how these components determine the discount rate. The first three components are quantifiable from public data. In some cases, the property-specific risk premium may be derived from available data, but the appraiser generally must estimate it. Refer to **Appendix A, Figure 11** for conditions that must be considered when estimating the property-specific risk premium.

DCF Method Techniques

The acceptable techniques for estimating discount rates using the DCF method include market surveys, oil and gas sales analysis and WACC (or band of investment). Ideally, the appraiser uses these three techniques simultaneously to develop a range of discount rates.

A typical WACC sets the lower limit while surveys and direct sales analysis provide a set of discount rates the appraiser can use as a database to estimate a mid-range discount rate and an upper limit to the discount rate. Examples of these techniques are found in **Appendix A, Figures 3-10**.

Some mineral properties may sell at or below the purchaser's WACC. One reason why is that a buyer (or appraiser) reduces the cash flows to account for reserve recovery risk; the discount rate will not reflect the risk, but the purchase price will. To calculate a discount rate that is comparable to discount rates from other sales, the appraiser must quantify the risk adjustment and add it back to the cash flows. This discount rate will be higher than the non-risk-inclusive rate.

Atypical income tax deductions or abnormally high or low overhead can also create an artificially high or low discount rate. When faced with market evidence that indicates a discount rate at less than a company's cost of capital, the appraiser reviews all appraisal parameters to determine why an abnormally low discount rate is indicated. An understated income stream is the most obvious reason. The appraiser may adjust the cash flows to derive a market discount rate or may delete the sale from consideration.

Market Surveys

An appraiser may use market surveys as an indicator of the discount rate. Many studies and surveys are published to help the appraiser estimate an appropriate discount rate, or range of rates, for appraising oil and gas properties. The Society of Petroleum Evaluation Engineers' (SPEE) Annual Survey asks producers', consultants' and bankers' opinions on future prices, cost escalation and economic indices (including the discount rate) used in petroleum property evaluation. **Appendix B** shows the formula for calculating the oil and gas price escalation/de-escalation percentage.

Market surveys result in rates that include all the discount rate components, but the rate included for the property-specific risk premium is the typical rate for the properties included in the survey. The appraiser must estimate the property-specific risk premium and adjust for atypically high or low risk. The appraiser must reduce the risk premium for properties with less than the typical risk and increase the risk premium for properties with more than the typical risk.

Oil and Gas Sales Analysis

Exhibit 5 lists the three basic steps used to develop a discount rate from sales.

EXHIBIT 5

Developing a Discount Rate from Sales
1. Obtain recent sales prices from a variety of oil- and gas-producing properties.
2. Develop cash flow projections for each property.
3. Calculate for each sale the internal rate of return (IRR), also known as the DCF return on investment (DCFROI).

Step 1: Obtain Sales

The best source for sales information is the buyer or seller. Other sources that list oil and gas property sales include the Texas Railroad Commission, Oil and Gas Journal, private firms and oil and gas companies. It is important to remember that the sale of an oil or gas property must be a market transaction when developing a discount rate from sales.

Like market surveys, sales analysis results in rates that include all of the discount rate components. The appraiser must estimate the property-specific risk premium (unless the sales sample is directly comparable to the property being appraised) and adjust for atypically high or low risk.

Step 2: Develop cash flow projections

The appraiser develops cash flow projections for each property using the verified sales prices. To the extent possible, the appraiser must talk with the parties to each sale to determine their expectations of the property. The derived discount rate's validity is a direct function of the buyer's and seller's cash flow projections. The appraiser must incorporate this information into the projections. If the appraiser's projections differ from the buyer's and seller's expectations, the discount rate derived from the sale will be invalid.

Step 3: Calculate the internal rate of return (IRR)

The IRR is the yield (discount) rate at which the cash income stream's present value equals the cash expenditure's present value (the sales price in our analysis) necessary to produce that income stream. This discount rate is prospective; it depends on the market's expectation of future performance rather than the historical performance of the property. The discount rate at which the cash flow's present value equals the sales price can be determined by trial and error or by using calculators and computer software that solves for the discount rate (IRR).

This measure is also referred to as the profitability index and investor's method. The IRR recognizes that funds received now are more valuable than those received at some future date. The investment outlay can be regarded as borrowed funds and the pre-tax cash flow as the payment of principal, plus compound interest on the investment.

Weighted Average Cost of Capital (WACC)

This third technique (aka band of investments) produces a rate that does not contain a component for property-specific risk. Because it lacks this component, potential purchasers' typical WACC sets a minimum value for a discount rate. The appraiser must calculate the typical WACC of potential purchasers to know this lower limit. On a case-by-case basis, the appraiser excludes oil companies from the WACC calculation if they cannot participate in the market for the subject property. For instance, small companies may not be able to bid on certain high-valued oil and gas properties due to insufficient capital. A typical WACC for larger oil companies would establish an appropriate minimum discount rate for appraising the subject property.

An investor should not buy a property at a discount rate lower than the WACC; otherwise, the investor's net worth will decrease. The appraiser must add the property-specific risk premium to potential purchasers' typical WACC to develop a discount rate.

The basis for this analysis is financial data from a broad sample of oil companies that derive most of their operating revenues from oil and gas production. Since petroleum property valuation typically involves discounting cash flows over a long period of time, a long-term cost of capital is most appropriate for developing an oil or gas property discount rate. The appraiser incorporates a broad time series of data to approximate a long-term cost of capital. **Exhibit 6** lists the four steps used to calculate WACC.

EXHIBIT 6

Calculating the WACC
1. Derive the typical capital structure and express it as a proportion of debt and equity.
2. Calculate the typical cost of outstanding debt based on bond yields.
3. Compute the typical cost of equity using the capital asset pricing model (CAPM) or another method, such as the DCF model.
4. Weight debt and equity costs according to the typical capital structure percentages to derive a typical cost of capital.

Step 1: Derive capital structure

Capital structure describes in percentages the funds (capital) used to purchase the assets necessary to operate a company. Debt and equity comprise the capital structure of any company. The debt portion consists of long-term debt (outstanding bonds) and preferred stock, while the equity portion consists of outstanding common stock. If the company is funded by debt and equity of equal value, the capital structure is 50 percent debt and 50 percent equity.

To estimate a discount rate for mass-appraisal purposes, the appraiser uses the typical market capital structure for a representative group of major and independent oil companies that derive most of their operating revenues from oil and gas production.

Step 2: Calculate cost of outstanding debt

The yield-to-maturity is the best approximation of the cost of debt capital. This yield is observable in the marketplace and can be found by referring to Standard and Poor's Capital IQ, Moody's Bond Report or comparable publications. Additional resources for yield-to-maturity information include Value Line, Morningstar, Yahoo Finance, Bloomberg Bond Record, Damodaran, Fidelity, Duff & Phelps and Zacks.

Step 3: Compute cost of equity

The capital asset pricing model (CAPM) is the preferred approximation of equity cost because it considers both historical market yields and current expectations, plus a market-derived equity risk factor. The CAPM method measures the cost of equity by considering that an investor's required rate of return on common stock includes a risk-free return, plus a risk-adjustment factor related to the specific stock. **Exhibit 7** shows the CAPM equation and defines its factors.

EXHIBIT 7

CAPM Equation K = Rfc + B(Rm - Rfh)	
K	Cost of equity (after tax), percentage/year
Rfc	Current risk-free rate, percentage/year
Rm	Historical market return on equities and common stocks, percentage/year
Rfh	Historical market return on long-term government bonds, percentage/year
B	Beta coefficient

The current risk-free rate (Rfc) is typically based on current, long-term government securities (i.e., the yield-to-maturity observed on an annual basis on a default-free Treasury bond, note or bill) of the relevant time period. For oil and gas property appraisal, the yield on a long-term bond is an appropriate measure of the risk-free rate.

Duff & Phelps SBBI® Yearbook – Stock, Bonds, Bills and Inflation provides the historical market return on equities (Rm) and common stocks and the historical arithmetic mean on long-term government bond income returns (Rfh). The beta coefficient (B) measures market risk by regressing the stock's total return against the market's total return. Duff & Phelps SBBI® Yearbook offers a detailed description of the beta calculation. Sources for the beta coefficient value include Value Line Publishing Inc.'s The Value Line Investment Survey, Standard and Poor's Corp.'s S&P Stock Reports and similar investment services.

The difference between the historical risk-free (Rfh) and market (Rm) rates of return is a measure of the non-systematic (non-market) related risk caused by changes specific to the companies comprising the stock rate of return sample and is, in effect, an equity risk premium. Note that the CAPM uses two different risk-free rates of return. The current risk-free rate (Rfc) acknowledges the expectational function of the model. To calculate the equity risk premium, use the historical risk-free rate (Rfh) in conjunction with the historical market return (Rm) for the same time period.

The cost of equity resulting from this model is a nominal (current dollar) after-tax rate. Conversion to a nominal, pre-tax rate requires dividing the equity cost (K) by 1 minus the federal statutory income tax rate for petroleum companies. The equation K(pre-tax) = K/(1 - .21) represents the current 21 percent income tax rate.

If the appraiser calculates a typical effective income tax rate from a representative sample of petroleum companies that could participate in the market for the subject property, the appraiser may substitute that typical effective income tax rate for the statutory rate.

Step 4: Weight debt and equity costs

Once capital structure, debt and equity costs are determined, the final step in deriving the WACC is to weight the cost of debt and equity by the proportional share each has in

the overall capital structure. **Exhibit 8** shows the equation for each, and **Exhibit 9** shows the discount rate component expanded. **Appendix A, Figures 3-6** illustrate the WACC estimating technique.

