July, 1999

State Brush Control Plan

Revised 1999

Texas State Soil and Water Conservation Board

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Texas State Soil and Water Conservation Board

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Section I: Introduction

Water will likely be the most limiting natural resource in Texas in the future (Texas Water Development Board 1997). The ability to meet the water needs will significantly impact growth and economic well-being. The U.S. Natural Resource Conservation Service (NRCS) estimates that brush in Texas uses about 10 million ac-ft of water annually, versus 15 million ac-ft per year for current human use. Possible benefits of brush control affecting water supplies are: additions to State water supplies, recharge of groundwater aquifers, and spring flow enhancement. Economic benefits of the use of brush control to enhance water yield have been estimated, but they were considered quantitatively unreliable because of numerous omissions and crude assumptions (McCarl et al. 1987). Some issues related to potential benefits, beneficiaries, and funding that are not yet adequately defined may limit the potential public investment in this program. (Walker and Dugas 1998)

In 1985, the Texas Legislature authorized the Texas State Soil and Water Conservation Board through local Soil and Water Conservation Districts to conduct a program that includes cost-share assistance for the "selective control, removal, or reduction of noxious brush such as mesquite, salt cedar, or other brush species that consume water to a degree that is detrimental to water conservation." The Texas State Soil and Water Conservation Board is also mandated to designate areas of critical need in the State in which to implement the brush control program. The brush control cost-share program has not been funded. Recently there has been renewed interest in brush control to increase water yield. A review of the Texas Water Plan (Texas Water Development Board 1997) shows few recommended water development projects for approximately the two-thirds of the state that lies west of I-35. Eighty percent of the conveyance and all of the proposed new reservoirs in the State are east of I-35. The siting of these projects is consistent with climatic patterns that result in much higher runoff and greater potential for capture and transfer of water in the eastern part of the State. In West Texas, brush control and cloud seeding are the two principal options for increasing water yield.

Water yield following brush control has been investigated in several areas of the State. Studies by Thurow and Hester (1997), Carlson et al. (1990) and Weltz and Blackburn (1995) show that at sites with precipitation ranging from about 12 to 35 inches per year, the majority of precipitation is used for evapotranspiration (ET). Following brush removal (original cover: 36% juniper, 24% oak) sixteen percent of the precipitation went to deep drainage compared to none for the untreated watershed, an amount equal to 100,500 gallons/acre/year (Thurow and Hester 1997). In contrast, controlling mesquite (*Prosopis glandulosa* Torr.) increased deep drainage only a small amount and then only in high rainfall years. The effect of controlling mesquite on runoff was variable. A major difference between controlling juniper (*Juniperus ashei* Bucholz) compared to mesquite is that control of juniper results in a much greater reduction in ET. This difference is due to the greater interception of rainfall by juniper and its evergreen nature compared to mesquite, and because juniper is normally associated with shallow sites, which facilitates the deep percolation of the water that is spared from ET.

The efficiency with which controlling brush can yield additional water that may be captured and used for public benefit is an important consideration for determining the location of publicly funded (i.e., cost-share) brush control projects. Other criteria to be considered for selecting sites for brush control include geology, the nature

of water yield, the presence of brush, the number of citizens impacted, and the potential impact on threatened or endangered species (Texas State Soil and Water Conservation Board, 1991).

Public benefit in the form of additional water depends on landowner participation and proper implementation and maintenance of the appropriate brush control practices. It is also important to understand that rancher participation in a brush control program will primarily depend on the rancher's expected economic consequences resulting from participation. With this in mind, the analyses described in this report are predicated on the objective of limiting rancher costs associated with participation in the program to no more than the benefits that would be expected to accrue to the rancher as a result of participation.

Literature summarizing water yield studies in the western U.S. and data from the Edwards Plateau in Texas indicate that a significant increase in water yield is possible if brush cover is converted to grassland or open savanna and if the area receives about 18 inches/year or more rainfall. Documentation of water yield potential in other portions of Texas and improvements in the operation of the existing simulation models have been constrained by a lack of funding committed to watershed scale research (Thurow, 1998).

Section II: Description of the Problem

Numerous written descriptions by early European settlers, summarized by Smeins et al. (1997), characterize most of Texas rangelands as grassland or open savanna. Prior to European settlement, grazing pressure tended to be light and/or periodic, thus allowing a robust stand of grass to establish. Most tree seeds deposited in a healthy grassland die soon after they germinate because they are unable to compete with the established grass for water and light. The few tree seedlings that are able to survive the competition with grass tend to perish in wildfires which periodically occur in "natural" rangelands. Thus, with fire and light grazing pressure, grasslands and savannas are stable and sustainable ecosystems characteristic of many Texas rangelands.

European settlement of rangelands altered the grazing and fire characteristics which had previously enabled grasslands to dominate the landscape. Continuous, often heavy, livestock grazing pressure reduced the ability of grasses to suppress tree seedling establishment. Furthermore, some invasive woody species (e.g., juniper and mesquite) have noxious chemicals in their leaves, resulting in livestock tending to avoid browsing the tree seedlings while repeatedly grazing the adjacent, palatable grasses. This selective grazing behavior gives unpalatable tree seedlings a competitive advantage over grasses. European settlers tended to aggressively suppress fires, a task made easier because continuous, heavy grazing pressure removed the fuel needed to carry a fire. Removal of fire and/or heavy grazing pressure created an environment that favored increased dominance of shrubs and trees in what had previously been grasslands or savannas. This pattern of vegetation change coincides with European settlement of rangelands throughout the world (Archer 1994).

Large increases in woody cover can adversely affect ranching operations by increasing the costs of management and decreasing the livestock carrying capacity. Therefore, ranchers have a vested interest in controlling brush. For example, analysis of the 80 square mile Cusenbary Draw watershed near Sonora, Texas revealed that investments in brush control by ranchers were able to keep overall brush cover within the watershed between 22% to 24% between 1955 and 1990 (Redeker et al. 1998). Some of the pastures within the watershed did not have any brush control applied. Brush cover on those sites increased to 37% over the same period. This illustrates the increase in shrub cover over a 35-year period that is possible in the area without a proactive policy of brush control.

Ranches throughout several regions of Texas are increasingly being subdivided into smaller parcels that are used mainly for recreation (Rowan 1994). According to survey data from the Edwards Plateau, landowners are less inclined to invest in brush control if they are not reliant on livestock income (Garriga 1998). As the demographics of rangeland owners shift away from an emphasis on livestock production, and as long as fire continues to be suppressed, it is likely that woody cover will continue to increase unless incentives are provided to encourage brush management.

2.1 Regional Overview of General Vegetative Communities

Texas is a diverse State with a broad range of climate and soil types. Within the combinations of soils and climates, there are distinctive vegetative communities that predominate. Gould, et al. (1960) described these general vegetative communities as follows. Although these descriptions may not be currently accurate in all details, they provide a general overview of the State.

2.1.1. Pineywoods

The Pineywoods area lies entirely within the Gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is a nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands over gray, yellow, red, or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the flood plains of minor streams. The dominant vegetation type is a mixed pine-

hardwood forest on the uplands and a mixed hardwood forest on the lowlands. Native pines are loblolly (*Pinus taeda*), shortleaf (*P. echinata*), and longleaf (*P. palustris*). Slash pine (*P. elliottii*), a native of the southeastern United States, has been widely planted on thousands of acres. Hardwoods grow in mixed stands with pines in the uplands but are generally dominant along major streams. The principal hardwoods in the region are sweetgum (*Liquidambar styraciflua*), oaks (*Quercus*), water tupelo (*Nyssa aquatica*), blackgum (*N. sylvatica*), magnolias (*Magnolia*), elms (*Ulmus*), cottonwoods (*Populus*), hickories (*Carya*), walnuts (*Juglans*), maples (*Acer*), American beech (*Fagus grandifolia*), ashes (*Fraxinus*), and baldcypress (*Taxodium distichum*).

Many species of shrubs, vines, forbs, and grasses occupy the forest floor, prairies, and cutover areas not used for cropland. In the mixed pine-hardwood forests, bluestem grasses and forbs make up a large proportion of the herbage in openings. Grasses commonly associated with forests are blackseed needlegrass (*Piptochaetium avenaceum*), Virginia wildrye (*Elymus virginicus*), Canada wildrye (*E. canadensis*), purpletop (*Tridens flavus*), broadleaf woodoats (*Chasmanthium latifolium*), narrowleaf woodoats Chasmanthium sessiliflorum, eastern little bluestem (*Schizachyrium scoparium* var. *divergens*), giant cane (*Arundinaria gigantea*), carpetgrass (*Axonopus*), and brownseed paspalum (*Paspalum plicatulum*). Typical prairie vegetation is present on locally included clay prairie sites. Rosette grasses (*Dichanthelium*) and paspalums (*Paspalum*) are common grasses throughout the area.

Common understory shrubs and vines are southern wax-myrtle (*Myrica cerifera*), American beautyberry (*Callicarpa americana*), grapes (*Vitis*), blueberries (*Vaccinium*), hawthorns (*Crataegus*), greenbriars (*Smilax*), rattan-vine (*Berchemia scandens*), trumpet honeysuckle (*Lonicera sempervirens*), dewberries (*Rubus*), yellow jessamine (*Gelsemium sempervirens*), and poisonivy (*Rhus toxicodendron*). The area is noted for its flowering understory shrubs such as dogwoods (*Cornus*), redbud (*Cercis canadensis*), and black-haws (*Viburnum*). Characteristic forbs species are wild indigos (*Baptisia*), sennas (*Cassia*), tickclovers (*Desmodium*), milkpeas (*Galactia*), clovers (*Trifolium*), vetches (*Vicia*), and goldenrods (*Solidago*), whereas sedges (*Carex* and *Cyperus*) and beakrushes (*Rhynchospora*) are common grasslike plants. Several species of orchids (Orchidaceae) are found only in this area.

Timber production is the leading land use in the Pineywoods. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are secondary common land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass (*Cynodon dactylon*), dallisgrass (*Paspalum dilatatum*), and bahiagrass (*Paspalum notatum*) and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production. The major livestock enterprise is the cow-calf operation. Herbage production in forests is generally negatively influenced by forest overstory canopy. Reservoirs provide recreation, including fishing, hunting, and swimming.

2.1.2. Gulf Prairies and Marshes

The Gulf Prairies and Marshes, covering approximately 500,000 acres, are on a narrow strip of lowlands adjacent to the coast and the barrier islands (e.g., Padre Island), which extend from Mexico to Louisiana. The Gulf Prairies, about 9 million acres, include the nearly flat plain extending 30 to 80 miles inland from the Gulf Marshes.

The Gulf Prairies and Marshes are a low, wet, marshy coastal area, commonly covered with saline water, and range from sea level to a few feet in elevation. The Gulf Prairies are nearly level and virtually undissected plains having slow surface drainage and elevations from sea level to 250 feet.

Soils of the Gulf Marshes are dark, poorly drained sandy loams and clays, and light neutral sands, typically showing little textural change with depth. The loamy and clayey soils are commonly saline and sodic. Prairie soils are dark, neutral to slightly acid clay loams and clays in the northeastern parts. Further south in the subhumid Coastal Bend, the soils are less acidic. A narrow band of light acid sands and darker loamy to clayey soils stretches along the coast. Inland from the dark clayey soils is a narrow belt of lighter acid fine sandy loam

soils with gray to brown, and red mottled subsoils. Soils of the river bottomlands and broad deltaic plains are reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial.

The original vegetation types of the Gulf Prairie were tallgrass prairie and post oak savannah. However, trees and shrubs such as honey mesquite (*Prosopis glandulosa*), oaks (*Quercus*), and acacia (*Acacia*) have increased and thicketized in many places. Characteristic oak species are live oak (*Quercus virginiana*) and post oak (*Q. stellata*). Typical acacias are huisache (*Acacia smallii*) and blackbrush (*A. rigidula*). Bushy sea-ox-eye (*Borrichia frutescens*), a dwarf shrub, is also typical.

