Section 14 – Long Term Peak Day Demand – Year 2040 – Canyon Lake #7

Content

a. Map of Lake #7
b. Region O Water Plan for Lake #7 (Includes Lake #8)
c. 1969 Feasibility Report on Canyon Lakes Project

Summary

The Bailey County Well Field has produced water now for over 50 years, and it has a projected future life of an additional 50 years if pumping is limited to 10,000 acre-feet annually, or less. Additional wells will be necessary to keep production levels up as water levels continue to decline. Eventually the BCWF may not be able to provide 10,000 acre-feet of water annually to Lubbock.

Annual production will drop from the 10,000 acre feet annually down to the annual recharge amount of 3,400 acre-feet or less. There will be some corresponding decrease in the gallons per day capacity since it will not be financially feasible to drill enough wells to keep production levels up. This means that the City will gradually lose up to 50% of the existing peak day capacity. The BCWF now delivers up to 40 million gallons per day (mgd). This peak day capacity must be replaced.

Canyon Lake #7, which would be located just southeast of Lubbock upstream from Buffalo Springs, may provide a means to meet this need. Both Canyon Lakes #7 and #8 were initially proposed as a way to supplement Lake Alan Henry by capturing water in the North Fork, and this alternative was included as an option in the Region O Water Plan. As discharge modeling efforts progressed between Black and Veatch, the City's engineer, and the Texas Commission on Environmental Quality (TCEQ), it was determined that the lakes may not be beneficial due to the lack of sufficient stream time before wastewater effluent reaches the lakes. This created a problem with predicted oxygen depletion in the lakes that the TCEQ might not approve.

At first it was proposed to drop both Lakes #7 and #8 from the plan due to the oxygen depletion possibility. Now it is proposed that only Lake #8 be dropped. Retaining Canyon Lake #7 would allow the City to benefit from local storage to address peak day demands, while maintaining the ability to discharge reclaimed water and capture it in this lake. Wastewater effluent discharge modeling efforts will continue to contemplate the completion of immediate, intermediate and a long term plans, with the immediate and intermediate plans not including Canyon Lake #7, and with the long term plan including Canyon Lake #7. Discharge at the Southeast Water Reclamation Plant will likely be discontinued or substantially reduced when Lake #7 is constructed.

Until Lake #7 is developed, as much reclaimed water as possible would be discharged at the Southeast Water Reclamation Plant (SEWRP). With the options of discharge at the head of the Canyon Lake System, at the SEWRP, and at the existing FM 400 site east of Lubbock, the City could submit a permit application for discharge of all effluent. Once Lake #7 is constructed, permitted discharge in the Canyon Lakes upstream of Lake #7 will have some quantity limitations, while discharge below Lake #7 and Ransom Canyon may be permitted at 18 million gallons per day or more.

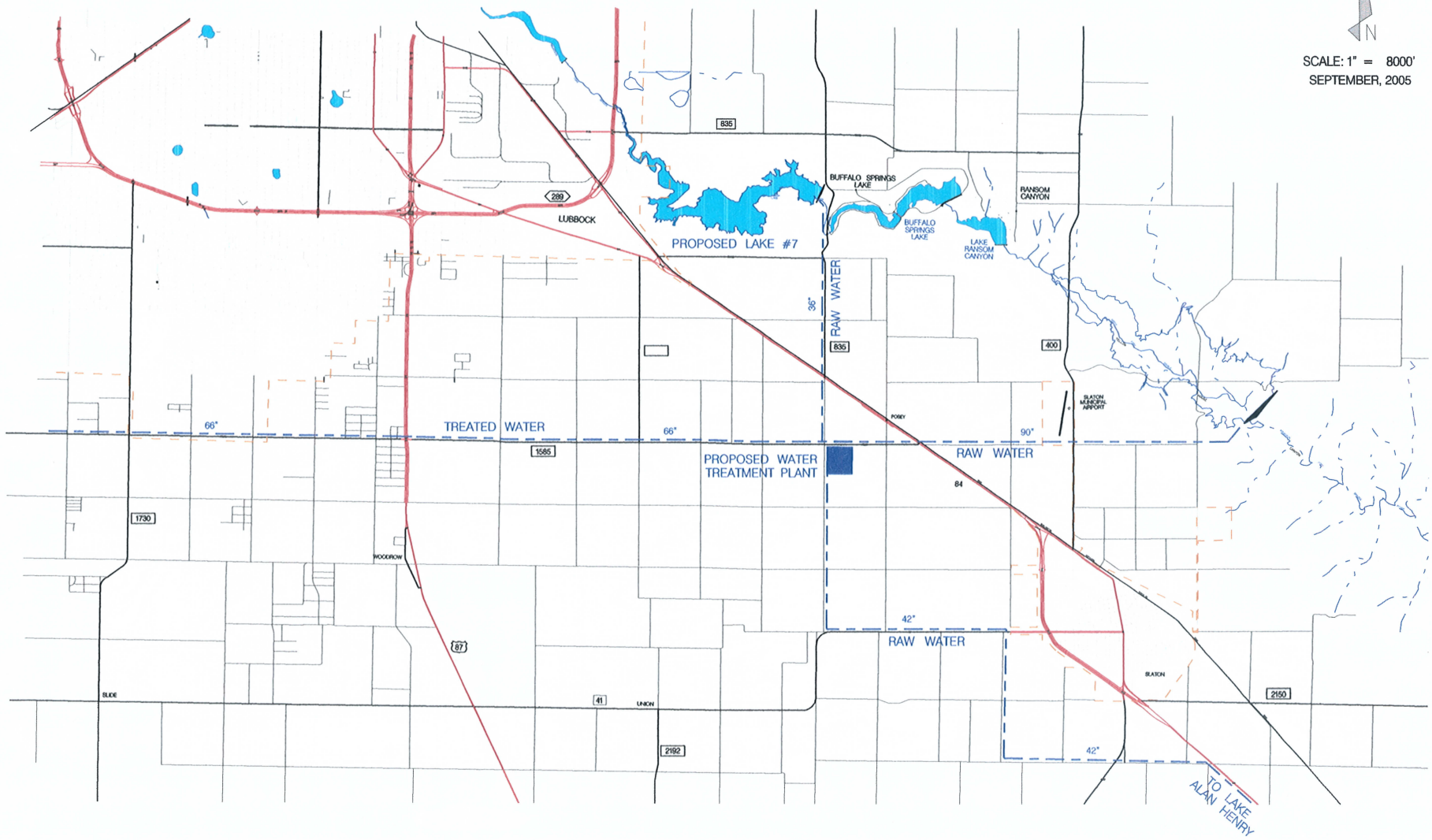
As an alternative to Lake #7, the City could consider recharging the Ogallala Aquifer in the Bailey County Well Field.

Section 14 – Future Supplement to Lake Alan Henry – Year 2030 - Post Reservoir Option

a. Map of Lake #7

STORM WATER AND RECLAIMED WATER SYSTEM
CITY OF LUBBOCK

CITY OF LUBBOCK
WATER UTILITIES



Section 14 – Future Supplement to Lake Alan Henry – Year 2030 - Post Reservoir Option

b. Region O Water Plan for Lake #7 (and #8)

4.4.3.7 Lubbock Jim Bertram Lake System (JBLS) Expansion

4.4.3.7.1 Description of Option[1]

This planning strategy would allow use of Lubbock's "developed water resources," including storm water collected within the City of Lubbock and transferred and discharged into the Yellowhouse Canyon, groundwater from the Lubbock Land Application Site, and treated wastewater (source of treated wastewater is groundwater and water from CRMWA) discharged into Yellowhouse Canyon. To achieve this, Lakes 7 and/or 8 from the Canyon Lakes System (now called the Jim Bertram Lake System) would be built to capture, store, and divert water (Figure 4.4-6). This water would be treated at a new water treatment facility located southeast of Lubbock. At some point in the future, water from Lake Alan Henry would also be treated at the same facility. This water would be transported to the south and southwest areas of Lubbock's service area. Key components of this system are:

- Lake 7: Storage Capacity: 20,700 AF
  Pump station & pipeline capacity: 4.65 MGD
  Pipeline length: 21,200 feet
  Pipeline diameter: 36 inches
- Lake 8: Storage Capacity: 49,900 AF
  Pump station & pipeline capacity: 26.7 MGD
  Pipeline length: 37,000 feet
  Pipeline diameter: 90 inches
- Water Treatment Plant: Capacity: 21 MGD (initially)
- Transmission main: Length: 79,200 feet
  Diameter: 66 inches

4.4.3.7.2 Quantity of Water Available

Water potentially available for impoundment in the proposed Lake 7 and Lake 8 was estimated using Run 3 of the Brazos River Basin Water Availability Model (Brazos WAM) developed by the Texas Commission on Environmental Quality (TCEQ)[2]. The model utilizes a timeframe from January 1940 through December 1997 hydrologic period

[1] "Lubbock, Texas; Feasibility Report on the Canyon Lakes Project," Freese, Nichols and Endress, Fort Worth, Texas, 1969.
[2] HDR Engineering, Inc., "Water Availability in the Brazos River Basin and San Jacinto-Brazos Coastal Basin," Texas Natural Resource Conservation Commission (now TCEQ), December 1991.

