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*Cover photo:*

Guadalupe River Nature Trail at Canyon Lake Dam.  
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# Dam Failure and Reconstruction in the Guadalupe Valley Lakes Region of Central Texas

Andrew T. Adams\*<sup>1</sup>, Melinda Villagran<sup>2</sup>, Robert E. Mace<sup>3</sup>

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**Abstract:** Along a segment of the Guadalupe River in Central Texas, multiple historic dams owned and operated by the Guadalupe-Blanco River Authority have failed. These dams create small lakes along which a string of communities have deeply embedded their lives. In this paper, we present a case study investigating the failure of the Lake Dunlap Dam and the subsequent responses at the community, regulatory, and state levels. The results highlight the social challenges of managing dam infrastructure and how the Lake Dunlap community navigated emotions, regulatory restrictions, and financial reality to create a solution that other communities along the river adopted. This case study also revealed that multiple communities facing similar issues posed by aging dam infrastructure will need alternative, less costly solutions. Future studies ought to consider the feasibility of reconstruction for aging dams across the state as well as the potential for alternatives. The case of the Guadalupe Valley Lake region dam failures and aftermath can inform policy and management regarding Texas's vast and aging dam infrastructure.

**Keywords:** water resources, infrastructure disaster, dam failure, policy analysis, historical geography, case study

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## Terms used in paper

Acronym/Initialism	Descriptive Name
ASCE-TS	Texas Section of the American Society of Civil Engineers
ASDSO	Association of State Dam Safety Officials
GBRA	Guadalupe-Blanco River Authority
NID	National Inventory of Dams
PLDA	Preserve Lake Dunlap Association
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WCID	water control and improvement district

## INTRODUCTION

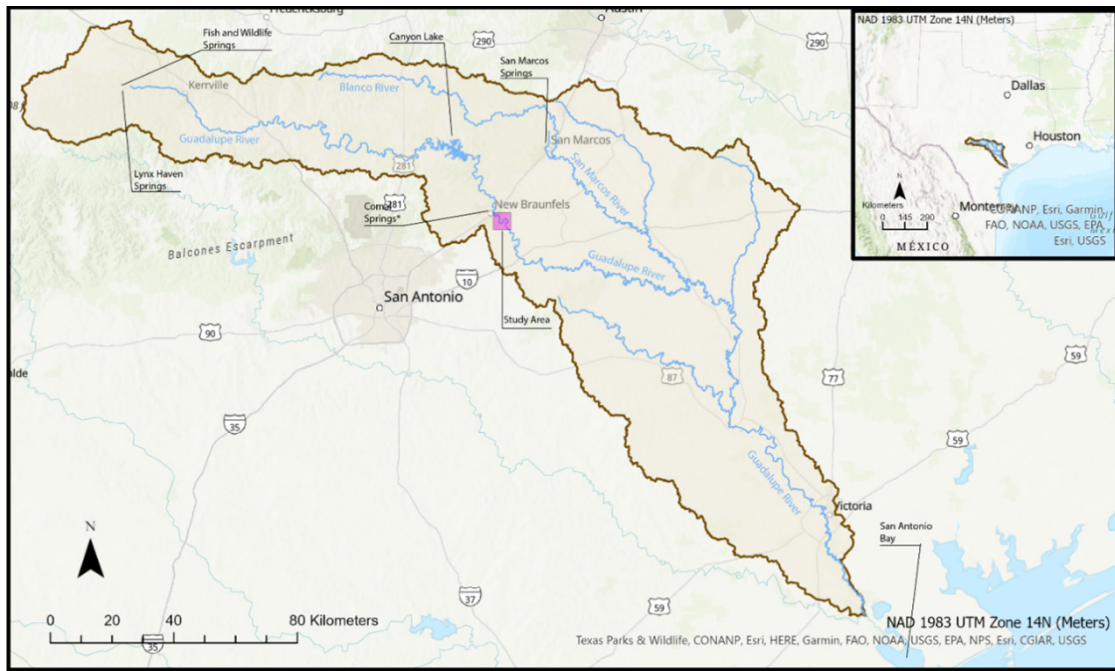
As climate change causes volatility in the environment, much of our critical water infrastructure, which is already failing ([Texas Section of the American Society of Civil Engineers \[ASCE-TS\], 2021](#)), is at significantly increased risk of damage ([Hui et al., 2018](#)). This is particularly true of dams in Texas, where dam incidents and failures are increasing ([ASCE-TS, 2021](#); [Association of State Dam Safety Officials \[ASDSO\], 2020](#); [Dascher & Meitzen, 2020](#)). Since 2001, dam incidents have more than doubled, and dam failures have increased by a factor of six, compared to the period between 1900 and 2000 ([ASCE-TS, 2021](#)).

The increase in dam incidents and failures can be attributed to the increasing ages of dams and their components, with many dams across Texas near or beyond their usable lifespans; an increase in severe weather events; and the need for restoration or other solutions ([ASCE-TS, 2021](#); [Dascher & Meitzen, 2020](#); [Guadalupe-Blanco River Authority \[GBRA\], 2023b](#); [Texas Water Development Board \[TWDB\], 2021](#)). Of particular concern to dams and reservoirs across the state are shifting and intensifying hydrologic extremes due to climate change, such as changes in rainfall seasonality, increasing rainfall intensities, and more intense and prolonged drought ([Dascher & Meitzen, 2020](#); [Marvel et al., 2021](#); [Nielsen-Gammon et al., 2020](#)). With more than 95% of dams in Texas being earthen, the risk of dam failure due to hydrologic events is high—a risk that is exacerbated in previously damaged dams

([Dascher & Meitzen, 2020](#)). Texas Commission on Environmental Quality (TCEQ) is responsible for managing a dam safety program intended to monitor and regulate private and public dams within TCEQ's regulatory criteria; however, the program struggles to fulfill its mandate due to a lack of resources ([Dascher & Meitzen, 2020](#); [TCEQ, 2022a](#)).

Along a segment of the Guadalupe River in Central Texas, numerous historic dams owned and operated by GBRA, a government-owned corporation that acts as a steward of water resources for a 10-county statutory district, have experienced the failure of critical engineering components ([ASCE-TS, 2021](#); [Dascher & Meitzen, 2020](#); [GBRA, 2021b, 2023b](#); [TWDB, 2021](#)). These dams create lakes along which a string of communities have become deeply embedded. Limited funding, in addition to the substantial issues in information management regarding dam incidents and failures and controversies concerning dam removal, makes it extremely difficult for communities to address incidents and failures, let alone commit to preventative processes and actions ([ASCE-TS, 2021](#); [ASDSO, 2020](#); [Dascher & Meitzen, 2020](#); [GBRA, 2020a](#)).

In this paper, we present a case study investigating the failure of the Lake Dunlap Dam and the subsequent responses at the community, regulatory, and state levels. TCEQ, the agency responsible for monitoring dams in the state, defines *dam failure* as overtopping or breaching and draining of the reservoir ([Dascher & Meitzen, 2020](#)). However, dams can fail due to other reasons, including maintenance and equipment failures ([Atallah, 2002](#); [Costa, 1985](#); [U.S. Army Corps of Engineers](#)



**Figure 1.** Guadalupe River Basin (the Comal River is not visible due to its short length).

[USACE], 2020). The dams discussed in this paper drained due to equipment failures and are referred to by local organizations and the regional authority as “dam failures,” so we refer to them as dam failures as well. This paper explores the story of the Lake Dunlap community, which experienced a dam failure and, within 2 years, developed a solution fit for their community—navigating social, legal, political, and bureaucratic systems to craft partnerships and break ground on the construction of a new dam.

## THE GUADALUPE RIVER

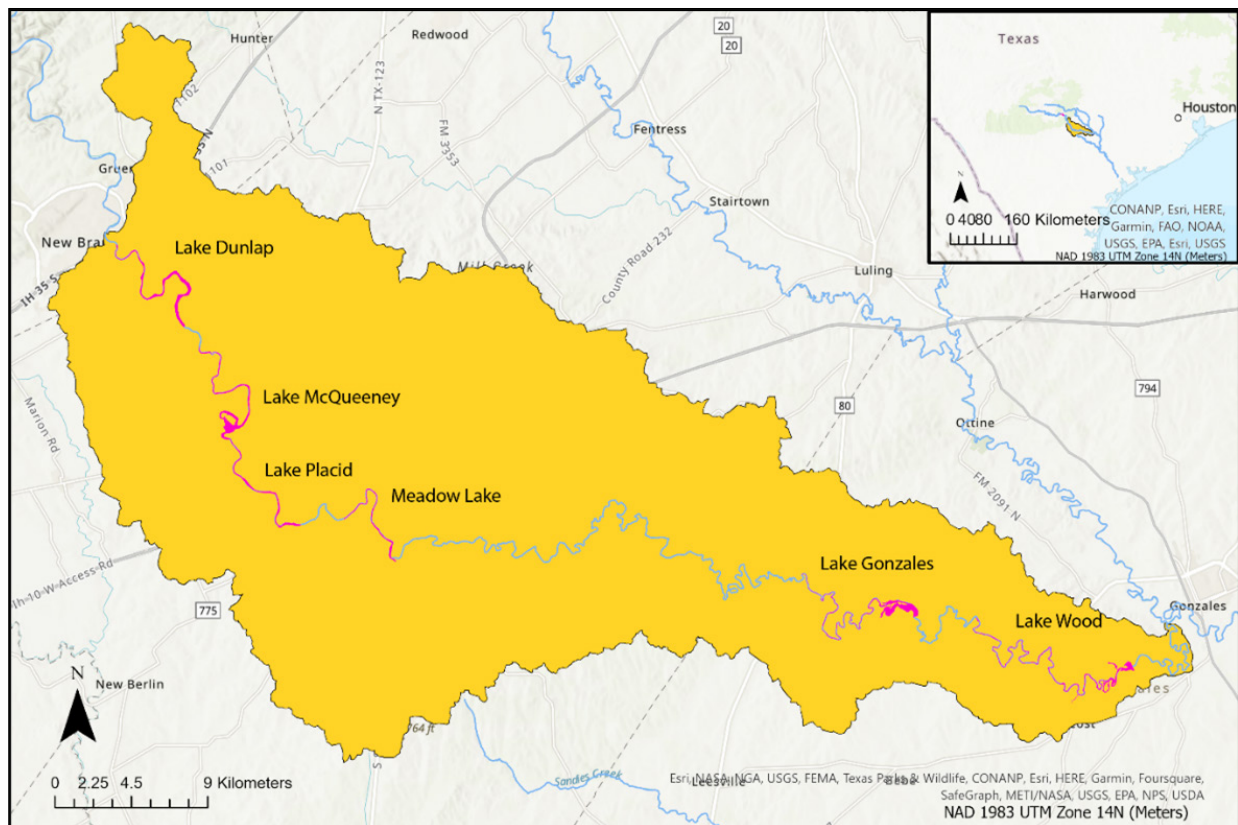
The Guadalupe River Basin headwaters flow from Central Texas to its mouth in the Gulf of Mexico (Figure 1). The total drainage area of the Guadalupe River Basin is approximately 15,500 square kilometers (5,985 square miles; [Dascher & Meitzen, 2020](#); [Joseph et al., 2013](#)). The headwaters of the Guadalupe River are springs of the Edwards-Trinity (Plateau) Aquifer located in Kerr County, Texas. The climate of the Guadalupe River Basin is classified as humid subtropical with hot summers ([Dixon & Moore, 2011](#); [Earl, 2007](#); [Kortek et al., 2006](#)). The climate along the course of the river transitions from subtropical semiarid in South Texas to humid subtropical in East Texas ([Earl, 2007](#)).

