Chapter 13

State Stakeholders: Implications & Opportunities

Texas General Land Office and University Lands

J. Tackett, J. Moss

Texas public education, from Kindergarten to University, benefits from oil and gas activities on public lands. Geothermal can play a meaningful role in expanding and diversifying the use of State-owned lands, ensuring the continued prosperity of public education in the State.

I. Introduction

Texas public lands, and income derived from these lands, are dedicated to free public education for present and future generations. Such is the mandate of the Texas Permanent University Fund ("PUF") and the Texas Permanent School Fund ("PSF"). The PUF benefits higher education, and is managed by University Lands. The PSF helps support K-12 public schools, and is managed by the Texas General Land Office ("GLO").

The Texas General Land Office ("GLO") is the trustee of the PSF portfolio of land and mineral rights. University Lands, an office within the University of Texas System, manages PUF Lands. As administrators, the GLO and University Lands are responsible for generating income to the trusts, as well as preserving and protecting the land assets (Reid, 1998). Energy development leases, land leases, land sales, and investment gains generate revenue for both funds.

With the mission of protecting the economic future of Texas by leasing the State's vast land and mineral holdings, trustees value "innovative responsible stewardship" and diverse leasing activities (Bush, 2020). Geothermal energy provides an opportunity for the State to gain experience with clean, baseload electricity generation through stewardship of its lands (Fiscal Notes, 2022).

https://doi.org/10.26153/tsw/44076

This Chapter explores considerations for leasing State-owned lands for geothermal energy projects. Drawing from insights described throughout this Report, geothermal may be well positioned to provide opportunities for diversification on State-owned lands, through applications such as electricity generation, desalination, and powering oil and gas operations.

II. Public Education Endowments

Both of the public education endowments in Texas rely on revenues from leasing public lands. The PUF advances higher education by supporting The University of Texas and Texas A&M University Systems. The Texas PSF is dedicated to public K-12 education. As of 2021, the total value of the PUF was over $30 billion (UTIMCO, 2021), and the value of the PSF was $56 billion (Timmins, 2021).

To promote the economic well being of future generations, public education endowments create a stock of wealth from fees or other revenue streams from present day natural resource extraction (i.e., gas, oil, and other minerals)[1]. The assets are carefully managed similar to any financial investment portfolio. In Texas, annual distributions are carefully allocated based on strict guidelines first outlined in the State Constitution (Texas PSF, 2021).

A. Land Holdings

As of 2021 reporting, the PSF portfolio of land and mineral rights totaled approximately 13 million acres (Table 13.1), roughly 65 percent of the State land and mineral rights that the GLO manages. Of this acreage, just over 658,000 acres of PSF land is surface real estate, much of it in West Texas. Of the surface assets, some parcels are not accessible, because they are landlocked by private acreage. Roughly four million acres of the PSF portfolio are Gulf Coast beaches and bays, and all submerged lands to 10.35 miles out into the Gulf of Mexico (Texas PSF, 2021). University Lands manages another 2.1 million acres of State-owned land that benefits the PUF. Most of these parcels are in West Texas.

Of note, the U.S. government claims less than 2 percent of Texas land. Of the 3.2 million Federally-owned acres in Texas, the National Park Service has oversight of 37.3 percent, the Fish and Wildlife Service has 23.4 percent, the Department of Defense has 21.1 percent, and the Bureau of Land Management has just 0.4 percent (Stacker, 2022).

B. History of Texas Public Lands

To understand the opportunities for geothermal projects on Texas public lands, it is useful to describe the history of the lands. Texas public lands can be traced to the State's history as an independent nation. When Texas joined

Table 13.1. Overview of Texas Public Education Endowment. *Source: Future of Geothermal Energy in Texas, 2023.*

Fund	Permanent School Fund (PSF)	Permanent University Fund (PUF)
Trustee	General Land Office	University Lands
Beneficiaries	K-12 state public education	UT and TAMU systems
Value in 2021	$56 billion	$32 billion
Acreage	13 million	2.1 million acres
Location (primary)	West Texas and coastal	West Texas

[1]The U.S. does not have a national Sovereign Wealth Fund. Rather, there are a number of State funds. In addition to Texas, other states with extraction-based state level endowments include Alaska, New Mexico, Wyoming, Montana, North Dakota, Idaho, and Utah (McIntosh, et al., 2022; SWFI, 2021).

the United States in 1845 as the 28th State, it retained ownership of its public land[2]. The Texas Constitution of 1876 bestowed millions of acres and formalized the PSF.

The Texas Constitution of 1876 also marked the beginning of the PUF, calling for the creation of the University of Texas ("UT") with an initial land grant of one million acres. These one million acres became forever known as "the constitutional million." State leaders added an additional million acres to the University Lands in 1883, the same year that UT Austin officially opened with a single building.

UT grew slowly over its first 40 years, but growth accelerated roughly 100 years ago. Oil was first discovered on PUF Lands in 1923 at the Santa Rita No. 1 well in Reagan County. As oil flowed, revenue fed into the PUF and sparked new development for the University in the 1920s and 1930s. The core of the Austin campus was built, including the iconic UT Tower. In 1931, the Texas legislature added Texas A&M University ("TAMU") as a PUF beneficiary, and authorized a split in net income from PUF investments that still exists today, with UT receiving two-thirds of the funds, and TAMU receiving one-third (University Lands, 2022b).

III. University Lands

University Lands is the fiduciary steward of 2.1 million acres of land across 19 counties in West Texas, including large parts of the Permian Basin, managing both the surface and mineral interests for the benefit of the PUF. Today, the PUF is the largest public university endowment in the United States, valued at over $30 billion. Unlike other endowments that support just one university, the PUF provides funds to 27 UT and TAMU institutions and agencies that collectively enroll more than 500,000 students (University Lands, 2021).