Principal climax grasses of the Gulf Prairie are Gulf cordgrass (*Spartina spartinae*), big bluestem (*Andropogon gerardii* var. *gerardii*), little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*), eastern gamagrass (*Tripsacum dactyloides*), gulf muhly (*Muhlenbergia capillaris*), tanglehead (*Heteropogon contortus*), and many species of Panicum and Paspalum. Common increasers and invaders are yankeeweed (*Eupatorium compositifolium*), broomsedge bluestem (*Andropogon virginicus*), smutgrass (*Sporobolus indicus*), western ragweed (*Ambrosia psilostachya*), tumblegrass (*Schedonnardus paniculatus*), threeawns (*Aristida*), and many annual forbs and grasses. Pricklypear (*Opuntia*) are common throughout the area. Characteristic forbs include asters (*Aster*), Indian paintbrush (*Castilleja indivisa*), poppy mallows (*Callirhoe*), phloxs (*Phlox*), bluebonnets (*Lupinus*), and evening primroses (*Oenothera*) (Jones 1982).

The Gulf Marsh areas, being variously salty, support species of sedges (*Carex* and *Cyperus*), rushes (*Juncus*), bulrushes (*Scirpus*), several cordgrasses (*Spartina*), seashore saltgrass (*Distichlis spicata* var. *spicata*), common reed (*Phragmites australis*), marshmillet (*Zizaniopsis miliacea*), longtom (*Paspalum lividum*), seashore dropseed (*Sporobolus virginicus*), and knotroot bristlegrass (*Setaria geniculata*). Marshmillet and maidencane (*Panicum hemitomon*) are two of the most important grasses of the fresh-water marshes of the upper coast. Common aquatic forbs are pepperweeds (*Lepidium*), smartweeds (*Polygonum*), docks (*Rumex*), bushy seedbox (*Ludwigia alternifolia*), green parrotfeather (*Myriophyllum pinnatum*), pennyworts (*Hydrocotyle*), water lilies (*Nymphaea*), narrowleaf cattail (*Typha domingensis*), spiderworts (*Tradescantia*), and duckweeds (*Lemna*). Common halophytic herbs and shrubs on salty sands are spikesedges (*Eleocharis*), fimbries (*Fimbristylis*), glassworts (*Salicornia*), sea-rockets (*Cakile*), maritime saltwort (*Batis maritima*), morningglories (*Ipomoea*), and bushy sea-ox-eye (Jones 1982).

The low marshy areas provide excellent natural wildlife habitat for upland game and waterfowl. The higher elevations of the Gulf Marshes are used for livestock and wildlife production. Ranch units are mostly in large landholdings. These marshes and barrier islands contain most of our National Seashore parks. Urban, industrial, and recreational developments have increased in recent years. Most land is not well suited for cultivation because of periodic flooding and saline soils. The Gulf Prairies are used for crops, livestock grazing, wildlife production, and increasingly for urban and industrial centers. About one-third of the area is cultivated mostly for rice, sorghum, corn, and tame pastures. Bermudagrass and several introduced bluestems (*Dichanthium* and *Bothriochloa*) are common tame pasture grasses.

In the Gulf Prairies and Marshes, ranches are primarily cow-calf operations that use forage produced from rangeland and tame pasture. Some of the area is cropped. Zebu or crossbreeds having Zebu blood are the most widely adapted and used cattle. Recreation, hunting, and fishing provide excellent multiple-use opportunities in the Gulf Prairies and Marshes.

Of all the areas in Texas, the Gulf Prairies and Marshes have seen the greatest industrial development in history since World War II. Chief concentration has been from Orange and Beaumont to Houston, and much of the development has been in petrochemicals. Corpus Christi, the surrounding Coastal Bend region, and Brownsville and the adjacent Lower Rio Grande Valley area are rapidly developing naval, agricultural, and industrial sections.

2.1.3. Post Oak Savannah

The Post Oak Savannah lies just to the west of the Pineywoods and mixes considerably with the Blackland Prairies area in the south. This area includes the entire Claypan land resource area of Texas, which is part of the Southern Coastal Plains. The Post Oak Savannah is a gently rolling, moderately dissected wooded plain.

Upland soils are gray, slightly acid sandy loams, commonly shallow over gray, mottled or red, firm clayey subsoils. They are generally droughty and have claypans at varying depths, restricting moisture percolation. The bottomland soils are reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial. Short oak trees occur in association with tallgrasses. Thicketization occurs in the absence of recurring fires or other methods of woody plant suppression. This distinctive pattern of predominantly post oak and blackjack oak (*Quercus marilandica*) in association with tallgrasses also characterizes the vegetation of the Cross Timbers and Prairies vegetational area. Associated trees are elms, junipers (*Juniperus*), hackberries (*Celtis*), and hickories. Characteristic understory vegetation includes shrubs and vines such as yaupon (*Ilex vomitoria*), American beautyberry, coralberry (*Symphoricarpos orbiculatus*), greenbriar, and grapes.

Climax grasses are little bluestem, indiangrass, switchgrass (*Panicum virgatum*), silver bluestem (*Bothriochloa saccharoides*), Texas wintergrass (*Stipa leucotricha*), brownseed paspalum, purpletop, narrow leaf woodoats (*Chasmanthium sessiliflorum*), and beaked panicum (*Panicum anceps*). Lower successional species include brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem (*Andropogon ternarius*), rosette grasses, and lovegrasses (*Eragrostis*).

Forbs similar to the true prairie species are wild indigo, indigobush (*Amorpha fruticosa* var. *augustifolia*), senna, tickclover, lespedezas (*Lespedeza*), prairie clovers (*Petalostemon*), western ragweed, crotons (*Croton*), and sneezeweeds (*Helenium*).

The area is well suited to grain crops, cotton, vegetables, and fruit trees. It was extensively cropped through the 1940's, but many acres have since been returned to native vegetation or tame pastures. Pasturelands have frequently been seeded with introduced species such as bermudagrass, bahiagrass, weeping lovegrass (*Eragrostis curvula*), and clover.

Deer, turkey, quail, and squirrel are perhaps the most economically important wildlife species for hunting enterprises although many other small mammals and birds exist in the region. The major livestock enterprise is mixed cow-calf-yearling operations with many small herds on small landholdings. Livestock use either tame pastures, native pastures, or the woodland areas for forage throughout the year. Wheat, oats, and rye are often planted for winter pasture.

2.1.4. Blackland Prairies

The Blackland Prairie area intermingles with the Post Oak Savannah in the southeast and has divisions known as the San Antonio and Fayette Prairies. This rolling and well-dissected prairie represents the southern extension of the true prairie that occurs from Texas to Canada.

The upland blacklands are dark, calcareous shrink-swell clayey soils, changing gradually with depth to light marls or chalks. Bottomland soils are generally reddish brown to dark gray, slightly acid to calcareous, loamy to clayey and alluvial. The soils are inherently productive and fertile, but many have lost productivity through erosion and continuous cropping.

This once-luxuriant tallgrass prairie was dominated by little bluestem, big bluestem, indiangrass, tall dropseed (*Sporobolus asper* var. *asper*), and Silveus dropseed (*S. silveanus*). Minor species such as sideoats grama (*Bouteloua curtipendula*), hairy grama (*B. hirsuta*), Mead's sedge (*Carex meadii*), Texas wintergrass, and buffalograss (*Buchloe dactyloides*) have increased with grazing pressure. Common forbs are asters (*Aster*), prairie bluet (*Hedyotis nigricans* var. *nigricans*), prairie-clover, and late coneflower (*Rudbeckia serotina*). Common legumes include snoutbeans (*Rhynchosia*) and vetch. Mesquite, huisache, oak, and elm are common

invaders on poor-condition rangelands and on abandoned cropland. Oak, elm, cottonwood, and native pecan (*Carya*) are common along drainages.

About 98 percent of the Blackland Prairie was cultivated to produce cotton, sorghum, corn, wheat, and forages during the latter part of the 19th century and the first part of the 20th century. Since the 1950's, pasture and forage crops for the production of livestock have increased, and now only about 50 percent of the area is used as cropland. Tame pastures occupy more than 25 percent of the land area, and the rest is used as rangeland. Small remnants of native vegetation exist for grazing or for native hay production. Livestock production with both cow-calf and steer operations are the major livestock use. Winter cereals are used extensively for livestock grazing in conjunction with tame pasture forages. Potential is good for increased production of food and fiber crops as well as forages. Mourning dove and bobwhite quail on the uplands and squirrel along streams are the most important game species.

2.1.5. Cross Timbers and Prairies

The Cross Timbers and Prairies area in North Central Texas includes the Cross Timbers, Grand Prairie, and North Central Prairies land resource areas. This area represents the southern extension of the Central Lowlands and the western extreme of the Coastal Plains.

The wide variances in geologic formations bring about sharp contrasts in topography, soils, and vegetation. Upland soils of both the East and West Cross Timbers are light, slightly acid loamy sands and sandy loams with yellowish brown to red clayey subsoils. Bottomland soils have small, dark, neutral to calcareous clayey areas, and loamy alluvial soils occur along the minor streams. Upland soils are dark, deep to shallow, and stony calcareous clays with subsoils of lighter, limy earths and limestone fragments. Bottomland soils are reddish brown, loamy to clayey calcareous alluvial. The North Central Prairies are interspersed with rapidly drained sandstone and shaley ridges and hills occupied by scrub live oak, juniper, and mesquite. Uplands are brown, sandy loam to silt loam, slightly acid soils over red to gray, neutral to alkaline clayey subsoils. Bottomland soils are brown to dark gray, loamy and clayey, neutral to calcareous, and alluvial.

Climax vegetation is composed primarily of big bluestem, little bluestem, indiangrass, switchgrass, Canada wildrye, minor amounts of sideoats grama, blue grama (*Bouteloua gracilis*), hairy grama, Texas wintergrass, and buffalograss. The minor species have generally increased with grazing. Invaders are hairy tridens (*Erioneuron pilosum*), Texas grama (*Bouteloua rigidiseta*), red lovegrass (*Eragrostis secundiflora*), wild barleys (*Hordeum*), threeawns, fringed-leaf paspalum (*Paspalum setaceum* var. *ciliatifolium*), and tumble windmillgrass (*Chloris verticillata*). This area once contained significant amounts of prairie forbs such as western ragweed, littlesnout sedge (*Carex microrhyncha*), heath aster (*Aster ericoides*), gayfeathers (*Liatris*), lespedeza, sageworts (*Artemisia*), and tephrosias (*Tephrosia*) (Dyksterhuis 1948).

Past mismanagement and cultivation have caused the uplands to be covered mostly by scrub oak, mesquite, and juniper with mid-and shortgrass understories. The bottomland trees are primarily hardwoods such as pecan, oak, and elm but have been invaded by mesquite. Characteristic understory shrubs and vines include skunkbush (*Rhus aromatica*), saw greenbriar (*Smilax bona-nox*), bumelia (*Bumelia lanuginosa*), and poison-ivy.

About 75 percent of the Cross Timbers and Prairies vegetational area is used as range and pasture. Major crops on the sandy Cross Timber soils are peanuts, fruits, sorghum, wheat, oats, corn, and forages. Dairy operations are common, but beef cattle cow-calf operations are the predominant livestock activities. Sheep and goat operations occur in the southern parts. Most holdings are small mixed farming and ranching operations.

White-tailed deer, raccoon, squirrel, quail, and mourning dove are locally plentiful and provide some commercial hunting. Stock ponds and lakes on tributaries of the Brazos River (Hubbard Creek and Possum Kingdom Lake) and the Trinity River provide recreational fishing.