The river begins its journey at Lynx Haven Springs, the source of the South Fork of the Guadalupe River, and Fish and Wildlife Springs, the source of the North Fork of the Guadalupe River, and flows 145 kilometers (90.1 miles) over the shales

and marls of the Edwards Plateau and the Glen Rose limestone ([McAlister, 2008](#)) until it reaches Canyon Lake ([McAlister, 2008](#); [Sansom, 2008](#)). Throughout its journey to Canyon Lake, the water pools, flows, and ripples through the Hill Country region of Texas. Texas beargrass, musk thistle, firewheels, Mexican hats, horsemint, Texas thistle, Texas persimmons, Arizona walnuts, soapberry, escarpment black cherries, scarlet leatherflower, black willows, various species of oaks, and various species of cypresses dominate the flora visible from the river ([McAlister, 2008](#)). The river carves through bluffs, creating rapids as well as flowing more docilely as it passes through numerous small cities and over dams ([McAlister, 2008](#)).

Downstream from Canyon Lake, the environment transitions. The river flows over rapids through the last reaches of the Hill Country, continuing south-southeast for 25.8 kilometers (16 miles) to New Braunfels as it crosses the Balcones Fault Zone ([McAlister, 2008](#)). Scheduled releases of water from Canyon Lake flow to New Braunfels at a rate of 11.3–22.7 cubic meters per second (399–802 cubic feet per second; [McAlister, 2008](#)). The upstream banks of this section of the river are lined with bald cypress, American elm, American sycamore, red mulberry, green ash, rough-leaf dogwood, soapberry, pecan, and abundant mustang grape ([McAlister, 2008](#)). There are green kingfishers, Carolina wrens, northern cardinals, yellow-billed cuckoos, wood ducks, green herons, giant swallowtails, and fox squirrels ([McAlister, 2008](#)).

In New Braunfels, the Comal River flows into the Guadalupe River. The Comal River, which is 4.8 kilometers (3 miles) long,



**Figure 2.** Guadalupe Valley Lakes. This 163-kilometer (101-mile) portion of the Guadalupe River expands from just below its confluence with the Comal River to its confluence with the San Marcos River near the City of Gonzales. It contains the six small hydroelectric dams and their associated reservoirs that make up the Guadalupe Valley Lakes region.

is fed by Comal Springs, which are the largest springs west of the Mississippi River. Comal Springs discharge the largest volume of water from the Edwards Aquifer, at a long-term annual average rate of 8.5 cubic meters per second (300 cubic feet per second; [Brown, 1996](#); [Burnett, 2008](#); [Earl, 2007](#); [McAlister, 2008](#); [Rosen, 2014](#); [U.S. Geological Survey \[USGS\], 2022](#)). Comal River joins the Guadalupe River just north of Interstate 35 in New Braunfels. When the Guadalupe River is experiencing low flows and minimal releases from Canyon Lake dam, the Comal River, supported by Comal Springs, contributes significant baseflow ([Sansom, 2008](#)). In many years, the flow of the Comal River contributes as much water to the Guadalupe River as the entire Upper Guadalupe River Basin ([Brown, 1996](#); [McAlister, 2008](#); [Sansom, 2008](#)).

The base of the Balcones Escarpment marks the end of the Hill Country, the beginning of the Blackland Prairie, Cross-timbers and Prairies, and the Coastal Plains, and the Guadalupe River's final segment, where the river is slower and more meandering ([Gould, Hoffman, & Rechenthin, 1960](#); [Sansom, 2008](#)). From here, the river runs southeast for approximately 322 kilometers (200.1 miles) from Interstate 35 in New Braunfels to San Antonio Bay ([Sansom, 2008](#); [Texas Parks and Wildlife Department, 1974](#)).

Immediately south of Interstate 35 in New Braunfels, the Guadalupe River enters the Guadalupe Valley Lakes region, a place name identified by GBRA. This region includes the Guadalupe River between the Comal River confluence and the San Marcos River confluence as it makes a controlled descent through a series of six hydroelectric dams and their reservoirs (Figure 2).

Commonly known as the “flash flood capital of the world,” the complex geography of the Balcones Escarpment lends itself to significant flooding ([Bomar, 1995, 2017](#); [Burnett, 2008](#); [Earl, 2007](#); [Sansom, 2008](#)). The change in topography across the Balcones Escarpment produces increased rainfall, while the thin soils, limestone bedrock, and steep slopes increases flood potential ([Lowrey & Yang, 2008](#); [Wang et al., 2008](#)). Contingent on previous rainfall that results in regionally saturated conditions, flash floods are virtually guaranteed due to a lack of infiltration and the steep slopes of rivers and creeks ([Bomar, 2017](#)).

Further contributions to the flood hazard are due to the region having a bimodal precipitation regime that produces a variety of storm types that are capable of producing large amounts of rainfall, such as (1) squall lines produced by cold fronts encountering maritime tropical air from the Gulf of

**Table 1.** Dams in the Guadalupe Valley Hydroelectric System. The National Inventory of Dams (2022) defines *max storage* as the “total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage.” *Normal storage* is defined as the “total storage in a reservoir below the normal retention level, including dead and inactive storage and excluding any flood control or surcharge storage.” Surface area is for the normal retention level. Data from Guadalupe-Blanco River Authority (2018a) and National Inventory of Dams (2022).

Reservoir name	Dam name	Dam height (feet)	Dam length (feet)	Year completed	Maximum storage (acre-feet)	Normal storage (acre-feet)	Surface area (acres)	Drainage area (square miles)	Spillway width (feet)
Lake Dunlap	TP-1 Dam	41	1800	1928	14330	5900	410	1676	779
Lake McQueeney	McQueeney Dam	42	1555	1928	6170	2999	396	1697	855
Lake Placid	TP-4 Dam	46.8	2057	1932	5650	750	248	37.75	325
Meadow Lake	Nolte Dam	43.6	2550	1930	3210	243	107	1771	741
Lake Gonzales	H-4	42	2170	1931	28070	7500	696	2058	480
Lake Wood	H-5 Dam	42	6450	1931	27450	4000	488	2110	1105

Mexico in late spring; (2) remnants of late summer and early fall tropical storms that sometimes stall over the Balcones Escarpment; (3) and, less frequently, tropical easterly waves (Earl, 2007). Beyond intense precipitation and floods, this region also experiences drought extremes (Bomar, 1995; Xie et al., 2011).

## DEVELOPMENT AND MANAGEMENT OF THE GUADALUPE RIVER

The cultural history of the Guadalupe River Basin is heavily tied to New Braunfels and early German settlements established in the Hill Country in the 1830s (Sansom, 2008); however, the records for dams constructed between 1800 and 1899 are limited (Dascher & Meitzen, 2020). Those that were built were designed without automation or electronic power systems (GBRA, 2020a). Dams built before 1900 were built for a variety of purposes, including recreation, flood control and stormwater management, and irrigation (Dascher & Meitzen, 2020).

The years between 1900 and 1939 are considered the early era of dam building in Texas (Dascher & Meitzen, 2020). In the early part of this era, prior to the existence of river authorities in Texas in 1917, speculators along the Guadalupe River began purchasing land to develop hydropower (Foster, Prociuk, & Samant, 2021; GBRA, 2020a; McAlister, 2008). One of the early speculators was W.B. Dunlap—a member of an investment consortium that purchased land between New Braunfels and Seguin to build a series of small dams (Foster, Prociuk, & Samant, 2021; McAlister, 2008). The consortium established the Guadalupe Water Power Company and was granted water rights (Permit No. 21, Application No. 21) by the State Board of Water Engineers on July 25th, 1914, which granted a continuous appropriation of 36.8 cubic meters per

second (1,300 cubic feet per second) for hydroelectric power generation (Foster, Prociuk, & Samant, 2021). World War I impacted the project timeline, so it was not until 1924, with \$2 million in backing and a partnership with the Comal Power Company, that an electric network was formed and the plan for a series of dams between New Braunfels and Seguin was put into action (Foster, Prociuk, & Samant, 2021). Prior to the beginning of construction, ownership of the site changed to the Texas Power Corporation, which completed construction of a dam at Dittmar Falls by 1928, creating a reservoir to generate hydroelectric power (Foster, Prociuk, & Samant, 2021; McAlister, 2008; National Inventory of Dams [NID], 2022). An additional appropriation (Permit No. 1096, Application No. 1163) was granted in 1929, under the Hunt Development Company, for up to 941,200 acre-feet of water per year (Foster, Prociuk, & Samant, 2021).