EXHIBIT 8

Capital Structure		
Weighted average cost of equity	=	(cost of equity percentage) X (equity fraction)
Weighted average cost of debt	=	(cost of debt percentage) X (debt fraction)
Weighted average cost of capital	=	weighted average cost of equity + weighted average cost of debt

EXHIBIT 9

Discount Rate Component Summary	
	Inflation rate
+	Risk-free component
=	Risk-free rate
	Risk-free rate
+	General risk premium
=	WACC

Final Discount Rate Selection

The typical WACC of potential purchasers sets the lower end of the discount rate range. To help establish the upper end of the discount rate range, the appraiser can calculate a standard deviation of all the discount rates indicated by the sales sample and the survey. One standard deviation above and below the mean contains 68 percent of all the observations in a normally distributed set of data. Two standard deviations above and below the mean contains more than 99 percent of all the observations in a normally distributed set of data. Although the data may not be normally distributed, this kind of analysis may help the appraiser to establish the upper end of the discount rate range.

High-risk properties (e.g., a one-well lease with high water production near the end of its economic life) may be discounted by the market at two standard deviations above the mean. Properties with lesser risk will have correspondingly lower discount rates. One standard deviation above the mean may establish an upper limit for properties in a typical risk-range. The mean or median of the discount rates from the sales analysis and the survey indicate the mid-range discount rate.

For a standard deviation analysis to have meaning in selecting an upper limit to the discount rate range, the survey or sales dataset must contain properties with broadly varying risk. A high-end discount rate selected by this method will not apply to very risky properties (it will be too low) unless the sales dataset used in the analysis contains similar risky properties.

To select a discount rate for an individual property, the appraiser must assess the property-specific risk inherent in the property.

Appendix A: Discounted Cash Flow Examples

The values used in the examples in these figures are for demonstration purposes only.

FIGURE1

DCF Method Example (Working Interest Only)

Year	(1) Net Oil Production (bbls)	(2) Oil Price ($/bbls)	(3) Gross Income ($)	(4) Op. Exp.+ Sev. Taxes* ($)	(5) Net Income ($)	(6) Discount Factor @15.67%	(7) Discounted Cash Flow ($)
1	31,938	56.26	1,796,832	159,015	1,637,817	.929800	1,522,842
2	25,550	54.43	1,390,687	159,341	1,231,346	.803839	989,803
3	20,440	55.11	1,126,350	160,692	965,658	.694941	671,076
4	16,352	55.79	912,258	162,946	749,312	.600797	450,184
5	13,081	56.48	738,826	165,982	572,844	.519406	297,538
6	10,465	57.18	598,404	169,733	428,671	.449041	192,491
7	8,372	57.89	598,404	174,115	310,547	.388209	120,557
						Subtotal	**$ 4,244,492**
				Salvage	$ 10,000	.360956**	3,610
						Total	**$ 4,248,101**

* Operating expenses plus severance taxes

**Note: End-of-year-seven factor = $1/(1+.1567)^7$

FIGURE 2

DCF Calculation Procedures

1. Net oil production is gross oil production multiplied by net revenue interest (NRI), which equals 87.5 percent.
2. Starting oil price equals $56.26 per barrel with an escalation rate of 4 percent per year.
3. Gross income equals net oil production multiplied by oil price.
4. Operating expenses plus severance taxes: Operating expenses escalated at a rate of 4 percent per year. Severance tax on oil is 4.6 percent per year.
5. Net income equals gross income less operating expenses and severance taxes.
6. Discount factor (mid-year) @15.67 percent equals:

Year	Formula		Discount Factor Percentage
1	$1/((1+.1567)^{(1-.5)})$	=	.929800
2	$1/((1+.1567)^{(2-.5)})$	=	.803839
3	$1/((1+.1567)^{(3-.5)})$	=	.694941
4	$1/((1+.1567)^{(4-.5)})$	=	.600797
5	$1/((1+.1567)^{(5-.5)})$	=	.519406
6	$1/((1+.1567)^{(6-.5)})$	=	.449041
7	$1/((1+.1567)^{(7-.5)})$	=	.388209
NOTE: The discount factor of 15.67 percent includes 1.85 percent for property taxes. Some appraisers handle property taxes as a deduction from gross income.			

7. DCF equals net income multiplied by the discount factor.

The DCF method should also include capital expenditures, environmental remediation costs and the present worth of equipment salvage value less well-plugging costs.

FIGURE 3

Estimation of WACC

1. Derive the typical capital structure of a broad sample of potential purchasers as a proportion of debt and equity. Data can be found in the 12/31/20xx issue of "The Value Line Investment Survey" under Petroleum (Integrated) Industry and Petroleum (Producing) Industry.

Outstanding common stock (oil company)	=	157,627,284 shares @ 12/31/20xx
Closing common stock price	=	$106.75/share
Common stock equity	=	157,627,284 shares X $106.75/share
	=	$16,827,000,000 @ 12/31/20xx
Total debt	=	$6,791,000,000 @ 12/31/20xx
Total capital	=	Debt + equity
	=	$6,791,000,000 + $16,827,000,000
	=	$23,618,000,000
Debt	=	$6,791,000,000/$23,618,000,000
	=	.288 or 28.8 percent
Equity	=	$16,827,000,000/$23,618,000,000
	=	.712 or 71.2 percent
The capital structure is 28.8 percent debt and 71.2 percent equity.		
Repeat this procedure for each company in the sample.		

FIGURE 4

Calculating the Cost of Outstanding Debt

2. Calculate the cost of outstanding debt. YTM = yield-to-maturity* @ 12/31/20xx

Debt Instrument	Debt (MM$)	YTM (% per year)	Debt X YTM ($)
Debt A	27	6.29	170
Debt B	586	8.42	4,934
Debt C	132	7.52	993
Debt D	600	7.84	4,704
Debt E	265	4.95	1,312
Debt F	100	8.65	865
Debt G	300	7.87	2,361
Debt H	450	8.28	3,726
Debt I	123	8.70	1,070
Debt J	224	8.78	1,967
Debt K	300	8.29	2,487
Debt L	500	8.38	4,190
Totals	**$ 3,607**		**$ 28,779**

Sum of debt	=	Debt (MM$) X YTM
	=	$28,779 MM
Cost of debt	=	Sum of debt (MM$)/Debt (MM$)
	=	($28,779 MM)/($3,607 MM)
	=	7.98 percent per year
Repeat this procedure for each company in the sample.		

*Note: Resources for yield-to-maturity information include Standards & Poor's, Value Line, Morningstar, Yahoo Finance, Bloomberg Bond Record, Damodaran, Fidelity, Duff & Phelps and Zacks.

FIGURE 5

Calculating the Cost of Equity Equation

3. Use the capital asset pricing model (CAPM) equation.

K = Rfc + B(Rm - Rfh)			
K	Cost of equity (after tax), percentage per year		
Rfc	Current risk-free rate, percentage per year*		2.26% per year
Rfh	Historic market return on long-term government bonds, percentage per year**		5.90% per year
Rm	Historic market return on equities, percentage per year**		11.90% per year
B	Beta coefficient***		1.70
K	=	Rfc + B(Rm - Rfh)	
	=	2.26 + 1.70 (11.90 - 5.90)	
	=	12.46 percent per year	
K (pre-tax)	=	12.46/(1 - .21)	
K	=	15.77 percent per year	

*Federal Reserve Statistical Release (January of current year)

**Duff & Phelps SBBI® Yearbook – Stocks, Bonds, Bills and Inflation®

***The Value Line Investment Survey, 4th Quarter, 20xx

FIGURE 6

Calculating a Typical WACC

4. Calculate a typical WACC by plugging the mean (or other measure of central tendency) cost of debt, cost of equity and capital structure from the sample companies.

WACC	=	((cost of debt) X (percent debt)) + ((cost of equity) X (percent equity))
	=	(7.98 X .288) + (15.77 X .712)
	=	13.53 percent/year

FIGURE 7

Average the Data Arithmetically

The standard deviation is the square root of the average squared difference between the individual observations and the average value. The first step in calculating the standard deviation is to average the data arithmetically. The arithmetic average or mean value is denoted as z.

$z = 1/n(x1 + x2 + x3 + ... + xn)$	
z	Mean value of a data set of n values
x1	Unique value in dataset
n	Total number of values in data set

FIGURE 8

Standard Deviation

The standard deviation is denoted by the symbol S.

$S = (((x1 - z)^2 + ... + (xn - z)^2)/(n-1))^{.5}$	
S	Standard deviation of a dataset with n values
x1	Unique value in dataset
xn	nth value in dataset
n	Total number of values in dataset

FIGURE 9

Standard Deviation Example

Procedure for calculating the standard deviation of a dataset that includes 10 sales with various internal rates of return (IRR).

Sales No.		IRR (%)	(x - z)	$(x - z)^2$
1	X 1	11.0	-4.7	22.09
2	X 2	25.0	9.3	86.49
3	X 3	6.0	-9.7	94.09
4	X 4	16.0	0.3	0.09
5	X 5	16.0	0.3	0.09
6	X 6	22.0	6.3	39.69
7	X 7	9.0	-6.7	44.89
8	X 8	14.0	-1.7	2.89
9	X 9	13.0	-2.7	7.29
10	X 10	25.0	9.3	86.49
Totals		**157.0**		**384.10**

FIGURE 10

Calculating the Standard Deviation

1. Calculate the arithmetic average z.

z	=	Sum(IRR (%)/Sum(Sales No.)
	=	157.0/10
	=	15.7

2. Calculate the arithmetic average S.

S	=	$\text{Sum}((x - z)^2)/\text{Sum}(\text{Sales No.}) - 1))^{.5}$
	=	$(384.1 / (10 - 1))^{.5}$
	=	6.5

3. Calculate the range of 1 standard deviation.

	=	$z \pm S$
	=	15.7 ± 6.5
	=	$9.2 < 15.7 < 22.2$

4. Calculate the range of 2 standard deviations.

	=	$z \pm S(2)$
	=	$15.7 \pm 6.5(2)$
	=	$2.7 < 15.7 < 28.7$

28.7 percent per year is the upper range of the discount rate for high-risk properties.