2.1.6. South Texas Plains

The South Texas Plains lie south of a line from San Antonio to Del Rio. This area is the western extension of the Gulf Coastal Plains merging with the Mexico Plains on the west. The area is a nearly level to rolling, slightly to moderately dissected plain. Upland soils are of three groups: dark, clayey soils over firm clayey subsoils; grayish to reddish brown, loamy to sandy soils; and brown loamy soils. Gray, clayey, saline, and sodic soils are extensive on the coastal fringe, along with Galveston deep sands. Bottomlands are typically brown to gray, calcareous silt loams to clayey alluvial soils.

The original vegetation was an open grassland or savannah-type along the coastal areas and brushy chaparral-grassland in the uplands. Originally, oaks and mesquite and other brushy species formed dense thickets only on the ridges, and oak, pecan, and ash were common along streams. Continued grazing and cessation of fires altered the vegetation to such a degree that the region is now commonly called the Texas Brush Country. Many woody species have increased, including mesquite, live oak, acacia, brazil (*Zizyphus obovata*), spiny hackberry (*Celtis pallida*), whitebrush (*Aloysia gratissima*), lime pricklyash (*Zanthoxylum fagara*), Texas persimmon (*Diospyros texana*), shrubby blue sage (*Salvia ballotiflora*), and lotebush (*Zizyphus obtusifolia*).

Characteristic grasses of the sandy loam soils are seacoast bluestem (*Schizachyrium scoparium* var. *littorale*), bristlegrasses (*Setaria*), paspalums, windmillgrasses (*Chloris*), silver bluestem, big sandbur (*Cenchrus myosuroides*), and tanglehead. The dominants on the clay and clay loams are silver bluestem, Arizona cottontop (*Digitaria californica*), buffalograss, common curlymesquite (*Hilaria belangeri*), and species of Setaria, Pappophorum, and Bouteloua. Low saline areas are characterized by gulf cordgrass, seashore saltgrass, alkali sacaton (*Sporobolus airoides*), and switchgrass. Forbs include pricklypear, orange zexmania (*Zexmania hispida*), bush sunflowers (*Simsia*), velvet bundleflower (*Desmanthus velutinus*), tallowweeds (*Plantago*), lazy daisies (*Aphanostephyus*), Texas croton (*Croton texensis*), and western ragweed. Grasses of the oak savannahs are mainly little bluestem, Indiangrass, switchgrass, crinkleawn (*Trachypogon secundus*), and species of Paspalum. Pricklypear is characteristic throughout most of the area. Forbs generally associated with all but the most saline soils are bush sunflower, orange zexmania, shrubby oxalis (*Oxalis berlandieri*), white milkwort (*Polygala alba*), American snoutbean (*Rhynchosia americana*), and greenthread (*Thelesperma nuecense*).

Because the South Texas Plains lie almost entirely below the hyperthermic line, introduced tropical species do well. The introduced species buffelgrass (*Cenchrus ciliaris*) has proliferated and is common on loamy to sandy soils in the western half of the area. Coastal bermudagrass, kleingrass (*Panicum coloratum*), and rhodesgrass (*Chloris gayana*) are also common introduced species in tame pastures.

Range is the major land use, but irrigated and dryland cropping of cotton, sorghum, flax, small grains, and forages are also important. Citrus, vegetables, and sugarcane do well in the Lower Rio Grande Valley. Many acres are in large landholdings, such as the King Ranch. Livestock production is primarily cow-calf range operations, and wildlife production for hunting and recreational use are becoming increasingly important. The South Texas Plains vegetational area is known nationwide for its large white-tailed deer. Quail, mourning dove, turkey, feral pigs, and javelina are other major game species. Stocker operations and feedlot operations are intermixed with cow-calf operations. Sheep and goat enterprises, once common throughout the area, are now confined mostly to the northern part because of coyote predation. Integrated use of range, crops, and forages is increasing as is vegetable and peanut production where irrigation is possible.

2.1.7. Edwards Plateau

The Edwards Plateau area includes 1.45 million acres known as the Granitic Central Basin in Llano and Mason Counties. The Balcones Escarpment forms the distinct boundary of the Edwards Plateau on its eastern and southern borders and outlines what is known as the Texas Hill Country.

The area is a deeply dissected, rapidly drained stony plain having broad, flat to undulating divides. The original vegetation was grassland or open savannah-type plains with tree or brushy species found along rocky slopes and

stream bottoms. Tallgrasses such as cane bluestem (*Bothriochloa barbinodis* var. *barbinodis*), big bluestem, indiangrass, little bluestem, and switchgrass are still common along rocky outcrops and protected areas having good soil moisture. These tallgrasses have been replaced on shallow xeric sites by midgrasses and shortgrasses such as sideoats grama, buffalograss, and Texas grama.

The western part of the area comprises the semiarid Stockton Plateau, which is more arid and supports short-to midgrass mixed vegetation. The climax grasses are cane bluestem, little bluestem, sideoats, hairy grama, common curlymesquite, buffalograss, fall witchgrass (*Leptoloma cognatum* var. *cognatum*), and Tridens and Elymus. Tobosa (*Hilaria mutica*) forms dense stands in conjunction with burrograss (*Scleropogon brevifolius*). Common forbs are Engelmann daisy (*Engelmannia pinnatifida*), orange zexmania, bush sunflower, western ragweed, and sneezeweed. Bitterweed (*Hymenoxys odorata*), broadleaf milkweed (*Asclepias latifolia*), smallhead sneezeweed (*Helenium microcephalum*), broomweeds (*Amphiachyris and Gutierrezia*), prairie coneflower (*Ratibida columnifera*), mealycup sage (*Salvia farinacea* var. *farinacae*), tasajillo (*Opuntia leptocaulis*), and pricklypear are common on overgrazed ranges.

Common woody species are live oak, sand shin oak (*Quercus havardii*), post oak, mesquite, and juniper. The eastern and southern edges of the Stockton Plateau support dense stands of ashe juniper (*Juniperus ashei*), whereas redberry juniper (*Juniperus pinchotii*) increases to the north and west.

The Edwards Plateau is 98 percent rangeland; arable lands are found only along narrow streams and some divides. The rangeland is used primarily for mixed livestock (combinations of cattle, sheep, and goats) and wildlife production. The area is the major wool-and mohair-producing region in the United States, providing perhaps 98 percent of the nation's mohair. It also supports the largest deer population in North America. Most ranches are managed for livestock as the major enterprise, but wildlife production is becoming increasingly important. Exotic big-game ranching is becoming important, and axis, sika, and fallow deer and blackbuck antelope are increasing in number (Traweek 1985). Management for all resources, livestock, wildlife, and recreation, provides the best use of the rangeland although other products such as cedar oil and wood products have local importance. Forage, food, and fiber crops such as sorghum, peanuts, plums, and peaches are well adapted to arable land.

2.1.8. Rolling Plains

The Rolling Plains area (24 million acres) coincides with the Rolling Plains land resource area of the southern Central Lowlands. The area is between the High Plains and the Cross Timbers and Prairies in the northern part of the state. It is a nearly level to rolling plain having moderate to rapid surface drainage. Soils of the uplands are pale brown to reddish brown to dark grayish brown, neutral to calcareous sandy loams, clay loams, and clays. Saline soils are common, as are shallow and stony soils with pockets of deep sand. Bottomlands have only minor areas of reddish brown, loamy to clayey, calcareous alluvial soils.

The original prairie vegetation included tall-, mid-, and shortgrasses such as little bluestem, big bluestem, sand bluestem (*Andropogon gerardii* var. *paucipilus*), sideoats grama, indiangrass, switchgrass, hairy grama, blue grama, and buffalograss on the uplands, and Canada wildrye, and western wheatgrass (*Elytrigia smithii*) on the moister sites. Buffalograss, common curlymesquite, tobosa, threeawns, sand dropseed (*Sporobolus cryptandrus*), and hooded windmillgrass (*Chloris cucullata*) are more common on the more xeric or overgrazed sites. Climax forbs include western yarrow (*Achillea millefolium*), broadleaf milkweed, Lambert crazyweed (*Oxytropis lambertii*), prairie coneflower, and slimleaf scurfpea (*Psoralea tenuiflora*). Western ragweed and annual broomweed are common invaders. Plant retrogression under continued overgrazing and reduction of fires is from a mid-and tallgrass-dominated community to shortgrasses, shrubs, and annuals.

Mesquite, lotebush, pricklypear, algerita (*Berberis trifoliolata*), and tasajillo are common invaders on all soils. Shinnery oak and sand sagebrush (*Artemisia filifolia*) invade the sandy lands, and redberry juniper has spread from rocky slopes to grassland areas. Dense stands of these species can be found throughout the Rolling Plains on overgrazed rangeland and abandoned cropland.

More than 75 percent of the area is rangeland, but dryland and irrigated sorghum, small grain, cotton, and forages are important crops. Livestock production, the major enterprises being cow-calf and yearling operations, includes use of rangeland forage, crop residue, and winter cereals. The intermixing of rangeland and cropland allows habitat for wildlife such as mourning dove, quail, white-tailed deer, and turkey, providing good to excellent recreational hunting opportunities.

2.1.9. High Plains

The High Plains area is part of the Southern Great Plains. It is separated from the Rolling Plains by the Llano Estacado Escarpment and dissected by the Canadian River Breaks in the northern part. Notable canyons include Tule and Palo Duro along the Caprock. This relatively level plateau contains many shallow siltation depressions, or playa lakes, which sometimes cover as much as 40 acres and contain several feet of water after heavy rains. These depressions support unique patterns of vegetation within their confines.

The upland soils are dark brown to reddish brown, mostly deep, neutral to calcareous clay and clay loams in the north to sandy loams and sands in the south. Caliche is present under many soils at various depths, especially on the Potter series. The original vegetation of the High Plains was variously classified as mixed prairie, shortgrass prairie, and in some locations on deep, sandy soils as tallgrass prairie. Blue grama, buffalograss, and galleta (*Hilaria jamesii*) are the principal vegetation on the clay and clay loam sites. Characteristic grasses on sandy loam soils are little bluestem, western wheatgrass, sideoats grama, and sand dropseed. Shinnery oak and sand sagebrush are restricted to sandy sites. The High Plains area characteristically is free from brush, but sand sagebrush and western honey mesquite (*Prosopis glandulosa* var. *torreyana*) have invaded the sandy and sandy loam sites along with pricklypear and yucca (*Yucca*). Several species of dropseeds (*Sporobolus*) are abundant on coarse sands. Various aquatic species such as curltop smartweed (*Persicaria lapathifolia*) are associated with the playa lakes. Forbs common to deep hardlands are slimleaf scurfpea, prairie coneflower, croton, fineleaf woollywhite (*Hymenopappus filifolius* var. *cinereus*), woolly loco (*Astragalus mollissimus* var. *mollissimus*), plains beebalm (*Monarda pectinata*), and tallow-weed (*Plantago patagonia*).

About 60 percent of the area is cropland, half of which is irrigated. Cotton, corn, sorghum, wheat, vegetables, and sugar beets are major crops. Winter cereals are used for stocker operations in preparation for feedlotting on the extensive grain supplies produced on the High Plains. Rangeland grazing is important on about 40 percent of the area. Few cow-calf operations exist, but stocker operations are common.

High winds, dry winters, and low annual rainfall present problems for cultivation and erosion control. As ground-water availability diminishes, use of pasture and range for livestock production increases.

Antelope were once common, but now only remnant populations provide hunting. Quail and mourning dove are abundant, and mule deer, turkey, and exotic aoudad sheep provide hunting along the breaks and canyons of the Caprock. Many playa lakes provide excellent migratory waterfowl habitat.