Between 1928 and 1932, the Texas Power Corporation and the Texas Hydro-Electric Corporation constructed six hydroelectric dams in the Guadalupe River Basin (Foster, Prociuk, & Samant, 2021; GBRA, 2020a, 2022c; Sansom, 2008; TWDB, 2021). The original designs were led by hydropower plant engineer William G. Fargo of Fargo Engineering Company out of Jackson, Michigan (Foster, Prociuk, & Samant, 2021). The design of the dams was considered “modern hybrid” and reflected “national trends in hydropower dam design in the early 20th century period,” which, “under the leadership of the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers,” combined elements of flood control and power production (Foster, Prociuk, & Samant, 2021, p. 4-13). The reservoirs associated with the six small hydroelectric dams are (ordered upstream to downstream): Lake Dunlap, Lake McQueeney, Lake Placid, Meadow/Nolte Lake, Lake Gonzales, and Lake Wood (Table 1). Only Lake Gonzales and Lake Wood are not used for public water supply.

The Texas Legislature established the Guadalupe River Authority in 1933 as a state-owned corporation that operates within a 10-county water conservation and reclamation district encompassing the Guadalupe and Blanco river basins in central to southeast coastal Texas (GBRA, 2019j; 2022a; Harper & Griffin, 1988; Hendrickson, 1985). After the Legislature created the Guadalupe River Authority, the board of directors held their first meeting in December 1933, where they prioritized a series of dams for flood control and hydropower (McAlister, 2008). In 1939, a report to Congress by the Guadalupe River Authority supported building a dam north of New Braunfels for flood control as well as for water and soil conservation (McAlister, 2008).

At the time, few electric companies provided services in rural areas, and the ones that did charged rural customers exorbitant prices (Cooke, 2017; Yancy, 1988). President Franklin D. Roosevelt, at the January 1935 State of the Union address, declared that “among the subjects that lie immediately before us are ... the restoration of sound conditions in the public utilities field through abolition of the evil features of holding companies” (Roosevelt, 2011, p. 14-15). While many people did not support the “concept of government-owned generation facilities selling to publicly-owned distribution systems”—a tension that still exists today—Roosevelt and those in this camp saw a lack of rural access to electric services as a fault of massive utility conglomerations under the umbrella of holding companies (Cooke, 2017, p. 67). Even avid supporters of holding companies, such as syndicated journalist Walter Lippmann, acknowledged the “occasional abuses and ‘flagrant profiteering’” (Cooke, 2017, p. 67). One month later, in February 1935, House Speaker Samuel Rayburn of Texas and Senator Burton K. Wheeler of Montana introduced the Public Utility Holding Company Act in both chambers of Congress to “discourage control of the electric utility industry by a few large corporations” (Cooke, 2017, p. 5). It passed and was signed into law on August 26th, 1935.

Throughout this time, Texas State Senator Alvin J. Wirtz, a close friend of U.S. Congressman Lyndon B. Johnson (later the 36th president of the United States from 1963 to 1969), championed legislation to create public power programs in Texas modeled after the Tennessee Valley Authority (Cooke, 2017; Foster, Prociuk, & Samant, 2021). Working alongside Wirtz, U.S. Congressman James P. Buchanan secured funding from the Works Progress Administration, and, in 1934, the Texas Legislature created the Lower Colorado River Authority (Cooke, 2017). One year later, in 1935, the Legislature reauthorized the Guadalupe River Authority as GBRA (Cooke, 2017; GBRA, 2019j, 2022a). According to Hendrickson (1985), the river authorities established in the 1930s required funding assistance, such as federal assistance, to launch their initial

operations. Some agencies, such as the Brazos River Authority and the Lower Colorado River Authority, were recipients of financial assistance that allowed them to establish and expand their operations (Hendrickson, 1985). Other agencies, such as GBRA and the Nueces River Authority, did not receive financial assistance, resulting in a period of dormancy (Hendrickson, 1985).

The most prolific era in dam building, the third era, during which dam building accelerated in Texas, lasted from 1940 to 1959 (Dascher & Meitzen, 2020). Starting just before World War II, the management of surface water in Texas focused on flood control and power generation (Hendrickson, 1985). By 1942, Congress authorized a dam north of New Braunfels, which came to be known as Canyon Lake Dam (McAlister, 2008). The Rivers and Harbors Act of 1945 authorized the initial funds with final approval in the Flood Control Act of 1954 (Comal County, 2015). A site was selected in 1949, and a shared control agreement between GBRA and the federal government was signed in 1957. Construction began in 1958, and impoundment of the river to fill the reservoir began in 1964. The dam reached its conservation level in 1968, though hydroelectric generation did not come online until January 14th, 1989 (Comal County, 2015; GBRA, 2022c; McAlister, 2008).

The final era of dam building, from 1960 to 1979, “captures the peak of dam construction in Texas” (Dascher & Meitzen, 2020, p. 9). During this period, just prior to the beginning of the Canyon Lake’s impoundment on May 1st, 1963, GBRA acquired the six small hydroelectric dams that were built in the Guadalupe River Basin between 1928 and 1932 from the Texas Power Corporation and the Texas Hydro-Electric Corporation (Brown, 2020; Foster, Prociuk, & Samant, 2021; GBRA, 2020a, 2022c; Sansom, 2008). After purchasing the entire reservoir system, GBRA renovated and automated hydroelectric operations at all six sites (Brown, 2020; Foster, Prociuk, & Samant, 2021; McAlister, 2008). These hydroelectric dams and their reservoirs create the Guadalupe Valley Hydroelectric System, which, along with the Canyon Hydroelectric System, produced electricity for the Guadalupe Valley Electric Cooperative (GBRA, 2022c; Yancy, 1988). They provided a stable and reliable source for electrical power and water, and with it, a new opportunity for developers to transform the land traditionally used for agriculture to residential developments (Foster, Prociuk, & Samant, 2021).

TCEQ initially issued water rights for the Guadalupe Valley Hydroelectric System to private developers; these rights transferred to GBRA when it purchased the dams (Foster, Prociuk, & Samant, 2021; GBRA, 2020a). GBRA is authorized to impound waters of the state in the reservoirs and divert waters for non-consumptive use for hydroelectric generation—mean-

ing all diverted water must be returned to the river ([GBRA, 2020a](#)).

The dams are intentionally designed to not act as barriers during flooding ([Foster, Prociuk, & Samant, 2021](#); [GBRA, 2020a](#)). They act as pass-through lakes that do not hold flood waters ([GBRA, 2020a](#)). This is in contrast to Canyon Lake, completed in 1964 and designed to hold about 355,000 acre-feet of flood water ([GBRA, 2020a](#)).

## Lake Dunlap Dam

At 11.3 kilometers (7 miles) long, Lake Dunlap was built in 1928 and is the first (most upstream) and largest of the six reservoirs in the Guadalupe Valley Lakes region (Figure 2). Lake Dunlap Dam was built on the first ledge of Dittmar Falls, and the streambed just below consists of the uppermost Cretaceous stratum in the area, the Taylor Marl ([McAlister, 2008](#); [Samson, 2008](#)). The Lake Dunlap Dam reservoir is shallow and riverine with a water residence time of less than 1 week ([Brown, 1996](#)). Toward the center of Lake Dunlap, the banks are approximately 180 meters (590.6 feet) apart. The depth of the lake varies from 3.7 to 8 meters (12.1 to 26.2 feet; [Brown, 1996](#); [McAlister, 2008](#)).

Lake Dunlap Dam was approximately 610 meters (2,001 feet) long and 15.4 meters (50.5 feet) high, with the water height behind the dam at 6.7 meters (22 feet) and a storage capacity of 7,278 megaliters (5,900 acre-feet; [GBRA, 2017, 2018b, 2020a](#); [McAlister, 2008](#)). The earthen dam was separated into three bays with three spillgates, operated by an internal sluice, which provide primary control of the headwater levels in the reservoir and were automated by GBRA in 1963 ([Foster, Prociuk, & Samant, 2021](#); [GBRA, 2020a](#); [McAlister, 2008](#); [TWDB, 2021](#)). The concrete superstructure was constructed with a hollow core that was reinforced by steel girders ([McAlister, 2008](#)). The earth bank on river right is concrete-capped, and the left bank is an earth-fill levee extending approximately 0.4 kilometers (0.2 miles) into the prairie ([Foster, Prociuk, & Samant, 2021](#); [McAlister, 2008](#)). Except during floods, the Lake Dunlap Dam routes the full flow of the river through the diversion channel ([Foster, Prociuk, & Samant, 2021](#); [McAlister, 2008](#)).

The powerplant is 3.2 kilometers (2 miles) downstream of the dam just before the diversion channel returns flow to the river. There is a drop in elevation between the spillway and the powerhouse of 14.2 meters (46.6 feet; [Foster, Prociuk, & Samant, 2021](#)). Specialized radial-arm Tainter gates guide the flow of water to a pair of hydropower turbines ([Foster, Prociuk, & Samant, 2021](#)). James Leffel and Company provided the turbines, and the General Electric Company built the generator and control equipment ([Foster, Prociuk, & Samant, 2021](#)). The equipment includes two 2,800 horsepower Francis-type

vertical turbines that can each generate 1,800-kilowatt, three-phase, 60-cycle, 2,400-volt electrical power for a total potential generating capacity of 3,600 kilowatts ([Foster, Prociuk, & Samant, 2021](#)). Electricity is only generated when the streamflow is at least 15 cubic meters per second (530 cubic feet per second), while the total flow capacity at normal operational levels averages 35.4 cubic meters per second (1,250 cubic feet per second; [Foster, Prociuk, & Samant, 2021](#); [GBRA, 2018a](#)). The flow passes over the spillgates at the hydropower site when conditions for electricity production are not met ([Foster, Prociuk, & Samant, 2021](#)).