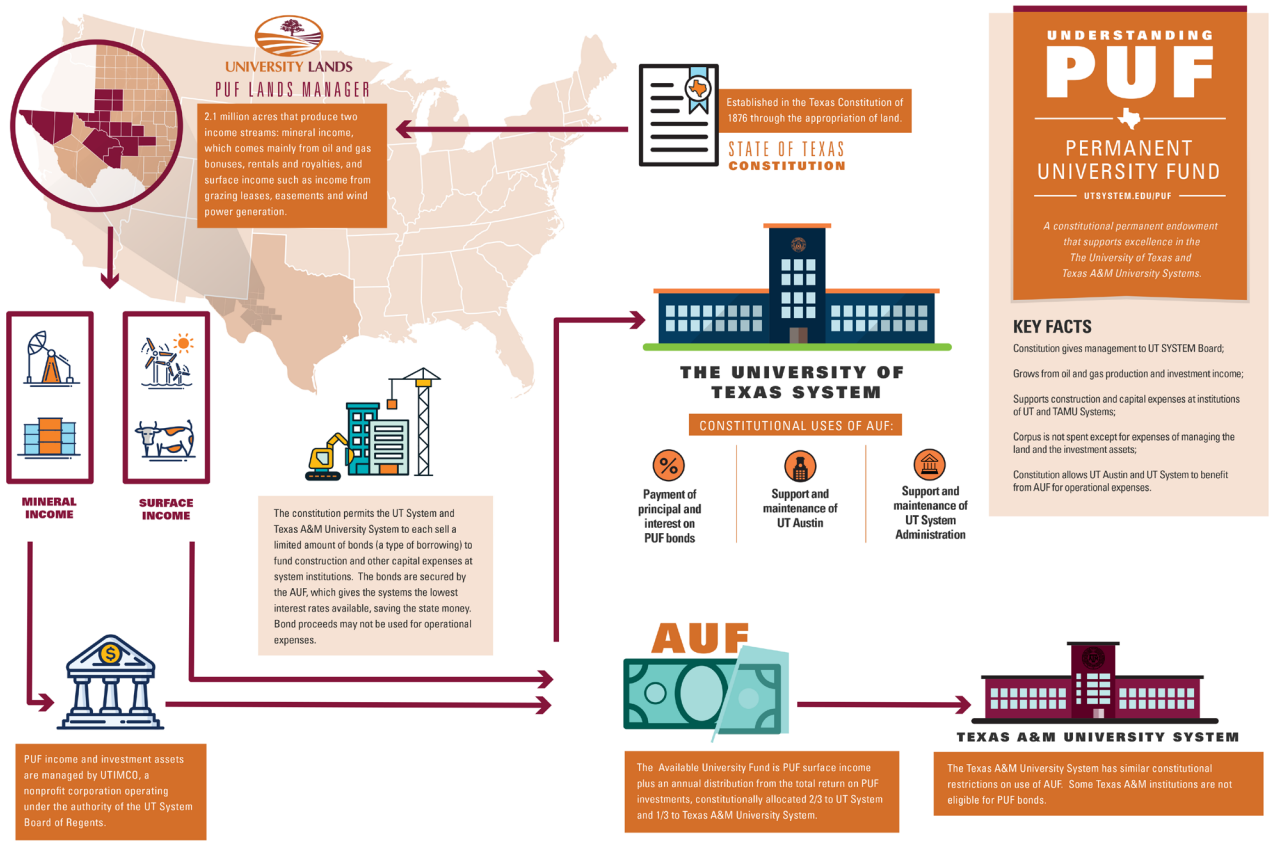


Figure 13.1. Permanent University Fund ("PUF") revenue comes from leasing surface and mineral rights for energy development, schools, hospitals, churches, and ranching. *Source: University Lands, 2021.*

[2]The story of Texas retaining its lands when it joined the U.S. also explains why there are so few lands in the State of Texas owned by the U.S. and managed by the Bureau of Land Management (Hewett, 2020).

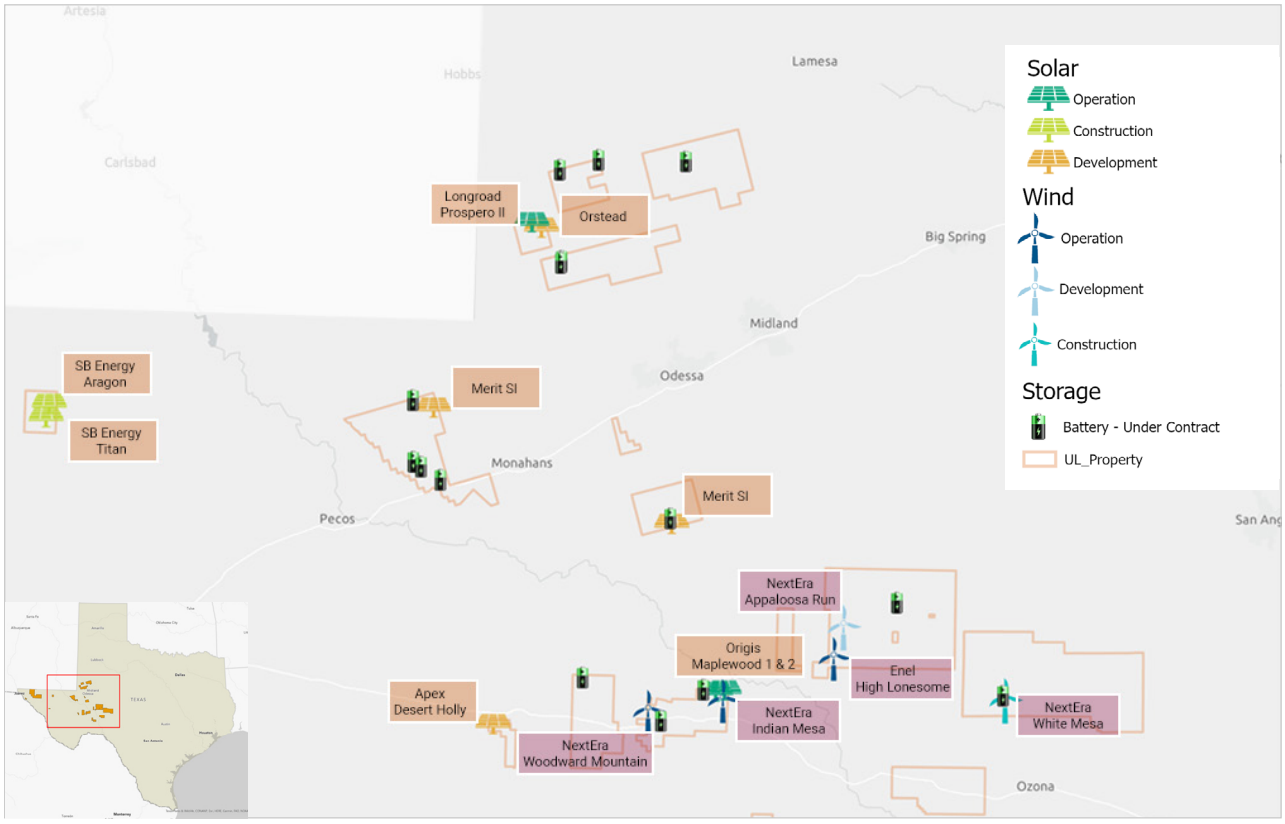


Figure 13.2. A map of West Texas PUF lands with renewable energy projects. *Source: University Lands, 2021.*

Leasing the surface and mineral rights of PUF lands produces two income streams. Mineral income is primarily derived from oil and gas production in the form of rentals and royalties. Surface income results from a diversity of land uses, including hospitals, churches, livestock grazing, pipeline and power line easements, wind and solar power generation, and agriculture (Figure 13.1). University Lands can also supply water to several West Texas municipalities from major and minor aquifers on the lands.

There is support and interest in diversifying the use of PUF Lands beyond oil and gas production, as is demonstrated by the growth of renewable energy projects on PUF Lands since 2020. Renewable energy is a growing source of land endowment income, with several solar and wind energy developments located on PUF lands (Figure 13.2).

A. Oversight of PUF Lands

The leasing of oil and gas on PUF Lands is under the purview of the Board for Lease ("BFL") of University Lands (Figure 13.3). Serving on this board are the Commissioner of the GLO, two members of the Board of Regents of the UT System, and one member of the Board of Regents of the TAMU System. For all minerals other than oil and gas, the UT System Board of Regents has management authority.

The Texas Constitution requires that income from mineral rights be invested. PSF funds are managed and invested by the Texas Education Agency (Mills, 2018). PUF investments are managed by The University of Texas/ Texas A&M Investment Management Company ("UTIMCO"), with oversight of the UT System Board of Regents. Returns from PUF investments, as well as surface lease income, are deposited in the Available University Fund ("AUF") and distributed for the exclusive benefit of the UT and TAMU Systems.

The endowment's annual distributions are governed by the Texas Constitution, and managed by The University of Texas System Board of Regents (Texas PSF, 2021).