2.1.10. Trans-Pecos

The **Trans-Pecos** area in Far West Texas is traversed by the eastern chain of the Rocky Mountains into the Basin and Range Province and is typical of the southwestern United States. Guadalupe Peak, having an elevation of 8,751 feet, of the Guadalupe Mountains, is the highest point in Texas. Surrounding peaks are El Capitan, Shumard, Bartlett, and Pine Top, all exceeding 8,000 feet. Mount Emory in the Chisos Mountains and Mount Locke in the Davis Mountains are 7,825 feet and 8,382 feet high, respectively. Notable canyons and gorges are Santa Elena, Boquillas, and Mariscal on the Big Bend of the Rio Grande; and McKittrick in the Guadalupe Mountains.

Uplands soils are mostly light reddish brown to brown clay loams, clays, and sands over reddish, loamy to clayey, calcareous, gypsic or saline subsoils. These include many areas of shallow soils and rocklands. Sizeable areas of deep sands exist. Drainage is rapid in the mountains, slow in the basins, and absent in the bolsons.

The original vegetation ranged from desert grassland and desert shrub on lower slopes and elevations through juniper, pinyon pine (*Pinus edulis*), and Mexican pinyon (*P. cembroides*) at mid elevations. The mountains support ponderosa pine (*Pinus ponderosa*) and forest vegetation on the higher slopes. Principal vegetation types of the basins are creosotebush (*Larrea tridentata*), tarbush (*Flourensia cernua*), catclaw acacia (*Acacia greggii*), catclaw mimosa (*Mimosa biuncifera*), whitethorn (*Acacia constricta*), yucca and juniper savannahs, and tobosa flats. Alkali sacaton and species of saltbush (*Atriplex*) occur on saline soils. Characteristic species of the plateaus and canyons are chino grama (*Bouteloua breviseta*), leatherstem (*Jatropha dioica* var. *dioica*), ocotillo (*Fouquieria splendens*), candelilla (*Euphorbia antisyphilitica*), lechuguilla (*Agave lecheguilla*), and sotols (*Dasylirion*).

The grass vegetation, especially on the higher mountain slopes, includes many southwestern and Rocky Mountain species not present elsewhere in Texas. Examples are Arizona fescue (*Festuca arizonica*) and mountain muhly (*Muhlenbergia montana*). On the desert flats, black grama (*Bouteloua eriopoda*) and tobosa have mostly been replaced by burrograss and fluffgrass (*Dasyochloa pulchella*). More productive sites have numerous species of grama (*Bouteloua*), muhly (*Muhlenbergia*), dropseed (*Sporobolus*), and perennial threeawn (*Aristida*) grasses. At the higher elevations, little bluestem and Texas bluestem (*Schizachyrium cirratum*), sideoats and blue grama, pinyon ricegrass (*Piptochaetium fimbriatum*), wolftail (*Lycurus phleoides*), and several species of Stipa are common.

Poisonous plants present considerable problems in this harsh environment. Major toxic species are threadleaf groundsel (*Senecio douglasii*), broom snakeweed (*Gutierrezia sarothrae*), rayless goldenrod (*Isocoma wrightii*), sacahiusta (*Nolina texana*), lechuguilla, twoleaf senna (*Cassia roemeriana*), and loco (*Astragalus*).

Under poor grazing management, range sites become more xeric, and perennial grassland vegetation gives way to desert shrub and annual forbs and grasses. Creosotebush and tarbush complexes now cover some 15 million acres of former desert grassland in the Trans-Pecos area. Tobosa draws, which once produced considerable forage, were invaded by burrograss and annuals as grazing pressure increased. Without the cover of perennial grass, the soils are subject to sheet and arroyo erosion from the intense summer thunderstorms.

More than 95 percent of the area remains as rangeland. Irrigated crops along the Rio Grande and other small drainages contribute to the economy. Cotton, alfalfa, sorghum, cantaloupe, sugar beets, grapes, and vegetables are grown. Most ranching operations are for livestock (cattle and sheep) production although management for mule deer, antelope, dove, and quail is important. Most livestock operations are cow-calf, and some stockers are carried over to use forages and irrigated fields.

2.2 Brush in Texas

All major land resource areas (MLRA) in Texas have significant brush infestations; however, different species predominate in different regions. Table 2.1 shows the major brush species and level of infestation in Texas based on brush surveys in 1982 and 1987 and 1991. These acreages illustrate the magnitude of Texas' brush problem. While not all species of brush are significant users of water, prickly pear, for example, others such as juniper and mesquite have been shown to drastically reduce water yield in a watershed.

Table 2.1. Acres of brush for different species and density ranges in Texas from USDA-NRCS 1982 and 1987 brush surveys. (compiled from TSSWCB, 1991)

	Light Canopy 1-10% Cover		Moderate Canopy 11-30% Cover		Heavy Canopy >30% Cover	
Species	*1982*	*1987*	*1982*	*1987*	*1982*	*1987*
Agarito	8,370,500	5,336,100	303,500	272,700	29,500	11,600
Ashe juniper	4,398,300	2,875,300	2,000,800	1,949,300	1,214,700	1,904,400
Baccharis	288,800	122,000	44,200	25,700	7,000	9,000
Blackbrush	3,780,100	2,167,200	2,068,400	2,445,000	602,200	623,000
Blackjack oak	765,700	401,700	365,700	164,200	52,500	50,500
Broom snakeweed	5,560,300	2,607,700	1,987,700	2,512,800	270,600	967,200
Catclaw acacia	7,045,400	3,554,200	611,600	335,700	13,700	1,700
Cenizo	258,300	107,300	12,500	21,000	0	0
Chinese Tallow[1]						507,400
Condalias/lotebush	9,168,400	6,991,700	551,100	594,000	88,300	23,100
Creosotebush	4,830,600	4,212,500	3,027,000	2,324,300	246,200	134,800
Eastern red cedar	633,800	374,700	166,900	101,000	97,000	27,900
Elbowbush	331,600	174,800	69,700	60,800	13,600	1,600
Elms	1,939,800	996,000	671,400	553,500	315,600	341,100
Granjeno	4,939,400	3,374,100	486,000	735,000	86,800	1,200
Guajillo	1,975,400	1,162,300	981,200	1,081,600	239,600	401,200
Huisache	745,700	589,900	194,000	145,500	63,500	46,600
Live oak	6,067,500	4,321,000	3,401,500	4,141,600	1,112,500	1,076,100
Macartney rose	176,100	70,300	56,900	146,000	21,900	0
Mesquite	32,162,700	24,936,500	14,690,900	16,670,800	4,262,900	5,610,000
Post oak	2,027,200	1,277,500	1,642,300	1,524,900	1,642,400	1,536,200
Prickly pear	28,688,500	19,642,000	1,686,100	2,176,200	170,900	189,200
Redberry juniper	6,900,600	6,133,600	2,532,400	2,707,800	414,700	558,300
Sand sagebrush	2,764,300	2,494,600	1,032,700	1,168,800	239,800	292,700
Sand shinoak	301,600	60,100	350,200	257,200	362,000	600,900
Tarbush	2,301,600	2,083,300	791,300	594,900	50,300	85,500
Tasajillo	4,475,800	3,092,000	271,500	283,100	16,600	0
Texas persimmon	5,833,600	3,315,900	850,600	767,600	124,200	54,400
Twisted acacia	1,061,500	748,000	156,800	181,600	0	0
Whitebrush	2,593,500	1,663,000	605,800	763,000	184,400	318,800
Yaupon	831,000	515,900	568,700	654,100	322,600	205,300
Yucca	13,353,800	8,279,600	601,300	499,300	12,600	0

1. Chinese tallow infestation for 1990 from a 1991 survey by NRCS. Infestation by the year 2000 was estimated at over 900,000 acres.

Percent canopy cover was not provided.

Section III: Increasing Water Yields with Rangeland Management

Water yield (runoff and deep drainage) can be estimated using the following water balance equation:

Runoff + Deep Drainage = Precipitation – Evapotranspiration.

The components of the water balance equation are defined as follows:

Evapotranspiration. The combination of transpiration and evaporation where:

Transpiration. The process by which water vapor is released to the atmosphere by passing through leaf tissue.

Evaporation. The process by which water vapor enters the atmosphere from the soil or surface water. Another source of evaporation is precipitation that has adhered to plants which then directly passes back to the atmosphere — this is known as interception loss.

Runoff. Water that exits the watershed via overland flow.

Deep Drainage. Water that exits the watershed via percolating through the soil beyond the reach of plant roots.

This implies that water yield can be increased if evapotranspiration can be decreased through vegetation management (Thurow 1998).

Many variables influence the degree to which water will exit a site via evapotranspiration, runoff or deep drainage.

Climatic factors. Precipitation characteristics such as amount, intensity, distribution over time, and form (i.e., rain or snow) influence the likelihood of runoff and deep drainage. It is more likely that runoff will occur when the rainfall is intense and/or occurs as large, prolonged storms. Deep drainage is most likely during prolonged rainy periods. If the rainfall is gentle and occurs in a series of small storms the chance for water yield is much lower.

The potential evapotranspiration rate is influenced by temperature, humidity and wind. In an arid environment the water will quickly evaporate from the soil and the transpiration demand from plant leaves will be very high. A high potential evapotranspiration rate lowers the chances that water will have the time needed to percolate through the soil profile and escape uptake by plant roots. Many aquifers have a better chance of recharging during the winter because many of the plants have lost their leaves and because the low temperature results in a low evapotranspiration rate.

Vegetation factors. The leaf surface area and type of cover determine the amount of water that can be held in the canopy and evaporate back to the atmosphere (interception loss). At the Texas Agriculture Experiment Station in Sonora, Texas it was documented that juniper and the associated litter have an annual interception loss averaging 73% of precipitation, compared with 46% interception loss for live oak and 14% interception loss for grass (Thurow and Hester 1997). These data dramatically indicate that the amount of water reaching the soil is markedly different among vegetation types. The leaf surface area and type of cover also influence the amount of water that will returne to the atmosphere via transpiration. On rangelands with a dense juniper cover essentially all of the rainfall returns to the atmosphere by either evaporation (in the form of interception loss) or transpiration (i.e., the small amount of water that does reach the soil is taken up by the trees). Therefore, rangeland with dense juniper cover would have little potential for water yield compared to a grassland, which has a much lower evapotranspiration loss and allows more water to leave the site via either runoff or deep drainage.

The amount and type of cover are often the most important variables affecting infiltration rate (water movement into the soil) at a particular site. Plant cover dissipates the erosive energy of raindrops before they strike the soil. If cover is not present, the pores into the soil will likely be clogged with soil particles dislodged by raindrop impact. This creates a "wash-in" layer at the soil surface which restricts infiltration and accelerates erosion. In extreme situations a crust forms on the soil surface. Since maintenance of productivity potential is an inherent characteristic of sound range management, accelerated erosion resulting from degraded infiltration characteristics is not acceptable. It is, therefore, important to maintain a type of cover that will protect the soil while having as little evapotranspiration loss as possible. On Texas rangelands, a healthy grass cover can hold the soil in place and will have the lowest evapotranspiration (and highest water yield) of the sustainable vegetation cover options.