Lake Dunlap Dam, like most of the historical dams in the Guadalupe Valley Lakes region, used roof-weir bear trap gates to control the headwater reservoir levels. These include two independently rotating gates with hinges on both sides that operate based on water pressure and buoyancy ([Black & Veatch, 2019](#); [Daniel & Paulus, 2019](#); [GBRA, 2021c, 2023b](#); [TWDB, 2021](#)). The inside chamber was filled with water from upstream and pressure was built by wooden boards wedged together between steel trusses, which provided a seal as well as protected the underlying steel components, forcing the gate into the up position ([Black & Veatch, 2019](#); [Daniel & Paulus, 2019](#); [GBRA, 2020a, 2021c](#)). This is the largest and earliest documented construction of bear trap roof-weir spillgates in Texas ([Foster, Prociuk, & Samant, 2021](#)).

This type of roof-weir “provided a limited degree of control over the water level” ([Foster, Prociuk, & Samant, 2021](#), p. 14). During a flood event, the spillgate positions had to be manually adjusted to ensure that the specified spill-to-hold water level (0.5–1.5 centimeters [0.2–0.6 inches] below the spill-point level) was maintained; however, the design of the spillgates made it difficult to maintain a specified position ([Foster, Prociuk, & Samant, 2021](#)). Consequently, adjustments to put the spillgates in operationally desired positions were “made by trial-and-error experience[s]” of dam operators ([Foster, Prociuk, & Samant, 2021](#), p. 17). The design of the dams made it difficult to access components that required regular maintenance and impossible to inspect some components without draining the lake ([Daniel & Paulus, 2019](#); [GBRA, 2021c, 2023b](#); [TWDB, 2021](#)).

## Aging Dam Infrastructure

Prior to the acquisition by GBRA, Lake Dunlap Dam underwent one major reconstruction on the original southern embankment and retaining walls in 1932, after a flood washed it out, during which minor design improvements were implemented to reduce erosion along the northern and southern banks ([Foster, Prociuk, & Samant, 2021](#)). The dam was operated as it was originally designed until 1963, when GBRA acquired the dam and modernized the control systems ([Foster, Prociuk, & Samant, 2021](#)).

According to GBRA, regular maintenance was consistent with “significant repairs” after the floods of 1998 and 2002 (GBRA, 2019c, p. 5). However, in 2008, GBRA recognized the dams were “nearing the end of their useful life” and hired an engineering firm to conduct a comprehensive evaluation of the dams (GBRA, 2023b). The evaluations did not include inspection of some internal and upstream elements because the lakes did not allow for dewatering to allow access to underwater parts of the systems (GBRA, 2022d, 2023b). It is unclear whether this evaluation resulted in a plan for repairs to all the dams in the system. However, in 2012, GBRA replaced tie bars and locking bars, associated structural brackets, and miscellaneous structural steel components of the Lake Dunlap Dam (GBRA, 2020a). Four years later, the first dam failure occurred.

On March 9th, 2016, the Lake Wood Dam tie-bar, a major structural component that connects the upstream and downstream leaves of the spillgates, failed, causing the downstream leaf of one of the spillgates to separate from the dam’s concrete superstructure (GBRA, 2020a; TWDB, 2021). After the failure, hydroelectric operations ceased, but maintenance of the dam and embankments continued in accordance with TCEQ regulations (GBRA, 2020a; NID, 2022; TCEQ, 2022b; TWDB, 2021).

In April 2016, GBRA staff, contractors, and engineers began an engineering feasibility study to determine “the best option for replacement of the failed gate and the remaining gates in the Guadalupe Valley Hydroelectrical Division” (GBRA, 2016, p. 12; TWDB, 2021). GBRA hired an engineering firm to “assess the failure at Lake Wood and make recommendations related to repairs needed at Lake Wood and the other gates in the system” (GBRA, 2020a, p. 7). In November 2016, the engineering firm concluded that the “damaged gate at Lake Wood was unrepairable and the remaining spillgates in the system required replacement” (GBRA, 2020a, p. 7). On November 16th, 2016, the GBRA board of directors authorized the general manager, Kevin Patteson, to “negotiate and execute contract(s) with the lowest responsible bidder for gate repairs ... in accordance with the engineering feasibility study for the gate replacement and rehabilitation program for the Guadalupe Valley Hydroelectric Division” (GBRA, 2016, p. 12).

On Thursday, March 9th, 2017, GBRA hosted a public meeting on issues related to the Lake Wood Dam failure, where it (1) walked “constituents through the dam gate failure and the most plausible replacement options” under consideration, and (2) “explained the financial challenges related to replacing” the dam gates throughout GBRA’s hydroelectric system (GBRA, 2017, p. 4). One of the most significant challenges was financing the dam replacements because the “electricity generated and sold ... [by the Guadalupe Valley Hydroelectrical Division] ... no longer provide[d] the revenue needed to repair or maintain the existing system” (TWDB, 2021, p. 3). Further, Lake

Wood, and all the reservoirs composing the Guadalupe Valley Lakes, served no flood control purposes—excluding them from qualifying for existing state or federal relief programs (Dascher & Meitzen, 2020; GBRA, 2020a, 2023b; TWDB, 2021).

Nonetheless, in August 2017, GBRA began emergency repair activities on 10 of 15 spillgates to address critical components in need of immediate repair at Lake Wood Dam, as well as the other dams in the system (Daniel & Paulus, 2019; GBRA, 2017, 2019c, 2020a). GBRA planned to first repair the dams at Meadow/Nolte Lake and Lake Placid, with repairs on the dams at Lake McQueeney and Lake Gonzales to follow (GBRA, 2020a; TWDB, 2021). GBRA stated that the repair sequence was designed to “preserve [GBRA’s] ability to operate the remaining spillgates to pass elevated flows” (GBRA, 2018c, p. 5). According to a June 11th, 2018, press release from GBRA, the Lake Dunlap Dam was not included in the scheduled repairs because it had “received substantial repairs in 2012, and is believed to be in good operational condition” (GBRA, 2018c, p. 1).

Just months later, in November 2017, GBRA retained the services of the engineering firm Black & Veatch to design the spillgate replacements for all six dams in the Guadalupe Valley Hydroelectric system (GBRA, 2020a; TWDB, 2021). According to TWDB (2021, p. 6), a hydraulically actuated crest gate system “was determined to be the most robust and operationally efficient ... [and GBRA] contracted with Black and Veatch to develop a preliminary design ... [for the] replacement gates for the six similarly configured hydroelectric dams in the system.” The design work occurred concurrently with the emergency repairs (TWDB, 2021).

However, in 2019, maintenance and repairs on all spillgates across all Guadalupe Valley Lakes dams ceased for safety reasons—another failure had occurred (TCEQ, 2022b).

## FAILURE OF LAKE DUNLAP

At approximately 7:49 a.m. on Tuesday, May 14th, 2019, the structural steel hinges of Lake Dunlap Dam’s middle gate, one of three total gates, failed—causing the total detachment of the spillgate that ejected from the dam’s concrete superstructure downstream (Black & Veatch 2019; Dascher & Meitzen, 2020; GBRA, 2019b, 2020a, 2021c, 2023b; NID, 2022; TCEQ, 2022b; TWDB, 2021). The failure event “sent flows of up to 11,000 cubic feet per second (cfs) [311 cubic meters per second] downstream, resulting in the dewatering (draining) of the lake” (GBRA, 2020a, p. 2).

GBRA reported that:

On this day of routine operations, elevated flows were being diverted to pass through the hydropower turbines. These elevated flows were the result of scheduled releases upstream at the Canyon Lake Res-



**Figure 3.** Entire lake comparison. Map depicting entirety of Lake Dunlap, Texas. Version A shows imagery from 2018, before the dam failed ([Google Earth, n.d.-a](#)). Version B shows imagery from 2019, after the dam failed ([Google Earth, n.d.-b](#)).

ervoir. A water level notification received in the control room caused crews to be dispatched to restore the gate position and lake level. However, a review of the surveillance video showed the gate had completely separated from the dam. ([GBRA, 2020a](#), p. 4)

GBRA released a 30-second video showing the 7 seconds leading to the failure event and an additional 23 seconds of footage of the actual failure and post-events ([GBRA, 2019d](#)). This video, and edited forms of it, went viral on the internet, amassing tens of millions of views across numerous social media, media upload, and news platforms.

In both failures—Lake Dunlap Dam and Lake Wood Dam—the cause of the spillgate failures was due to multiple failures in the original steel components, a fact that intensified “concerns surrounding the unpredictability of spillgate failures” ([GBRA, 2019c](#), p. 5, [2020a](#), [2023b](#)). The hinge that failed was “embedded in the concrete superstructure behind the spillgates,” an area where dam elements were not evaluated due to their inaccessibility during the 2008 evaluation ([GBRA,](#)

[2023b](#)). In both cases, the reservoirs were effectively dewatered and left without hydroelectric production or recreational access (see Figure 3 and Figure 4 for imagery of Lake Dunlap; [Black & Veatch 2019](#); [Dascher & Meitzen, 2020](#); [TWDB, 2021](#)).