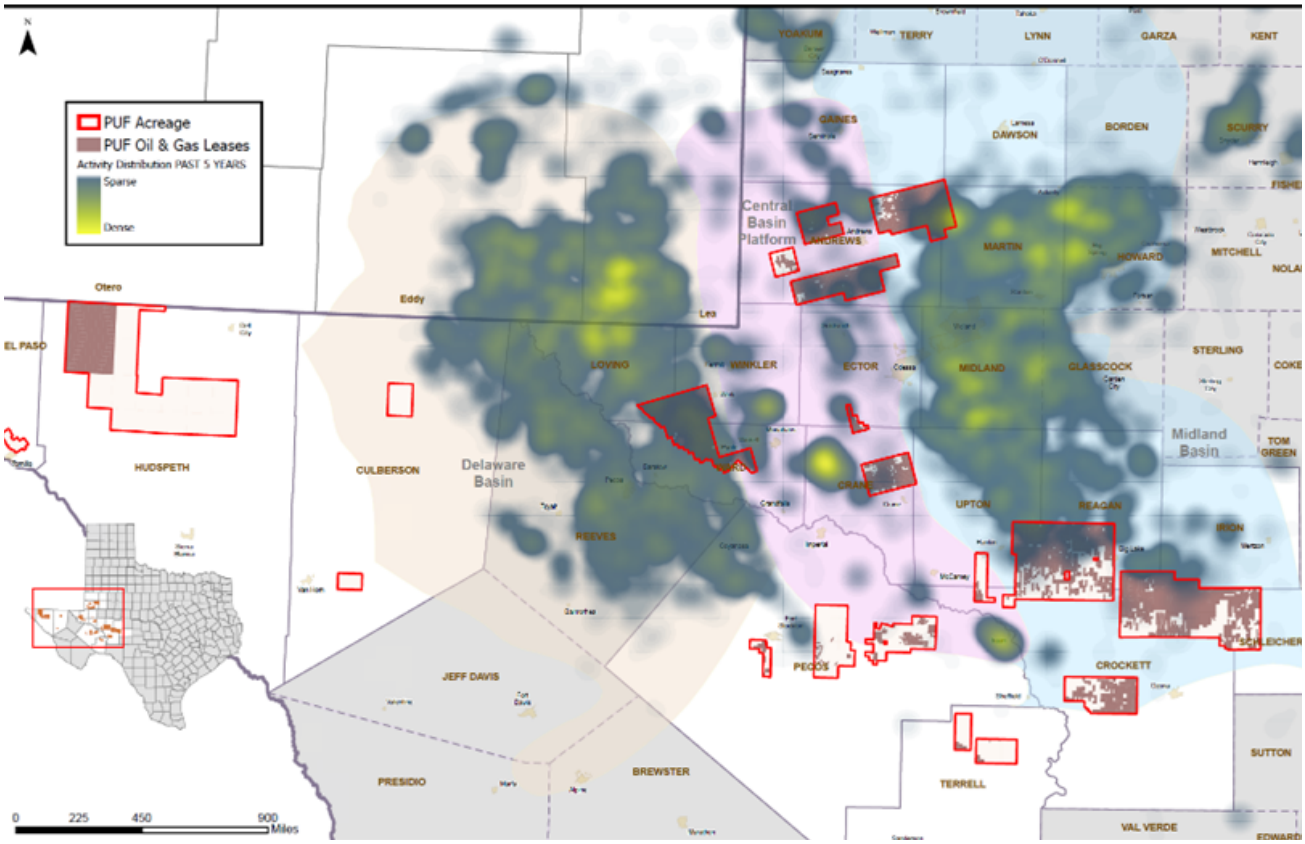


Figure 13.3. PUF acreage in West Texas Permian Basin outlined by red polygon. Previous five years of Oil & Gas activity (as of November 2022) described by dark blue for sparse activity and yellow for dense activity. *Source: University Lands, 2021.*

B. Sustainability of PUF Lands

University Lands strives to be the best land management organization in the country, providing prudent stewardship aimed at protecting the environment while earning the best possible return on investment. According to University Lands, achieving this mission ensures the lands continue to thrive for generations to come, supporting not only Texas public higher education, but also life changing and life saving research and innovations that improve the lives of Texans and people around the world (University Lands, 2021).

To this end, the organization employs experienced professionals in environmental, conservation, land, geoscience, engineering, and information technology disciplines who work to protect the interests of the UT and TAMU systems, promote awareness and sensitivity for the environment, and maximize the value of PUF Lands (University Lands, 2021).

University Lands prioritizes sustainability on PUF Lands, with attention to reducing truck traffic, monitoring construction, promoting shared infrastructure, and restoring surface leases that have expired or terminated. University Lands monitors water resources to ensure prudent water related commercial activities on PUF Lands. All mineral developers are required to meter and report water sources. In 2019, the organization implemented a groundwater import fee to encourage recycling of produced water and decrease use of freshwater.

The Lease Evaluation Team evaluates leasehold performance and compliance. This team identifies oil and gas leases that are non-producing or low producing. If a lease is terminated, the operator is required to properly plug the wells and remove all equipment and restore the acreage back to pastureland.