Soil factors. The texture and structure of the soil is a primary determinant of how fast water can percolate through the soil. The textural and structural characteristics combined with soil depth determine how much water can be stored in the soil after it has had a chance to drain (field capacity). The geologic characteristics underlying the soil influence the amount of and rate at which water will exit a site via deep drainage. For example, the Edwards Plateau is characterized by shallow soils with a rapid infiltration rate underlain by fractured limestone. Consequently, the potential for deep drainage leading to aquifer recharge is high. Deep, coarse-textured soils, such as those overlying the Carrizo-Wilcox aquifer, also have a high aquifer recharge potential because of their rapid transmissive characteristics and low water retention capacity. These characteristics make it likely that much of the water yield associated with a change from brush to grass dominance will occur as deep drainage. In contrast, a typical site in the Rolling Plains ecoregion of North-Central Texas is characterized by deep silty clay soil with a high water retention capacity and a slow drainage rate. As a result, very little water is lost to deep drainage (Carlson et al. 1990). The same is true of the clay soils of the Blackland Prairie ecoregion. Any extra water yield associated with a change from brush to grass dominance on a site with poor deep drainage potential will likely occur as runoff.

Topographic factors. The steepness and length of slope affects the potential for runoff and the erosion hazard. It is generally accepted forestry practice that trees should not be cleared from hillsides with a 20% slope or more (FAO 1977). Many areas in Central Texas with slopes of this magnitude were historically forested "cedar breaks," probably because the associated rocky character made it difficult for them to sustain a natural fire. These sites should not be considered for brush control efforts intended to increase water yield.

The basis for using brush management to increase water yield is founded on the premise that shifting vegetation composition from species associated with high evapotranspiration potential (trees and shrubs) to species with lower evapotranspiration potential (grass) will increase water yield. Water yield tends to decrease as woody cover increases because, compared to grasses, trees and shrubs have:

(1) a more extensive canopy which catches precipitation which evaporates back to the atmosphere (i.e., interception loss),

(2) a greater leaf area from which transpiration can occur,

(3) a more extensive root system with greater access to soil water,

(4) a greater ability to extract water from very dry soil, and

(5) many invasive woody species that are evergreen allowing rapid resumption of water use when it becomes available (as opposed to most grasses which senesce during dry periods and require time to re-establish green tissue).

Climate and soil traits influence whether reduction in transpiration and interception losses resulting from brush to grass conversion would be offset by increased evaporation from soil. An analysis of climate, evapotranspiration, and field runoff measurements indicated that sites with tree and shrub communities in the Colorado River basin of the western U.S. need to receive over 18 inches/year of precipitation and need to have a

potential evapotranspiration of over 15 inches/year to yield significantly more water if converted to grasslands (Hibbert 1983). Since all regions of Texas have a potential evapotranspiration of over 15 inches/year, these data suggest that a reasonable criteria for deciding where brush control is likely to increase water yield is to concentrate on areas that receive at least 18 inches of rain/year.

In general, conversion of cover from brush to grass does not influence water yield on sites that receive less than 18 inches/year because the extra water that reaches the ground and the reduced transpiration loss is offset by high evaporation from the soil. Studies in many other forest and rangeland ecosystems throughout the world corroborate that a water yield increase can occur when the dominant vegetation cover is shifted from brush to grass (cf. Douglass, 1983; Jofre and Randal, 1993) in areas that receive at least 18 inches/year precipitation and have at least 15 inches/year potential evapotranspiration.

3.1 Increased Water Yield in Texas

Very few field studies in Texas have attempted to measure water yield enhancement by brush control at a catchment scale. Research on the Texas A&M Agricultural Research Station at Sonora shows that there is a very significant water yield potential associated with converting brush to grassland on a site with these characteristics (over 18 inches of rain/year, shallow soils with high infiltration rates overlying fractured limestone, dense juniper oak woodland cleared and replaced with shortgrass and midgrass species). These data were collected over a 10-year period from seven 10-acre catchments and supplemented with data on water movement through the soil using 45 x 45 x 30 inch weighing lysimeters.

Similar estimates of vegetation effects on water yield were made for the Cusenbary Draw Watershed, which includes part of the Texas Agriculture Experiment Station at Sonora within the watershed. The Cusenbary Draw Watershed estimates were derived independently of the field data estimates and were obtained using the Simulation of Production and Utilization of Rangelands (SPUR-91) model (Redeker et al. 1998). The SPUR-91 model has been validated to be an effective tool for estimating water yield and livestock carrying capacity on range sites throughout Texas (Carlson et al. 1995, Carlson and Thurow 1996). Aerial photographs were used to form a composite photograph of the watershed for both 1955 and 1990. The amount of woody cover in 1955 and 1990 and the rate of change between these dates was calculated using image analysis technologies on each of the five range sites delineated within the watershed (Redeker 1998). Literature and expert opinion were used to validate and refine the aerial photo composition estimates of woody (juniper, oak, mesquite) and herbaceous (bunchgrass, shortgrass, forbs) cover.

Both the field study and modeling investigations conclude that water yield increases exponentially as brush cover declines in the treated area (i.e., very little change in water yield from dense brush canopy cover to about 15% brush canopy cover and a rapid rise in water yield from 15% to 0% brush canopy cover). These findings imply that it is necessary to remove most of the brush in the treatment area to maximize water yield potential. This conclusion is corroborated by numerous anecdotal observations by ranchers and agency personnel with brush control experience in the region (cf. Kelton 1975, Willard et al. 1993). The exponential pattern of water yield increase relative to a decrease in brush cover has also been postulated for the Colorado River Basin (Hibbert 1983). The exponential relationship is believed to occur because the intraspecific competition among trees (Ansley et al. 1998) and interspecific competition with herbaceous vegetation results in little increase in water yield until the tree density becomes sparse. In other words, trees have a capability for luxuriant water use. If a stand is thinned the remaining trees will in a short time expand their root systems to use the extra water. Only when the thinning reduces tree cover to less than about 15% in a specific area is there a potential for significant yields of water. It should be noted that the brush canopy reflects the average density over the treated area, not necessarily the total number of plants in a watershed. For example, 25% of a watershed could be left untreated to allow for wildlife habitat, while the remaining 75% could be treated to 0% canopy cover. Then the 75% of the watershed that is treated could have a significant improvement in water yield, while the untreated portion would have no change from the present condition.

In 1985, TSSWCB and the Texas Water Development Board developed a list of water supply reservoirs where brush control could possibly enhance water supplies (Table 3.1). The following criteria were used:

1. Where surface reservoirs have vacant storage and can accept an increase in surface flow.
2. Watershed of approximately 500 square miles or less and boundary conditions are minimized.
3. A record of historical baseflow.
4. Where brush clearance would progress upstream from a reservoir site.
5. Where zero or minimal stream diversions occur.
6. Where annual runoff averages more than 0.5 inches and less than 5.0 inches.
7. Where rainfall is between 15 and 36 inches per year.
8. Where trees can remain along streams and channelization is not necessary.
9. Where state and federal regulations regarding wetland and pollution will not be violated.
10. Where brush and/or phreatophyte infestation exceeds twenty percent.
11. Where dissolution of near-surface salts is minimal and such areas can be identified.
12. Where municipalities have water supply problems.
13. Where the best historical data as available such as, stream flow and ground - water level.
14. Where groundwater recharge and storage can be increased.
15. Where hydrogeological conditions are favorable.
16. Where the ratio of water use by brush/phreatophytes covered areas converted to grasslands or other vegetation is favorable. Also, where the ratio of the soil moisture with and without the brush is favorable to induce ground water recharge.

Most areas considered under the preliminary criteria outlined above can expect an increase in surface water runoff. With respect to ground water augmentation, however, the hydrogeological setting plays an important role in the selection. For example, streams should traverse the recharge outcrops of aquifer; and if faulting exists, this would be even better. Along the breaks of the Edwards Plateau, brush control would perhaps result in increased spring flows.

Table 3.1 Water supply reservoirs where brush control could enhance supplies.

County	Reservoir	Water Course	User	Comments
Archer	Lake Kickapoo	N. Fork Little Wichita	Wichita Falls	
Archer	Lake Arrowhead	Little Wichita River	Wichita Falls	
Bandera	Lake Medina	Medina River	Medina Irr. Co.	
Baylor	Millers Creek	Millers Creek	N. Central Texas MWA	Not more than 20% canopy
Blanco	Blanco River	Blanco River	Blanco	
Blanco	Johnson City Lake	Pedernales River	Johnson City	Lake part of Pedernales River
Bosque	Bosque River	Bosque River	Meridian	
Bosque	Bosque River	Bosque River	Clifton	Proposed reservoir
Brown	Lake Brownwood	Pecan Bayou	Brownwood WCID	Irr. and mun. supply
Burnet	Lake Georgetown	N. Fork San Garbiel	Brazos RA	
Callahan	Lake Baird	Mexia Creek	Baird	
Callahan	Lake Clyde	N. Prong Pecan Bayou	Clyde	
Clay	Arrowhead	Little Wichita River	Wichita Falls	
Coleman	Lake Coleman	Jim Ned Creek	Coleman	
Eastland	Lake Cisco	Sandy Creek	Cisco	
Erath	Bailey's Lake	Kickapoo Creek	Lipan	
Erath	Thurber Lake	Gibson Creek	Thurber	
Falls	Lake Marlin	Big Sandy Creek	Marlin	
Falls	Lake Rosebud		Rosebud	
Goliad	Coleto Creek	Coleto Creek	Guadalupe-Blanco R. A	Power cooling lake
Hamilton	Leon River	Leon River	Hamilton	Above Proctor
Haskell	Lake Stanford	Paint Creek		
Jack	Lake Jacksboro	Lost Creek	Jacksboro	
Jim Wells	Lake Alice	Chiltipin Creek	Alice	
Johnson	Lake Cleburne	Nolan River	Cleburne	
Jones	Ft. Phantom Hill	Elm Creek	Abilene	
Kimble	Lake Junction	Llano River	Junction	
Kindall	City Lake	Cibolo Creek	Boerne	
Llano	Llano/City Lake	Llano River	Llano	
Mills	City Lake	Colorado River	Goldthwaite	
Mitchell	Lake Colorado City	Morgan Creek	Colorado City	
Montague	Lake Nocona	Farmers Creek	Nocona	
Montague	Amon Carter	Sandy Creek	Bowie	
Nolan	Lake Trammel	Sweetwater Creek	Sweetwater	
Nolan	Lake Sweetwater	Bitter Creek	Sweetwater	
Palo Pinto	Palo Pinto	Palo Pinto Creek	Palo Pinto MWD	
Palo Pinto	Lake Mingus	Gibson Creek	Mingus	
Palo Pinto	Tucker Lake	Russell Creek	Strawn	
Parker	Lake Weatherford	Clear Fork Trinity	Weatherford	
Real	Camp Wood Creek	Camp Wood Creek	Camp Wood	
Runnels	Lake Winters	Elm Creek	Winters	
Runnels	Lake Ballinger	Valley Creek	Ballinger	
Shackelford	McCarty Lake	Salt Prong Hubbard Creek	Albany	
Somerville	Paluxy River	Paluxy River		
Stephens	Lake Daniel	Gonzales creek	Breckenridge	Base flow decline
Stephens	Hubbard Creek	Hubbard Creek	W. Central Texas MWD	
Taylor	Lake Abilene	Elm Creek	Abilene	
Taylor	Lake Kirby	Cedar Creek	Abilene	
Taylor	Lake Lylte	Lylte Creek	Abilene	
Uvalde	Leona River	Leona River		Increase base flow
Val Verde	San Felipe	San Felipe Creek	Del Rio	San Felipe springs
Victoria	Coleto Creek	Coleto Creek	GBRA	Cooling res
Williamson	Lake Georgetown	N. Fork san Gabriel	Brazos RA	
Young	Lake Olney		Olney	
Young	Lake Graham	Salt Creek	Graham	
Young	Lake Whiskey Creek	Whiskey Creek	Newcastle	
Zavala	Upper Nueces	Nueces River		Irr.

Section IV: The Brush Control Law

4.1 Overview

The Texas Brush Control Program was created by Senate Bill 1083 of the 69th Legislature in 1985. SB1083 amended Title 7, Agriculture Code by adding Chapter 203, Brush Control. It gives responsibility for the program to the Texas State Soil and Water conservation Board. Appendix I contains Chapter 203 of the Agricultural Code.