Black & Veatch ([2019](#)) indicated that the remaining four dams in the Guadalupe Valley Hydroelectric System were likely to have similar issues with their structural components. Dascher and Meitzen ([2020](#)) summarized that:

Though neither the Lake Wood or Lake Dunlap dam incidents met the [TCEQ] classification of a dam failure, they were portrayed as such in the media, and their very publicized damage sparked a highly controversial debate on what entity is responsible for the hazard liability, maintenance, and repair of aging dam infrastructure and who ultimately benefits from the dams. (p. 26)

Following the 2019 failure, USACE, Fort Worth District, and the Texas State Historic Preservation officer reassessed and determined Lake Dunlap Dam was eligible to be listed with the National Register of Historic Places under Criterion A (local



**Figure 4.** Zoomed lake comparison. Map depicting Lake Dunlap, Texas at its final bend before the dam. Version A shows imagery from 2018, before the dam failed ([Google Earth, n.d.-c](#)). Version B shows imagery from 2019, after the dam failed ([Google Earth, n.d.-d](#)).

community development) and Criterion C (engineering design qualities; [Foster, Prociuk, & Samant, 2021](#)). The report characterized the “integrity of location, design, materials, setting, feeling, and association to represent historically significant trends in water conservation and hydroelectric dam engineering as they were developed by Reclamation and the USACE and adapted by the design engineering firm, Fargo Engineering Company, for small-scale regional needs” of Lake Dunlap Dam as historically distinctive due to the “dam design qualities and engineering components that are not represented by other [National Register of Historic Places]-listed or [National Register of Historic Places]-eligible dams in the Guadalupe River Valley of Texas” ([Foster, Prociuk, & Samant, 2021](#), p. 4-5).

As a result of the dam failures, the physical landscapes of multiple lake communities were significantly altered: Houses were left hanging above barren riverbanks, once peaceful porches became falling hazards, and piers and boat ramps led only to a muddy, waterless lake bed. Appraisals for real estate across entire communities tanked, and the lifestyle and business of recreation ceased. It would take years to resolve the question of responsibility, the resolution of anger, and the journey to find a solution that these communities agreed was in their best interest.

## ORGANIZATIONAL RESPONSE TO THE FAILURE

GBRA formally announced the spillgate failure at Lake Dunlap Dam in a press release dated May 16th, 2019 ([GBRA, 2019b](#)). However, during a board meeting on May 15th, 2019, the directors acknowledged the dam failure and stated that their primary focus was ensuring that water deliveries to existing customers—including Canyon Regional Water Authority, Guadalupe Energy Center, and GBRA’s regional raw water clients (Hays Energy, Hays/Caldwell counties and the city of San Marcos)—continued ([GBRA, 2019e](#)). GBRA installed temporary pumps to continue withdrawing water, stating that “when river flows decrease a detailed assessment of the failure will be investigated” ([GBRA, 2019e](#), p. 3).

Due to the previous failure at Lake Wood Dam, GBRA’s contracted work with Freese and Nichols and Black & Veatch meant that (1) it was already informed that all the spillgates at all the dams across the entire Guadalupe Valley Hydroelectric System needed to be replaced; (2) all spillgates would be replaced by hydraulically actuated crest gates; and (3) 30% of the design and engineering work for construction was already completed ([GBRA, 2019b, 2019c, 2020a](#)). That same month,

GBRA directed Black & Veatch to finalize the remaining 70% of the design work for Lake Wood Dam, with plans to immediately pursue construction on Lake Dunlap Dam once financing was secured (GBRA, 2020a). The Authority's general manager, Kevin Patteson, said that "the ability to move forward with construction at Lake Dunlap, Lake Wood, and the other dams is dependent on securing funding for these multi-year, multi-million dollar projects" (GBRA, 2019b, p. 3). At this point, the design was expected to take an additional year to complete—with construction expected to take 2–3 years—at a cost of approximately \$15–\$35 million per dam (GBRA, 2019b).

State institutions, such as the Legislature, responded to the catastrophic failures at Lake Wood Dam and Lake Dunlap Dam. In 2019, the 86th Legislature amended Subchapter B, Chapter 201 of the Texas Agricultural Code by adding the following, Section 201.0227 (d-1):

The water development board, in coordination with the [Texas State Soil and Water Conservation Board] and the Texas Commission on Environmental Quality, shall prepare a report of the repair and maintenance needs of all dams that:

- (1) Are not licensed by the General Energy Regulatory Commission;
- (2) Do not have flood storage;
- (3) Are required to pass floodwaters; and
- (4) Have failed. (TWDB, 2021, p. 4)

With this change in statute, the Texas State Soil and Water Conservation Board and other agencies identified which dams met the criteria, resulting in two: Lake Wood Dam and Lake Dunlap Dam (TWDB, 2021). TWDB and TCEQ then coordinated with GBRA to produce a comprehensive report on the repair and maintenance needs for these dams published in November 2021 (TWDB, 2021).

After the failure, GBRA hired Black & Veatch to evaluate the damaged components (Dascher & Meitzen, 2020; GBRA, n.d.). The resultant hinge inspection report focused on one of the hinge assemblies from Lake Dunlap Dam and reported that the spillgates across the system had warping and misalignment issues within the structure because of debris impacts and vibration during repeated flood events leading to the deterioration and instability of the structural steel components (Black & Veatch 2019; GBRA, 2020a, 2021f). The report stated that additional inspection of these components at other dams in the system would require the dewatering of the lakes and destruction of critical components, an expensive process that would have impacts on the communities (Black & Veatch 2019). Without inspecting the other components but considering the historical and engineering evidence, the engineers concluded that the hinge assemblies were no longer adequate for service

and recommended the dams be taken out of operation (Black & Veatch 2019; GBRA, n.d.).

As a result of the failure of Lake Dunlap Dam and the engineering report by Black & Veatch (2019), which was the second third-party engineering evaluation of the dams over the course of 3 years (2016–2019), GBRA took the position that other dam failures were imminent and voluntarily dewatered the remaining four lakes in the system as a preventative measure to reduce the risk of failure (Dascher & Meitzen, 2020; GBRA, 2019c, 2019f, 2019g, n.d.). GBRA coordinated with the Texas Parks and Wildlife Department to develop a dewatering plan that minimized impacts on the environment (GBRA, 2019a, 2019c, 2019g, 2019h). The dewatering was scheduled to begin on September 16th, 2019, and finish by the end of the month (GBRA, 2019c). Dewatering would take 3 days per lake, and GBRA would work downstream to upstream: Lake Gonzales, Meadow Lake, Lake Placid, and then Lake McQueeney (GBRA, 2019c). Members of the community were not pleased with GBRA's decision.

## LEGAL RESPONSE TO THE FAILURE

GBRA's plan to dewater the lakes that were not in a state of failure, as Lake Dunlap and Lake Wood were, was met with immediate backlash and concern for the local economy, personal property, and lifestyle from the communities (Baugh, 2019; Brown, 2020; GBRA, 2019a, 2019g, 2019h; Kless, 2021; Short et al., 2019). On July 17th and August 21st, 2019, GBRA's board of directors held public meetings (with 260 and 160 individuals in attendance, respectively) where they heard comments from 20 (July) and 32 (August) members of the community, including Texas State Representative John Kuempel, Guadalupe County Judge Kyle Kutscher, and City of Seguin Mayor Don Keil (GBRA, 2019a, 2019g). The comments focused entirely on desires to maintain the lake levels in locations where the dams had not yet failed, replace the dams, and restore the lakes where dams had already failed (GBRA, 2019a, 2019h).

Two lawsuits were filed against GBRA. The first, *Kevin Skonord et al. v. Guadalupe-Blanco River Authority* (Cause No. 19-2053-CR), was brought by property owners from Lake McQueeney and Lake Placid and focused on stopping the dewatering of the lakes, ensuring the maintenance of normal operational water levels until solutions were found and getting GBRA to financially contribute to whatever solution was developed (25th Judicial District Court of Guadalupe County, 2019). The second lawsuit, *Jimmy and Cheryl Williams et al. v. Guadalupe-Blanco River Authority* (Cause No. 19-2054-CV), also intended to stop GBRA from dewatering the lakes, but it later focused on pursuing GBRA for damages due to the destruction of aesthetic and recreational value that resulted in reduced property values (25th Judicial District Court of

[Guadalupe County, 2019](#); [Dascher & Meitzen, 2020](#); [GBRA, 2021a](#); [Kless, 2021](#)).

On September 5th, 2019, the plaintiffs in both suits filed a request for an order to joinder the defendants in the pursuit of a temporary injunction that would stop the dewatering of the lakes and ensure that normal operating levels were maintained ([25th Judicial District Court of Guadalupe County, 2019](#); [GBRA, 2020b](#)). On September 11th, 2019, the court conducted an evidentiary hearing, ruling that the plaintiffs' suits could be joined and issuing a temporary restraining order preventing the lakes from being dewatered by GBRA until the outcomes of the temporary injunction hearing ([25th Judicial District Court of Guadalupe County, 2019](#); [Brown, 2020](#); [Dascher & Meitzen, 2020](#)).

All parties came to an agreement, and on September 16th, 2019, the Honorable Stephen B. Ables of the 25th Judicial District Court of Guadalupe County issued an agreed temporary injunction (*Kevin Skonnord et al.* [Plaintiffs] [Cause No. 19-2053-CV] v. *Guadalupe-Blanco River Authority* [Defendant], v. *Jimmy and Cheryl Williams et al.* [Plaintiffs] [Cause No. 19-2054-CV]), which established that:

- GBRA is enjoined from the dewatering, drawing down, or draining of the lakes except as otherwise permitted by the order—requiring that water levels remain the same as they were under normal operating conditions on September 11th, 2019;
- GBRA may maintain its restrictions on activity and recreation in areas GBRA has designated unsafe—effective 12 a.m. on September 19th, 2019—until an evaluation can be conducted by independent experts to identify areas that are unsafe and make recommendations;
- all parties shall reasonably cooperate; and
- an independent expert panel shall be created to evaluate and make recommendations on areas, and activities in those areas, which should be prohibited and restricted, due within 30 days; and (5) a full trial for October 5th, 2020 ([25th Judicial District Court of Guadalupe County, 2019](#); [Independent Expert Panel, 2019](#); [Brown, 2020](#); [Dascher & Meitzen, 2020](#); [GBRA, 2019i](#), [2020b](#)).

As a result of this ruling, on September 25th, 2019, GBRA issued an ordinance to bring its activities and operations into compliance ([GBRA, 2019i](#)). These ordinances superseded the original ordinances issued by GBRA and installed new temporary rules to prohibit and restrict activities on the lakes that would be in effect until the conclusion of the independent expert panel ([25th Judicial District Court of Guadalupe County, 2019](#); [Brown, 2020](#); [GBRA, 2019i](#)).