FIGURE 11

Property-Specific Risk Factors

Property-Specific Risk Factors
One well lease
Oil lease with high water production
Lease near the end of its economic life
Gas well reservoir under partial or active water drive (recovery uncertain)
Curtailed gas well
Rapidly declining lease
Lease with less than six (6) months' production history
Secondary recovery project in early stages before fill-up
Offshore oil or gas lease
Unusually high operating expenses (e.g.: paraffin problems, sour gas etc.)
The appraiser should add any other property-specific factors that increase the investor's risk to the base discount rate (WACC).

Appendix B: Escalation or De-escalation Formula

This is the formula for determining the maximum average annual escalation or de-escalation percentage of crude oil and natural gas prices for years two through six of the appraisals.

$((X/100)^{(1/Y)}-1) \times 100$	
X	Most recent year annual average (not seasonally adjusted) producer price index (PPI) for crude petroleum (domestic production) [Commodity Code 0561, Series ID# WPU0561] or natural gas [Commodity Code 0531], obtained from the U.S. Bureau of Labor Statistics during the month of January, which may contain preliminary statistics.
Y	Number of years from base year 1982 through the most recent year (most recent year minus base year).
	The denominator of 100 in the formula is the PPI annual average for domestically produced petroleum and natural gas in base year 1982.

Most recent year	=	2019
X	=	157.8 for crude petroleum domestic production (Commodity Code 0561) [Series ID# WPU0561]; 185.8 for natural gas (Commodity Code 0531)
	=	2019 - 1982 = 37 years
1/Y	=	1/37
	=	0.027027027

Crude petroleum (domestic production)	=	$((157.8/100)^{0.027027027} - 1) \times 100$
	=	1.240 percent
Natural gas	=	$((85.6/100)^{0.027027027} - 1) \times 100$
	=	-0.419 percent

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2023 School District Property Value Study

Discount Rate Range for Oil and Gas Properties

December 2023

2023 School District Property Value Study

Discount Rate Range for Oil and Gas Properties

The Texas Comptroller of Public Accounts conducts a School District Property Value Study (SDPVS) that includes oil and gas property appraisals. The Comptroller's Property Tax Assistance Division (PTAD) conducts these appraisals according to methods and procedures outlined in the Comptroller's *Manual for Discounting Oil and Gas Income,* as required by Tax Code Section 23.175.

As part of the SDPVS, we calculate a range of discount rates used to discount the projected future income of oil and gas produced from individual properties. For the 2023 SDPVS, we will use a range of 11.21 to 16.80 percent unless property-specific risk requires use of a discount rate outside this range.

This report summarizes the 2023 SDPVS methodology for the discount rate range determination. For more detailed information, contact us at **800-252-9121** or **ptad.oilandgas@cpa.texas.gov**.

Oil and Gas Property Appraisal

One of the primary economic parameters in oil and gas property appraisals is the discount rate used to convert future income streams to a present value. The discounted cash flow analysis is the process of coverting the value of cash projected to be received in the future to the current price investors would pay for the right to receive the income. This method is a widely accepted appraisal method for oil and gas properties.

Each year, we calculate a discount rate based upon the **overall mean weighted average cost of capital (WACC)** of a sample of petroleum companies. To account for inherent risk associated with oil and gas production from a single property rather than a company-wide portfolio of producing properties, we add two percentage points to the **overall mean WACC** to establish the **base discount rate** for each oil and gas property in the annual SDPVS. Other property-specific risk considerations may warrant additional risk adjustments (increase or decrease) that we use to calculate an **adjusted discount rate** for each property. The **adjusted discount rate** will usually fall within the discount rate range determined each year.

In accordance with International Association of Assessing Officers (IAAO) guidelines, we add the county and school district ad valorem total tax rates to the **adjusted discount rate** to determine a **property-specific discount rate** (city and special district tax rates are not included). We then apply the **property-specific discount rate** to our appraisal to discount the projected future income of oil and gas produced from the property.

Discount Rate

The three generally accepted methods for estimating a discount rate are: analysis of oil and gas property sales, market surveys and the weighted average cost of capital.

Market Survey Methods

The Society of Petroleum Evaluation Engineers (SPEE) conducts an annual opinion poll market survey. Responses from petroleum company executives, industry consultants and energy banks concerning property acquisitions and divestitures offer insight into the discount rates used to analyze properties in the market.

The Weighted Average Cost of Capital (WACC) Method

Each year we calculate the WACC for several petroleum companies operating in Texas that are listed on the New York Stock Exchange or the Over-The-Counter stock market. We calculate a discount rate based upon the average of the companies' WACC.

For the 2023 SDPVS, we compiled year-end 2022 financial data for 19 petroleum companies to calculate the WACC for each company. **Table 1** presents the results of the WACC calculations. The overall mean WACC for the 19 companies is 14.67 percent with a standard deviation of 1.70 percent. The Comptroller's *Manual for Discounting Oil and Gas Income* includes information on the methodology used to calculate a WACC.

TABLE 1

Petroleum Companies' Financial Information Used for WACC Method

Company Name	Total Capital	Total Equity	Total Convertible Preferred Stock	Total Long-Term Debt	Equity % of Capital	Convertible Preferred Stock % of Capital	Long-Term Debt % of Capital	Beta Factor	After Income Tax Cost of Equity %	Before Income Tax Cost of Equity %	Cost Of Convertible Preferred Stock %	Cost Of Debt %	Before Income Tax WACC %	
Apache Corporation	$19,614,478,914	$14,163,478,914	$0	$5,451,000,000	72.21	0.0000	27.79	1.85	15.74	19.92	0.00	6.47	16.18	
Callon Petroleum	$4,491,096,622	$2,249,801,622	$0	$2,241,295,000	50.09	0.0000	49.91	1.95	16.38	20.73	0.00	0.09	14.75	
Chevron Corporation	$362,360,117,708	$340,985,117,708	$0	$21,375,000,000	94.10	0.0000	5.90	1.20	11.58	14.66	0.00	4.89	14.08	
ConocoPhillips Petroleum Co.	$158,878,663,752	$142,652,663,752	$0	$16,226,000,000	89.79	0.0000	10.21	1.25	11.90	15.06	0.00	5.89	14.13	
Devon Energy Corporation	$45,845,690,000	$39,656,690,000	$0	$6,189,000,000	86.50	0.0000	13.50	1.50	13.50	17.09	0.00	5.70	15.55	
Diamondback Energy	$30,511,112,371	$24,273,112,371	$0	$6,238,000,000	79.55	0.0000	20.45	1.55	13.82	17.49	0.00	3.86	14.71	
Earthstone Energy Inc	$3,019,562,327	$1,956,683,327	$0	$1,053,879,000	65.10	0.0000	34.90	1.30	12.22	15.47	0.00	6.34	12.28	
EOG Resources, Inc.	$79,020,148,928	$75,225,148,928	$0	$3,795,000,000	95.20	0.0000	4.80	1.20	11.58	14.66	0.00	4.92	14.19	
ExxonMobil Corporation	$483,905,020,000	$443,346,020,000	$0	$40,559,000,000	91.62	0.0000	8.38	1.10	10.94	13.85	0.00	4.75	13.09	
Hess Corporation	$51,155,008,035	$42,877,008,035	$0	$8,278,000,000	83.82	0.0000	16.18	1.35	12.54	15.87	0.00	5.71	14.23	
Marathon Oil Corporation	$18,938,720,000	$12,112,720,000	$0	$6,826,000,000	63.96	0.0000	36.04	1.45	13.18	16.68	0.00	5.46	12.64	
Matador Resources Company	$7,952,859,036	$6,739,629,036	$0	$1,213,230,000	84.74	0.0000	15.26	1.75	15.10	19.11	0.00	6.86	17.24	
Murphy Oil Corporation	$10,063,016,949	$8,240,564,949	$0	$1,822,452,000	81.89	0.0000	18.11	1.65	14.46	18.30	0.00	6.60	16.18	
Occidental Petroleum Corp.	$76,531,212,211	$56,061,212,211	$800,000,000	$19,670,000,000	73.25	1.0453	25.70	1.55	13.82	17.49	7.41	7.24	14.75	
Ovintiv Inc	$15,466,914,000	$12,289,914,000	$0	$3,177,000,000	79.46	0.0000	20.54	1.60	14.14	17.90	0.00	9.79	16.23	
Pioneer Natural Resources	$57,320,324,692	$53,195,324,692	$0	$4,125,000,000	92.80	0.0000	7.20	1.25	11.90	15.06	0.00	4.76	14.32	
Range Resources Corporation	$8,515,082,096	$5,807,312,096	$0	$2,707,770,000	68.20	0.0000	31.80	0.95	9.98	12.63	0.00	7.34	10.95	
SM Energy Company	$6,348,378,330	$4,316,381,330	$0	$2,031,997,000	67.99	0.0000	32.01	2.20	17.98	22.76	0.00	7.16	17.77	
Vital Energy	$1,957,834,201	$844,811,201	$0	$1,113,023,000	43.15	0.0000	56.85	2.20	17.98	22.76	0.00	9.94	15.47	
Total	$1,441,895,240,172	$1,287,002,594,172	$800,000,000	$154,092,646,000	1,463.43	1.0453	435.53	28.85	258.74	327.52	7.41	113.76	278.74	
				Entries	19	1	19	19	19	19	1	19	19	
				Average	77.02	1.05	22.92	1.52	13.62	17.24	7.41	5.99	14.67	WACC
				Standard Deviation	14.65	0.24	14.63	0.35	2.25	2.85	1.70	2.13	1.70	
												Hurdle Rate	2.00	
												Base Discount Rate	16.67	

Base Discount Rate for All Oil and Gas Properties in the School District Property Value Study

We add two percentage points to the overall mean WACC of 14.67 percent to establish the base discount rate of 16.67 percent for the 2023 SDPVS. The two percentage points account for inherent risk associated with oil and gas production from an individual property. Other considerations may warrant additional property-specific risk or risk reduction in determining the adjusted discount rate for an individual property.

Adjusted Discount Rate

The base discount rate may be adjusted to reflect a wide variety of property-specific risks. We consider specific risks associated with a property to determine its adjusted discount rate. Below are some common examples of risk that we routinely consider and the associated adjustments.