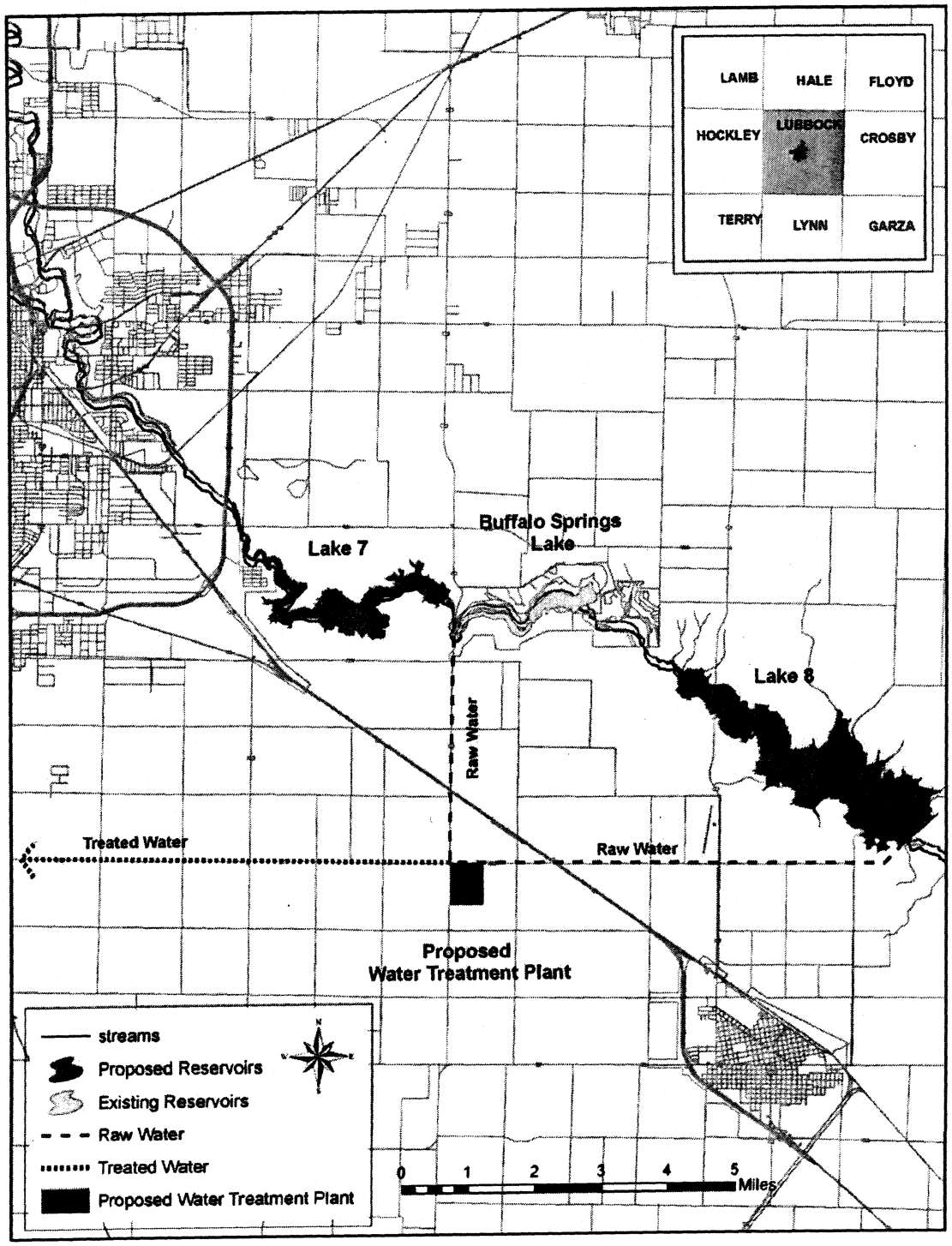


Figure 4.4-6: Lubbock Jim Bertram Lake System (JBLS) Expansion

of record to estimate water available to existing and potential water rights. The model assumes that existing perpetual water rights are fully utilized, reservoir storage capacity is as originally permitted, and wastewater treatment plant effluent is fully reused (zero return flows). The City of Lubbock has estimated that 22.9 million gallons per day (MGD) of effluent will be available in the future that can be dedicated to developing water supply from the reservoirs. These return flows are in excess of the 9 MGD for which the City has recently applied to the TCEQ for reuse authorization. The 22.9 MGD (25,648 acft/yr) of return flows were input into the Brazos WAM and used in conjunction with available unappropriated flows to develop firm yield estimates for Lakes 7 and 8. Other sources of developed water were not considered in the analysis, but could be used to augment firm supplies and also provide interruptible supplies in excess of the firm yield estimates presented herein.

Available unappropriated streamflows was determined by the Brazos WAM without causing increased shortages to existing downstream rights. Firm yield was computed subject to the reservoirs having to pass natural inflows to meet Consensus Criteria for Environmental Flow Needs (CCEFN) instream flow requirements. The streamflow statistics used to determine the Consensus Criteria pass-through requirements for the reservoirs are shown in Table 4.4-55. Only natural unappropriated flows were subjected to the CCEFN requirements; the return flows were not.

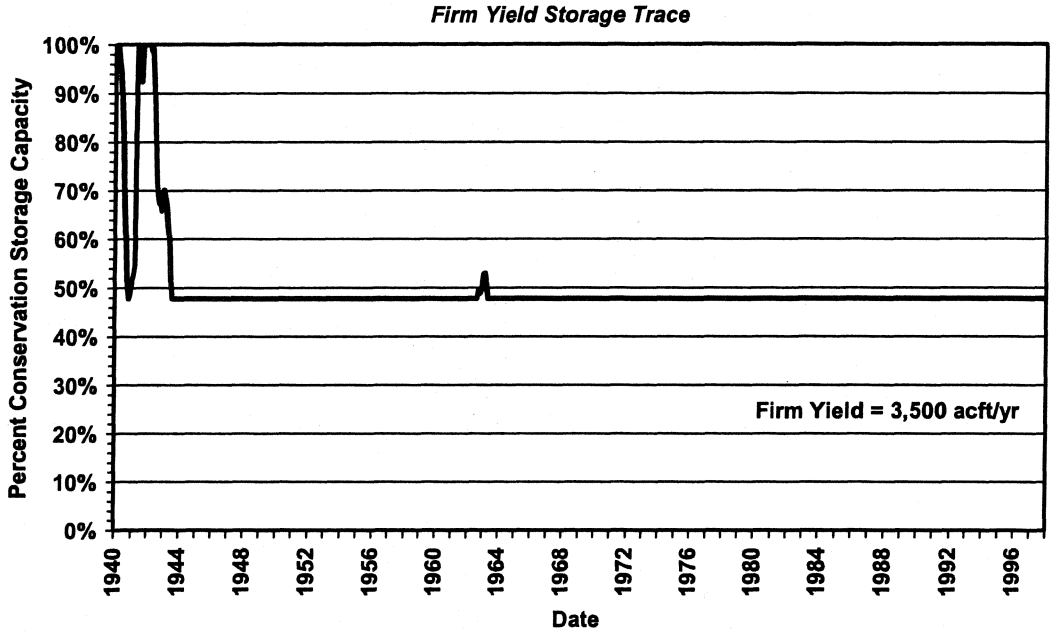
The firm yield of the system was calculated by establishing a firm yield for Lake 7 of 3,500 acft/yr, then operating Lake 8 such that at least 10,000 acft of storage would be maintained in Lake 7. Note that releases from Lake 7 would be passed through Buffalo Springs Lake in order to reach Lake 8. The resulting firm yield of Lake 8 was estimated to be 17,720 acft/yr, for a total combined system yield of 21,200 acft/yr.

Figure 4.4-7 illustrates the simulated Lake 7 and Lake 8 storage levels for the 1940 to 1997 historical period, subject to the firm yield of 17,720 acft/yr for Lake 8 with annual diversions from Lake 7 of 3,500 acft/yr.

Figure 4.4-8 illustrates the changes in streamflows of the North Fork Double Mountain Fork of the Brazos River caused by impounding the unappropriated waters of the Brazos River. There are no significant changes in streamflows at Lake 8. At Lake 7,

Table 4.4-55.
Daily Natural Streamflow Statistics
Lubbock Jim Bertram Lake System (JBLS) Expansion
Llano Estacado Water Planning Region

Month	*Median Flows – Zone 1 Pass-Through Requirements (cfs)*	*25th Percentile Flows – Zone 2 Pass-Through Requirements (cfs)*
	Lake 7	
January	0.2	0.0
February	0.2	0.0
March	0.1	0.0
April	0.2	0.0
May	3.4	0.1
June	5.1	0.5
July	1.5	0.0
August	0.6	0.0
September	1.3	0.0
October	0.9	0.0
November	0.6	0.0
December	0.4	0.0
Zone 3 (7Q2) Pass-Through Requirement (cfs):		0
	Lake 8	
January	0.3	0.0
February	0.3	0.0
March	0.1	0.0
April	0.3	0.0
May	3.8	0.1
June	5.7	0.5
July	1.7	0.0
August	0.7	0.0
September	1.5	0.0
October	1.0	0.0
November	0.7	0.0
December	0.4	0.0
Zone 3 (7Q2) Pass-Through Requirement (cfs):		0



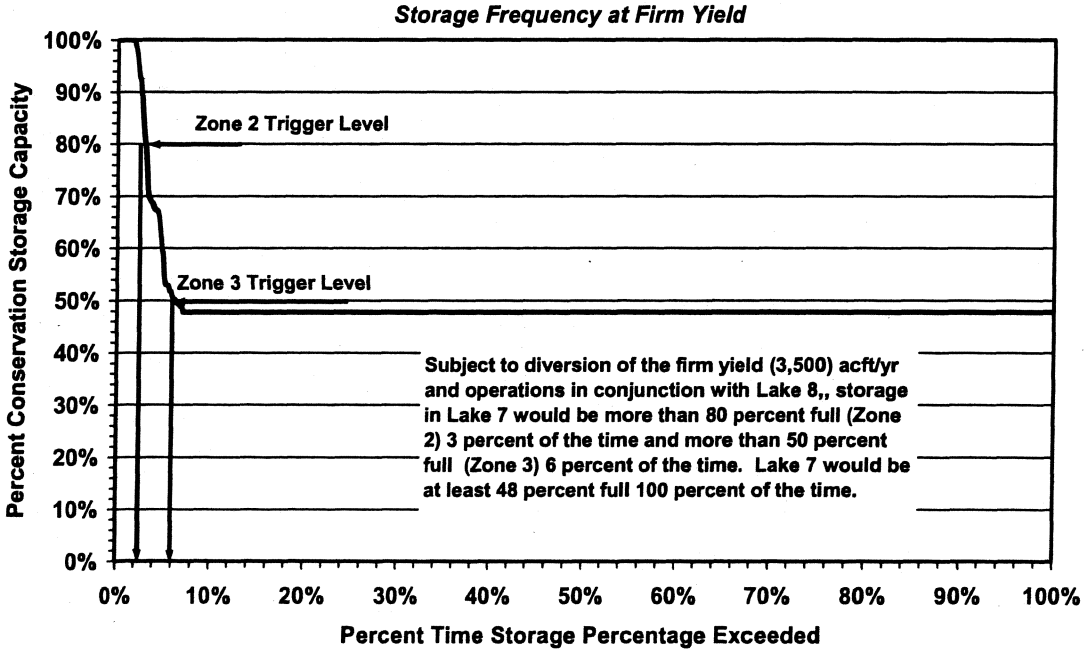
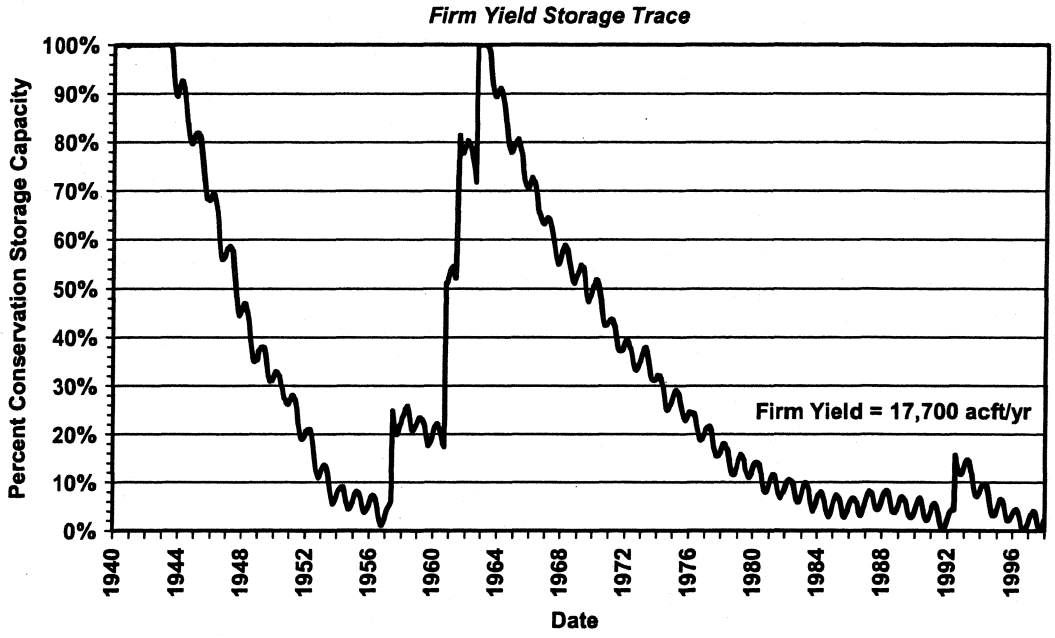