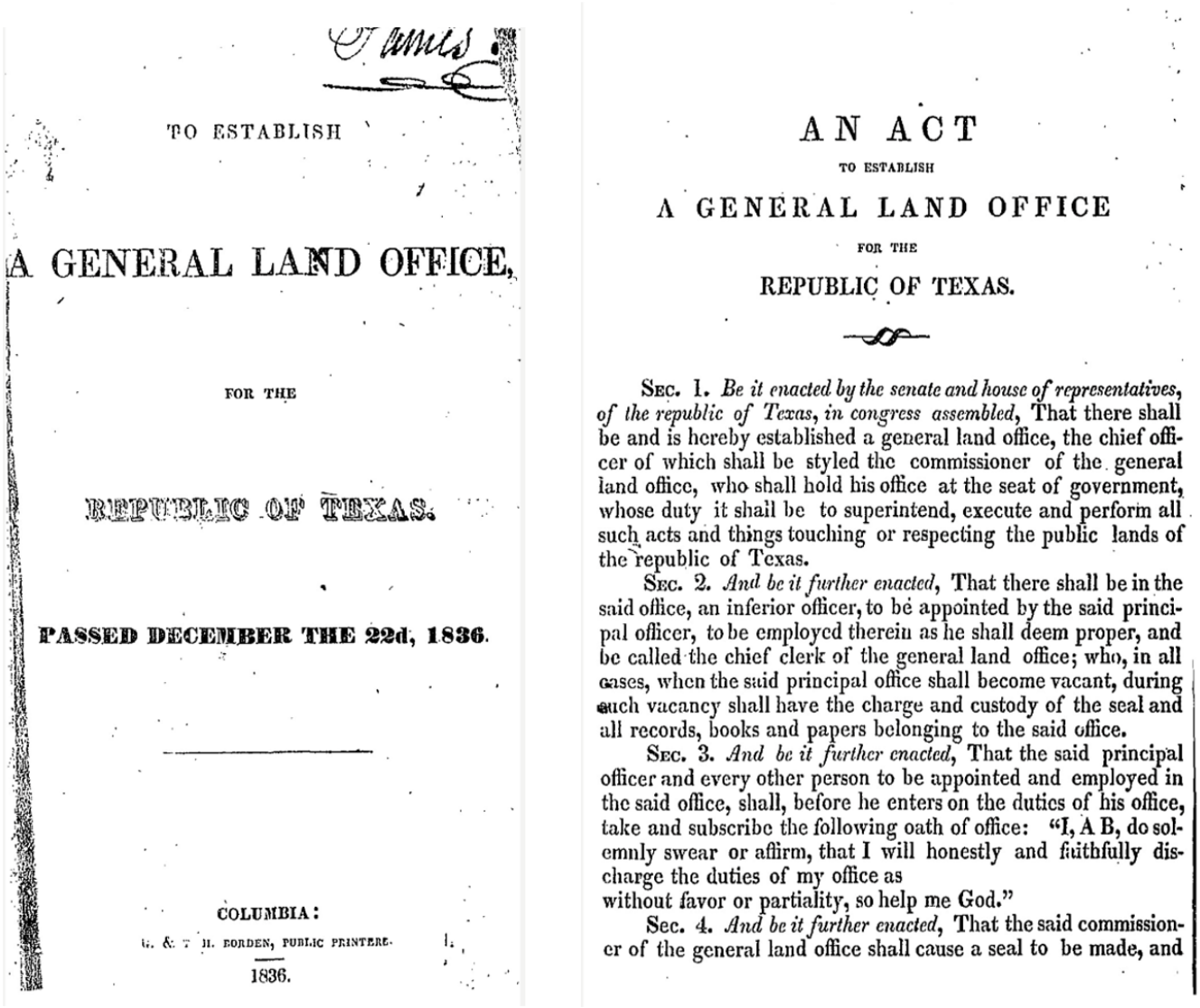
IV. Texas General Land Office

In 1836, the Republic of Texas Congress (Texas was a sovereign republic from 1836 to 1846) formed the GLO to collect and keep records, provide maps and surveys, and issue titles (Figure 13.4). To this day, the GLO manages State lands and mineral rights, including submerged lands out to three marine leagues (about 10.3 miles) into the Gulf of Mexico. The agency's mission is to serve Texas schoolchildren, veterans, and the environment (Texas, 2022b).

In addition to leasing Texas lands, the GLO surveys for exact location of State owned land and minerals, oversees coastal protection, administers Disaster Recovery from Community Development Block Grants ("CDBG-DR") as well as Mitigation funds ("CBBG-MIT"), preserves historic archives, and watches over the Alamo. Two veteran programs are also under the purview of the GLO, the Texas Veterans Land Board (Veterans Homes) and Texas State Veterans Cemeteries.

Through its State Energy Marketing Program, the GLO sells gas and electricity competitively to public entities through its State Energy Marketing Program. The State's electricity market to public retail customers is being phased out as of 2019, but the gas market continues (Texas, 2022a; Texas PSF, 2021).

The GLO Commissioner is elected by Statewide ballot and serves a four year term. While the titles "Commissioner of the Texas General Land Office" and "Texas Land Commissioner" are used interchangeably, there is no



TO ESTABLISH

A GENERAL LAND OFFICE,

FOR THE

REPUBLIC OF TEXAS.

PASSED DECEMBER THE 22d, 1836.

COLUMBIA:

G. & T. H. BORDEN, PUBLIC PRINTERS.

1836.

AN ACT

TO ESTABLISH

A GENERAL LAND OFFICE

FOR THE

REPUBLIC OF TEXAS.

SEC. 1. *Be it enacted by the senate and house of representatives, of the republic of Texas, in congress assembled*, That there shall be and is hereby established a general land office, the chief officer of which shall be styled the commissioner of the general land office, who shall hold his office at the seat of government, whose duty it shall be to superintend, execute and perform all such acts and things touching or respecting the public lands of the republic of Texas.

SEC. 2. *And be it further enacted*, That there shall be in the said office, an inferior officer, to be appointed by the said principal officer, to be employed therein as he shall deem proper, and be called the chief clerk of the general land office; who, in all cases, when the said principal office shall become vacant, during such vacancy shall have the charge and custody of the seal and all records, books and papers belonging to the said office.

SEC. 3. *And be it further enacted*, That the said principal officer and every other person to be appointed and employed in the said office, shall, before he enters on the duties of his office, take and subscribe the following oath of office: "I, A B, do solemnly swear or affirm, that I will honestly and faithfully discharge the duties of my office as without favor or partiality, so help me God."

SEC. 4. *And be it further enacted*, That the said commissioner of the general land office shall cause a seal to be made, and

Figure 13.4. The Republic of Texas formed the General Land Office in 1836.
Source: Texas General Land Office.

Land Commission (Texas, 2022a). The sale and mineral leasing of PSF lands are managed by the School Land Board ("SLB"). The SLB is composed of three members. The Commissioner of the Texas General Land Office serves as Chairman of the SLB, and is joined by two citizen members. The fund's financial assets are managed by the State Board of Education, overseen by an office within the Texas Education Agency (Texas PSF, 2021).

A. State Land Classifications

As shown in Figure 13.5, public land parcels are distinguished by State interests in the minerals. A brief history lesson is necessary to explain the patchwork of classifications on any map of State owned lands. This Section describes Relinquishment Act lands, free royalty lands, and minerals fully retained.

Before 1895, when Texas sold its public lands, the minerals were released to landowners. After 1895, Texas retained the rights to minerals during land sales (McFarland, 2009). But in response to the surge of oil discoveries in Texas in the early 1900s, lawmakers passed the retroactively enforced Relinquishment Act of 1919 (updated by the Relinquishment Act of 1931). Designed to prevent "armed rebellion" by surface owners eager to profit on the discovery of oil, this law appointed the surface owners as the mineral leasing agents of the State.