Limited History

A major risk associated with appraising oil and gas properties is often limited production history. Decline curve analysis requires sufficient production history and knowledge of the reservoir drive mechanism to enhance the confidence level for reserve forecasts.

Type of Risk	Added Percentage Points
Limited History:	
Less than one year	3
One to two years	2
Two to three years	1
More than three years	0

Single Completion Leases

Single completion leases have a greater chance of early abandonment because they do not involve or exhibit the potential for production from additional zones in a single well bore. Multiple completion wells are not adjusted for this risk.

Type of Risk	Added Percentage Points
Single Completion Lease	1

Offshore Leases

Offshore properties often involve production and economic risks greater than those associated with onshore properties.

Type of Risk	Added Percentage Points
Offshore Lease	2

Enhanced Oil Recovery (EOR) Leases

This recovery method, by definition, involves complex production methods and additional economic risks. Early-stage projects have a high degree of uncertainty for success, and pilot projects experience unusual risks associated with expansion throughout the field.

Type of Risk	Added Percentage Points
EOR Projects	Varies from 1 to 3

Other Adjustments

Other risk adjustments may be applied to individual properties at the appraiser's discretion.

Type of Risk	Adjustment Trend
Short Remaining Life (< 2 years)	may increase risk
High or Increasing Water Cut	may increase risk
Gas Curtailment	may increase risk
Environmental Concerns	may increase risk
Erratic Production	may increase risk
Long History, Stable Production	may decrease risk

Reconciling Results into the Discount Rate Range

The lower end of our base discount rate defines this year's discount rate range of 11.21 to 16.8 percent. We establish the upper end of the discount rate range by reconciling survey and study data as shown in **Table 2**. The upper end of the discount rate range is the average of the high-end values listed in the Upper Discount Rate Range column. Similarities are evident when comparing the statistical results of the data; however, differences in the data highlight contrasting views in the market.

TABLE 2

Summary of Findings from Annual Market Survey and the School District Property Value Study

Study Author	Discount Rate	Standard Deviation	Discount Rate Range Lower	Discount Rate Range Upper	Data Points
Society of Petroleum Evaluation Engineers*	13.00	N/A	9.00 to	15.00	31
Texas Comptroller of Public Accounts / Property Tax Assistance Division**	15.32	1.09	13.43 to	18.61	3,951
Average	14.16	1.09	11.21	16.80	

* *Discount Rate based on 31 survey responses: Survey of Parameters Used in Property Evaluation, June 2022*

** *Discount Rate based on the appraisal of 3,951 properties (average, excluding ad valorem taxes): 2022 School District Property Value Study*

Conclusions

A range of discount rates adjusted for individual property risk is appropriate for the appraisal of the wide variety of oil and gas properties in Texas. Use of a particular adjusted discount rate should be tailored to the appraiser's perception of risk associated with a specific property. Based upon the reconciliation of data from the sales analysis, market survey, WACC and study results, we conclude that a discount rate range of 11.21 to 16.80 percent is generally suitable for the appraisal of oil and gas properties in the 2023 SDPVS unless property-specific risk requires use of a discount rate outside this range. We add the appropriate ad valorem tax rates to the adjusted discount rate to determine the property-specific discount rate that we apply to our appraisal to discount the projected future income of oil and gas produced from the property.

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Texas Comptroller of Public Accounts
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December 2023

MINERAL PROPERTY
APPRAISAL PARAMETERS

PRODUCING MINERAL PROPERTY PRESENT VALUE OF FUTURE WORTH CALCULATION

PRODUCTION WITH DECLINE
X
CALCULATED PRICE OF PRODUCT
=
GROSS INCOME

ESTIMATED GROSS INCOME
-
SEVERENCE AND ESTIMATED
AD VALOREM TAX
-
ESTIMATED ANNUAL OPERATING COSTS
=
NET INCOME

TOTAL NET INCOME
(ALL YEARS OF ECONOMIC LIFE)
X
DISCOUNT FACTOR
PRESENT WORTH FACTOR
(CAPITAL + RISK)
=
PRESENT VALUE

CONSTANT RATE PRESENT WORTH FACTORS

MID YEAR BASIS

YEAR	10%	12%	14%	15%	18%	20%	25%	YEAR
1	0.953463	0.944911	0.936586	0.932505	0.920575	0.912871	0.894427	1
2	0.866784	0.843671	0.821567	0.810874	0.780148	0.760726	0.715542	2
3	0.787986	0.753278	0.720673	0.705108	0.661142	0.633938	0.572433	3
4	0.716351	0.672569	0.632169	0.613137	0.560290	0.528252	0.457947	4
5	0.651228	0.600508	0.554535	0.533163	0.474822	0.440235	0.366357	5
6	0.592025	0.536168	0.486434	0.463620	0.402392	0.366862	0.293086	6
7	0.538205	0.478722	0.426696	0.403148	0.341010	0.305719	0.234469	7
8	0.489274	0.427430	0.374295	0.350563	0.288991	0.254766	0.187575	8
9	0.444797	0.381634	0.328329	0.304837	0.244908	0.212305	0.150060	9
10	0.404361	0.340745	0.288008	0.265076	0.207549	0.176921	0.120048	10
11	0.367601	0.304237	0.252639	0.238501	0.175889	0.147434	0.096038	11
12	0.334183	0.271640	0.221613	0.200346	0.149059	0.122861	0.076831	12
13	0.303803	0.242536	0.194397	0.174292	0.126321	0.182385	0.061464	13
14	0.276184	0.216558	0.170524	0.151558	0.107052	0.085320	0.049172	14
15	0.251877	0.193348	0.149583	0.131790	0.090722	0.071100	0.039337	15
16	0.228251	0.172632	0.131213	0.114600	0.076883	0.059250	0.031470	16
17	0.287581	0.154136	0.115099	0.099652	0.065155	0.049375	0.025176	17
18	0.188638	0.137621	0.100964	0.086654	0.055216	0.041146	0.028141	18
19	0.171489	0.122876	0.088565	0.075351	0.046793	0.034288	0.016113	19
20	0.155899	0.109711	0.077689	0.065523	0.039655	0.028574	0.012898	20
21	0.141726	0.097956	0.068148	0.056976	0.033606	0.023811	0.010312	21
22	0.128842	0.087461	0.059779	0.049545	0.028480	0.019843	0.008250	22
23	0.117129	0.078898	0.052438	0.043082	0.024135	0.016536	0.006600	23
24	0.186481	0.069723	0.045998	0.037463	0.020454	0.013780	0.005280	24
25	0.096881	0.062253	0.040349	0.032576	0.017334	0.011483	0.004224	25

2024 – MINERALS PRICING – TPTC SECTION 23.175 (a)

The Energy Information Administration (EIA) of the U.S. Department of Energy has released its January 2024 Short-Term Energy Outlook (STEO) concerning crude oil and natural gas prices for use in calculation of the price adjustment factors. For appraisal year 2024, the January STEO publication will be used to calculate the price adjustment factors (PAF's) as a secondary source per Texas Property Tax Code Section 23.175(a).

PAF using the AEO released on January 9, 2024:

Crude Oil PAF	**=**	**$ 77.99 / $ 77.58**	**=**	**1.00528**
Natural Gas PAF	**=**	**$ 2.66 / $ 2.54**	**=**	**1.04724**

Price Escalator Factor 2024:

Years 2024-2029

Oil: 1.018578%

Gas: .998284%

Years 2030 and after:

Oil: FLAT

Gas: FLAT

GAS PRICE AVERAGE 2023 - $ 2.54 per Mcf

ECTOR COUNTY APPRAISAL DISTRICT

2024
OIL AND PRICE DATA

AVERAGE POSTED PRICE 2023 ANNUAL

	WTI
CONOCO (Conoco Phillips 66)	74.21
VALERO MARKETING	74.39
PLAINS MARKETING LP	74.24
SHELL	74.23
FLINT HILLS RESOURCES (KOCH)	74.11

West Texas Sour (WTS) Differential 1.8% Addition from WTI Price or $1.36 per/barrel

REFERENCE (Default) BASE PRICE 2024 WTI $ 74.35 WTS $ 75.71

Subject to adjustments for specific gravity, basic sediments, and water, trucking, gathering & other related charges. May be subject to bonus premiums and a market condition factor.

Adjustments for severance and ad valorem property taxes have not been included in these listed prices.

No adjustments to market price will be made without price verification.

2024 – Price Adjustment Factor Oil – 1.00528

Default Price Adjusted per 2024 PAF WTI $ 74.74 WTS $ 76.11

ECTOR COUNTY APPRAISAL DISTRICT

2024 ADJUSTED GROSS OIL PRICES
(APPRAISAL YEARS 1-25)

YEAR	WTI	WTS	PERCENTAGE CHANGE
*	74.35	75.71	
1	74.74	76.11	Start-PAF Applied
2	76.13	77.52	1.0186%
3	77.55	78.96	1.0186%
4	78.99	80.43	1.0186%
5	80.45	81.93	1.0186%
6	81.95	83.45	1.0186%
7	83.47	85.00	FLAT
8	83.47	85.00	FLAT
9	83.47	85.00	FLAT
10	83.47	85.00	FLAT
11	83.47	85.00	FLAT
12	83.47	85.00	FLAT
13	83.47	85.00	FLAT
14	83.47	85.00	FLAT
15	83.47	85.00	FLAT
16-25	83.47	85.00	FLAT

*****Gross oil prices have an increased price adjustment factor of 1.00528 for Year-1.
Adjustments for severance and ad valorem property taxes not included in listed prices.