Some key points in the law are as follows:

- Sec. 203.001. "Brush Control" and "Critical Area" are defined
- Sec. 203.012. The Board shall adopt rules to carry out this chapter.
- Sec. 203.013. Responsibilities may be delegated to districts.
- Sec. 203.016. The Board shall consult with the Parks and Wildlife Department.
- Sec. 203.051. The Board shall prepare and adopt a State brush control plan.
- Sec. 203.052. The Board shall hold a hearing on the proposed plan.
- Sec. 203.053. Criteria for designating critical areas are specified. The board shall give priority to areas with the most critical water conservation needs with the highest potential for substantial water conservation.
- Sec. 203.054. The Board shall review the plan every two years.
- Sec. 203.055. The Board must approve all methods used to control brush.
- Sec. 203.056. Before January 31 of each year, the Board must report to the governor, speaker, and lieutenant governor on the activities of the program during the previous year.
- Sec. 203.102. The Board shall prepare and distribute information to each district concerning procedures for processing cost-sharing assistance applications.
- Sec. 203.103. Districts may accept and comment on applications for cost-sharing. After review, the district shall submit the application and comments to the Board.
- Sec. 203.104. Districts may inspect and supervise projects within their jurisdiction on behalf of the board..
- Sec. 203.151. A cost-sharing program is created.
- Sec. 203.152. A "Brush Control Fund" is created.
- Sec. 203.154. The State's portion of the cost-sharing is limited to 70 percent.
- Sec. 203.155. Cost-sharing is available only in designated critical areas using approved brush control methods.
- Sec. 203.156. Individual applications for cost-sharing must be filed with the district in which the land for the project is located.
- Sec. 203.157 – 203.158. Considerations and conditions of application approval are specified.
- Sec. 203.160. The board or a designated district shall negotiate contracts with successful applicants.
- Sec. 203.161. Districts may administer State money as required by a cost-sharing contract.

4.2 Responsibilities of the State Board Under Title 7, Chapter 203, Texas Agriculture Code

1. The Board has jurisdiction over and shall administer the Brush Control Program.

2. The Board shall adopt reasonable rules that are necessary to carry out the program.
3. The Board shall consult with the Texas Parks and Wildlife Department.
4. The board shall prepare and adopt a state Brush Control Plan
    a. must include a comprehensive strategy for managing brush in those areas where brush is contributing to a substantial water conservation problem
    b. must designate areas of critical need in the State
5. The Board shall hold a hearing on the proposed plan.
6. The Board shall review the plan every two years.
7. The Board must report to the governor, speaker, and lieutenant governor on the activities of the program during the previous year.
8. The Board must approve all brush control methods used under the program.
9. The Board shall prepare and distribute all the information necessary for participation in the program to all districts.
10. If the demand for cost-share funds is greater than funds available, the Board may establish priorities favoring the most critical areas that would have the greatest water conservation benefits.
11. The Board or a district delegated by the board is responsible for receiving and approving individual applications for cost-share assistance.
12. The Board or a designated district shall negotiate contracts with successful applicants.
13. The Board or a designated district must certify that the work to be cost-shared has indeed been completed before the State's share of the cost is paid.
14. The State or a designated district must administer State money as required by a cost-share contract.

Section V: Brush Control Projects

The State Board will work closely with other State agencies to utilize their expertise and resources in the process of developing and implementing brush control studies and projects. Wildlife habitat and endangered species issues will be coordinated with Texas Parks and Wildlife. The expertise of the Texas Agricultural Experiment Station will be utilized in watershed modeling and critical area delineation. Resources for landowner education will be provided by the Texas Agricultural Extension Service. The State Board will cooperate with the Texas Water Development Board on groundwater and streamflow monitoring, regional water needs, and regional water plans. Cooperation with USDA-NRCS will be essential in developing and implementing individual landowner plans. River Authorities will provide local and regional knowledge into the planning process and feasibility studies.

5.1 Overview of Brush Management Program

Brush management will be accomplished through a series of watershed or sub-watershed projects in critical areas in which brush management shows a strong potential to significantly increase water yield. The process will be briefly summarized here, and each element of the process will then be discussed in further detail. The elements of the brush management plan are:

- Critical Area Delineation
- Project Development
- Project Approval and Prioritization
- Project Implementation

The State Board may delineate critical areas in which brush control has a strong potential to increase water yield. Critical area delineation will be based on watershed studies—scientific studies, modeling, climate, hydrology—brush infestation, and water needs. Soil and water conservation districts will manage individual projects. Within a critical area, districts may develop brush control projects where there is sufficient local support. Project proposals will be submitted to the State Board for approval. After receiving a project proposal, the State Board, through staff and other experts, may conduct additional feasibility studies of the project area. A project that meets all requirements may then be approved by the State Board. If there are more project proposals than can be supported by available cost-share funds, the State Board will prioritize the projects, favoring the areas with the most critical water conservation needs and the projects that will be most likely to produce substantial water yields. The State Board will approve brush control methods on the State level and furnish the list to districts for use in developing individual plans. The State Board will set maximum cost-share rates for individual projects. Districts will set cost-share rates and costs for practices for individual plans. Districts may contract with landowners to develop and implement individual brush control plans within project areas. Landowners may then implement brush control plans and receive cost-share payments upon completion of the brush control practices specified in the individual plans.

5.2 Critical Area Delineation

The State Board will delineate critical areas eligible for brush control projects and cost-share funding based on watershed studies conducted by the State Board and local soil and water conservation districts in cooperation with other State agencies, universities, and appropriate local interests. Watershed studies will consider the following criteria:

- Brush type, density, and canopy cover
- Geology and soils data

- Water needs or potential needs
- Hydrology
- Potential water yield
- Wildlife concerns
- Economics
- Landowner interest

In general, the results of watershed studies will be used to delineate critical areas within the general brush control area (16 – 36 in rainfall area) of the State. This delineation is not meant to pick out specific projects, but rather to set areas in which projects will be eligible for brush control cost-share. Because of the many factors involved in developing a successful project such as willingness of the local people to participate, landowner cooperation, social and economic considerations, and wildlife concerns, project applications must come from the local level.

5.2.1 General Brush Control Area

The general area eligible for watershed studies statewide is based on the location of infestations of mesquite, blue-berry and red-berry junipers, South Texas brush complex, and salt cedar. Areas in Texas with infestations of these species located between the 16-inch rainfall belt and the 36-inch rainfall belt may be considered for feasibility studies. (Figure 5.1) Proposed studies for watersheds located outside of this area may be reviewed by the Board on a case-by-case basis.

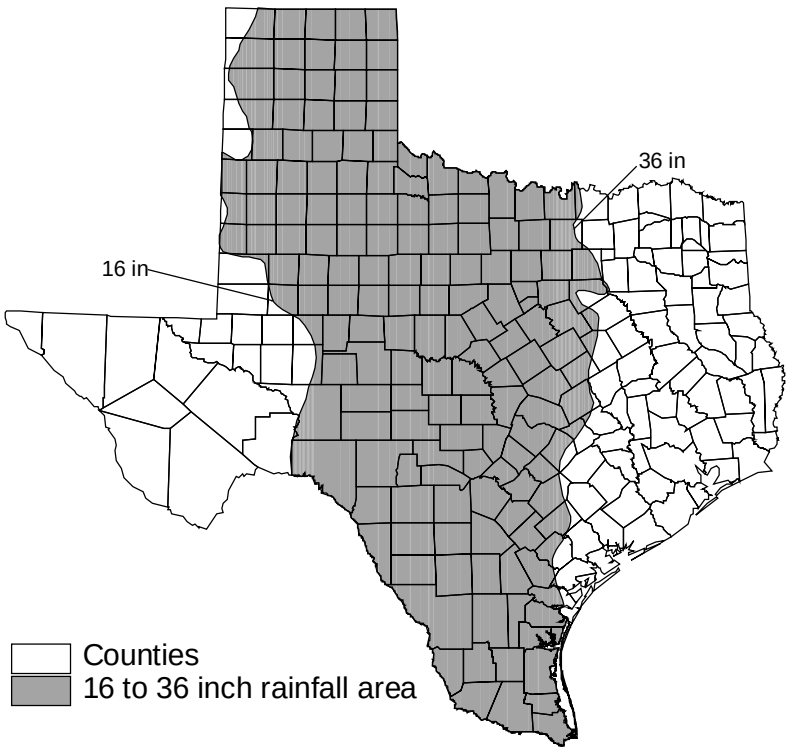

Figure 5.1. Map showing the 16 to 36 inch rainfall area of Texas

5.2.2 Watershed Studies

As funding becomes available, watershed studies, which include water yield modeling, will be used as a tool for delineating critical areas. These studies may be done in cooperation with other State agencies, universities, and local entities. These studies will be conducted in watersheds in the general brush control area (section 5.2.1) or where designated by the State Board. Specific watersheds for studies will be determined by the State Board in consultation with SWCDs, other State and local agencies, and universities or as determined by the Texas Legislature. Factors that weigh heavily in watershed studies include brush type and density, water needs of the area, and potential water yield.

5.2.2.1 Brush Type, Density, and Canopy Cover

Table 2.1 shows the predominant brush species and the level of infestation statewide. TSSWCB (1991) updated this survey with 1987 natural resources inventory data and compiled the species infestation on the basis of the eighteen Major Land Resource Areas in Texas. All areas of the State have significant brush infestation problems.

Recent research shows that brush canopy cover must be reduced to below about 15% on specific areas where treatment occurs for brush removal to have a significant effect on enhanced water yield. Reducing brush cover to below 15% on treated acreage exponentially increases water yield (Thurow, 1998)

5.2.2.2 Water Needs

Many towns and cities in Texas are now or will in the future suffer water shortages. Since the major purpose of the brush control program is to provide additional yield from the rangeland watersheds of the State, a major consideration in delineating areas or prioritizing projects will be the benefit to water users. After evaluating water needs, the information will be used to assist in identifying areas with the most critical water conservation needs.

The Texas Water Development Board (TWDB) updated the State Water Plan in 1997 (TWDB, 1997). According to the plan, “TWDB forecasts indicate that water shortage problems could blanket the entire State with every Texas county in deficit at some point in the 50 year planning period.” Texas has subdivided the State into sixteen water planning regions. Each of these regions is developing a regional water plan. All of the regions have significant water needs over the next fifty years and will need a variety of tools, from water conservation to developing alternative supplies to meet their needs.

The State Board will work with the regional planning groups and the TWDB in prioritizing the regions as to water conservation needs.

5.2.2.3 Potential Water Yield

Knowledge exists to make fairly accurate predictions as to rangeland areas where potential is high for increasing water yields. Thurow (1998) summarized the factors that influence water yield from rangeland. They are discussed in the following sections.

5.2.2.3a Geological Information

An essential ingredient in successfully increasing the water yield from an area for downstream or aquifer use is water transfer. The precipitation that falls on the land and is absorbed must have an avenue to underground aquifers before it can recharge them and/or emerge as spring flow. The coarse, shallow soils overlying fractured limestone typical of the Edwards aquifer is an example of a formation that would have a high potential for enhancing ground water supplies. Extra water yield in areas such as the Blackland Prairie with heavy clay soil

and poor deep drainage would occur as increased runoff, and would potentially enhance surface reservoir supplies (Thurow, 1998).

5.2.2.3b Climatic Conditions

The amount of precipitation that falls on the land is directly related to the water yield potential. Therefore, practical limits must be set as to how much average annual rainfall is necessary to allow potential enhancement. There is a point where even grassland will use all of the available moisture. In general, water yield increases from brush control occur in areas where potential evapotranspiration is over 15 inches/year (all of Texas) and rainfall is over about 18 inches/year (Thurow, 1998). The weighing of water needs in the area with yield potential may justify projects with lower potential while less need for water may negate larger yield potentials.