Figure 4.4-7A. Jim Bertram Lake System (JBLS) Expansion Reservoir Storage Considerations – Lake 7



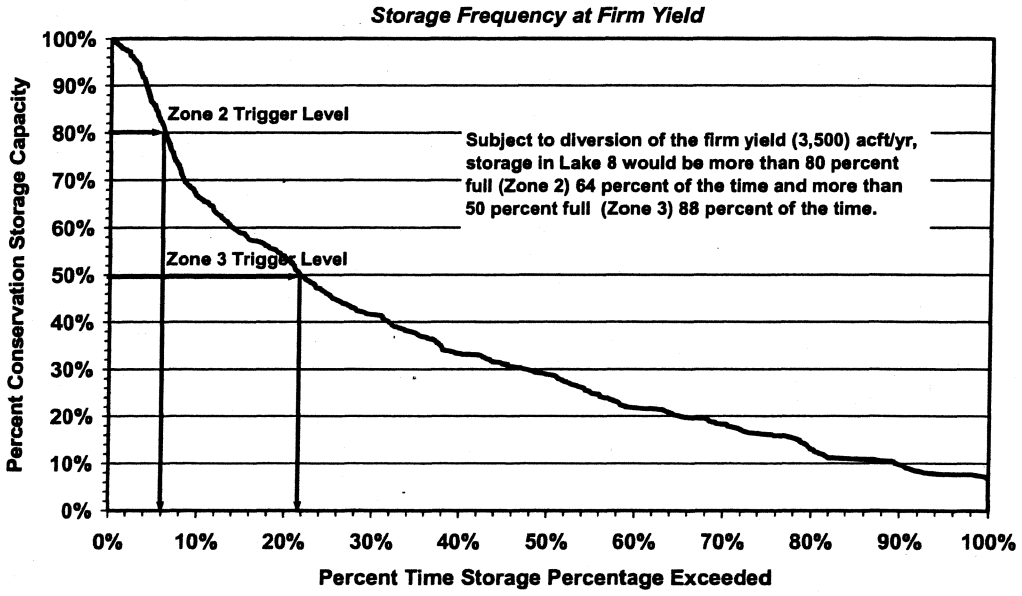
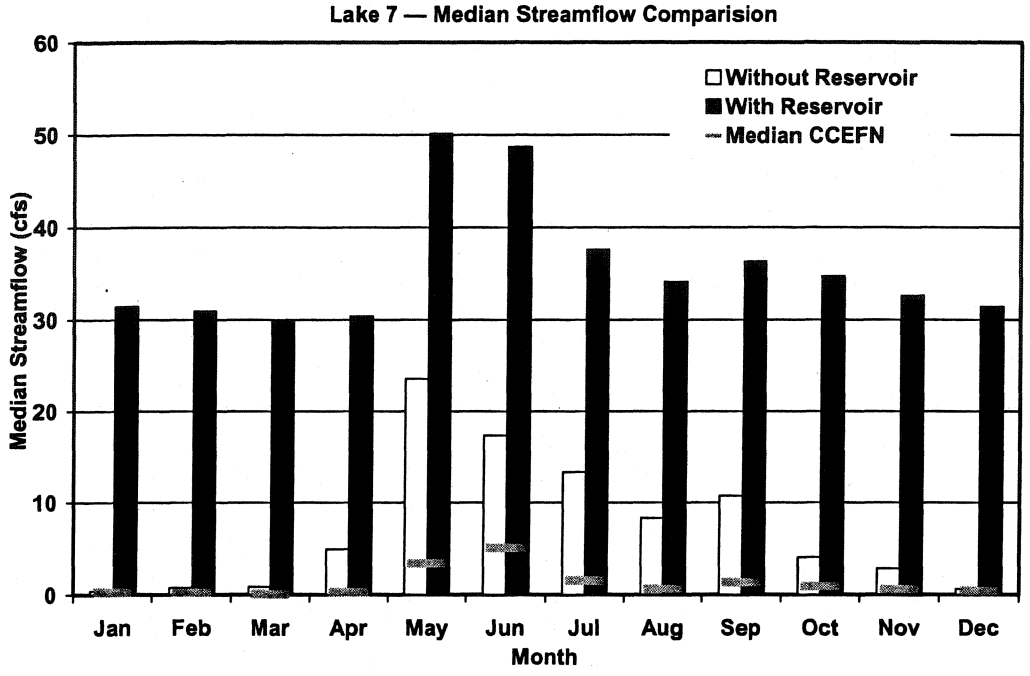


Figure 4.4-7B. Jim Bertram Lake System (JBLS) Expansion Reservoir Storage Considerations – Lake 8



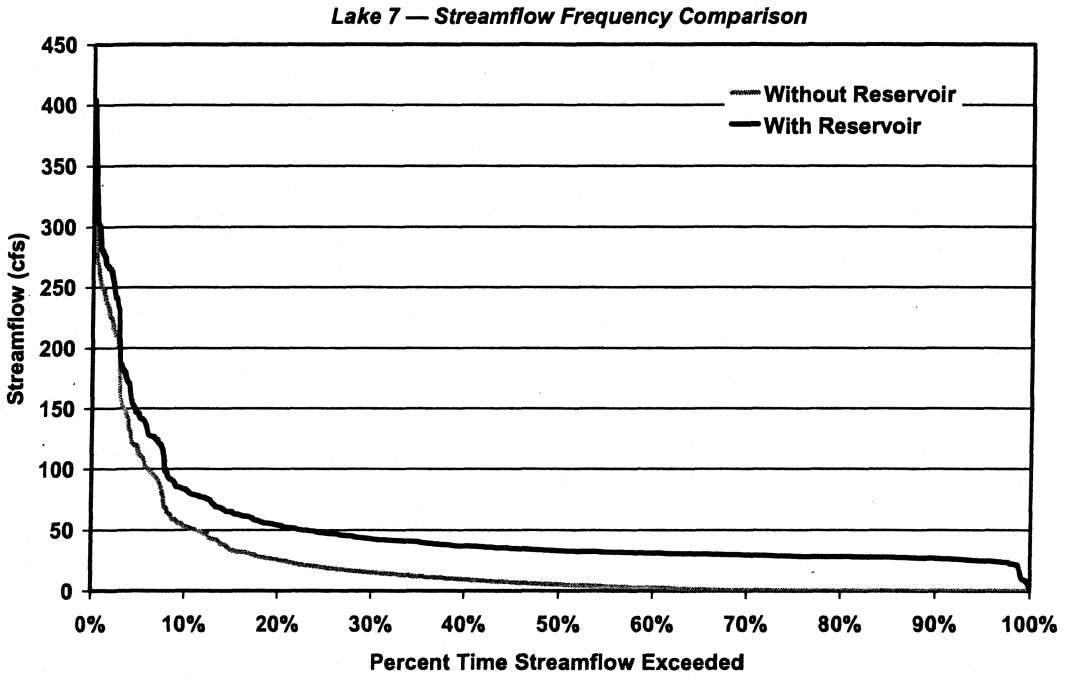
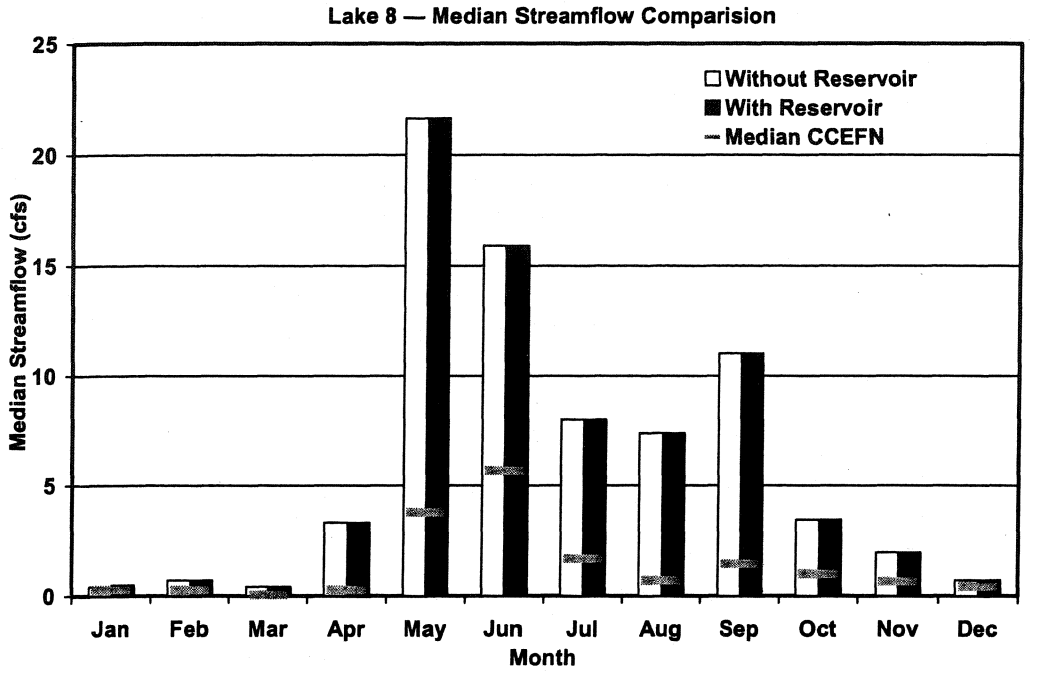


Figure 4.4-8A. Jim Bertram Lake System (JBLS) Expansion Streamflow Comparisons – Below Lake 7



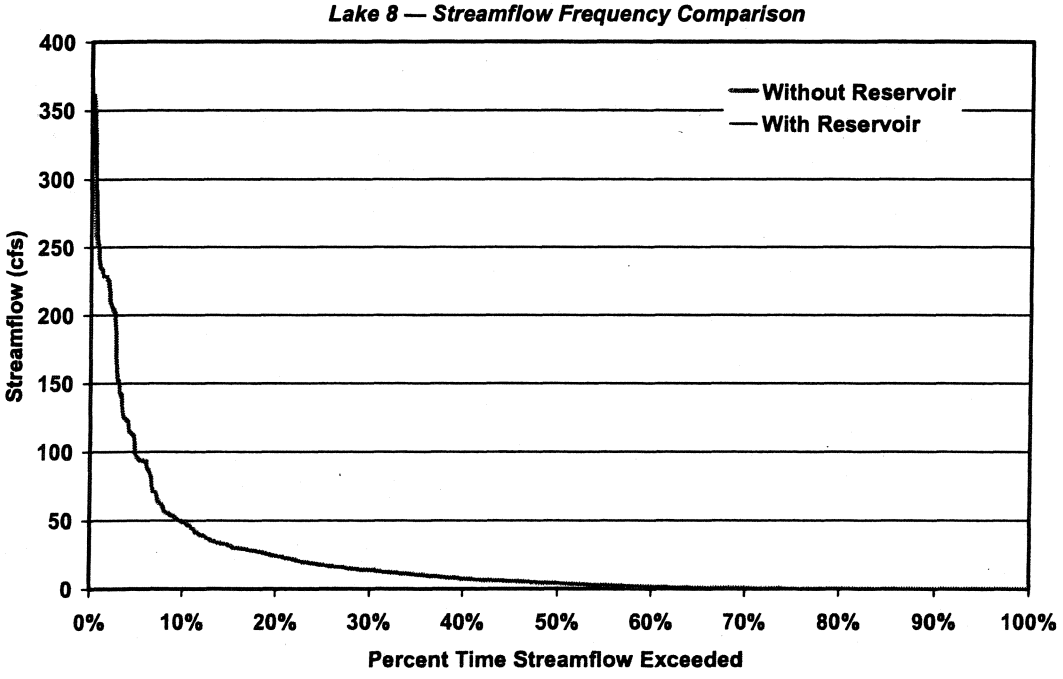


Figure 4.4-8B. Jim Bertram Lake System (JBLS) Expansion Streamflow Comparisons – Below Lake 8

however, releases of impounded return flows to Lake 8 would increase streamflows between Lake 7 and Lake 8 over natural conditions.