ECTOR COUNTY APPRAISAL DISTRICT

2024 ESCALATED GROSS GAS PRICES
(APPRAISAL YEARS 1-25)

	YEAR	GAS	PERCENTAGE CHANGE
Pr. Yr. Avg.	*	2.54	
	1	2.66	Start-PAF Applied.
	2	2.66	.9983%
	3	2.65	.9983%
	4	2.65	.9983%
	5	2.64	.9983%
	6	2.64	.9983%
	7	2.63	FLAT
	8	2.63	FLAT
	9	2.63	FLAT
	10	2.63	FLAT
	11	2.63	FLAT
	12	2.63	FLAT
	13	2.63	FLAT
	14	2.63	FLAT
	15	2.63	FLAT
	16-25	2.63	FLAT

*Gross gas prices have an increased price adjustment factor of 1.04724 for Year-1.
Adjustments for severance and ad valorem property taxes not included in listed prices.

REFERENCE (Default) PRICE PAF Applied $2.66

ECTOR COUNTY APPRAISAL DISTRICT

2024 Lease Equipment Schedule

WELL SCHEDULE	MAX TYPE	SALVAGE DEPTH	VALUE
01	OIL	3,000	4,000
02	OIL	5,000	6,000
03	OIL	7,000	9,000
04	OIL	10,000	12,000
05	OIL	15,000	18,000
06	GAS	2,000	3,000
07	GAS	4,000	7,000
08	GAS	8,000	10,000
09	GAS	10,000	15,000
10	GAS	15,000	25,000
11	W INJ	5,000	3,000
12	W INJ	7,000	4,000
13	W INJ	10,000	6,000
14	W INJ	15,000	9,000
15	CO2 INJ	5,000	5,000
16	CO2 INJ	7,000	6,000
17	CO2 INJ	10,000	9,000
18	CO2 INJ	15,000	12,000
19	S.W.D.		2,000
20	OIL – SHUT IN	ANY	5,000
21	GAS – SHUT IN	ANY	5,000

Schedule salvage value will be discounted to present worth based on the economic life of the property. Net Salvage will be at a 6% discount rate. Maximum life 25 years.

January 1, 2024

COST OF CAPITAL STUDY

Weighted Average Cost of Capital

For the Year 2024

For Incorporation into the Ector County Appraisal District's 2024 Mineral Appraisal Manual

Analysis and Report prepared by:

George K. Lagassa, PhD, ASA (retired)

Mainstream Associates
26 Maple Road
North Hampton, New Hampshire 03862

Prepared for:

Ector County Appraisal District

Odessa, Texas

February 20, 2024

MAINSTREAM ASSOCIATES

26 Maple Road
Post Office Box 947
North Hampton, New Hampshire 03862

February 19, 2024

Mr. Layne Young, RPA
Assistant Chief Appraiser
Ector County Appraisal District
1301 East 8th Street
Odessa, Texas 79761

Dear Mr. Young,

Enclosed, in duplicate, is my report "Weighted Average Cost of Capital for the Year 2024", for incorporation into the Ector County Appraisal District's 2024 Mineral Appraisal Manual.

Please do not hesitate to contact me if you have any questions or concerns about its form or content. Thank you for your continued confidence in the quality of our work and for continuing to use Mainstream Associates for this assignment.

Sincerely,

George K. Lagassa, PhD, ASA (retired)

TABLE OF CONTENTS

	Page
Cover Letter	
Cost of Capital	1
Figure 1: Estimated Cost of Capital (WACC) Petroleum Operating Industry as of January 1, 2024	1
Weighted Average Cost of Capital	2
Capital Structure	3
Figure 2: Petroleum Operating Industry Capital Structures	4
Cost of Debt	5
Figure 3: S&P's, Moody's and Fitch Bond Ratings 28 Benchmark Companies	5
Cost of Equity	7
(1) The Build-Up Method	7
Figure 4: Value Line Beta, 34 Benchmark Companies	9
Figure 5: Kroll/Duff & Phelps 5 Yr. Ave. Size Categories and Estimated Risk Premia	10
Figure 6: Cost of Equity by the Build-Up Method	10
(2) The Capital Asset Pricing Model (CAPM)	11
Figure 7: Cost of Equity by CAPM Approach	11
(3) Discounted Cash Flow Model (based on Gordon Growth formula)	12
Figure 8: Cost of Equity by Gordon Growth Formula (based on Dividend Growth Rate)	13
Figure 9: Gordon Growth DCF Cost of Equity by Market Capitalization	14
(4) Discounted Cash Flow Model (based on Forecast Average Annual Total Returns)	15
Figure 10: Cost of Equity, based on *Value Line* Projected Annual Total Return	16
Figure 11: Annual Total Return DCF Cost of Equity by Market Capitalization	17
(5) Cost of Equity Summary	18
Figure 12: Indicated Cost of Equity by Market Capitalization	18

COST OF CAPITAL

Valuation of petroleum operating properties using the discounted cash flow technique requires determining the correct discount rate to apply to future cash flows from the subject pipeline and other operating properties. This is typically the opportunity cost of capital or the return on investment otherwise available in the marketplace, if it were not invested in the subject properties. The opportunity cost of capital is the return that must be provided by the subject property in order to attract capital investment.

Recognizing that capital can come from both debt and equity contributions to an investment, financial theory develops the cost of capital using a band of investment technique or a weighted average cost of capital (WACC), where the expected return to each band of capital contribution is weighted, based on relative contribution, and then summed for a total weighted average cost of capital. In this report, we explain the various determinants of WACC for petroleum, gas and liquid pipeline operating property and develop the expected WACC for varying sizes of investors in such properties, as of January 1, 2024[1]. Our results are shown in **Figure 1**, below. The rest of this report explains the various factors that contributed to the conclusions in **Figure 1**.

Figure 1
Estimated Cost of Capital (WACC)
Petroleum Operating Industry
As of January 1, 2024

Market Cap	After Tax Cost of Debt	%age of Debt	Wtd. Average Cost of Equity	%age of Equity	WACC
Large Cap	4.57%	22%	13.08%	78%	11.21%
Mid Cap	4.57%	22%	13.91%	78%	11.86%
Low Cap	4.57%	22%	14.59%	78%	12.39%
Micro Cap	4.57%	22%	16.58%	78%	13.94%

[1] However, the data used to support this report were reported in *Value Line* on November 24, 2023 and January 26, 2024, and generally reflect data as of Q4 2023.

WEIGHTED AVERAGE COST OF CAPITAL

The basic formula for the Weighted Average Cost of Capital (WACC) is as follows:

$$WACC = (\%D \times R_D) + (\%P \times R_P) + (\%E \times R_E)$$

Where: WACC = Weighted Average Cost of Capital

%D = relative contribution of debt to the capital structure

R_D = market-based return on debt

%P = relative contribution of preferred shares to the capital structure

R_D = market-based return on preferred shares

%E = relative contribution of common equity to the capital structure

R_D = market-based return on common equity

Thus, determination of the WACC requires determination of the following contributing factors:

(1) Capital Structure (i.e., percent contribution of each capital source)

(2) Expected Return on Debt

(3) Expected Return on preferred shares

(4) Expected return on common equity

For the development of information about each of these factors we rely primarily upon the most current available (November 24, 2023 and January 26, 2024) *Value Line Investment Survey*, which reports past and projected future financial expectations for participants in the Integrated Petroleum, Petroleum Producing, Oil and Gas Distribution, and Diversified Natural Gas Industries. The *Value Line Investment Survey* is a well-respected investment advisory service that monitors the performance of thousands of companies and is typically used by analysts as a source of information about the strength and financial expectations of particular industries and particular companies.

Market costs of debt are taken from *Federal Reserve Statistical Release H.15, Selected Interest Rates,* which reports current and historical data with respect to market interest rates on corporate and municipal bonds, US treasuries, and bank loans.

For the development of the cost of equity, we found guidance in the computations performed by Aswath Damadoran, professor of corporate finance and valuation at the Stern School of Business at New York University (see pages.stern.nyu.edu/adamador) and in past issues of the *Cost of Capital Navigato*r developed by Kroll Inc. (formerly Duff & Phelps) together with their updated guidelines.

CAPITAL STRUCTURE

Capital structure is the relative contribution of each type of capital – debt, preferred shares, and common shares -- to the typical investment in the Integrated Petroleum, Petroleum Producing, Oil and Gas Distribution, and Diversified Natural Gas industries[2]. As shown in **Figure 2**, using data from the *Value Line Investment Survey*, we have determined the capital structure of 35 companies active in these industries to be approximately 78% equity and 22% debt, as of Q1 of 2024. Currently, preferred shares are rarely utilized to raise capital in this industry, and only two of the benchmark companies selected made use of a small proportion of preferred shares.

Note that *Value Line* provides data with respect to the book value of debt and preferred issuances and the market value of equity. Typically, the market value of debt and preferred stock are very close to book value, leading us to conclude that the use of book capital structure for debt and preferred stock supports a reasonable indicator of the market capital structure.

The mean (average) and median (center of the distribution) represent two measures of central tendency. The mean long-term debt percentage is 19.4%, while the median long-term debt percentage is 20.6%. We supplement these measures with an adjusted mean from which we exclude the highest equity ratio (Occidental) and the lowest equity ratio (Delek U.S. Holdings). With these excluded from the analysis, and ignoring the limited contribution from preferred shares, the adjusted mean debt portion shows an increase from 19.9% to 23.2%, and the median debt portion increases slightly to 22.9%. Based on these measures of central tendency, as of January 1, 2024, I conclude that the typical capital structure is 78% equity and 22% debt.

[2] Data are collected for all three industries but referred to herein as the Petroleum Operating Industry.