5.2.2.3c Historic Evidence

Historic evidence is probably the most reliable indicator of water enhancement possibilities (Kelton, 1975). In many areas of the state, historical records indicate much higher levels of spring flow and base flow of rivers and streams than is now apparent. Brush encroachment along with other factors caused declines in these base flows. After investigating irrigation records and municipal and industrial use in the area, portions of the State with large amounts of positive historical evidence would be some of the most likely candidates for critical area delineation.

5.2.3 Critical Area Delineation

Currently one watershed has been designated a critical area.

North Concho River Watershed.

The Upper Colorado River Authority, Texas Agricultural Experiment Station, USDA-NRCS, and TSSWCB conducted a study of the North Concho River watershed in 1998. The study concluded that reduction of brush cover on all eligible lands to a 5% canopy would increase the North Concho River flow by over 33,500 ac-ft above the current discharge rate. This is over a five-fold increase in streamflow. The cost of the enhanced yield delivered to San Angelo was estimated to be $53 per ac-ft. This compares to $160 per ac-ft for water from Lake Ivie. Results of this study designated the North Concho as a critical area for brush control.

5.2.4 Additional Watershed Studies

As funding becomes available, watershed studies will be conducted in the following areas:

- Edwards Aquifer recharge zone
- Nueces River Basin
- Wichita River Basin
- Middle Concho River Basin
- Pedernales River Basin
- Canadian River Basin
- Frio River Basin

5.3 Project Development

Local soil and water conservation districts or other agencies in cooperation with districts may develop project proposals within critical areas. The proposals will be submitted to the State Board for its prioritization and

approval. The State Board, on its own initiative, may initiate project development in cooperation with local soil and water conservation districts.

5.3.1 Sponsorship—Soil and Water Conservation Districts

Local soil and water conservation districts will be the keys to the development of successful brush control projects. Districts have experience in the development and implementation of P.L. 566 Watershed Projects as well as other types of locally initiated projects similar to brush control projects. When local interest is such that action is deemed necessary, someone must lead and coordinate the effort. Soil and water conservation districts are qualified to assume this role. They are accessible to anyone and they especially have considerable experience in working with landowners and landusers, both individually and as a group.

A district may administer aspects of the brush control program within any critical area located within the jurisdiction of that district. The State Board must prepare information on the brush control program and procedures for cost-sharing and provide this information to each SWCD. Districts may accept, review, and comment on individual applications for cost-share, and submit them to the State Board for action. Districts may inspect and supervise projects within their jurisdictions. Subchapter D, Sections 203.101 – 203.104 of the Brush Control Law (Appendix I) describes the powers and duties of districts in administering brush control projects.

5.3.2 Requirements of Project Proposals

1. A proposal must denote sufficient interest by a group of landowners and operators in a critical area or a part of a critical area designated by the State Soil and Water Conservation Board to allow for the eventual completion of the project.
2. A valid proposal must show adequate sponsorship by one or more soil and water conservation districts. Enlisting additional sponsors such as cities, counties, other political subdivisions, etc. could be beneficial to the project and is encouraged.
3. The soil and water conservation district involved must agree to take leadership and coordinate the project through implementation.
4. The project area proposed in the proposal should be of sufficient size to provide a significant potential gain in the water yield from the critical area where the project is located.
5. The proposal should provide as much evidence as possible that the acreage to be treated within the project area does have the potential to improve water yields. Subjects that should be addressed are:
   (a) size and location of the area
   (b) brush – type, density, and canopy cover
   (c) water needs or potential needs
   (d) potential yield
   (e) wildlife compatibility to the project
   (f) landowner cooperation
   (g) ability of participants to pay their share of the cost
   (h) types of treatment measures
   (i) completion schedule
6. Proposals should be submitted as required by the State Board to the Texas State Soil and Water Conservation Board, P. O. Box 658, Temple, Texas 76503.

The State Board will provide assistance to districts in the development of project proposals as needed.

5.4 State Board Approval and Prioritization

5.4.1 Watershed Studies

The State Board will most likely be involved with all project proposals during the proposal development phase. Considerable information will have to be gathered to meet the requirements of the project proposal. The final document should give a fairly accurate assessment of the potential for that particular project. In most cases, this information will have been developed as part of a watershed study. If a proposal is developed for an area in which a watershed study has not been conducted, the State Board may authorize a watershed study. Once the proposal is complete and has been received by the State Board it will be necessary to conduct a preliminary feasibility review of the proposal.

This review has two basic purposes:

- To determine if the information about the potential project is complete and sufficient to meet requirements for approval by the State Board.
- To make a determination of the relative merit of the project for use by the State Board in setting priorities.

After determination has been made that the proposal meets requirements each of the project prioritization criteria will be applied to the project proposal. The project area will be ranked in each category and this ranking will be a part of the feasibility determination by the State Board. Any other information relating to the viability of the project or relating to the prioritization of the project may be included.

5.4.2 Project Approval

A project proposal received by the State Board may be approved or disapproved after a feasibility review is conducted in the project area. Two requirements must be met before approval will be granted.

1. The proposal must include in as much detail as possible all of the information described in Section 5.3.2. This information must show that in the best judgement of those preparing the proposal the project area will meet minimum requirements to be feasible.
2. The feasibility review must show that the application is indeed complete and accurate and meets minimum requirements in all six-project prioritization criteria.

If the proposal meets the requirements set forth by the State Board it will be approved. This approval signifies that the project is viable and should be considered in the prioritization process.

Project proposals that are disapproved may be reconsidered after information is presented that would make a feasible determination possible.

5.4.3 Prioritization of the Project for Implementation

The amount of cost-share funding appropriated as well as the general economic condition of farming and ranching will play a large part in determining feasibility of individual projects. Provision must be made, however, to select the projects that will be most effective in reaching the goals of the program.

Section 203.159 of the Agriculture Code states that (a) If the demand for funds under the cost sharing program is greater than funds available, the board may establish priorities favoring the areas with the most critical water conservation needs and projects that will be most likely to produce substantial water conservation.

The project prioritization criteria discussed in Section 5.4.4 were developed to give the State Board an impartial way to evaluate each project proposal. This will allow the Board to objectively view new proposals in relation to proposals that have been on the books for some time. Because the ranking process points out deficiencies, projects with a low priority may be upgraded through improvements in those areas in which they are weak.

5.4.4 Project Prioritization Criteria

Brush—Type, Density, and Canopy Cover

A list of brush species in the State will be developed ranking each species according to its water use potential. This ranking will also include information on the minimum density and canopy cover for each species to make control cost effective. The first list of brush type, density, and canopy cover will be the best estimated of knowledgeable range scientists. As more research becomes available the list will be revised as needed.

The brush species list will be used during the feasibility review to establish that the brush infestation in the proposed area meets minimum requirements for a successful brush control project. After this is established, the type, density, and canopy cover of the brush will be ranked as to severity, and this will be a factor in the overall ranking of the project.

Water Needs or Potential Needs

Information on water needs in a watershed will be obtained on a project-by-project basis from the Texas Water Development Board. In addition, the State Board will work with the regional water planning groups to determine needs within the planning regions for brush control projects.

Potential Yield

There are three basic areas, which will be considered in estimating relative potential yield. These areas are discussed in Section 5.2.

1. Historic Evidence –Areas with large amounts of positive historical evidence would receive a higher potential yield ranking on the premise that the heavy brush infestation is at least partially responsible for the decline in the water yield of the area. Checking irrigation records and municipal and industrial use in the area would further verify this assumption.
2. Climate Conditions –With all other factors being equal the area that has a higher average rainfall should have more water yield potential. This is not to say that the drier areas of the state will not receive consideration since many other factors such as need, geological potential, and brush infestation are also factors. Temporary drought conditions or abnormal wet periods must also be considered in trying to determine the effect of climate on potential yield.
3. Geological Information – The soil and geologic factors that favor groundwater enhancement will be given priority in areas with groundwater needs. Those that favor surface runoff will be given priority in those watersheds needing surface water enhancement.

Wildlife Considerations

Section 203.106 of the law states that “The board shall consult the Parks and Wildlife Department in regard to the effects of the brush control program on fish and wildlife.”

Historically, incorporating fish and wildlife concerns into the planning and implementation of brush control and revegetation projects has had a high priority. If properly included in brush control planning, maintenance and even enhancement of wildlife habitats is possible through activities such as identification of priority grassland restoration areas for wildlife.

The Texas Parks and Wildlife Department is presently involved with the State Board in coordinating the fish and wildlife aspects of the program. Parks and Wildlife personnel will be included in the watershed studies and will help determine the feasibility of project proposals. They will be asked to provide a prioritized listing of the wildlife species in the area with the effect that the proposed brush control project would have on them.

Landowner Cooperation

Cooperation of the landowners and operators in the project area is the key to a successful program. The state brush control program is voluntary in nature, and therefore, treating sufficient acreage to achieve the desired results depends upon landowner interest and participation.

During the watershed study, estimates will be made as to the minimum acreage that can be treated and still show significant results. Landowners and operators controlling sufficient acreage to meet or exceed this figure must show significant interest for a district to have a viable project.

The project prioritization process will take place after the watershed studies are completed so more exact figures will be available concerning the acreage necessary for an optimum project. Those prospective projects showing sufficient landowner interest to meet these acreage figures will receive the highest ranking.

Time Elements

This criteria is somewhat related to landowner cooperation. The project that has landowners and operators ready, willing, and able to proceed will receive preference. Obviously planning and implementation take a certain amount of time, but generally projects with excessively long timetables reflect a lower degree of landowner cooperation.

5.5 Project Implementation

Once a project has been approved and funding made available, the responsible soil and water conservation district will begin implementation. Project implementation requires the following elements.

5.5.1 Practice Selection

The State Board , in consultation with districts, will approve a list of practices that are eligible for cost-share statewide (Section VI Cost-share Program). These practices may include chemical and mechanical methods and prescribed burning. The local district will select and approve from this list the practices that are applicable to its specific project. For example, in some areas, there may be legal restrictions on certain chemicals, or there may be endangered species requirements, or other local issues that would preclude using some of the statewide practices in a specific project area. This local list will be used in developing individual plans. Results of watershed studies may be used to evaluate control options and their feasibility.

Identifiable units must be established for each practice. An identifiable unit must be either all or an essential part or subdivision of a practice that when carried out is complete within itself and can be clearly identified. For example, an identifiable unit could be a certain acreage that can be clearly marked on the ground and on a site map so that the district can positively identify a unit of land and certify that treatment has been completed on that unit of land. An identifiable unit also can be managed independently as to maintenance of the practice. Establishment of identifiable units and an average cost or a specified maximum cost permits cost-share payments to be made to producers when an identifiable unit is treated. A list of practices, applicable cost-share rates, average costs or specified maximum costs will be developed for each identifiable unit.

5.5.2 Site Eligibility Determination

Before individual landowner plans can be developed, decisions will have to be made in each project area concerning the practices, which will be eligible for cost sharing on certain general categories of land. First an evaluation will be performed to group similar combinations of topography, soils, land use, or grazing systems into categories. Then each category of land will be assigned a set of practices that will be eligible for cost sharing. These categories should be broad enough to allow maximum flexibility on the part of the landowner but still discourage excessive project costs. Generally certain land classes with a certain brush canopy would be

eligible for a given set of practices. Some practices may be excluded in some areas for reasons such as unfeasibility, wildlife considerations, or local, state, or federal regulation.