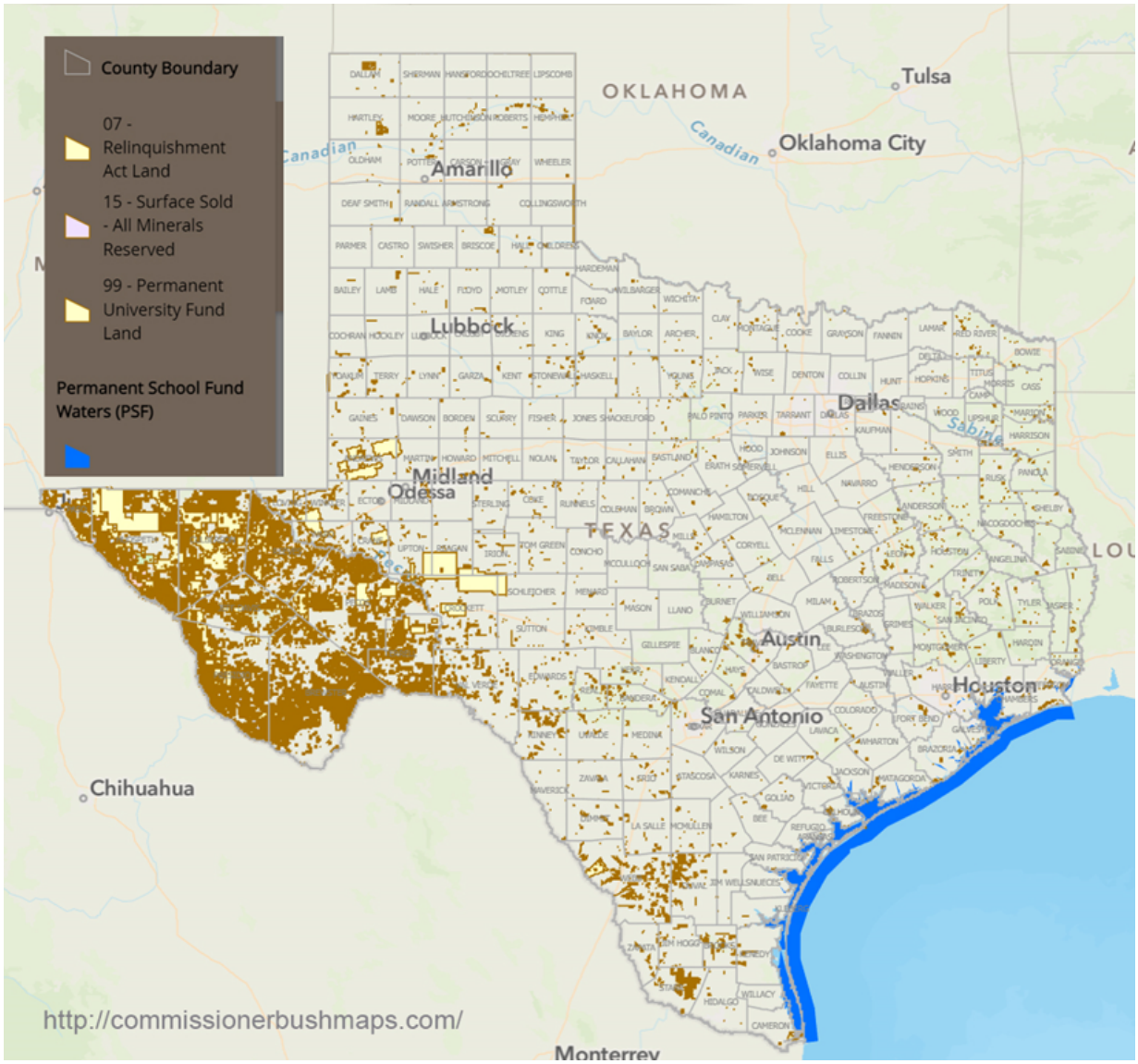


Figure 13.5. Map of Texas State lands produced from an online, customizable map.
Source: Bush, 2020.

The legacy of this law is that when an entity wants to develop a "Relinquishment Act" parcel, the surface owner is the only party who can lease the lands for oil and gas development. While surface owners negotiate the mineral rights, the GLO provides final approval of leasing terms, and the State retains half of the bonus, rentals, and royalties. Furthermore, the State has the authority to enforce and cancel the lease. These rules are specific to oil and gas. Other minerals are subject to different provisions (Covert & Sweeney, 2019; Fambrough, 2013).

Sold after 1931, "free royalty" lands transferred nearly all mineral rights to the surface owner. Leases are resolved by private negotiations, and the GLO does not approve the terms of the lease; however, the State receives an additional royalty payment, in the range of 1/8th to 1/16th share of output, on top of the bonus and royalty payments paid to the surface owner (Whitworth & Miller, 1986). The oil crisis of the 1970s prompted yet another change. As of 1973, the State retained full mineral rights on all PSF lands (i.e., minerals fully retained).

B. Leasing of PSF Lands

The primary source of income for the PSF and PUF are proceeds from leasing mineral interests for oil and gas activities. In the 2021 Financial Statement of the PSF, mineral interests accounted for 81 percent of the fund's Real Assets value (Texas PSF, 2021). The GLO typically earns a 20 to 25 percent royalty from oil and gas produced from leases. Royalty payments are accepted as cash or in-kind, meaning sold competitively to public entities as gas or electricity through its energy market. Leases are also available for a variety of other purposes, including agricultural related activities, commercial development, and solar, wind, and geothermal power (Texas, 2022a).

The State awards leases on PSF parcels through a sealed bid lease sale offered by the SLB (Covert & Sweeney, 2019). Interested parties can also request to the GLO that a tract be made available for a lease sale according to the Texas Natural Resources Code, Chapter 9, Section 9.22, Leasing Procedures.

Between 2007 and 2009, the GLO issued a total of nine offshore geothermal energy production leases in State owned coastal waters. Each lease had a primary ten year term to begin generating electricity. Had they met this goal, the lessors had the option for a 30-year lease extension. The focus on these earlier leases was to produce enough electricity to participate in the ERCOT market. At that time, geothermal sourced electricity was not sufficiently competitive. All leases expired by 2012 without any geothermal power being developed (Batir & Richards, 2022).

Until recently, no other geothermal leases had been granted on State lands. In September 2022, the GLO opened bidding on six geothermal leases near El Paso. Only one of the tracts received a bid, which won at $8.46 per acre for 640 acres (EnergyNet, 2022). The lease was listed with the following stipulations:

The royalty on all surveyed school land is 10% of the gross revenue of geothermal energy. The primary term of the lease shall be ten (10) years. The annual delay rental thereon is fixed at $3.00 per acre beginning with the first year of the lease (EnergyNet, 2022).

The sample lease goes on to say:

If the drilling or reworking operations result in the completion of a well incapable of producing sufficient Geothermal Energy for the Commercial Production of Electricity (hereinafter an "Inoperable Well"), the Lease shall terminate, unless the Lessee commences additional drilling or reworking operations within sixty (60) days after the completion of the Inoperable Well. This Lease shall remain in full force and effect for so long as such operations continue in good faith and in a workmanlike manner without interruptions totaling more than sixty (60) days (Texas GLO, 2022).

V. Geothermal Energy on Texas Public Lands

In the spirit of an all-of-the-above energy transition, there is support and interest in diversifying the use of Texas public lands beyond oil and gas production (Bush, 2020). Leasing for geothermal energy production can build on the existing leasing processes for oil and gas or renewable energy projects. The question of "who owns heat?" is important to resolve, and is considered in detail in Chapter 14, Who Owns Heat? Legal Considerations for Texas Geothermal Developers of this Report. As explained earlier in this Chapter, the State retains mineral interests in much of the land for which it sold the surface rights.

Typically, royalty fees are based on the value of the resource produced. With geothermal, the resource is heat, steam, or fluids, and valuation is likely based on revenue from electricity (or Direct Use heat) production. As a potential model, the U.S. Bureau of Land Management favors a valuation model that escalates – starting lower for the first ten years to offset the high capital expenditure. "Royalty rates for geothermal resources produced for the commercial generation of electricity but not sold in an arm's length transaction are: 1.75 percent for the first 10 years of production and 3.5 percent after the first 10 years" (BLM, 2007).

While the actual leasing process is likely to be familiar, administrative and operational oversight for geothermal projects may require additional training. Mineral audit and field inspection teams will need a better understanding of pricing, production, and transportation of geothermal heat and electricity to ensure that proper royalty payments are being made. Furthermore, lease valuation would need to consider the added value of geothermal resources when pricing leases.

A. State Owned Lands & Geothermal Energy Considerations

When analyzing a State owned tract for geothermal electricity production, developers should consider proximity to transmission infrastructure, distance from population centers, as well as the depth required to access high temperatures compared to other parts of Texas. Texas Geothermal Resources are considered in depth in Chapter 4, The Texas Geothermal Resource: Regions and Geologies Ripe for Development.