Figure 2
Petroleum Operating Industry
Capital Structures

	Company	Symbol	LT Debt (millions)	Pfd Stock (millions)	Shr Equity (millions)	% LT Debt	%Pfd St	% Equity
1	Antero Resources	AR	$ 1,607	$ -	$ 7,827	17.0%	0.0%	83.0%
2	APA Corp	APA	$ 5,582	$ -	$ 9,981	35.9%	0.0%	64.1%
3	Callon Petroleum	CPE	$ 1,949	$ -	$ 2,211	46.8%	0.0%	53.2%
4	Cenovus	CVE.TO	$ 7,224	$ 519	$ 47,214	13.1%	0.9%	85.9%
5	Chevron Corp	CVX	$ 201,190	$ -	$ 271,836	42.5%	0.0%	57.5%
6	CNX Resources	CNX	$ 1,844	$ -	$ 3,315	35.7%	0.0%	64.3%
7	Conoco Phillips	COP	$ 18,182	$ -	$ 132,633	12.1%	0.0%	87.9%
8	CVR Energy	CVI	$ 1,583	$ -	$ 3,073	34.0%	0.0%	66.0%
9	Delek US Holdings	DK	$ 2,609	$ -	$ 1,692	60.7%	0.0%	39.3%
10	Devon Energy	DVN	$ 5,675	$ -	$ 29,101	16.3%	0.0%	83.7%
11	Diamonback	FANG	$ 6,230	$ -	$ 27,691	18.4%	0.0%	81.6%
12	EQT Corp.	EQT	$ 5,417	$ -	$ 16,371	24.9%	0.0%	75.1%
13	Exxon-Mobil	XOM	$ 36,510	$ -	$ 415,472	8.1%	0.0%	91.9%
14	Hess Corp.	HES	$ 8,796	$ -	$ 43,824	16.7%	0.0%	83.3%
15	HF Sinclair	DINO	$ 2,862	$ -	$ 9,740	22.7%	0.0%	77.3%
16	Imperial Oil	IMO	$ 3,013	$ -	$ 32,130	8.6%	0.0%	91.4%
17	Magnolia Oil & Gas	MGY	$ 392	$ -	$ 4,224	8.5%	0.0%	91.5%
18	Marathon Oil	MRO	$ 4,876	$ -	$ 13,695	26.3%	0.0%	73.7%
19	Marathon Petrol.	MPC	$ 26,463	$ -	$ 55,724	32.2%	0.0%	67.8%
20	Matador Resources	MTDR	$ 1,714	$ -	$ 6,594	20.6%	0.0%	79.4%
21	MDU Resources	MDU	$ 2,280	$ -	$ 3,682	38.2%	0.0%	61.8%
22	Murphy Oil	MUR	$ 1,576	$ -	$ 6,667	19.1%	0.0%	80.9%
23	National Fuel Gas	NFG	$ 2,385	$ -	$ 4,661	33.8%	0.0%	66.2%
24	Occidental Petro	OXY	$ 18,597	$ 8,287	$ 542,396	3.3%	1.5%	95.3%
25	Ovintiv	OVV	$ 5,454	$ -	$ 12,201	30.9%	0.0%	69.1%
26	PBF Energy	PBF	$ 1,243	$ -	$ 5,428	18.6%	0.0%	81.4%
27	Par Pacific Holdings	PARR	$ 533	$ -	$ 2,300	18.8%	0.0%	81.2%
28	Phillips 66	PSX	$ 18,531	$ -	$ 50,221	27.0%	0.0%	73.0%
29	Pioneer Nat Res	PXD	$ 4,880	$ -	$ 52,189	8.6%	0.0%	91.4%
30	Range Resources	RRC	$ 1,773	$ -	$ 7,448	19.2%	0.0%	80.8%
31	Shell (ADR)	SHEL	$ 72,000	$ -	$ 230,499	23.8%	0.0%	76.2%
32	Suncor Energy Inc	SU	$ 9,718	$ -	$ 60,257	13.9%	0.0%	86.1%
33	Targa Resources	TRGP	$ 12,318	$ -	$ 18,933	39.4%	0.0%	60.6%
34	Total SA (ADR)	TOT	$ 57,900	$ -	$ 163,999	26.1%	0.0%	73.9%
35	Valero Energy	VLO	$ 10,107	$ -	$ 42,308	19.3%	0.0%	80.7%
	TOTAL/AVERAGE		$ 563,013	$ -	$ 2,337,538	19.4%	0.0%	80.6%
	ADJ MEAN		$ 541,807	$ -	$ 1,793,450	23.2%	0.0%	76.8%
	MEDIAN		$ 1,714	$ -	$ 6,594	20.6%	0.0%	79.4%

COST OF DEBT

The typical cost of debt for the petroleum operating industry was estimated by determining the bond ratings set by Moody's for 28 of the 35 benchmark companies from the Petroleum Operating Industry as listed in the *Value Line Investment Survey.* **Figure 3** indicates those ratings and the corresponding S & P and Fitch ratings.

Figure 3
S & P., Moody's and Fitch Bond Ratings
28 Benchmark Companies

	Company	Symbol	S+P Rating	Moody's Rating	Fitch
1	Antero Resources	AR	BB+	Ba1	BB+
2	APA Corp	APA	BBB-	Baa3	BBB-
3	Callon Petroleum	CPE	B+	B1	B+
4	Cenovus	CVE.TO	BBB	Baa2	BBB
5	Chevron Corp	CVX	AA	Aa2	AA
6	CNX Resources	CNX	BB-	Ba3	BB-
7	Conoco Phillips	COP	A	A2	A
8	CVR Energy	CVI	BB-	Ba3	BB-
9	Delek US Holdings	DK	BB-	Ba3	BB-
10	Devon Energy	DVN	BBB	Baa2	BBB
11	Diamonback	FANG	BBB	Baa2	BBB
12	EQT Corp.	EQT	BBB-	Baa3	BB+
13	Exxon-Mobil	XOM	AA	Aa2	AA
14	Hess Corp.	HES	BBB-	Baa3	BBB-
15	HF Sinclair	DINO	BBB-	Baa3	BBB-
16	Imperial Oil	IMO		NA	
17	Magnolia Oil & Gas	MGY		NA	
18	Marathon Oil	MRO	BBB-	Baa3	BBB-
19	Marathon Petrol.	MPC	BBB	Baa2	BBB
20	Matador Resources	MTDR	BBB-	Ba3	BBB-
21	MDU Resources	MDU		NA	
22	Murphy Oil	MUR	BBB	Ba2	BBB
23	National Fuel Gas	NFG	BBB-	Baa3	BBB-
24	Occidental Petro	OXY	BBB-	Baa3	BBB-
25	Ovintiv	OVV	BBB-	Baa3	BBB-
26	PBF Energy	PBF		NA	
27	PAR Pacific Holdings	PARR		NA	
28	Phillips 66	PSX	A-	A3	A-
29	Pioneer Nat Res	PXD	BBB+	Baa1	BBB+
30	Range Resources	RRC	BB	Ba2	BB
31	Shell (ADR)	SHEL		NA	
32	Suncor Energy Inc	SU	BBB+	Baa1	BBB+
33	Targa Resources	TRGP	BBB-	Baa3	BBB-
34	Total SA (ADR)	TOT		NA	
35	Valero Energy	VLO	BBB	Baa2	BBB
	MEDIAN		BBB-	Baa3	BBB-

In December 2023 the Moody's Seasoned BBB U. S. corporate bond yield had declined from the previous month and the reported yield on the last day of 2023 was 5.64%. The reported monthly yield as of January 31, 2024 had increased slightly to 5.68% and was reported to be 5.50% on February 1. By mid-February the yield had increased to 5.85%. In this context of increasing yields and given the slightly lower rating of the median benchmark bond, we select 5.75% as a fair measure of the required return on debt for the Petroleum Operating Industry as of Q1 2024. This rate of return is further adjusted to reflect anticipated debt issuance costs of 0.6%[3], indicating a total cost of debt of 5.78%. Since interest on debt is sheltered from federal income taxes, the actual cost to the investor is less on an after-tax basis. Assuming an income tax rate of 21%, as established by the federal tax code, the after-tax cost of debt is 5.78% X (1-21%) or 4.57%.

[3] See Nevada Department of Taxation, Division of Local Government Services, *Capitalization Rate Study Calendar Year 2021 for the 2023-2024 Secured and 2022-2023 Unsecured Tax Year*

COST OF EQUITY

Unlike capital structure and return on debt, the cost of equity is not easily observable in the market and needs further analysis in order to be estimated. Several methods exist for measuring the cost of equity.

(1) the Build-Up Method,

(2) the Capital Asset Pricing Model (CAPM),

(3) the Discounted Cash Flow Model (based on Dividend Growth)

(4) the Discounted Cash Flow Model (based on Average Annual Total Returns)

(1) The Build-Up Method

The build-up method is additive, requiring us to sum various components to derive the estimated cost of equity capital.

The first component is the risk-free rate, which represents the base return that investors in the marketplace perceive as obtainable with essentially no risk. This is measured by the yield on long-term U.S. Treasury Coupon Bonds. Ideally the selected bond term matches the life of the investment being appraised. In this instance, we believe 20 years is a reasonable choice. The Kroll *Cost of Capital Navigator* (formerly Duff & Phelps) recommends use of their normalized risk-free rate of 3.5% or the spot yield on 20-year treasuries (if higher) as of the valuation date. The *Federal Reserve Statistical Release H.15, Selected Interest Rates* indicates a spot 20-year treasury yield of 4.25% as of January 2, 2024. We adopt 4.25% as a reasonable estimate of the risk-free rate as of Q1 2024.