The independent expert panel was composed of three independent engineers, with the goal of producing an unbiased opinion on the safety of the lakes ([25th Judicial District Court](#)

[of Guadalupe County, 2019](#); [Independent Expert Panel, 2019](#); [Brown, 2020](#); [TWDB, 2021](#)). The composition of the independent expert panel was determined by the terms of the agreed temporary injunction. GBRA assigned Samuel K. Vaughn of HDR Engineering, Inc.; the plaintiff assigned Gregory R. Wine of Huitt-Zollars, Inc.; and the assigned independent experts, in a review of four candidates, selected W. Nim Kidd, the chief of the Texas Division of Emergency Management ([Independent Expert Panel, 2019](#)). The independent expert panel filed their final assessment with the 25th Judicial District Court of Guadalupe County on November 15th, 2019, validating GBRA's safety concerns, with the entire panel concluding that specific areas around the dams must be prohibited or restricted from use for activities ([Independent Expert Panel, 2019](#); [GBRA, 2020b](#), [2022b](#); [TWDB, 2021](#)). GBRA implemented the measures recommended by the independent expert panel, with enforcement by local authorities until replacement gates are constructed or the dams are decommissioned ([Brown, 2020](#); [GBRA, 2020b](#); [TWDB, 2021](#)).

The *Kevin Skonnord et al. v. Guadalupe-Blanco River Authority* (Cause No. 19-2053-CR) suit was settled on July 30th, 2020, resulting in a cancellation of the full trial that was scheduled for October 2020 ([GBRA, 2020c](#)). As part of the settlement, GBRA agreed to only drain what is necessary to replace the dams and only just prior to the work ([GBRA, 2020c](#), [2020b](#)). Additionally, GBRA agreed to commit revenues from the sale of hydroelectric power at each lake to the water control and improvement district (WCID) of that lake in perpetuity ([GBRA, 2020c](#)). After the completion of the project, GBRA agreed to continue to perform operations and maintenance of the dams ([GBRA, 2020c](#)).

Just weeks later, on August 20th, 2020, the *Jimmy and Cheryl Williams et al. v. Guadalupe-Blanco River Authority* (Cause No. 19-2054-CV) suit was mostly dismissed when the court ruled in favor of the dismissal of all but two claims, which the court found appropriate to be taken up by the appeals court ([GBRA, 2020d](#)). However, the court warned that if the two claims were returned, they were likely to be dismissed ([GBRA, 2020d](#)). GBRA's general manager stated that the "results should encourage the lake residents to work with [GBRA] to find a sustainable solution," and that "[i]t is our firm belief that the viable way forward is to follow the path we are taking with the three Water and Control Improvement Districts (WCIDs) that have recently been created" ([GBRA, 2020d](#), p. 3).

Nearly 1 year later, on July 7th, 2021, the Fourth Court of Appeals decided that the plaintiffs in the *Jimmy and Cheryl Williams et al. v. Guadalupe-Blanco River Authority* (Cause No. 19-2054-CV) case lacked legal standing to sue GBRA ([2021f](#); [Kless, 2021](#)). The judge ruled that the damage to aesthetic and recreational value concerned itself with injury to the commu-

nity at large, which was different from the particularized injury required of personal loss/injury they would have to prove they suffered at the hands of GBRA to continue the suit (GBRA, 2021a). A lawyer for the plaintiffs expressed their disagreement with the ruling, stating that “it’s very brief and it doesn’t even refer to the basis of our lawsuit . . . The court took an instructive case as opposed to an applicable case and went off on the decision” (Kless, 2021, p. 10-12). The lawyer went on to express interest in proceeding with the case in a different court stating that, if they were not successful, they could go to the Texas Supreme Court on an application for review (Kless, 2021).

The final resolution came on June 6th, 2022, when the Texas Supreme Court denied the plaintiff’s petition to review, affirming the decision by the Fourth Court of Appeals and making the dismissal of all claims against GBRA final and immediate (GBRA, 2021a, 2023c). GBRA’s general manager stated that:

We are pleased with today’s timely and decisive decision from the Court of Appeals . . . The decision further demonstrates that cooperation and collaboration is the path forward for the Guadalupe Valley Lakes. The collective effort continues to yield results: Construction is underway on the Lake Dunlap [D]am with Lake McQueeney and Lake Placid to follow, thanks to the formation and voter confirmation of Water Control and Improvement Districts (WCIDs). (GBRA, 2021a, p. 3)

## PRESERVE LAKE DUNLAP ASSOCIATION’S RESPONSE TO THE FAILURE

While the lawsuits were beginning, another organization was springing into action. On May 14th, 2019, the day of the dam failure, the Preserve Lake Dunlap Association (PLDA) made a post on its website announcing the failure and urging residents to contact their state representatives, State Senator Donna Campbell and Representative John Kuempel, regarding the restoration of Lake Dunlap Dam (PLDA, 2019k). Four days later, PLDA announced that Representative Kuempel made a \$35 million amendment to Senate Bill 8, which, if passed, would fund the repair of the dam (PLDA, 2019m). The next day, Senator Campbell shared a letter with PLDA, which was sent to the Office of the Texas Governor, where she expressed concerns about the failure and requested financial assistance on \$28 million in estimated costs (PLDA, 2019a). However, just 6 days later, PLDA urged community members to make a last-minute appeal to the governor’s office in addition to State Senator Jane Nelson’s office as the funding amendment to the bill did not pass muster with the Senate Committee on Finance (PLDA, 2019e). PLDA pointedly blamed Nelson, the senate chair for appropriation, saying she “failed the people of Texas” (PLDA, 2019e, p. 1).

PLDA next communicated with the community when it announced a town hall meeting for June 5th, 2019 (PLDA, 2019l). In addition to PLDA’s board, representatives from GBRA’s management, county representatives, and members of the Texas senate and house were there to provide information about the status of funding and repair of the dam (PLDA, 2019l). PLDA accepted that the funding requests had failed and that nearly all options were exhausted (PLDA, 2019l).

On June 19th, 2019, the GBRA board of directors held a public meeting where they were briefed on several meetings held with homeowner associations, Guadalupe County officials, the governor’s office, and a Washington, D.C., delegation (GBRA, 2019f). PLDA’s president, J. Harmon, addressed the GBRA board and informed them that PLDA had begun paperwork for the creation of a WCID to assist with funding the replacement of the dam (GBRA, 2019f). Just weeks later, on June 24th, PLDA announced a restoration proposal that, for the first time, brought into focus the potential future of the Lake Dunlap Dam and other dams in the Guadalupe Valley Hydroelectric System (PLDA, 2019c). Homeowners on Lake Dunlap attributed the rapid development of a solution to replace the dams to influential and knowledgeable individuals, political will, and a sense of urgency (Adams, 2022). Some community members expressed the benefits of returning the lake to a natural form, as a river, noting less recreational traffic, which would reduce noise and increase safety. However, they also noted that the permanent removal of the dam would affect property values and lifestyles (Adams, 2022). The parties making the decisions were the ones with strong incentives for the dams to be rebuilt—GBRA to preserve power generation and water supply and PLDA to preserve the economic value of real estate, aesthetics, and lifestyle—so it is not surprising that the focus was on replacing the dams rather than removing them.

## CREATING A WATER CONTROL AND IMPROVEMENT DISTRICT

GBRA’s inability to finance the dam spillgate replacements and other repairs had been known for years (GBRA, 2016, 2017, 2019b). In addition to not being able to qualify for existing state and federal funds, GBRA’s hydroelectric operations had not produced adequate revenue to cover the cost of maintenance and operations for over 10 years (Dascher & Meitzen, 2020; GBRA, 2020a, 2020b, 2021d).

On June 24th, 2019, PLDA announced that its ongoing collaboration with local government agencies and local political leaders to source funding for the replacements and repairs had failed, stating “the fact is that unless we come together with one mind, determined to create a solution where none currently exists, the lake is going to stay the way it is” (PLDA,

2019c, p. 6). PLDA discussed a proposal for the waterfront property owners to step in and fix the dam themselves by creating a WCID, a proposal PLDA's board approved in a meeting the night prior with more than 100 PLDA members in attendance (Brown, 2020; PLDA, 2019c). A key financial feature of WCIDs is that they can levy taxes. The goals of the proposed WCID were to (1) restore and preserve the value of the waterfront property along the shores of Lake Dunlap; (2) restore the economic viability of businesses that support recreation on Lake Dunlap; and (3) ensure that the dam is repaired in a way that preserves the legacy of Lake Dunlap for families and future property owners for generations to come (PLDA, 2019c).

PLDA created an advisory committee, composed of local business and community leaders, that assisted PLDA's board by (1) advising PLDA on communication strategies and materials and associated tasks; (2) looking at the bond/debt markets and developing financial projections; (3) assisting TCEQ with the application for creating the WCID; (4) advising on the development of web and email strategies and, ultimately, the bond election; (5) helping the public understand the engineering work GBRA had done; and (6) looking at all options for funding (PLDA, 2019c, 2019d).

In the first week of July 2019, PLDA issued a notice to members that stated the Friends of Lake McQueeney announced its lack of involvement in a publicly disclosed lawsuit that had been recently filed against GBRA (PLDA, 2019h, 2019j). One week later, on July 16th, PLDA clarified that a demand letter had been sent to GBRA, GBRA's board members, a list of state and local leaders, and a list of members of the local business community by Douglas Sutter of the firm Kelly, Sutter, and Kendrick, PC, who was representing plaintiffs in the *Jimmy and Cheryl Williams et al. v. Guadalupe-Blanco River Authority* (Cause No. 19-2054-CV) case (PLDA, 2019j). On July 3rd, 2019, the letter and other details were published in the local paper in Seguin, Texas, with a meeting and press conference to occur between the lawyer and GBRA later that week (Bustamante, 2019; PLDA, 2019j).