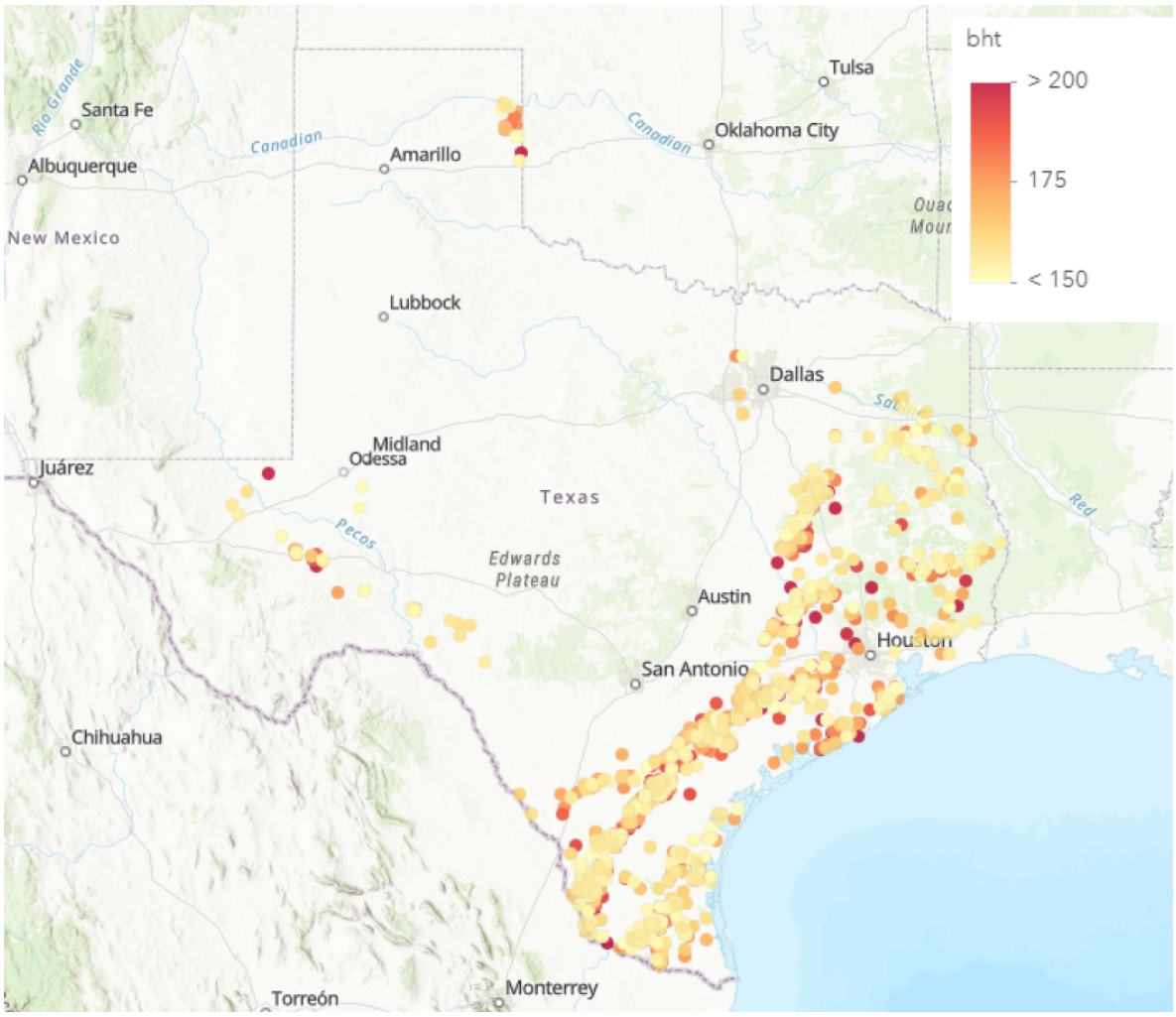


Figure 13.6. Mapping GLO tracts by bottom hole temperatures (BHT). *Source: Adeoshun et al., 2021.*

Table 13.2. Top three leasing opportunities identified by Texas A&M MBA team. *Source: Adeoshun, et al., 2021.*

Location	City Intended to Provide Power	GLO PSF Availability	Temperature	Average Depth	Future Population Projects in Area	Distance from Populated Area	Distance from Transmission Line	Score
Camp Creek Lake	College Station/Waco	3	5	5	5	5	3	**4.3**
Jennings/ Armstrong Oil Fields	Laredo	5	5	5	1	3	3	**4.0**
Fort Stockton	Fort Stockton	5	3	1	5	5	3	**3.6**
Weight		*25%*	*20%*	*20%*	*15%*	*10%*	*10%*	

Acting as consultants to the GLO, an MBA capstone team from TAMU produced a report that rated State land holdings for geothermal energy production potential (Adeoshun et al., 2021). With their permission, we synthesize here their analysis and findings.

The MBA team identified three regions that were promising, specifically at Camp Creek Lake, Jennings West Oil and Gas Field, Armstrong Oil Fields, and Fort Stockton. The team's recommendations were informed by mapping bottom hole temperature ("BHT") data from the SMU Geothermal Lab for wells near GLO tracts (Figure 13.6). Areas were then ranked for geothermal suitability using temperature, distance from population centers (including projected growth), proximity to transmission lines, and GLO land availability (Table 13.2).

The team found that the Camp Creek Lake location had high temperature ranges with BHTs in excess of 200 °C (392 °F), some of which were within 3.1 miles (five kilometers) of transmission lines or less. These GLO tracts are within 30 miles (48.2 kilometers) of College Station. The Jennings and Armstrong oil fields are located within 50 miles (80.5 kilometers) of Laredo. With active oil and gas production here, there is an opportunity for geothermal co-generation. With an average viable temperature depth of 4.3 miles (seven kilometers), Fort Stockton represented a PUF lands prospect.

Another PUF prospect was discussed in Chapter 4, The Texas Geothermal Resource: Regions and Geologies Ripe for Development. In the eastern and central portions of Crockett County (east of Fort Stockton), recent heat flow mapping from BHT data indicated temperatures reaching 150 °C (302 °F) on PUF Lands at 3.4 miles (5.5 kilometers) depth, and areas at 125 °C to 150 °C (257 °F to 302 °F) at 11,480 feet (3.5 kilometers) depth. At 10 km depth, resource temperatures range from 200 °C (392 °F) to over 300 °C (572 °F) on PUF Lands (Batir & Richards, 2020; 2021).

Table 13.3. Two land acquisition opportunities identified by Texas A&M MBA team. *Source: Adeoshun, et al., 2021.*

Location	City Intended to Provide Power	GLO PSF Availability	Temperature	Average Depth	Future Population Projects in Area	Distance from Populated Area	Distance from Transmission Line	Score
Brushy Creek & Helen Oil Fields	Victoria	1	5	5	3	5	3	**3.5**
Brenham	College Station/Waco	1	3	5	5	3	5	**3.4**
Weight		*25%*	*20%*	*20%*	*15%*	*10%*	*10%*	

The TAMU team also recommended three locations for GLO land acquisition based on the same criteria. Those prospects were Brushy Creek, Helen Oil Fields, and a plot in Brenham (Table 13.3).

Brushy Creek and Helen Oil Fields were selected because of high temperatures near active oil and gas production, suggesting the possibility of geothermal co-generation. Brenham was promising because of its proximity to two growing population centers – Houston and College Station.

B. Geothermal Co-Production with Oil and Gas Operations

There are almost 1.2 million wells in Texas. Of the nearly 300,000 wells that are actively producing oil and gas in Texas, the State owns an interest in over a third of them (Bush, 2020). That leaves millions of abandoned wells (Malewitz, 2016). Further, when transmission lines are not nearby, oil and gas producers typically run diesel or gas generators for their large power needs (for pumps, compressors, drilling rig motors, and other field equipment).