Computation of the return on equity by the build-up method requires adding two other components of systematic risk: the equity risk premium and the size risk premium. In addition, unsystematic risk is accounted for by a company or industry risk premium generally more specific to the company or industry in question. In this instance, where we are dealing with an entire industry not any particular company, the final adder is an industry risk premium (IRP). Thus, the formula for measuring the cost of equity capital by the build-up method is as follows:

$K_e = RFR + ERP + SRP + IRP$, where

K_e = cost of equity capital

RFR = the risk-free rate

ERP = the equity risk premium (systematic risk inherent in equity markets)

SRP = the size risk premium

IRP = industry risk premium

The equity risk premium can be computed on a historical basis or on a forward-looking basis. Looking to historical market performance, the equity risk premium represents the long-term (since 1926) average premium paid to investors in the stock market over and above the risk-free rate. As reported by Kroll, the long-term-supply side equity risk premium (1926 – present) is typically within a range of 6.5% to 7.0%. For purposes of this analysis we use 6.5%, indicating a base cost of capital (prior to other adders) of 4.0% + 6.5% = 10.5%. Damadoran adopts a more future oriented, forward looking approach and has computed an overall ERP of 4.60% as of January 1, 2024[4]. For purposes of this analysis, we take the mean of the two estimated ERPs (4.6% and 6.5%) to be the correct ERP, or 5.55%, indicating a total base cost of capital of 4.25% + 5.55% or 9.80%.[5]

The industry risk premium is added to reflect the impact on capital costs associated with the crude petroleum and natural gas industry by comparison to the stock market as a whole. This is measured by the industry beta which indicates the extent to which a particular industry tracks the variability of the stock market as a whole. A beta of 1 indicates equal volatility, a beta of less than one indicates less volatility than the market as a whole, and a beta greater than 1 indicates greater volatility. In **Figure 4** below Value Line data indicates that the mean beta for the 35 benchmark petroleum industry members presented is 1.34 and the median is 1.33. For purposes of this analysis we adopt 1.34 as the appropriate industry beta. The associated industry risk premium (based on the estimated ERP of 5.55%) is 1.89% (i.e., 5.55% x 1.34 – 5.55% = 1.89%).

The size risk premium attempts to account for the fact that the market views smaller firms as less liquid and riskier and demanding of higher returns. This relationship between size and expected returns cuts across all industries and measures the additional effect of firm size on expected total equity returns across industry broken into size deciles. These deciles are also grouped into four groups – large cap, mid-cap, low-cap, and micro-cap. During the several years that we have prepared this cost of capital analysis, the size premium has generally remained stable in each of these categories, though the actual size thresholds have fluctuated somewhat.

For purposes of this analysis, we have utilized the average capitalization thresholds set forth by the Kroll/Duff & Phelps *Cost of Capital Navigator* for the years 2019 - 2023 and applied the averaged matching size premium over this time period for each category. These are shown in **Figure 5**, below.

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[4] When added to his estimated RFR of 3.88% in January 2024 this supports a base equity return of 8.48%.

[5] Following the market stresses of 2008, Duff & Phelps (now Kroll) computes a normalized risk-free rate and equity risk premium, which are intended to reflect the sustainable average return on long-term U.S. government bonds without the impact of flight to quality or the impact of monetary intervention to maintain lower risk-free rates. As of January 1, 2024 Kroll estimated the normalized risk free rate to be 3.5% or the spot yield to 20 year bonds as of the valuation date (4.25%), if higher, and the normalized equity risk premium to be 5.5%, indicating a base cost of equity of 9.75% .

Figure 4
Value Line Beta
34 Benchmark Companies

	Company	Symbol	Value Line Beta
1	Antero Resources	AR	1.25
2	APA Corp	APA	1.75
3	Callon Petroleum	CPE	1.90
4	Cenovus	CVE.TO	1.40
5	Chevron Corp	CVX	1.15
6	CNX Resources	CNX	0.80
7	Conoco Phillips	COP	1.25
8	CVR Energy	CVI	1.20
9	Delek US Holdings	DK	1.25
10	Devon Energy	DVN	1.50
11	Diamonback	FANG	1.50
12	EQT Corp.	EQT	1.00
13	Exxon-Mobil	XOM	1.10
14	Hess Corp.	HES	1.35
15	HF Sinclair	DINO	1.25
16	Imperial Oil	IMO	1.35
17	Magnolia Oil & Gas	MGY	1.30
18	Marathon Oil	MRO	1.40
19	Marathon Petrol.	MPC	1.50
20	Matador Resources	MTDR	1.65
21	MDU Resources	MDU	NMF
22	Murphy Oil	MUR	1.65
23	National Fuel Gas	NFG	0.85
24	Occidental Petro	OXY	1.50
25	Ovintiv	OVV	1.60
26	PBF Energy	PBF	1.75
27	Par Pacific Holdings	PARR	1.35
28	Phillips 66	PSX	1.25
29	Pioneer Nat Res	PXD	1.20
30	Range Resources	RRC	0.90
31	Shell (ADR)	SHEL	1.20
32	Suncor Energy Inc	SU	1.25
33	Targa Resources	TRGP	1.55
34	Total SA (ADR)	TOT	1.10
35	Valero Energy	VLO	1.45
	MEDIAN		**1.33**
	MEAN		**1.34**

Figure 5
Duff & Phelps (Kroll) 5 Year Average Size Categories and Estimated Size Risk Premia

Name	Decile	Size Range (in millions)	Size Premium
Large-Cap	1 – 2	>$13,289.217	0.00%
Mid-Cap	3 – 5	$2.697.184 to $13,279.408	0.80%
Low-Cap	6 – 8	$551.495 to $2,694.9911	1.45%
Micro-Cap	9 – 10	$3.948 to $550.121	3.36%

Figure 6 adds the risk-free rate, the equity risk premium, the industry risk premium, and the size risk premium for these four different categories and indicates the cost of equity as computed using the Build-up Method.

Figure 6
Cost of Equity by the Build-Up Method

Size	Risk Free Rate	Equity Risk Prem	Industry Risk Premium	Size Risk Prem	Total Cost of Equity
Large-Cap	4.25%	5.55%	1.89%	0.00%	11.69%
Mid-Cap	4.25%	5.55%	1.89%	0.80%	12.49%
Low-Cap	4.25%	5.55%	1.89%	1.45%	13.14%
Micro-Cap	4.25%	5.55%	1.89%	3.36%	15.05%

(2) The Capital Asset Pricing Model (CAPM)

The capital asset pricing model is among the most widely used methods for measuring the cost of equity. Like the build-up method, it is additive to the risk-free rate, but adds an equity risk premium that differentiates between systematic risk and unsystematic risk. Unsystematic risk does not merit a reward, but systematic risk is rewarded with a risk premium that is proportionate to the degree of covariance (volatility) of the subject asset or investment and the market as a whole. The measure of this covariance is *beta* and the formula for calculating the cost of equity using CAPM is as follows:

$$Ke = RFR + (Beta \times ERP) + SRP$$

For our analysis using the build-up method, we determined a risk-free rate of 4.25%, and an estimated equity risk premium (ERP) of 5.55%. If we use these data and the same industry beta of 1.34, the CAPM calculation will necessarily produce the exact same results. Thus, in the interests of more balanced results, for purposes of our CAPM analysis we utilize the normalized risk-free rate (3.5%) and normalized equity risk premium (5.5%) recommended by Kroll as of February 3, 2023, the same industry beta (1.34), and the same average size risk premia (SRP) for four company size categories. **Figure 7** indicates the cost of equity as computed using the CAPM approach based on these inputs.

Figure 7
Cost of Equity by CAPM Approach

Size	Normalized Risk Free Rate	Normalized Equity Risk Premium	Industry Ave. BETA	Size Risk Prem	Total Cost of Equity
Large-Cap	3.50%	5.50%	1.34	0.00%	10.87%
Mid-Cap	3.50%	5.50%	1.34	0.80%	11.67%
Low-Cap	3.50%	5.50%	1.34	1.45%	12.32%
Micro-Cap	3.50%	5.50%	1.34	3.36%	14.23%

(3) Discounted Cash Flow Model (based on Gordon Growth formula)

One reasonable estimate of the cost of equity is the return an investor might expect from owning a share of stock. This may be computed using the Gordon Growth Model, invented by Myron J. Gordon in 1959 to assist in determining the value of a stock. Essentially, Gordon's formula determines the intrinsic value of a stock, based on anticipated dividend size and their expected future growth rate. Given a per share dividend to be paid one year into the future and assuming a fixed dividend growth rate in perpetuity, the Gordon formula computes the present value of the infinite series of dividend payments. For this exercise, the formula is manipulated to solve for expected return on equity in the market. Thus, the Gordon growth formula, reconfigured to solve for the cost of equity, is as follows:

$Ke = (D1/P0) + g$, where

Ke = the market cost of equity

D1 = the dividends for the next period

P0 = the present market price of the equity

G = the estimated future dividend growth rate

Figure 8, below, shows the results of our analysis and indicates a mean cost of equity of 14.13% and an estimated median cost of equity of 16.2%. Mindful that the indicated median cost of equity is actually within the range of the 16th and 17th equity costs reported in the frequency distribution, and that the lower end of this range (15.3%) which is very close to the overall mean of 15.1%, we adopt the mean as the indicator of equity cost at the beginning of 2023, which we round to 15%.

Figure 9 further refines this figure by adding the size risk premium for each category of market capitalization.

Figure 8
Cost of Equity by Gordon Growth Formula
(based on Dividend Growth Rate)

	Company	Symbol	Dividend Yield	Dividends Growth Rate	Ke
1	Antero Resources	AR	0.00%	0.0%	0.00%
2	APA Corp	APA	3.70%	32.0%	35.70%
3	Callon Petroleum	CPE	0.00%	0.0%	0.00%
4	Cenovus	CVE.TO	2.40%	NMF	
5	Chevron Corp	CVX	4.40%	7.0%	11.40%
6	CNX Resources	CNX	1.27%	0.0%	1.27%
7	Conoco Phillips	COP	2.10%	15.0%	17.10%
8	CVR Energy	CVI	6.50%	16.5%	23.00%
9	Delek US Holdings	DK	3.70%	14.5%	18.20%
10	Devon Energy	DVN	1.80%	13.5%	15.30%
11	Diamonback	FANG	2.20%	15.5%	17.70%
12	EQT Corp.	EQT	1.60%	28.0%	29.60%
13	Exxon-Mobil	XOM	3.60%	2.0%	5.60%
14	Hess Corp.	HES	1.30%	15.0%	16.30%
15	HF Sinclair	DINO	3.60%	17.5%	21.10%
16	Imperial Oil	IMO	2.60%	15.5%	18.10%
17	Magnolia Oil & Gas	MGY	2.30%	24.0%	26.30%
18	Marathon Oil	MRO	2.00%	27.5%	29.50%
19	Marathon Petrol.	MPC	2.20%	7.5%	9.70%
20	Matador Resources	MTDR	1.40%	NMF	
21	MDU Resources	MDU	2.80%	-4.5%	-1.70%
22	Murphy Oil	MUR	2.50%	11.5%	14.00%
23	National Fuel Gas	NFG	3.90%	3.5%	7.40%
24	Occidental Petro	OXY	1.40%	24.0%	25.40%
25	Ovintiv	OVV	2.70%	15.0%	17.70%
26	PBF Energy	PBF	2.30%	35.0%	37.30%
27	Par Pacific Holdings	PARR	0.00%	0.0%	0.00%
28	Phillips 66	PSX	3.90%	6.0%	9.90%
29	Pioneer Nat Res	PXD	2.70%	0.5%	3.20%
30	Range Resources	RRC	1.30%	NMF	
31	Shell (ADR)	SHEL	4.00%	7.5%	11.50%
32	Suncor Energy Inc	SU	4.50%	14.5%	19.00%
33	Targa Resources	TRGP	3.50%	26.0%	29.50%
34	Total SA (ADR)	TOT	4.80%	4.0%	8.80%
35	Valero Energy	VLO	3.30%	2.0%	5.30%
	MEAN		2.72%	12.38%	15.10%
	MEDIAN				16.20%