In both notices to members, PLDA clarified its non-involvement in all those affairs, stating that “we want to be clear that we are neither part of this lawsuit, nor do we endorse any part of it, or support the action in any way” (PLDA, 2019j, p. 3). PLDA also clarified in both statements that its preference was to “work together as a community, standing with our neighbors, local leaders, government, and business to solve the problems we are currently facing” (PLDA, 2019j, p. 4) and to work in the “spirit of collaboration, community, and full transparency” (PLDA, 2019h, p. 8). PLDA went on to state that it had entered a partnership with GBRA to create a WCID with

GBRA responsible for the restoration, upgrade, and future maintenance of the dam (PLDA, 2019j).

With the establishment of the formal partnership with GBRA, PLDA moved forward with creating the petition, required by the Texas Water Code, to create the WCID (PLDA, 2019j). PLDA asked waterfront property owners who supported the creation of the WCID to file petitions for each parcel of waterfront property owned, a task that would satisfy one of the TCEQ requirements (PLDA, 2019j). PLDA also hired a lawyer, Tony Corbett of McLean and Howard, LLP of Austin, to represent it in the application process to create and approve the WCID (PLDA, 2019f).

In a statement summarizing the week of August 24th, 2019, PLDA discussed another high-level meeting with several state elected officials, local business leaders, and local elected officials, among others, to discuss financial alternatives, including the possibility of a below-market interest loan from TWDB (PLDA, 2019g). PLDA also announced that the lake associations for Lake Dunlap, Lake McQueeney, and Lake Placid were having meetings to discover where “each lakes’ needs and interest align with the other, and where they might diverge” with “plans to continue these discussions, particularly in light of all the potential interest of the Water Board in our collective situation” (PLDA, 2019g, p. 3). This spirit of partnership was also shared by GBRA, which designated the lake associations as points of contact, in addition to supporting the lake associations’ efforts to find solutions that address each lake’s best path forward to the replacement and repair of the dams (GBRA, 2020a, 2021a, 2021d).

The biggest news came just 6 weeks later, near the beginning of October 2019, when PLDA announced that the GBRA board of directors voted unanimously to approve and endorse a memorandum of understanding with PLDA (PLDA, 2020c). This memorandum of understanding was a broad stroke of a plan to fulfill the goals of the WCID—repairing the Lake Dunlap Dam and keeping it filled for generations to come (PLDA, 2020c). PLDA clarified that the next steps were “working with GBRA, our lawyers, and our advisors on the many details that we need to work through to turn the [memorandum of understanding] into a formal contract we can share with the voters” (PLDA, 2020c, p. 4).

With the establishment of a formal relationship between GBRA and PLDA, bureaucratic and engineering work by GBRA, and a clear direction for PLDA's advisory committee, the organizations entered a period of significant work. During this period, PLDA continued contract negotiations with GBRA, using the previously established memorandum of understanding as a foundation for the formal contract, which would eventually need to be approved by TCEQ and the Texas

Office of the Attorney General (PLDA, 2020b). PLDA also continued to work on various items required for the review and official formation of the WCID, including ensuring everything was in place for the deadline to file for the May 2nd, 2020, election (PLDA, 2020b, 2020c).

On January 28th, 2020, GBRA published a market analysis that identified changes in property value across the Guadalupe Valley Lakes (Brown, 2020). The analysis determines values based on new restrictions put into place by GBRA as well as projections based on hypothetical assumptions that WCIDs were established to negotiate the repair of dams to be completed within 3 years which reestablished lake levels to prior levels (Brown, 2020). The analysis predicted an initial decrease in values of 28% for land, 33% for land in unsafe zones (prohibited unsafe zones are those designated by the Guadalupe-Blanco Authority, with consultation, and approved by a court order, that are deemed unfit for activity on or in the water), and 28% for lakefront houses with the predicted delta value for January 1st, 2025, as 10% for land, 10% for land in prohibited unsafe zones, and 0% for lakefront houses (Brown, 2020). The analysis also identified Lake Dunlap lakeshore properties as having a total 2019 market value of \$270,851,301 across 569 property owners (Brown, 2020). Dascher and Meitzen (2020) noted the benefit to county school districts because of the lakeside property tax—a tax base that was significantly impacted by the initial failure event and had the potential to lower even more if the lakes were drained or the dams removed.

A couple of weeks later, on February 7th, 2020, the creation order for Lake Dunlap WCID was approved by TCEQ (PLDA, 2020a). The WCID is located within Comal and Guadalupe counties and has a population of approximately 1,375 residents (TWDB, 2021). The order also named a temporary board, with some members also being PLDA board members who had led the WCID creation effort (PLDA, 2020a). PLDA noted that, moving forward, it needed to detach from the work of Lake Dunlap WCID and “return to its longstanding, community-focused mission” (PLDA, 2020a, p. 6).

The next step was for registered voters of Lake Dunlap WCID to vote in the May 2nd, 2020, election to ratify the creation of Lake Dunlap WCID, authorize it to levy a tax, and vote for board members to fill the seats of Lake Dunlap WCID, all details that would emerge by the March 18th town hall meeting (PLDA, 2020a). Yet while PLDA moved rapidly to prepare voters, and other items, for the May 2nd, 2020, election, the COVID-19 pandemic struck just before the March 18th town hall meeting, resulting in the vote being postponed to November 3rd, 2020 (PLDA, 2019b, 2020b).

In the meantime, PLDA and GBRA finalized contract negotiations with both boards, approving final terms and submitting them for review by TCEQ and the Texas Office of the Attorney General (PLDA, 2019b). GBRA agreed to contribute 100% of the gross hydroelectric revenues from Lake Dunlap for the life of the 30-year loan (valued at approximately \$21 million), with the expectation that the modern dam technology would be able to increase those revenues (PLDA, 2019b). GBRA also contributed the entire cost of the engineering, valued at approximately \$3 million, for the design of the Lake Dunlap Dam (PLDA, 2019b). Lake Dunlap WCID would then levy taxes against property owners to pay the remaining balance (estimated at \$4 to \$6 million at the time; PLDA, 2019b).

Leaders within PLDA created a political action committee called Restore Lake Dunlap to influence voters. Because PLDA was unable to directly engage in political activities, the political action committee was created as a completely independent organization with the goal to work parallel to PLDA in the passage of the relevant ballot measures in the November 3rd vote (PLDA, 2019b). The political action committee organized neighborhoods to get out the vote, disseminated information regarding the vote, conducted email and mail campaigns, and organized meetings, all in support of the ballot measures that would support the replacement, repairs, and ongoing maintenance of the Lake Dunlap Dam (PLDA, 2019b). Any voter who was registered at an address within Lake Dunlap WCID boundaries was allowed to vote on the approval of WCID, the associated propositions, and the board of directors (PLDA, 2019b, 2020c).

In August 2020, GBRA applied for financial assistance through TWDB’s Clean Water State Revolving Fund (TWDB, 2021). Totalling \$120 million, the application combined the spillgate replacements and repairs at Lake Dunlap, Lake McQueeney, and Lake Placid under a single project called the “Guadalupe Valley Hydroelectric System” (TWDB, 2021). Each proposed WCID would provide tax-supported revenues to pay the debt service for its portion of the financing if approved by voters in the election (TWDB, 2021). Six days before the election, on October 28th, 2020, TCEQ approved an order authorizing Lake Dunlap WCID to enter into a contract to levy a contract tax (TCEQ, 2020). This enabled Lake Dunlap WCID to levy two taxes, the contract tax and the maintenance and operations tax, and allowed GBRA to receive the tax payments (TCEQ, 2020). However, none of this would matter if Lake Dunlap WCID was not approved by voters.

Finally, on November 3rd, 2020, registered voters in the proposed WCID’s boundaries cast their ballots on the three propositions: Proposition A to create Lake Dunlap WCID, Proposition B to set an upper limit on the maintenance and

**Table 2.** Lake Dunlap Water Control and Improvement District election results from Comal and Guadalupe counties (November 3rd, 2020; [Comal County, 2020](#); [Guadalupe County, 2020](#)).

Propositions and candidates	Comal County (precincts 302 and 304) votes (% total)	Guadalupe County (precincts 117, 208, and 213) votes (% total)	Total votes (% total)
<b>PROPOSITION A</b>			
For	249 (88.6%)	484 (91.7%)	733 (90.6%)
Against	32 (11.4%)	44 (8.3%)	76 (9.4%)
<b>PROPOSITION B</b>			
For	219 (79.4%)	471 (89.4%)	690 (85.9%)
Against	57 (20.7%)	56 (10.6%)	113 (14.1%)
<b>PROPOSITION C</b>			
For	210 (77.5%)	473 (89.9%)	683 (85.7%)
Against	61 (22.5%)	53 (10.1%)	114 (14.3%)
J. Raymond Harmon	111 (22.4%)	377 (22.5%)	488 (22.5%)
Doug Harrison	112 (22.6%)	336 (20.1%)	448 (20.6%)
Laurence F. Johnson	100 (20.2%)	322 (19.2%)	422 (19.4%)
Harry Alvin Moeller	80 (16.1%)	330 (19.7%)	410 (18.9%)
Vernon Gary Schaub	93 (18.8%)	310 (18.5%)	403 (18.6%)

operations tax at \$00.10 per \$100.00 total assessed property value, and Proposition C to select Lake Dunlap WCID board members (Table 2). All the propositions were overwhelmingly (>85%) passed by voters ([Canterberry, 2020](#); [TWDB, 2021](#)).

One month after the vote, in December 2020, TWDB's governing board approved the Clean Water State Revolving Fund financial assistance totaling \$40 million in bond funding (GBRA, 2021a; [TWDB, 2021](#)). As a result of this approval, alongside all three propositions approved by voters, Lake Dunlap WCID was officially approved and could levy taxes to pay debt and future maintenance and operations ([TCEQ, 2020](#); [Lake Dunlap WCID, n.d.](#)).