4.4.3.7.3 Environmental and Cultural Resource Issues

The City of Lubbock Storm Water and Reclaimed Water System Project involves the construction of two reservoirs along an approximately 14.5-mile reach of the North Double Mountain Fork of the Brazos River, raw water intake structures and their associated water transmission lines. The proposed lake sites, designated as Lake 7 and Lake 8 are located in Lubbock County southeast of the City of Lubbock within the Western High Plains ecoregion,[3] in the High Plains vegetational area of Texas,[4] and in the Kansan biotic province.[5] The High Plains Region is a nearly level treeless plain with a relatively even surface. It is dominated by native grasses, the major species including buffalo grass (*Buchloe dactyloides)*, blue grama (*Bouteloua gracilis*), and sideoats grama (*Bouteloua curtipendula*). Annual and perennial forbs, legumes and woody species such as beargrass and cholla cactus occasionally invade this grassland region. In zones with loamy soils, honey mesquite (*Prosopis glandulosa)* and yucca have invaded large areas. The prevalent landuse within the proposed Lake 7 project area is mixed rangeland (52%)[6], with additional areas of nonforested wetlands (19%), gravel pits (15%), confined feeding operations (10%), and minor amounts of cropland or pasture. It is unlikely that the area designated as nonforested wetlands has a large amount of wetland areas; however the presence and location of actual wetland areas potentially affected by reservoir construction would have to be determined by a site survey. In addition, a small portion of this proposed lake area is currently an existing reservoir (5%). The Lake 8 project area is divided between nonforested wetland areas (65%), and mixed rangeland (35%). Based upon a review of information available, the dominant vegetation type within the area of both Lake 7 and Lake 8 is considered to be Mesquite-Lotebush-Brush,

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[3] Omernik, James M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1), pp. 118-125, 1986.
[4] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas, 1962.
[5] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.
[6] U. S. Geological Survey, 1990. Reston, Virginia

with the exception of approximately 24% of the southeastern portion of Lake 8 which is identified as juniper[7].

Within the proposed lake sites, the General Soil Map for Lubbock County shows Potter-Berda-Bippus soils. These soils, found on bottomlands and uplands, and can be very shallow, shallow, or deep, and are located on nearly level to steep slopes. Two of these soil types are found on gently sloping to steep slopes, and include Potter soils which are found on uplands and Berda soils which are generally found on foot slopes. Slopes of areas containing these soils are generally found to be 1 to 45 percent. Bippus soils are found on nearly level areas on frequently flooded bottom lands. These soils areas have very little slope, generally less than one percent. The surface layer for all of these soils is composed of a friable, alkaline loam which differs in depth within each soil type from 5 to 30 inches. Rangeland is the most common landuse occurring within areas of Bippus soils. Cultivated crops are not generally grown in this area due to the steep slopes, and the potential for water erosion and flooding.

There are six existing, smaller impoundments along the North Double Mountain Fork of the Brazos River in the upper reaches of the canyon above the proposed Lake 7 location, and two larger lakes, Buffalo Springs Lake and Lake Ransom Canyon above Lake 8 but downstream of Lake 7. The North Double Mountain Fork of the Brazos River (Segment 1241A) is considered perennial from its confluence with the Double Mountain Fork to the dam impounding Lake Ransom Canyon. The water is typically high in dissolved solids, with segment standards for chloride and sulfate of 2500 mg/l and 2400 mg/l, respectively. This segment is on the Draft 2004 303(d) list for excessive bacterial concentrations, and is listed in the Statewide Water Quality Inventory (305b list) for concerns over algal growth and nitrogen concentrations. Although the current data listing on the Brazos River Authority web site indicates that the segment meets the average screening criterion for Fecal Coliforms of 200 MPN/100 ml, 23% of the samples collected exceeded the single grab criterion of 400 MPN/100 ml. Additional study will be required to confirm this result before a TMDL is scheduled. There are no Ecologically Significant River and Stream Segments within the project area.[8]

[7] The Vegetation Types of Texas. Texas Parks and Wildlife
[8] Texas Parks and Wildlife, Water Resources Branch, 2005.

The major sources for these water bodies include streamflow from natural rainfall, which is generally infrequent and irregular in this area, future return flows, releases of cooling water from a municipal power plant, springs associated with the irrigation of adjoining farm lands by effluent from the main Lubbock Sewer Treatment Plant, and runoff from the city's storm sewer system. The principal function of the proposed Lakes 7 and 8 will be to store and reuse reclaimed water and storm water, and to provide additional recreation opportunities. The upper six small impoundments presently form the core of a municipal park which stretches for approximately eight miles through the southeast quadrant of the city

Health concerns for the two proposed lakes include bacteria from discharged water and pollution from storm runoff. Storm runoff, particularly from urban areas, will likely be a source of coliform bacteria, oxygen demanding materials, nutrients and other materials (e.g., oil and grease, metals, household chemicals) potentially affecting water quality. However, this condition is common in streams and their impoundments receiving urban runoff, and has proved a serious problem in limited cases. Water quality and aquatic life conditions in the existing reservoir system are the best predictors of conditions most likely to develop in the proposed Lakes 7 and 8.

Plant and animal species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Lubbock County are listed in Table 4.4-56. There are two species listed as endangered by the State of Texas found within Lubbock County, the Whooping Crane (*Gus Americana*), and Black-footed Ferret (*Mustela nigripes*). In addition there are three threatened species which are state-listed within the county, the Arctic Peregrine Falcon (*Falco peregrinus tundrius*), Bald Eagle (*Haliaeetus leucocephalus*), and Texas horned lizard (*Phrynosoma cornutum*).

The Whooping Crane, Arctic Peregrine Falcon and Bald Eagle are potential migrants to Lubbock County which may use habitats in the area during migration. A survey of the lake sites may be required to determine whether populations of or potential habitats used by listed species occur in the area to be affected. The Black-footed Ferret is generally found in areas occupied by prairie dogs, usually dry, flat short grasslands including land overgrazed by cattle and the Texas Horned Lizard generally prefers open,

Table 4.4-56.
Potentially Occurring Species that are Rare or Federal-and State-Listed at the Lubbock Jim Bertram Lake System (JBLS) Expansion
Llano Estacado Water Planning Region

BIRDS	Federal Status	State Status
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Baird's Sparrow (Ammodramus bairdii) – shortgrass prairie with scattered low bushes and matted vegetation.		
Bald Eagle (*Haliaeetus leucocephalus*) - found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds.	LT-PDL	T
Ferruginous Hawk (Buteo regalis) – open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers.		
Lesser Prairie Chicken (Tympanuchus pallidicinctus) – arid grasslands, generally interspersed with shrubs and dwarf trees; nests in a scrape lined with grasses.	C1	
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Snowy Plover (Charadrius alexandrinus) – formerly an uncommon breeder in the Panhandle; potential migrant		
Western Burrowing Owl (*Athene cunicularia hypugaea*) - open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows and man-made structures, such as culvert.		
Whooping Crane *(Grus americana)* - potential migrant; winters in and around Aransas National Wildlife Refuge and migrates to Canada for breeding; only remaining natural breeding population of this species.	LE	E
MAMMALS		
Black-footed Ferret (Mustela nigripes) – considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area.	LE	E
Black-tailed Prairie Dog (Cynomys ludovicianus) – dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups.		
Cave Myotis Bat (Myotis velifer) – roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow *(Petrochelidon pyrrhonots)* nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore.		

Table 4.4-56 - continued

MAMMALS cont.	Federal Status	State Status
Plains Spotted Skunk (Spilogale putorius interrupta) – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie.		
Swift Fox (Vulpes velox) – restricted to current and historic shortgrass prairie; western and northern portions of Panhandle.		
REPTILES		
Texas Horned Lizard (Phrynosoma cornutum) – open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September.		T
Status Key: LE, LT-Federally Listed Endangered/Threatened, PE, PT-Federally Proposed Endangered/Threatened, E/SA, T/SA-Federally Listed Endangered/Threatened by Similarity of Appearance, C1-Federal Candidate for Listing, E,T-State Listed Endangered/Threatened, "blank"-Rare, but with no regulatory listing status		
June 2005, Annotated County Lists of Rare Species maintained by TPWD, Austin, Texas.		

arid areas with sparse vegetation. Either of these two species might be found within the mixed rangeland areas of the project.

There are two fish species found in the Brazos River Basin which are candidates for Federal Listing, the sharpnose shiner (*Notropis oxyrhynchus*), and the smalleye shiner (*Notropis buccula*). Both of these species require fairly shallow water in broad, open sandy channels with moderate current. Neither of these shiner species is listed as occurring within Lubbock County.

The primary impacts that would result from construction and operation of the proposed lakes would include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. Figure 4.4-7A (Lake 7 Storage) shows that operation of the proposed Lake 7 near its 50% capacity elevation more than 90% of the time will result in the permanent inundation of 514 acres of brush – invaded grassland habitat and its conversion to a lacustrine environment in which an aquatic community will develop. Excursions above 50 % capacity will be rare and relatively brief, and would be expected to result in little change in the terrestrial habitat now present in the zone between the 50 and 100% capacity elevations. On-site surveys will be required to document existing habitat values and determine the necessity and scope of mitigation for significant losses.

The storage trace for Lake 8 (Figure 4.4-7B) indicates that this larger impoundment will experience water surface elevations exceeding the 50% capacity level more frequently (22%), but diversion of the system yield from this impoundment will result in a more gradual dewatering regime than in Lake 7, and Lake 8 will experience periodic drawdowns to elevations below 10% capacity. The mosaic of grassland and thorny shrublands within the footrprint of Lake 8 will experience decreasing frequencies and durations of inundation at successively higher capacity elevations. At the 8% capacity elevation, about 351 acres will be inundated permanently, while the median water surface elevation for the simulation period, which corresponds to the 30% capacity level, indicates that the lower 889 acres will be under water half or more the time and the upper 829 acres will be inundated half or less of the time. While annual grasses and forbs will rapidly recolonize formerly inundated areas, perennial grass and shrub populations will recover more slowly. With respect to aquatic communities, frequent changes in reservoir surface elevation may be detrimental to shallow-water nesting species, which include the recreationally and economically important sunfish and bass, particularly when these changes occur during the spring and summer seasons when these fish are reproducing.