Figure 9
Gordon Growth DCF Cost of Equity
by Market Capitalization

Market Capitalization	Estimated Cost of Equity	Size Premium	Total Cost of Equity
Large-Cap	15.0%	0.00%	15.0%
Mid-Cap	15.0%	0.80%	15.8%
Low-Cap	15.0%	1.45%	16.45%
Micro-Cap	15.0%	3.36%	18.36%

(4) Discounted Cash Flow Model (based on Forecast Average Annual Total Returns)

As an alternative DCF method, similar to the dividend growth model, we use the Annual Total Returns forecasted in *Value Line,* which considers returns based on forecast dividend income and capital appreciation in stock values. *Value Line* forecasts future total returns based on a low stock price and a high stock price scenario. We take the mean of the two projections as shown in **Figure 10**, below. Looking at all thirty-five benchmark companies, the mean indicated equity return is 15.23% and the median is 17.0%. We select the mean (15.23%), because it is well supported by the results of the Gordon Growth technique. Again, after adjusting for the size risk premium, the total estimated cost of equity is broken out by market capitalization in **Figure 11** below.

Figure 10
Cost of Equity Based on *Value Line*
Projected Annual Total Return

	Company	Symbol	*High*	*Low*	*Ke*
1	Antero Resources	AR	23.0%	4.0%	13.50%
2	APA Corp	APA	32.0%	14.0%	23.00%
3	Callon Petroleum	CPE	21.0%	5.0%	13.00%
4	Cenovus	CVE.TO	15.0%	3.0%	9.00%
5	Chevron Corp	CVX	20.0%	15.0%	17.50%
6	CNX Resources	CNX	17.0%	-1.0%	8.00%
7	Conoco Phillips	COP	9.0%	-1.0%	4.00%
8	CVR Energy	CVI	26.0%	12.0%	19.00%
9	Delek US Holdings	DK	23.0%	17.0%	20.00%
10	Devon Energy	DVN	27.0%	13.0%	20.00%
11	Diamonback	FANG	8.0%	-1.0%	3.50%
12	EQT Corp.	EQT	34.0%	14.0%	24.00%
13	Exxon-Mobil	XOM	8.0%	-1.0%	3.50%
14	Hess Corp.	HES	8.0%	-2.0%	3.00%
15	HF Sinclair	DINO	31.0%	19.0%	25.00%
16	Imperial Oil	IMO	24.0%	13.0%	18.50%
17	Magnolia Oil & Gas	MGY	13.0%	3.0%	8.00%
18	Marathon Oil	MRO	40.0%	23.0%	31.50%
19	Marathon Petrol.	MPC	8.0%	-1.0%	3.50%
20	Matador Resources	MTDR	24.0%	10.0%	17.00%
21	MDU Resources	MDU	24.0%	11.0%	17.50%
22	Murphy Oil	MUR	30.0%	15.0%	22.50%
23	National Fuel Gas	NFG	37.0%	23.0%	30.00%
24	Occidental Petro	OXY	13.0%	2.0%	7.50%
25	Ovintiv	OVV	29.0%	12.0%	20.50%
26	Par Pacific Holdings	PARR	32.0%	16.0%	24.00%
27	PBF Energy	PBF	19.0%	3.0%	11.00%
28	Phillips 66	PSX	10.0%	7.0%	8.50%
29	Pioneer Nat Res	PXD	19.0%	9.0%	14.00%
30	Range Resources	RRC	26.0%	9.0%	17.50%
31	Shell (ADR)	SHEL	16.0%	8.0%	12.00%
32	Suncor Energy Inc	SU	29.0%	18.0%	23.50%
33	Targa Resources	TRGP	24.0%	11.0%	17.50%
34	Total SA (ADR)	TOT	18.0%	8%	13.00%
35	Valero Energy	VLO	14%	5%	9.50%
	MEAN				15.23%
	MEDIAN				17.00%

Figure 11
Annual Total Return DCF Cost of Equity
by Market Capitalization

Market Capitalization	Estimated Cost of Equity	Size Premium	Total Cost of Equity
Large-Cap	15.23%	0.00%	15.23%
Mid-Cap	15.23%	0.80%	16.03%
Low-Cap	15.23%	1.45%	16.68%
Micro-Cap	15.23%	3.36%	18.59%

(5) Cost of Equity Summary

We have estimated the cost of equity by four different techniques. None of these cost estimates account for expected equity flotation costs of approximately 4.0%[6], which are factored in to **Figure 12**, summarizing all of the costs of equity discussed above. Of the four metrics for cost of equity we have more confidence in the first two (Build-Up and CAPM), as they are based on actual past experience, while the latter two (Gordon Growth and Annual Total Growth) are based on speculative projections of future growth that may or may not be accurate.

The indicated equity returns by the build-up and CAPM approaches are quite close to one another and the other two more future oriented methods (Gordon Growth and Forecast Total Return) are higher but close to one another self-reinforcing. Therefore, we weigh the first two indicators more highly, giving equally weight to each (1/3 each) and the average of the latter two as an additional 1/3. The final estimated cost of equity reflects this weighting after adjusting for flotation costs.

Figure 12
Indicated Costs of Equity (Weighted)
by Market Capitalization
(Including Flotation Costs @ 4.0%)

Market Cap	Build-Up	CAPM	DCF Gordon Growth	DCF Annual Total Ret.	Indicated Cost of Equity
Large-Cap	11.69%	10.87%	15.00%	15.23%	
w/flotation cost	**12.18%**	**11.32%**	**15.63%**	**15.86%**	**13.08%**
Mid-Cap	12.49%	11.67%	15.80%	16.03%	
w/flotation cost	**13.01%**	**12.16%**	**16.46%**	**16.70%**	**13.91%**
Low-Cap	13.14%	12.32%	16.45%	16.68%	
w/flotation cost	**13.69%**	**12.83%**	**17.14%**	**17.38%**	**14.58%**
Micro-Cap	15.05%	14.23%	18.36%	18.59%	
w/flotation cost	**15.68%**	**14.82%**	**19.13%**	**19.36%**	**16.58%**

[6] See Nevada Department of Taxation, Division of Local Government Services, *Capitalization Rate Study Calendar Year 2021 for the 2023-2024 Secured and 2022-2023 Unsecured Tax Year.*

WEIGHTED AVERAGE COST OF CAPITAL (WACC)

2023 CURRENT CORPORATE TAX RATES
for TAX YEAR ENDED 12-31-2023

Taxable Income Bracket	Tax Rate
AVERAGE of CORPORATE TAX RATE	**21%**

WEIGHTED AVERAGE COST OF CAPITAL (WACC)

2023 CURRENT INDIVIDUAL TAX RATES

For TAX YEAR ENDED 12-31-2023

Taxable Income Bracket*	Tax Rate
$0 - $11,000	10%
$11,001 - $44,725	12%
$44,726 - $95,375	22%
$95,376 - $182,100	24%
$182,101 - $231,250	32%
$231,251 - $578,126	35%
>$578,157	37%
AVERAGE of SINGLE INDIVIDUAL TAX RATES	24.57%
CALLED AVERAGE OVERALL TAX RATE	25%

*Single Filing and Trusts

WEIGHTED AVERAGE COST OF CAPITAL (WACC)

2024 CONVERSION TO PRE-TAX RATE
for TAX YEAR ENDED 12-31-23

CAPITAL ASSET PRICING MODEL (CAPM)

COST OF EQUITY – LARGE CAP
LARGE CAP = 10.87
10.87/(1-.25) [Average Overall Tax Rate = 25%]
COST of EQUITY = 14.49%

DEBT PRE-TAX BASIS = 5.78%

COST of EQUITY * PERCENTAGE of EQUITY
14.49% * 75% = 10.87%

DEBT PRE-TAX BASIS * PERCENTAGE of DEBT
5.78% * 25% = 1.45% / YEAR

10.87% + 1.45% = 12.32%
CALLED BASE RATE ON PRE-TAX BASIS = 12% (ROUNDED)

Added Price Risk Rate – 1%

Called Base Rate – **13%**

ECTOR COUNTY APPRAISAL DISTRICT

2024 Discount Rate Schedule

GROSS W T I - $74.35	PAF W T I - $74.74
GROSS W T S - $75.71	PAF W T S - $76.11
GROSS GAS - $ 2.54	PAF GAS - $ 2.66

CALLED BASE RATE: **13 %**

DECLINE RATE	ADJUSTMENT
0 - 25%	BASE RATE
25 – 35%	+ 1%
35 – 45%	+ 2%
45% - 55%	+ 3%
55% +	+ 4%

SINGLE WELL OIL LEASE	+ 1%
SHORT PRODUCTION HISTORY (LESS THAN 1 YEAR)	+ 3%
	21% MAX

2024* Oil price adjustment factor 1.00528
2024* Gas price adjustment factor 1.04724

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