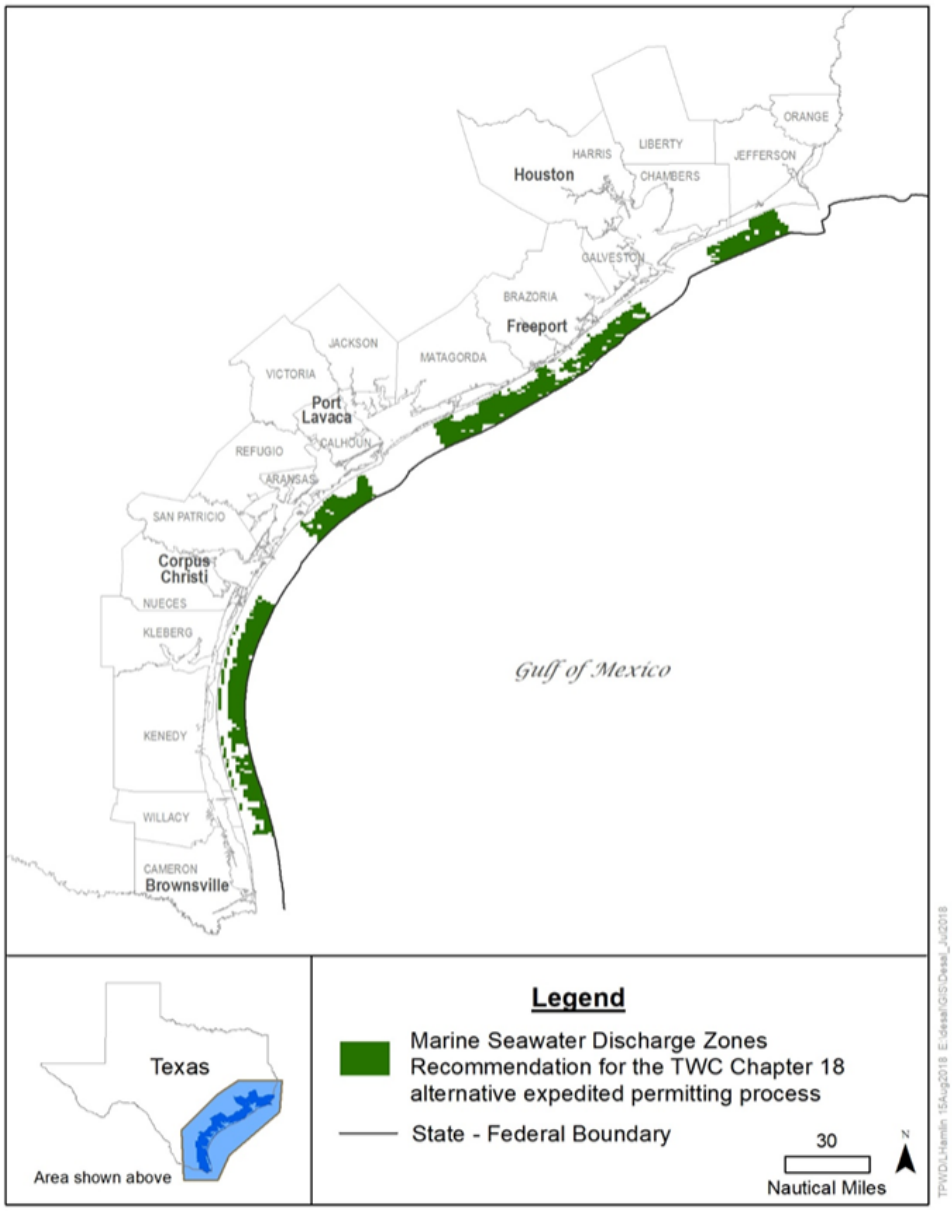


Figure 13.7. In a 2018 report prepared for the 84th Texas Legislature in response to HB 2031, Texas Parks and Wildlife Department ("TPWD") and the GLO mapped zones deemed appropriate for the discharge of desalination waste into the Gulf of Mexico. *Source: TPWD & GLO, 2018.*

As discussed in Chapter 3, Other Geothermal Concepts with Unique Applications in Texas, there are concepts in development that utilize abandoned and existing wells for geothermal energy production. Modular, Organic Rankine Cycle geothermal power plants can generate electricity with a small surface footprint to power oil and gas operations in the field, and can easily be removed once they are no longer needed.

C. Geothermal for Desalination

Tapping into seawater accessed along the 367-mile (590-kilometer) Texas coastline may be necessary to meet increasing demand for water (e.g., municipal, industrial, and agricultural) in a changing climate (TWDB, 2019). As discussed further in Chapter 2, Direct Use Applications, desalination is the energy intensive process of purifying salt water for drinking or agricultural use. Geothermal energy can be utilized to reduce the environmental footprint of desalination (Aminfard, et al., 2019).

At the direction of the 84th Texas Legislature, the GLO worked with the Texas Parks and Wildlife Department to identify zones that are appropriate for the discharge of desalination brine, and diversion to protect marine organisms (Figure 13.7). The goal of their study was to expedite the permitting process for desalination projects (TPWD & GLO, 2018).

D. Support from University Lands and Public Universities

University Lands can support geothermal in Texas by contributing to subsurface studies and exploration, as well as piloting field trials for geothermal projects. Further, the UT and TAMU Systems could support their campuses in the installation of Direct Use geothermal projects, like district heating and cooling system installations, as is discussed in further detail in Chapter 2, Direct Use Applications of this Report.

Furthermore, the UT and TAMU Systems can provide valuable assistance to geothermal energy development by offering tailored courses, certificates, majors, and minors in critical areas geothermal drilling engineering, plant design, geophysics, and other unique aspects of geothermal energy production, and even geothermal focused research and development, which the two Systems could support through funding to the schools. In Fall 2022, for instance, Dr. Ken Wisian, an author on this Report, taught a course at The University of Texas at Austin called "Fundamentals of Geothermal Energy Systems," a first for the university. Students explored traditional hydrothermal systems, as well as the potential for Advanced Geothermal Systems in Texas. The class was attended by graduate and undergraduate students with concentrations ranging from Geology, Energy and Earth Resources, and Public Policy. Geothermal curriculum should be offered at all UT and TAMU System universities to support the education of the future geothermal workforce in the State of Texas.

VI. Conclusion

Ensuring the future of Texas public education means managing Texas public lands responsibly, sustainably, and with vision. Geothermal provides an opportunity for the State to expand its revenue sources, while gaining experience with new technologies, reducing greenhouse gas emissions, supporting local communities, and creating jobs.

In addition to electricity generation, powering oil and gas operations, and desalination, more immediate opportunities for geothermal on public lands include bitcoin mining, storage for excess solar and wind generation, or direct air capture and CO2 sequestration. These concepts are discussed in further detail in Chapter 3, Other Concepts with Unique Applications in Texas. Furthermore, University Lands and the UT and TAMU systems have extensive resources and capabilities to contribute to geothermal exploration on public lands. Both University Lands and the GLO have demonstrated interest in diversifying the use of State owned lands to ensure the continued prosperity of public education in the State. Geothermal provides a viable and unique pathway to accomplish that goal.

Conflict of Interest Disclosure

John Tackett serves as Geoscience Manager & Chief Geologist for University Lands in Texas, and is compensated for this work. Outside of this role, John Tackett certifies that he has no affiliations, including board memberships, stock ownership and/or equity interest, in any organization or entity with a financial interest in the contents of this manuscript, and has no personal or familial relationship with anyone having such an affiliation or financial interest.