TWDB approved its commitment to financial assistance to GBRA for repairs to Lake Dunlap Dam with GBRA selecting Zachry Group as the contractor for construction ([TWDB, 2021](#)). The project was implemented via a contract between GBRA and Lake Dunlap WCID ([TWDB, 2021](#)). TWDB provided GBRA with authorization to issue the formal notice to proceed on May 14th, 2021 ([GBRA, 2021a, 2021b](#)).

### Current Status of Lake Dunlap

GBRA initiated the construction phase to replace, rehabilitate, and update Lake Dunlap Dam in May 2021 (Figure 5; [GBRA, 2023a](#); [TCEQ, 2022b](#); [TWDB, 2021](#)). The project's estimated timeline was 24 months, pending weather events and

other delays, and was ultimately completed, impounded, and operationally resumed within 32 months, on November 2nd, 2023 ([GBRA, 2021a, 2023a, 2023b, 2023d](#); [TCEQ, 2022b](#)). An official opening ceremony was held in March 2024 ([GBRA, 2023d](#)). In a meeting of the GBRA board of directors in March 2024, the chairman congratulated staff on the event that was "held to commemorate the completion of [the] Lake Dunlap construction project and recognized Doug Harrison and Jay Harmon for the contributions of the Lake Dunlap Water Control and Improvement District and the Preserve Lake Dunlap Association for their collaborative efforts with GBRA on the project" ([GBRA, 2024a](#), p. 1).

The construction of the new spillgate required dewatering the area below the existing concrete, excavating about 6 meters (19.7 feet) into the mud of the river channel, and installing a concrete bulkhead about 6 meters (19.7 feet) upstream to form a maintenance dewatering system ([GBRA, 2021c, 2022d](#)). While the previous design did not allow for maintenance on the upstream side of the spillgates without completely dewatering the lake, the new maintenance system includes a dewatering system that employs a bulkhead to allow GBRA to dewater the upstream area and complete maintenance ([GBRA, 2022d](#)). In all, GBRA removed numerous original dam components; structurally modified and hardened the earthen dam components; structurally modified the spillway; installed three



**Figure 5.** One year into the construction phase, Lake Dunlap Dam. A photo of construction on the Lake Dunlap Dam. May 26th, 2022. Photo by Andrew Adams.

hydraulically actuated steel crest gates; and made upgrades to the mechanical, electrical, and safety systems (GBRA, 2023d).

Throughout the construction process, GBRA provided regular updates through a combination of press releases, update videos, and informational websites, such as [www.gvlakes.com](http://www.gvlakes.com), which hosts information regarding the state of affairs for all the lakes and dams in the Guadalupe Valley Hydroelectric System (GBRA, 2020a, 2021b, 2021c, 2022d, 2023a, 2023b, 2023d).

## DISCUSSION

Over the course of 4.5 years, the Lake Dunlap community was able to move through the complex bureaucratic and social processes required to establish agential and regulatory powers; form beneficial cooperative agreements; design and construct a replacement dam system; and reestablish the lake and hydroelectric power generation. Their goals, and the solutions to achieve them, were followed by other communities along the Guadalupe River, including those that initially pursued lawsuits over collaboration.

In November 2020, communities in the Guadalupe Valley Lakes region created and confirmed two new WCIDs in addition to Lake Dunlap WCID: the Lake McQueeney WCID and the Lake Placid WCID (Dascher & Meitzen, 2020; GBRA, 2023a, 2023d; TWDB, 2021). The process and terms for both lakes were very similar to the agreements made and processes undertaken between PLDA and GBRA. GBRA was able to

secure \$40 million in bond funding for both WCIDs—\$80 million total—via TWDB’s Clean Water State Revolving Fund, at below-market interest rates (GBRA, 2021a; TWDB, 2021). The publication of the *Senate Bill 8 Report of the Repair and Maintenance Needs of Lake Wood and Lake Dunlap Dams on the Guadalupe River* in November 2021 revealed that the listed plans for the replacement and rehabilitation of Lake McQueeney Dam and Lake Placid Dam will also be the same as what was done at Lake Dunlap Dam (TWDB, 2021). The design phase of the engineering of both the Lake McQueeney and Lake Placid replacement dams was expected to be completed by November 2021, with the construction to begin in spring 2022 (Friends of Lake McQueeney, 2021; Lake Placid WCID, 2022a; TCEQ, 2022b). However, GBRA was required to obtain additional permits (wetland mitigation requirements, environmental requirements, and cultural resource requirements) for Lake McQueeney and Lake Placid—permits that were not needed for Lake Dunlap—which delayed the construction (Lake Placid WCID, 2022a, 2022b).

Meanwhile, on August 3rd, 2021, another failure occurred when a large tree hit the spillgate at the Lake Gonzales Dam while the gate was partially lowered (GBRA, 2021d). While the tree passed through the gate within minutes, when operators tried hours later to raise the spillgate to its normal position of 3.7 meters (12.1 feet), the spillgate would not rise and lowered to a fully open position within 5 minutes (GBRA, 2021d, 2021e).

Two months later, on October 14th, 2021, GBRA partially lowered the spillgates of the Lake Placid Dam to pass heavy rainfall with flows exceeding 425 cubic meters per second (15,009 cubic feet per second), and the spillgate became unresponsive, ultimately dropping to a fully open position (GBRA, 2021f). An evaluation report by Black & Veatch noted “permanent and significant deflection, or warping, in the upstream leaf of the spillgate” (GBRA, 2021f, p. 3).

As it stands, GBRA began construction on the dam restoration projects at Lake McQueeney and Lake Placid on June 19th, 2023 (GBRA, 2023a). The anticipated completion date for the Lake Placid Dam is April 2025, while the Lake McQueeney Dam is expected to be completed 2 months later in June 2025 (GBRA, 2023a). Both projects will include the replacement of the roof-weir bear trap spillgates with hydraulically actuated steel crest gates; structural modifications to the existing spillway structures, including the hardening of the earthen dam structure; installation of updated mechanical and electrical operating systems; improved safety systems and backup power; enhanced instrumentation and controls, including headwater and tailwater measurement tools as well as control and data interfaces; and a dewatering system that enables maintenance activities to take place while the lake is at full levels (GBRA, 2023a).

While some communities, such as Lake Dunlap, Lake McQueeney, and Lake Placid, have the tax base and development to support the creation of WCIDs to pay for dam replacement, repair, and maintenance, other communities do not (Brown, 2020; Dascher & Meitzen, 2020; GBRA, 2021b, 2023b). There is also a lack of existing state or federal funding assistance because the dams are not flood control structures (Dascher & Meitzen, 2020). To date, Lake Wood and Lake Gonzales are partially dewatered because of dam failures, and Meadow Lake has been drawn down by order of GBRA. All three are without prospect for dam replacement or repair without the support of state and federal funding assistance and stakeholder partnerships (Dascher & Meitzen, 2020; GBRA, 2020b, 2021b, 2021d, 2021e; TCEQ, 2022b). As the Senate Bill 8 report stated, “the availability of funding has a direct impact on the ability to move forward with design, construction, and installation of necessary replacement gates. Ultimately, these steps will be needed ... to restore the dam[s]” (TWDB, 2021, p. 9).

Lake McQueeney, Lake Placid, Lake Wood, Meadow Lake, and Lake Gonzales all have some combination of prohibited and/or restricted areas due to a combination of recognized risks of dam failures, destroyed and/or damaged spillgates, and partial dewatering (GBRA, 2020b, 2022b, 2023a, 2023b, 2023d; Independent Expert Panel, 2019; TWDB, 2021). These prohibited and restricted areas are temporary safety measures, rec-

ommended by the independent expert panel that have been “implemented by court order until replacement gates can be constructed or dams decommissioned” (GBRA, 2023b, 2023d; TWDB, 2021, p. 3).

This case study highlights the social, legal, political, and other bureaucratic challenges of managing dam infrastructure and documents the Lake Dunlap community’s unique solution to the Lake Dunlap Dam failure. The dynamic journey to find agreeable terms for collaboration between the community and the river authority that owns the dam provides other communities facing dam failure with a baseline of knowledge for issues and processes that may lead to resolution. This solution has already influenced other communities in the region who are following suit; however, this case study also revealed that multiple communities facing similar issues posed by aging dam infrastructure will need alternative, less costly solutions. Future studies ought to consider the feasibility of reconstruction for aging dams across the state as well as the potential for alternatives. Policymakers, dam managers, and other stakeholders can use the example of the Guadalupe Valley Lakes dam failures and aftermath to inform policy and management regarding Texas’s vast and aging dam infrastructure.

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## Appendix

### DAMS OF THE GUADALUPE VALLEY LAKES REGION

Information on all six reservoirs and dams owned and operated by the Guadalupe-Blanco River Authority (GBRA), which constitute the Guadalupe Valley Lakes region (data from GBRA [2018a] and National Inventory of Dams [2022]). NID ID = National Inventory of Dams Identification Number. TCEQ = Texas Commission on Environmental Quality.

<b>Reservoir name</b>	<b>Dam name</b>	<b>Public water supply?</b>	<b>NID ID (Federal ID)</b>	<b>TCEQ assessment unit</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Number of spillgates</b>	<b>Hazard category</b>
Lake Dunlap	TP-1 Dam	Yes	TX01602	AU1804_04	29.65399	-98.0663	3	High
Lake McQueeney	McQueeney Dam	Yes	TX01601	AU1804_03	29.59436	-98.0407	3	High
Lake Placid	TP-4 Dam	Yes	TX01600	AU1804_02	29.54845	-97.9996	2	High
Meadow Lake	Nolte Dam	Yes	TX01599	AU1804_02	29.52883	-97.9395	3	High
Lake Gonzales	H-4	No	TX01912	AU1804_05	29.49582	-97.6245	2	High
Lake Wood	H-5 Dam	No	TX01913	AU1804_01	29.46836	-97.4921	2	High