Operation of the reservoir system will result in an increase in the volume and constancy of streamflow in the North Fork reach between the Lake 7 dam and the Buffalo Springs Lake backwater, and between Buffalo Springs Lake and the Lake 8 backwater, presumably enhancing lotic habitats in those areas (Figure 4.4-8A). These reaches will vary in length depending on the contents of Buffalo Springs Lake and Lake 8. Below Lake 8, the North Fork will experience no change in streamflow at and below existing median monthly flow levels, but reductions in flood flows will occur as the reservoir system captures these infrequent events. Potential changes in channel morphology, and consequent habitat changes below the Lake 8 dam, will reflect the extent that reductions in the frequency of "bankfull" events result from system operation. Although large floods can result in severe scour and extensive redoposition of stream sediments, the events that maintain a stream's typical channel width, characteristic distribution of sediment particles, riffle-pool ratios and nature of streamside vegetation typically recurr

at 1 to 2 year intervals.[9] Reduction in the frequency of these events can result in channel narrowing, siltation of large particle substrate areas and encroachment of vegetation into the channel. Reductions in flood flows and stabilization of flow levels in arid areas with water containing high levels of dissolved solids can result in channel encroachment by salt cedar (*Tamarix* spp), which has been a problem significantly affecting both lotic and riparian habitats where it has occurred (e.g., in the Pecos River above Red Bluff Reservoir).

Federal and state laws such as Section 106 of the National Historic Preservation Act and the Antiquities Code of Texas require that impacts to cultural resources be considered. To address impacts these laws outline a consultation process that may involve the State Historic Preservation Officer (SHPO), Native American Tribes, the Advisory Council on Historic Preservation, and other interested parties. The consultation process is usually initiated by gathering information regarding cultural resources located within project area and presenting it to the SHPO for an effect determination. Based on the information available the SHPO makes a determination as to whether the properties affected are eligible for listing on the National Register of Historic Places (NRHP) or for formal designation as a State Archeological Landmark (SAL). If the SHPO feels that more information is needed in order to evaluate eligibility, they may request additional information such as archival research, or archeological field investigations. If the SHPO determines that there is "no effect" to properties eligible for listing on the NRHP or for formal designation as an SAL, the consultation process ends and project activities may proceed. On the other hand, if it is determined that eligible properties will be affected, then mitigation of the effects will likely be required. Mitigation may include additional archeological investigations, archival research, or avoidance and protection.

Available information regarding know cultural resources was gathered from the Texas Archeological Research Laboratory in Austin. Examination of their map files identified 14 recorded archeological sites within the footprint and park boundary of Lake 7 and three within the footprint and park boundary of Lake 8 (see Table 4.4-57).

[9] Allan, J. D. 1995. Stream Ecology. Chapman & Hall, New York.

Sites 41LU9 through 41LU23 have no eligibility recommendations. However sites 41LU132 and 41LU48 were recommended for listing on the NRHP. Site 41LU49 was not recommended for the NRHP.

As there is no evidence of any systematic archeological investigations being conducted for the lake areas, it is likely that the Texas Historical Commission and the U.S. Army Corps of Engineers will require an intensive archeological survey of the dam sites, the maximum flood pool area, and the proposed park areas of both lakes. This information will be required in order to begin the Section 106 and Antiquities Code consultation with these agencies.

Table 4.4-57.
Archeological sites on record for Lake 7 and Lake 8

Lake 7	*Site Description*	*Lake 8*	*Site Description*
41LU9	Prehistoric camp	41LU21	Prehistoric camp
41LU10	Prehistoric camp	41LU22	Prehistoric camp
41LU11	Prehistoric camp	41LU23	Prehistoric camp
41LU12	Prehistoric camp		
41LU13	Prehistoric camp		
41LU14	Prehistoric camp		
41LU15	Prehistoric camp		
41LU16	Prehistoric camp		
41LU17	Prehistoric camp		
41LU18	Prehistoric camp		
41LU19	Prehistoric camp		
41LU132	Prehistoric camp		
41LU48	Stone wall		
41LU49	Prehistoric lithic scatter		

4.4.3.7.4 Engineering and Costing

Costs for this option include the following:

- Land and right-of-way for Lakes 7 and 8, and pipelines and water treatment plant site;
- Construction of dams for Lakes 7 and 8;

- Pump stations and pipelines;
- Environmental impact assessments and archeological studies and recovery, and mitigation, if needed;
- State and federal permit acquisition;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated at $150,759,000 (Table 4.4-58). Annual operation and maintenance costs, including energy, are estimated at $3,808,000, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $14,575,000 (Table 4.4-58). For an annual quantity of 21,200 acft/yr of treated water ready for delivery to customers, the cost is $696 per acft, or $2.13 per 1,000 gallons (Table 4.4-58). To the extent that interruptible water and other firm developed water are available, the unit costs of water would be lowered.

4.4.3.7.5 Implementation Issues

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-59, and the option meets each criterion.

The implementation of this option to supply additional water to the City of Lubbock depends upon acquisition of the necessary permits, including water rights and those required for construction, as well as other issues as summarized below:

Potential Regulatory Requirements:

- Texas Commission on Environmental Quality Water Right and Storage permits;
- U.S. Army Corps of Engineers Permits will be required for discharges of dredge or fill into wetlands and waters of the U.S. for dam construction, and other activities (Section 404 of the Clean Water Act);
- Texas Commission on Environmental Quality administered Texas Pollutant Discharge Elimination System Storm Water Pollution Prevention Plan;
- General Land Office Easement if State-owned land or water is involved; and
- Texas Parks and Wildlife Department Sand, Shell, Gravel and Marl permit if state-owned streambed is involved.

State and Federal Permits may require the following studies and plans:

- Environmental impact or assessment studies;

- Wildlife habitat mitigation plan that may require acquisition and management of additional land;
- Flow releases downstream to maintain aquatic ecosystems;
- Assessment of impacts on Federal- and State-listed endangered and threatened species; and
- Cultural resources studies to determine resources impacts and appropriate mitigation plan that may include cultural resource recovery and cataloging; requires coordination with the Texas Historical Commission.

Land Acquisition Issues:

- Land acquired for reservoir and/or mitigation plans could include market transactions and/or eminent domain;
- Additional acquisition of rights-of-way and/or easements may be required; and
- Possible relocations or removal of residences, utilities, roads, or other structures.

Table 4.4-58.
Cost Estimate Summary for
Lubbock Jim Bertram Lake System (JBLS) Expansion (23,500 acft/yr)
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	*Estimated Cost*
Capital Costs	
Construction of Dams and Reservoirs (Lakes 7 and 8)	$15,889,000
Intake and Pump Stations (4.62 MGD and 26.7 MGD)	7,115,000
Transmission Pipelines (21,200 ft , 36 in; 37,000 ft, 90 in, and 79,200 ft, 66 in)	48,407,000
Water Treatment Plant (21 MGD)	22,079,000
Total Capital Cost	**$ 93,490,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies)	30,301,000
Environmental and Archeological Studies and Mitigation	2,768,000
Land Acquisition and Surveying (2,613 acres)	3,405,000
Interest During Construction (7 years, 4 percent)	20,795,000
Total Project Cost	**$ 150,759,000**
Annual Costs	
Debt Service (Pipelines, Pump Stations, & Treatment Plant) (6 percent for 30 years)	$ 8,779,000
Debt Service (Reservoirs) (6 percent for 40 years)	1,988,000
Operation and Maintenance	
Intake, Pipelines, and Pump Stations	662,000
Dams and Reservoirs	238,000
Water Treatment Plant	1,942,000
Pumping Energy Costs (16,096,384 kWh @ $0.06/kWh)	966,000
Total Annual Cost	**$ 14,575,000**
Quantity of Water (acft/yr) Firm Yield	**21,200**
Annual Cost of Water ($ per acft) Firm Yield[1]	**$ 696**
Annual Cost of Water ($ per 1,000 gallons)[1]	**$ 2.13**

[1] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems. To the extent that interruptible water is available, unit cost would be lower.

Table 4.4-59.
Comparison of Lubbock Jim Bertram Lake System (JBLS) Expansion to Plan Development Criteria
Llano Estacado Water Planning Region

Impact Category	*Comment(s)*
A. Water Supply	
1. Quantity	1. Sufficient to meet needs
2. Reliability	2. High reliability
3. Cost	3. Reasonable to High
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low impact
3. Cultural Resources	3. Moderate impact
4. Bays and Estuaries	4. Negligible impact
5. Threatened and Endangered Species	5. Possible Low impact
6. Wetlands	6. Low impact
C. Impact on Other State Water Resources	• No apparent negative impacts on state water resources; no effect on navigation
D. Threats to Agriculture and Natural Resources	• Potential impact on bottomland farms and habitat in reservoir area
E. Equitable Comparison of Strategies Deemed Feasible	• Option is considered to meet municipal and industrial shortages
F. Requirements for Interbasin Transfers	• Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	• None

Section 14 – Future Supplement to Lake Alan Henry – Year 2030 - Post Reservoir Option

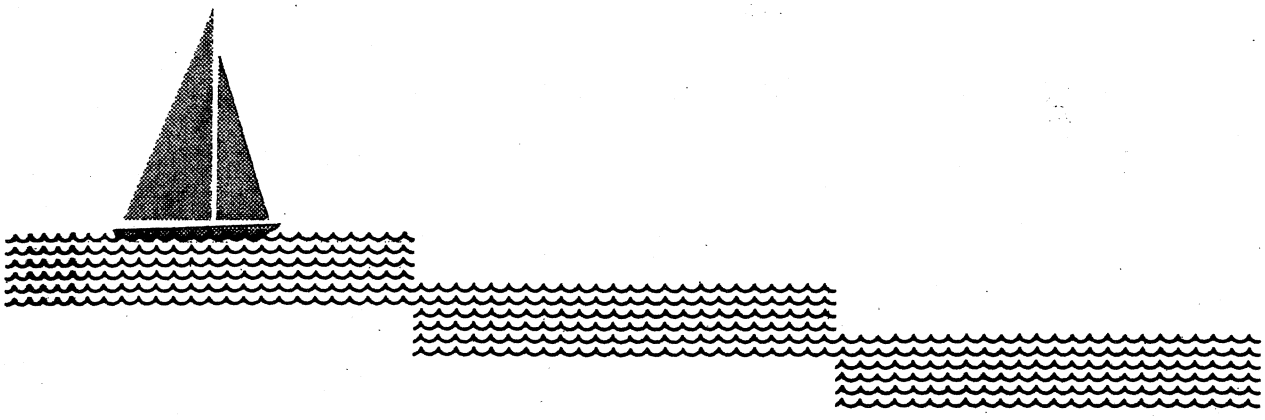
c. 1969 Feasibility Report on the Canyon Lakes Project