Jacquie Moss serves as an independent consultant, and is compensated for this work. She is a full-time Ph.D. student at The University of Texas at Austin, LBJ School of Public Affairs. Outside of these roles, Jacuiq Moss certifies that she has no affiliations, including board memberships, stock ownership and/or equity interest, in any organization or entity with a financial interest in the contents of this manuscript, and has no personal or familial relationship with anyone having such an affiliation or financial interest.

Chapter 13 References

Adeoshun, O., Daddario, P., Sheppard, B., Uchiyama, K., Vasek, H., & Yim, J. (2021). Texas GLO Geothermal Analysis [Unpublished manuscript for a professional MBA capstone project and used with permission from authors and GLO]. Mays Business School at Texas A&M University.

Aminfard, S., Davidson, F. T., & Webber, M. E. (2019). Multi-layered spatial methodology for assessing the technical and economic viability of using renewable energy to power brackish groundwater desalination. Desalination, 450, 12–20.

Batir, J., & Richards, M. (2022). Determining Geothermal Resources in Three Texas Counties. Texas Water Journal, 27-44 Pages.

Batir, J.F., & Richards, M. C., (2021). Updated Heat Flow and Temperature-at-Depth Maps of Three Texas Counties, Geothermal Resources Council Transactions, 45, 20. 1952-1970.

Batir, J. F. & Richards, M. C. (2020). Analysis of Geothermal Resources in Three Texas Counties (No. 1291). USDOE Geothermal Data Repository (United States); Southern Methodist University Huffington Department of Earth Sciences.

Bureau of Land Management - BLM. (2007). Offer to Lease and Lease for Geothermal Resource (Form 3200-24a). U.S. Department of the Interior. Retrieved October 23, 2022, from https://www.blm.gov/sites/blm.gov/files/uploads/Services_National-Operations-Center_Eforms_Fluid-and-Solid-Minerals_3200-024a.pdf.

Bush, G. P. (Ed.). (2020). George P. Bush's Energy Map of Texas [Story Map]. Texas General Land Office. Retrieved October 12, 2022, from http://commissionerbushmaps.com/.

Covert, T. R., & Sweeney, R. L. (2019). Relinquishing Riches: Auctions vs Informal Negotiations in Texas Oil and Gas Leasing (Working Paper No. 25712). National Bureau of Economic Research.

EnergyNet. (2022). Texas General Land Office Oil, Gas, and Geothermal Lease Sale (TX-2022-11). EnergyNet: Government Resources Listings. Retrieved October 12, 2022, from https://www.energynet.com/property_information.pl?lot=102118.

Fambrough, J. (2013). "Mineral Law West of the Pecos." Tierra Grande Magazine. Retrieved October 23, 2022, from https://assets.recenter.tamu.edu/documents/articles/2026.pdf.

Fiscal Notes. (2022). Texas' Energy Profile. Texas Comptroller of Public Accounts. Retrieved October 23, 2022, from https://comptroller.texas.gov/economy/fiscal-notes/2022/sep/energy.php.

Hewett, C. (2020). A Comparative Analysis of Texas and New Mexico Oil and Gas Laws from a Title Examiner's Perspective Survey on Oil & Gas. Texas A&M Journal of Property Law, 6(3), 225–235.

Malewitz, J. (2016). Abandoned Texas oil wells seen as "ticking time bombs" of contamination. The Texas Tribune. Retrieved October 15, 2022, from https://www.texastribune.org/2016/12/21/texas-abandoned-oil-wells-seen-ticking-time-bombs-/.

McFarland, J. (2009). The Relinquishment Act – an Interesting Chapter in Texas History. Oil and Gas Lawyer Blog. Retrieved October 12, 2022, from https://www.oilandgaslawyerblog.com/the-relinquishment-act-an-inte/.

McIntosh, C. R., Wilmot, N. A., Dinneen, A., & Shogren, J. F. (2022). Minnesota—Too late for a Sovereign Wealth Fund? Mineral Economics, 35(1), 67–85.

Mills, K. (2018). Doing Business with the General Land Office – Renewable Energy Leases and Surface Use (Accommodation) Agreements. The University of Texas School of Law Continuing Legal Education. Retrieved October 12, 2022, from https://utcle.org/ecourses/OC7764/get-asset-file/asset_id/43071.

Reid, S. L. (1998). 18. Texas General Land Office. In R. C. I. Telfair (Ed.), Texas Wildlife Resources and Land Uses (pp. 285–292). University of Texas Press.

Stacker. (2022). See How Much Land in Texas is Owned by the Federal Government | Stacker. Stacker. Retrieved October 7, 2022, from https://stacker.com/texas/see-how-much-land-texas-owned-federal-government.

Sovereign Wealth Fund Institute - SWFI. (2021). Does the United States Have a Sovereign Wealth Fund?. Sovereign Wealth Fund Institute (SWFI). Retrieved October 17, 2022, from https://www.swfinstitute.org/news/87828/does-the-united-states-have-a-sovereign-wealth-fund.

Texas GLO. (2022). Geothermal Lease (SAMPLE). Texas General Land Office. Retrieved October 12, 2022, from https://www.energynet.com/govt_listing.pl?sg=5735.

Texas, S. of. (2022a). GLO Energy Business Overview. The Texas General Land Office, George P. Bush - Commissioner. Retrieved October 12, 2022, from https://www.glo.texas.gov/energy-business/oil-gas/mineral-leasing/overview/index.html.

Texas, S. of. (2022b). The GLO Overview. The Texas General Land Office, George P. Bush - Commissioner. Retrieved October 12, 2022, from https://www.glo.texas.gov/the-glo/about/overview/index.html.

Texas PSF. (2021). Texas Permanent School Fund, A Permanent Fund of the State of Texas: Annual Comprehensive Financial Report, Fiscal Year Ending August 31, 2021 (Financial Report). General Land Office.

Timmins, B. H. (2021). Message from the Executive Administrator. Texas Education Agency. Retrieved October 12, 2022, from https://tea.texas.gov/sites/default/files/PSF_Annual_Report.pdf.

TPWD, & GLO. (2018). Marine Seawater Desalination Diversion and Discharge Zones Study (HB 2031; 84th Texas Legislature). Texas Parks and Wildlife Department, Texas General Land Office. Retrieved October 12, 2022, from https://tpwd.texas.gov/publications/pwdpubs/media/hb2031dz.pdf.

TWDB. (2019). Desalination: Seawater. Texas Water Development Board. Retrieved October 23, 2022, from https://www.twdb.texas.gov/publications/shells/Desal_Seawater.pdf.

University Lands. (2021). University Lands FY21 Annual Report. University Lands. Retrieved October 2, 2022, from https://online.flippingbook.com/view/367436202/.

University Lands. (2022a). About University Lands. Retrieved October 2, 2022, from https://universitylands.utsystem.edu/Home/AboutUs.

University Lands. (2022b). History of University Lands & The PUF Lands. Retrieved October 2, 2022, from https://universitylands.utsystem.edu/Home/History.

University Lands. (2022c). The Permanent University Fund (PUF). Retrieved October 2, 2022, from https://universitylands.utsystem.edu/Home/PUF.

The University of Texas Investment Management Company - UTIMCO. (2021). Financial Statements and Independent Auditor's Report Permanent University Fund: Years Ended August 31, 2021 and 2020.

Whitworth, H. P., & Miller, E. N. (1986). Texas Mineral Interests. Natural Resources & Environment, 2(1), 33–35, 72–74.