LUBBOCK, TEXAS

FEASIBILITY REPORT ON THE

CANYON LAKES PROJECT

1969



FREESE, NICHOLS AND ENDRESS
CONSULTING ENGINEERS

LUBBOCK, TEXAS

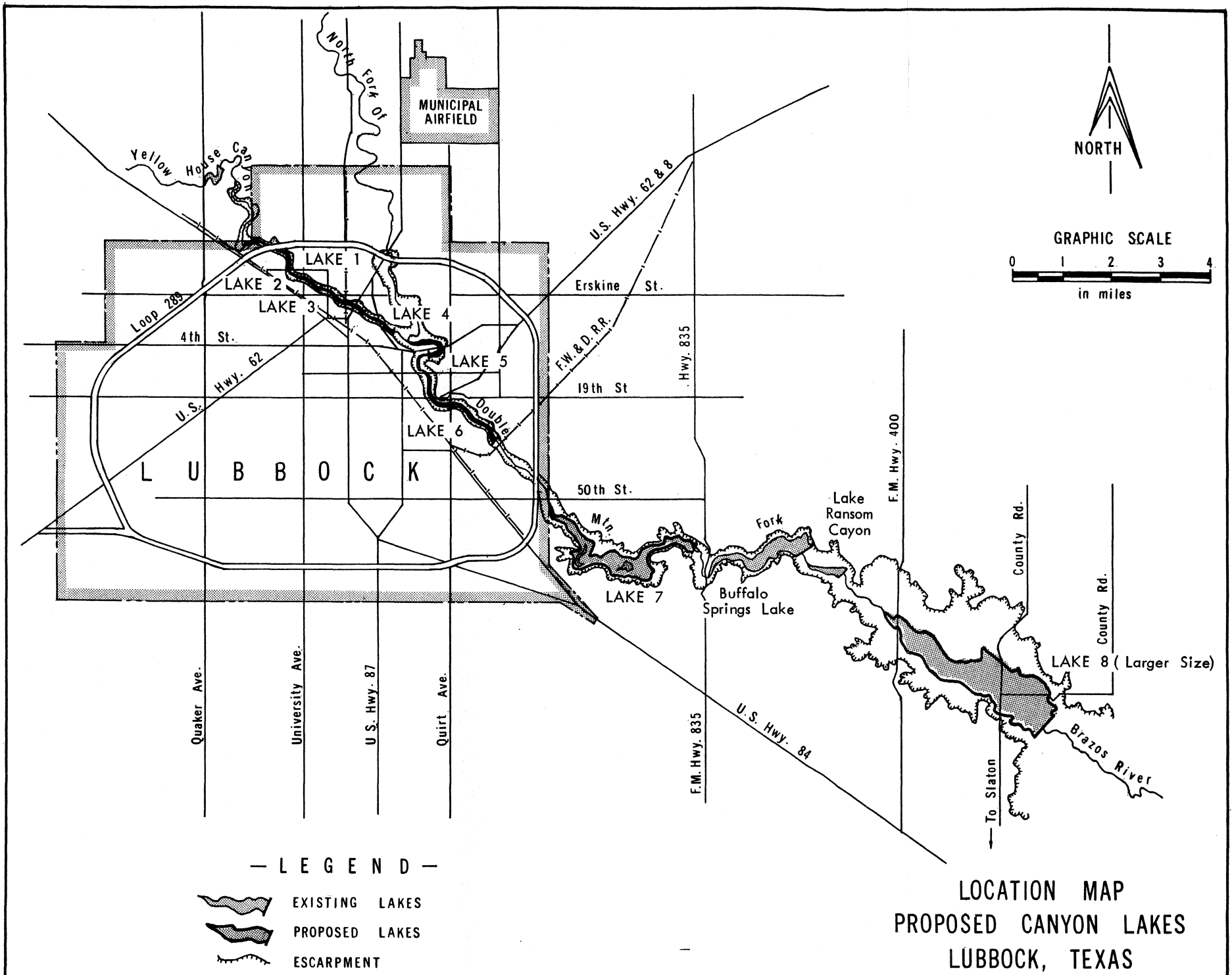
FEASIBILITY REPORT ON THE CANYON LAKES PROJECT

1969

1. INTRODUCTION

One of the most prominent topographic features of the Lubbock area is Yellow House Canyon, which has been formed by the waters of Yellow House Draw and the North Fork of the Double Mountain Fork of the Brazos River where they flow through the northeast corner of the city (see Figure 1.1). Although relatively shallow at the north edge of town, the canyon deepens perceptibly with distance downstream, so that the bed is about 60 feet below the surrounding plains at the east crossing of Loop 289, and reaches a depth of 250 feet or more by the time it crosses the county line. Primarily because of the threat of periodic flooding, the canyon floor is in most places unimproved, and at some points within the city limits it has often been used as a disposal area for refuse. Such locations are in striking contrast with MacKenzie State Park and Mae Simmons Park, where several hundred acres have been developed into pleasant recreational facilities. In deeper sections not far to the southeast, where conditions are still close to a natural state, there are surprising numbers of antelope and other wild animals living in the canyon, virtually within sight of the city.

Stream flow from natural rainfall is irregular and infrequent, and there is normally little or no water in the channel upstream from MacKenzie State Park. Beginning near the confluence of Yellow House Draw


North Fork of
MUNICIPAL AIRFIELD
Yellow House Canyon
U.S. Hwy. 62 & 8
NORTH
GRAPHIC SCALE
0 1 2 3 4
in miles
LAKE 1
LAKE 2
LAKE 3
LAKE 4
LAKE 5
LAKE 6
LAKE 7
LAKE 8 (Larger Size)
Loop 289
4th St.
U.S. Hwy. 62
Erskine St.
F.W. & D.R.R.
Hwy. 835
19th St
Double Mtn. Fork
50th St.
L U B B O C K
Lake Ransom Cayon
F.M. Hwy. 400
County Rd.
County Rd.
Buffalo Springs Lake
Quaker Ave.
University Ave.
U.S. Hwy. 87
Quirt Ave.
F.M. Hwy. 835
U.S. Hwy. 84
To Slaton
Brazos River
— L E G E N D —
EXISTING LAKES
PROPOSED LAKES
ESCARPMENT
LOCATION MAP
PROPOSED CANYON LAKES
LUBBOCK, TEXAS

and the North Fork of the Double Mountain Fork, there is usually some flow, due mainly to releases from the cooling system of the municipal power plant. From East 50th Street on, there are frequent contributions from springs, which earlier investigations (1,2,3)* have associated with irrigation of adjoining farm lands. Effluent from the main Lubbock sewage treatment plant has for many years been placed on the fields along the rim of the canyon, and the water table underlying the irrigated acreage has been raised noticeably by the resulting recharge. Flow from the springs is now continuous and appears to be increasing with the gradually rising rate of flow from the treatment plant. There are several existing lakes in the canyon, ranging in size from a small pond in MacKenzie Park to the much larger Buffalo Springs Lake, which has 5,350 acre-feet of storage capacity at spillway level. Normally, the water derived from the springs is enough to keep these lakes full. Much of Lubbock's storm sewer system also discharges into the stream at one point or another, so that large volumes of runoff are received from the built-up areas of the city during heavier rain storms.

In January of 1968, the Lubbock City Planning Department proposed to the City Council that serious consideration should be given to building additional lakes to store and make use of reclaimed waste water and runoff which would otherwise be lost. Through a series of reports (4,5,6) and a color slide presentation, the Planning Department has since explained this proposal to a number of interested citizens, outlining both the advantages and potential difficulties of the plan.

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*Numbers in parentheses indicate references listed in Appendix A.

Public reaction has been quite enthusiastic, since the idea would offer several worthwhile benefits to the community. The present unsightly conditions in the upper reaches of the canyon could be eliminated and replaced by new park acreage. A significant amount of water could be reclaimed and put to further beneficial use. The additional lakes would add opportunities for water-oriented recreation in an area where such opportunities are scarce and highly valued.

There are precedents elsewhere for this concept, and waste water reclamation projects are already being operated for similar purposes in other parts of the nation. Perhaps the best known of these is at Santee, California, where reclaimed sewage has been used to transform an otherwise arid canyon into a string of lakes for public use (7,8). With the support of local and federal agencies, the Santee project has been very carefully monitored since its inception in 1961, to determine the degree and type of use which can be accepted without jeopardizing public health or safety. Under suitable safeguards, the project was opened to the public first for picnicking, then for boating and "fishing for fun", and eventually for regular fishing with the fishermen allowed to keep and eat their catches. Since 1965, a swimming pool has been in service, using water taken from the lake system and given further treatment to raise it to a level of quality suitable for bathing. Throughout this program, there has been continuing surveillance of bacterial and virological conditions. Local health authorities and the Santee District personnel have insisted on a deliberate, cautious approach to the question of potential health hazards and have opened the facility to progressively closer personal contact with the water only after careful investigation.

The Santee experience to date shows that, with due precautions and proper methods, recreational use of reclaimed sewage can be both practical and safe.

In October of 1968, the City authorized an engineering study by Freese, Nichols and Endress to evaluate the basic feasibility and probable costs of the Canyon Lakes project. Among other considerations, it was recognized at that time that problems of water quality would be of critical importance, and that two fundamental questions would be (a) whether the proposed lakes can be kept virologically and bacteriologically safe for public recreation use and (b) whether it will be possible to control the growth of algae and aquatic plants within reasonable limits. This report sets forth the results of the feasibility study, with particular emphasis on the water quality factors. It is intended to furnish the factual background which the City will need in order to decide whether or not to go further with the project.

2. THE CANYON LAKES

As now proposed, the Canyon Lakes plan includes eight separate impoundments. The first six are relatively small and are located in the upper reaches of the Canyon, within the corporate limits of Lubbock; the other two are much larger and are some distance downstream. Figure 2.1 shows the intended layout of the upper lakes, which form a coherent group within themselves and can logically be considered as more or less independent of the two bigger reservoirs. Except for a short space between Dam 4 and the headwaters of Lake 5, the upper dams would create a continuous chain of lakes for approximately 8 miles through the city and would serve as nucleus for a municipal park extending from Loop 289 on the north to the Fort Worth and Denver Railway tracks at the lower end. Tentative park boundaries, which were established with the assistance of the City Planning Department, are also shown in Figure 2.1. Included in the over-all area would be MacKenzie State Park, which is owned by the State but operated by the City, and also the present facilities at Hodges Park and Mae Simmons Park. The suggested park outline conforms generally to the canyon walls, following established property lines and avoiding conflicts with existing improvements where possible. In all, the proposed upper lake system represents approximately 1,371 acres of recreational space, of which 721 acres would be new land not included in the present parks.

Lake 7 would be considerably larger than any of the first six. Dam 7 would be located immediately above Buffalo Springs Lake and would back water up to the vicinity of 50th Street. Figure 2.2 is a map of Lake 7 and surrounding area, showing the contemplated limits of a 2,931-acre

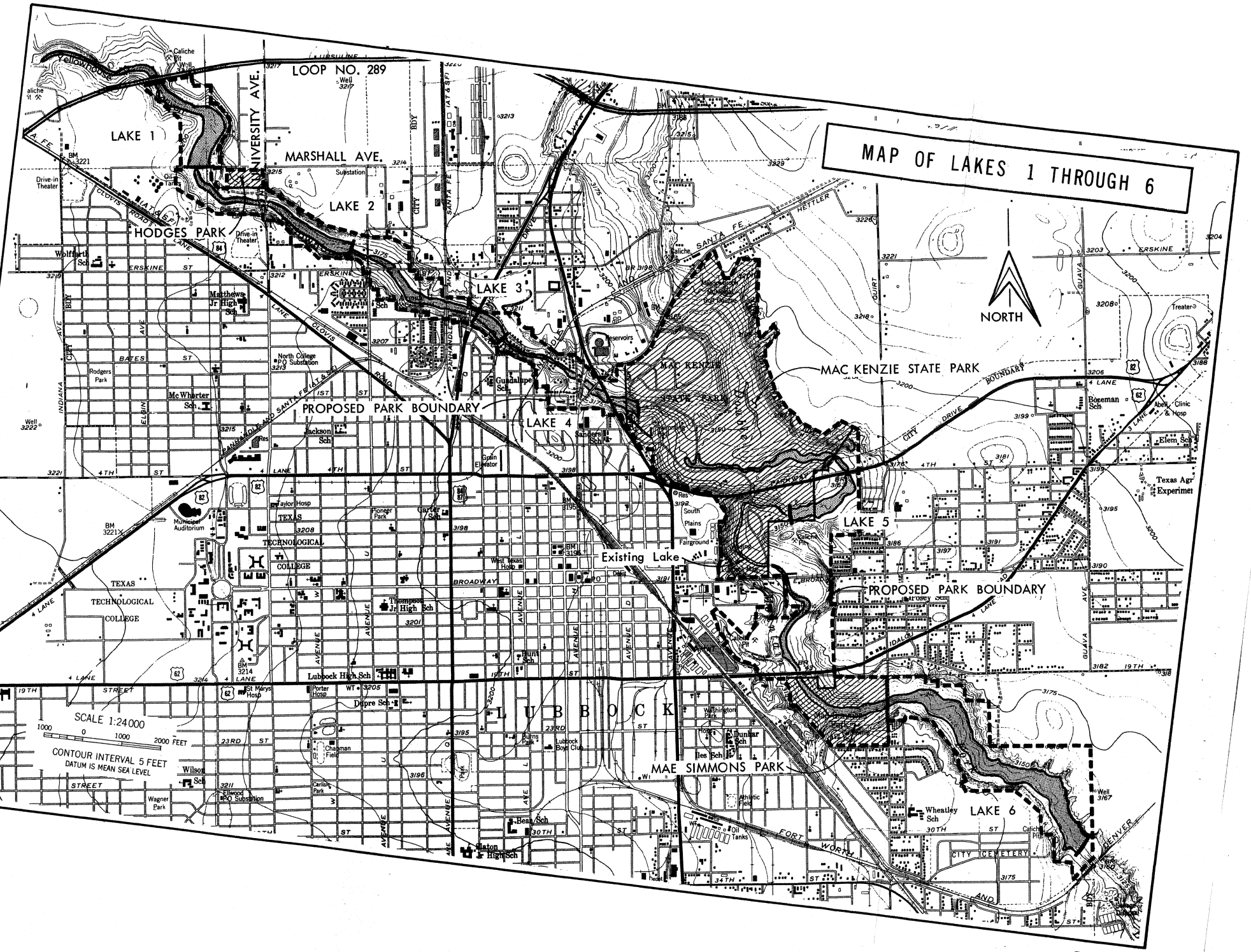

MAP OF LAKES 1 THROUGH 6
LAKE 1
LAKE 2
LAKE 3
LAKE 4
LAKE 5
LAKE 6
HODGES PARK
MAC KENZIE STATE PARK
MAE SIMMONS PARK
PROPOSED PARK BOUNDARY
Existing Lake
PROPOSED PARK BOUNDARY
LOOP NO. 289
MARSHALL AVE.
UNIVERSITY AVE.
NORTH
SCALE 1:24000
1000 0 1000 2000 FEET
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
L U B B O C K
TEXAS TECHNOLOGICAL COLLEGE

FIGURE 2.1

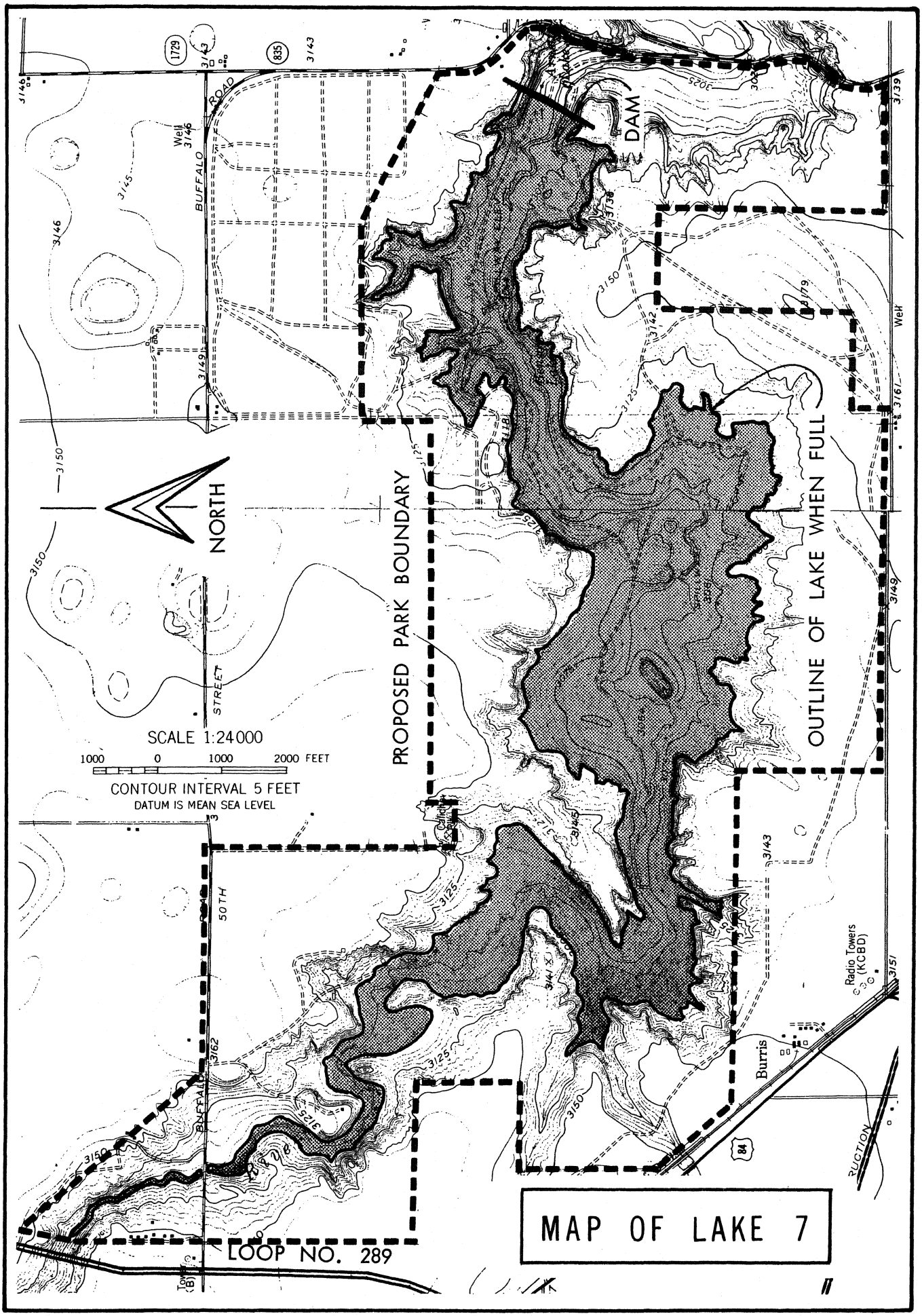

MAP OF LAKE 7
PROPOSED PARK BOUNDARY
OUTLINE OF LAKE WHEN FULL
DAM
NORTH
SCALE 1:24000
1000 0 1000 2000 FEET
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
BUFFALO ROAD
50TH STREET
Well 3146
Well
Burris
Radio Towers (KCBD)
LOOP NO. 289
1729
835
84

FIGURE 2.2

public park similar to that proposed for Lakes 1 through 6. Lake 8, the largest of them all, would be northeast of Slaton, about 20 miles by road from the center of Lubbock. Figure 2.3 shows the layout of Lake 8, including a suggested public recreation area of some 8,800 acres.

The more significant characteristics of the lakes are summarized in Table 2.1. Capacities vary from a minimum of 29 acre-feet in Lake 5 to 49,930 acre-feet at Lake 8, and surface areas range from as little as 10 acres at Lake 4 to as much as 1,690 acres at Lake 8. Reservoir area and capacity characteristics were derived from maps of the Lubbock area at a scale of 1 inch to 2,000 feet, published by the U. S. Geological Survey. Tables of the area-capacity relationships are compiled in Appendix B. Watershed areas were measured from the same series of maps, based on delineation of the terrain which would contribute runoff to the canyon during reasonably heavy storms and excluding the adjoining drainage which would contribute to closed playa lakes instead.

The upper lakes have been sized for relatively low heads of 9 to 11 feet at Dams 1 through 5 and 18 feet at Dam 6, so that most of the streets and railroads which now cross the canyon would remain clear of the water under normal conditions. Avenue "S" and one road in MacKenzie Park would need to be raised; Marshall Street and a park road would be relocated across the tops of Dams 1 and 4, respectively.

Typical details of the six upper dams are shown in Figure 2.4. These are envisioned as paved overflow structures which would allow flood waters to spill across the full width of the embankment. The center portion of each dam would be composed of earth stabilized with a controlled admixture of portland cement, forming what is commonly known as

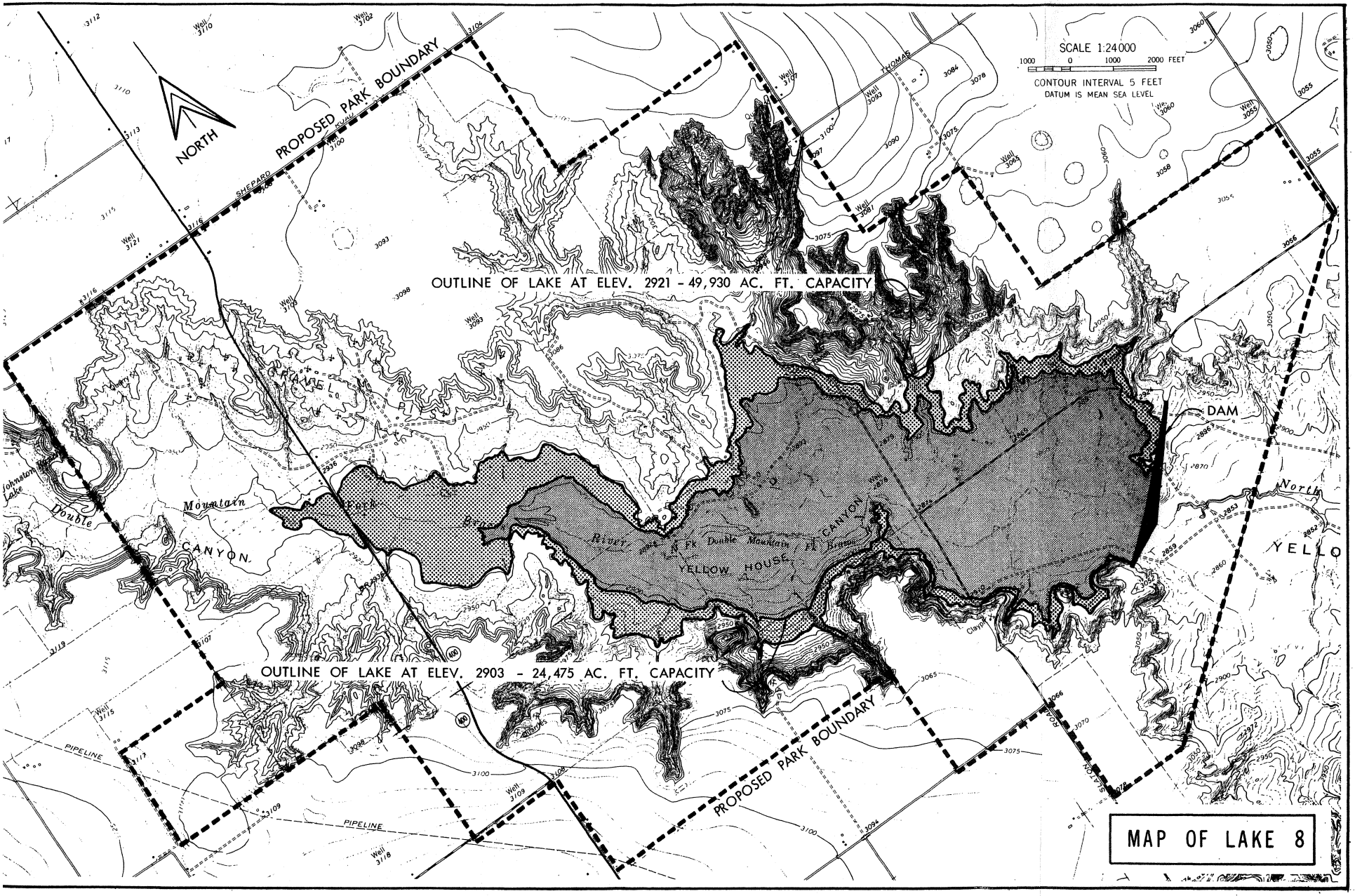

NORTH
PROPOSED PARK BOUNDARY
SCALE 1:24000
1000 0 1000 2000 FEET
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
OUTLINE OF LAKE AT ELEV. 2921 - 49,930 AC. FT. CAPACITY
OUTLINE OF LAKE AT ELEV. 2903 - 24,475 AC. FT. CAPACITY
DAM
PROPOSED PARK BOUNDARY
PIPELINE
PIPELINE
MAP OF LAKE 8

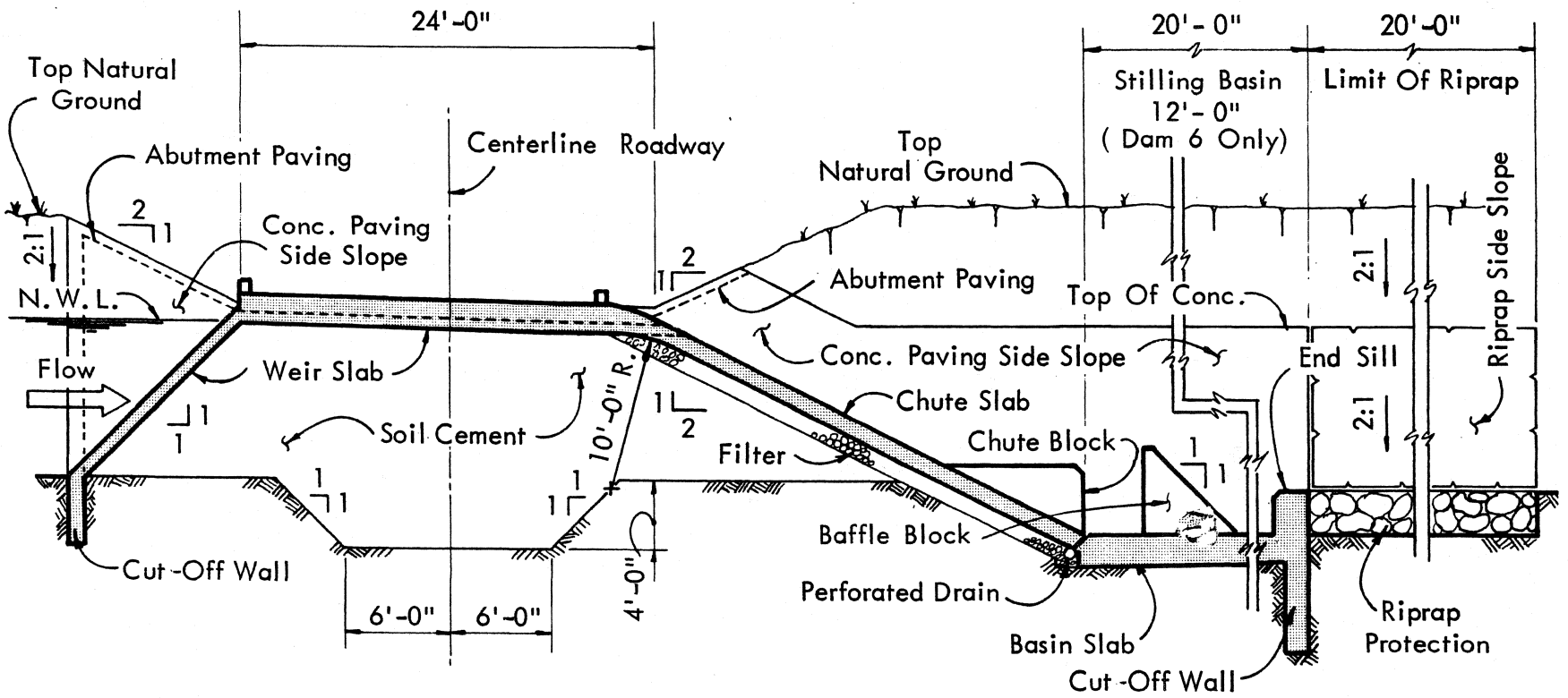
FIGURE 2.3

Table 2.1

Lubbock Canyon Lakes: Pertinent Data

Dam No.	Dam Location	Channel Elev.	Spillway Elev.	Capacity In Ac-Ft	Surface Acres	Contrib. Area (Sq. Mi.) Increment	Total
1	At Marshall Street	3175	3185	121	33	202	202
2	400' West of Ave. U	3167	3177	78	22	2	204
3	900' Downstream from North Drive	3159	3168	65	15	10	214
4	700' Downstream from U.S. Hwy. 87, in MacKenzie State Park	3149	3160	36	10	2	216
5	700' South of Parkway Drive, in MacKenzie State Park	3133	3144	29	13	118	334
6	500' Upstream from the Fort Worth and Denver Railroad Bridge	3112	3130	536	82	8	342
7	West of Farm Road 835 upstream from Buffalo Lake	3016	3100	20,708	801	36	378
8	Northeast of Slaton	2848	2903* 2921*	24,475 49,930	1,150 1,680	30	408

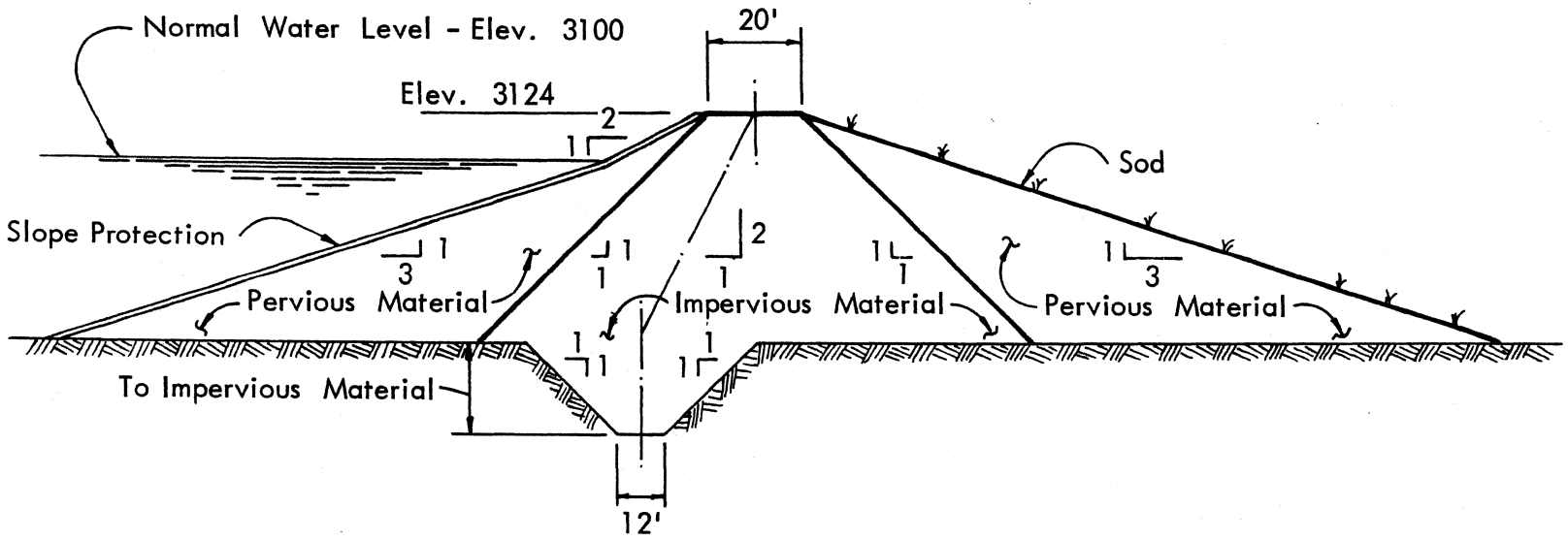
*Note: Two sizes are shown for Lake 8. The first is the feasible capacity without direct utilization of sewage effluent. The second is the size which could be supported if there is a level of treatment which will allow the effluent to be released directly into the stream.



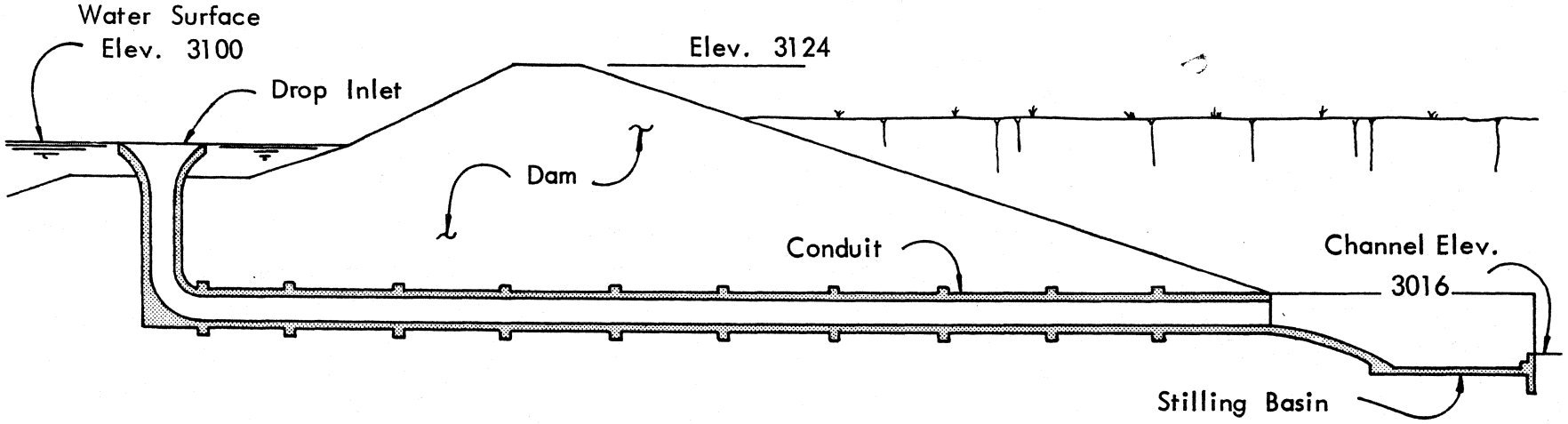
TYPICAL SECTION - CHANNEL DAMS 1 THROUGH 6

FREESE, NICHOLS AND ENDRESS

FIGURE 2.4



TYPICAL EMBANKMENT SECTION - DAM 7



TYPICAL SERVICE SPILLWAY SECTION - DAM 7

FREESE, NICHOLS AND ENDRESS

FIGURE 2.5

receive very little flow that did not pass first through Lake 7. Finally, Lake 8 would depend on spills from the upstream reservoirs and on runoff from the intervening contributing drainage area of about 30 square miles. Inflows to Lake 8 would be irregular, and the surface level would vary appreciably over the years. Analyses of predicted system performance will be discussed in Section 6, based on estimates of what would have happened historically if the Canyon Lakes had been in service since 1940.