5.5.3 Wildlife Considerations – Planning for Wildlife Objectives

The basic concern of the wildlife manager in implementing any brush management system has to do with the design and retention of a brush mosaic. Patterning of brush treatments is driven by wildlife considerations more than by any other set of management objectives. The design of a favorable habitat mosaic will be considered for each specific project plan. Following are some general guidelines for planning for wildlife.

The types of brush control patterns used will depend upon the terrain in the area to be treated. To a great degree, natural terrain features will dictate the types and conformation of patterns.

Sufficient brush cover should be left along water courses which usually serve as wildlife travel lanes. The width of the strips to be left for most wildlife can be determined by visual inspection. The strips of brush should be wide enough to prevent seeing through them at most points from December through February when most species have lost their leaves. All natural wildlife travel ways, which would include water courses, saddles between ridges, headers or canyon beginnings, extensions of ridges, and any unusually high-quality wildlife food plants should be left.

When cleared strips extend for great distances, a belt or block of brush should be left every 200 to 300 yards to break up the open spaces and provide covered travel lanes for wildlife. In South Texas where the terrain is relatively flat with no prominent features, alternate strips of cleared areas and brush produce good results, although clearing in an irregular pattern is more desirable. In large areas the strips can be established in gently curving patterns to block excessive views, and belts or blocks of brush can be left at desirable intervals across cleared areas. Brush strips should be left along drainage areas or draws used as natural travel ways by wildlife.

Where cleared areas tend to be excessively large, islands of brush should be left interspersed within the cleared areas to provide escape cover. As with brush strips, the islands should be large enough that they cannot be seen through from December through February. Where islands do not provide sufficient escape cover, extensions or necks of brush can be left for escape cover and travel ways to prominent terrain features frequented by wildlife.

During the initial planning of a brush control operation, extreme care should be taken to retain the many different types of woody food and cover plants necessary to maintain a resident wildlife population of all species. For example, woody plants or brush species are necessary to wild turkey populations, not only as food producing plants, but also as cover and roosting timber. Existing winter roost timber should be left standing. In association with this, brush and smaller trees under or adjacent to the roosting areas should be retained. Turkeys require cover as they enter and depart the roost and while loafing under the roost trees. Sufficient quantities of food-producing woody species such as chittum, hackberry, lotebush, oak, pecan, and elm also should be maintained.

Following mechanical treatment, some areas will require reseeding. The seeding mix should include forbs that benefit wildlife.

The improvement in range conditions through brush management will increase the available food supply for wildlife and domestic livestock. This additional food supply will improve the quality of the animals being produced. Brush should be managed in conjunction with sound range management practices.

Although some basic rules for brush management may be applied to all treated areas, the topography, types of vegetation, and wildlife species present on each ranch unit and even from pasture to pasture within a ranch will be different. Therefore, an on-the-ground inspection of the entire ranch is necessary prior to formulating sound management plans.

It is likely that only a few candidate pattern/treatment combinations will emerge for which equipment is locally available and which suits the preferences of ranch management. These should be ranked by wildlife specialists

in terms of their utility for satisfying game management objectives from a biological point of view. Interaction and compromise among management objectives should result in further limitation of options and finally result in identification of the candidate system that shows most promise for meeting the goals of the program.

5.5.4 Cost-Share Rate

Soil and water conservation districts will set average costs and maximum costs for each practice to be used in a project. The cost-share rate to be used for each practice will also be set by the district with advice from the State Board based on data developed as part of the watershed study. The cost-share rate set by the district cannot exceed the maximum cost-share rate set by the State Board. Details of the cost-share program are in Section VI

5.5.5 Completion Schedule

Proper timing and sequence of land treatment are essential to successful implementation of any conservation program. This is true concerning either the entire project or individual landowner plans. One major factor that enters into a state cost-share program is the time limits placed on the use of state money. State funds are appropriated on a biannual basis. This will allow only two-year contracts at a maximum even though the entire project may take several years to complete.

5.5.6 Individual Landowner Plans

The responsible districts will, with any needed technical assistance provided by the NRCS field office and/or Texas State Soil and Water Conservation Board, assist landowners with development of individual plans for brush management for the purposes of increasing watershed yield. The extent and methods of brush management included in each plan will be determined in accordance with specifications in the *Field Office Technical Guide*, as approved by the local districts. Each plan will include implementation of sound grazing management following treatment. Based on these plans, the district may enter into contracts with the landowners for the application of brush management.

Each cost-share agreement will include a maintenance agreement by which the landowner agrees to maintain the brush management practice for a period of ten years after implementing the plan.

Section VI: Cost-share Program

6.1 General Criteria

Subchapter E, Section 203.151 of the Agriculture Code created a cost-sharing program to be administered under Chapter 203 and rules adopted by the board. Section 203.152 of the law created the brush control fund, which is a special fund in the State treasury to be used to provide the State's share of the cost of brush control projects. Sections 203.156, 203.157, and 203.158 discuss individual applications for cost-share assistance, and Section 203.160 set out the requirements for contracts between soil and water conservation districts and individual landowners. Section 203.161 provides for the administration of cost-share funds.

The Texas State Soil and Water Conservation Board adopted rules to administer the brush control cost-share program (31 TAC §§ 517.22 - 517.30) with the following program characteristics.

1. Not more than 80 percent of the total cost of a single brush control project may be made available as the state's share in cost sharing. (Section 203.154 (a) Texas Agriculture Code)
2. Funds will be allocated from the State Brush Control Fund
3. Requests for allocations will be part of brush control project proposals submitted by SWCDs.
4. Approval of allocations. The State board shall consider, approve, reject, or adjust funding requests based on priority of projects (Section 5.4), and amount of available funding. Only districts for which the State Board has approved a project are eligible for cost-share funds.

6.2 Cost-share Agreement

Soil and water conservation districts may enter into cost-share agreements with individual land owners. Cost share agreements must be based on an approved brush control plan developed by the landowners with assistance provided through the conservation district. Only those costs directly associated with removal of brush, as specified in the watershed study for that watershed, are eligible for cost-share assistance.

6.3 Brush Control Methods

The Soil and Water Conservation Board is directed to approve all methods of brush control used under this program. The Board may approve methods of controlling brush based on a finding that the method:

1. has proven effective and efficient for controlling brush,
2. is cost efficient,
3. has beneficial impact on wildlife habitat,
4. will maintain topsoil to prevent erosion or siltation of rivers or streams, and
5. allows for revegetation of the area with plants that are beneficial to livestock and wildlife after brush is removed.

The Board will approve brush control methods for each brush control project based upon information from the watershed study along with other data or information the Board deems revelant. approved methods will be transmitted to the appropriate conservation districts when funding allocations are approved.

6.4 Maintenance of Brush Management

Cost-share agreements must contain a commitment on the part of the landowner to maintain areas for which cost-share funding for brush control is received for a period of ten years after the initial brush control is accomplished. Maintenance includes periodically retreating the area with appropriate brush control methods to prevent brush reinfestation over the duration of the contract period. Maintenance treatments will be scheduled as needed according to specifications in the *Field Office Technical Guide*. Cost-share rates will be based on the present value of the cost, including maintenance cost over the ten-year period.

6.5 Certification of Practice Implementation

Upon completion of brush control on any identifiable unit of land, the district may certify to the Board that the practice has been implemented in accordance with specifications on that portion of the planned area.

6.6 Cost-share Payments

Based upon certification by the conservation district that brush control has been implemented according to specifications on all or any identifiable unit of land in a brush control plan, the Board may process a request for payment of cost-share funds and cause payment to be made directly to the landowner.

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Appendix I: The Brush Control Law

Agriculture Code

CHAPTER 203. BRUSH CONTROL

SUBCHAPTER A. GENERAL PROVISIONS

Sec. 203.001. Definitions.

In this chapter:

(1) “Board” means the State Soil and Water Conservation Board.

(2) “District” means a soil and water conservation district created under Chapter 201 of this code.

(3) “District board” means the board of directors of a soil and water conservation district created under Chapter 201 of this code.

(4) “Brush control” means:

(A) the selective control, removal, or reduction of noxious brush such as mesquite, prickly pear, salt cedar, or other phreatophytes that consume water to a degree that is detrimental to water conservation; and

(B) the revegetation of land on which this brush has been controlled.

(5) “Critical area” means an area of critical need designated by the board under the plan for the brush control program.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.002. Creation of Program.

The Texas Brush Control Program is created and shall be implemented, administered, operated, and financed as provided by this chapter.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.011. Authority of Board.

The board has jurisdiction over and shall administer the brush control program under this chapter.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.012. Rules.

The board shall adopt reasonable rules that are necessary to carry out this chapter.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.013. Authority of Districts.

Each district in which all or part of a critical area is located may carry out the responsibilities provided by Subchapter D of this code as delegated by the board in that critical area.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.014. Personnel.

The board may employ or contract with any person necessary to assist the board or a district to carry out this chapter.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.015. Expenditures.

In addition to any other expenditures authorized by this subchapter, the board may make expenditures provided by the General Appropriations Act.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.016. Consultation.

The board shall consult the Parks and Wildlife Department in regard to the effects of the brush control program on fish and wildlife.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.051. State Plan.

The board shall prepare and adopt a state brush control plan that shall:

(1) include a comprehensive strategy for managing brush in areas of the state where brush is contributing to a substantial water conservation problem; and

(2) designate areas of critical need in the state in which to implement the brush control program.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.052. Notice and Hearing.

(a) Before the board adopts the plan under Section 203.051 of this code, the board shall call and hold a hearing to consider a proposed plan.

(b) Not less than 30 days before the date the hearing is to be held, the board shall mail written notice of the hearing to each district in the state. The notice must include the date and place for holding the hearing and must state the purpose for holding the hearing.

© At the hearing, representatives of a district and any other person may appear and present testimony including information and suggestions for any changes in the proposed plan.

(d) After the conclusion of the hearing, the board shall consider the testimony including the information and suggestions made at the hearing and, after making any changes in the proposed plan that it finds necessary, the board shall adopt the plan.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.053. Criteria for Designating Critical Areas.

(a) In designating critical areas under the plan, the board shall consider:

(1) the location of various brush infestations;

(2) the type and severity of various brush infestations;

(3) the various management methods that may be used to control brush; and

(4) any other criteria that the board considers relevant to assure that the brush control program can be most effectively, efficiently, and economically implemented.

(b) In designating critical areas, the board shall give priority to areas with the most critical water conservation needs and in which brush control and revegetation projects will be most likely to produce substantial water conservation.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.054. Amending Plan.

At least every two years the board shall review and may amend the plan to take into consideration changed conditions. Amendments to the plan shall be made in the manner provided by this chapter for adopting the original plan.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.055. Approved Methods for Brush Control.

(a) The board shall study and must approve all methods used to control brush under this Act considering the overall impact the project will have within critical areas.

(b) The board may approve a method for use under the cost-sharing program provided by Subchapter E of this chapter if the board finds that the proposed method:

(1) has proven to be an effective and efficient method for controlling brush;

(2) is cost efficient;

(3) will have a beneficial impact on the wildlife habitat;

(4) will maintain topsoil to prevent erosion or silting of any river or stream; and

(5) will allow the revegetation of the area after the brush is removed with plants that are beneficial to livestock and wildlife.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.056. Report.

(a) Before January 31 of each year, the board shall submit to the governor, the speaker of the house, and the lieutenant governor a report of the activities of the brush control program during the immediately preceding calendar year.

(b) The board may make copies of this report available on request to any person and may charge a fee for each report that will allow the board to recover its costs for printing and distribution.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.101. General Authority.

Each district may administer the aspects of the brush control program within any critical area located within the jurisdiction of that district.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.102. Provide Information Relating to Program.

The board shall prepare and distribute information to each district relating generally to the brush control program and concerning the procedures for preparing, filing, and obtaining approval of an application for cost sharing under Subchapter E of this chapter.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.103. Acceptance and Comment on Application.

(a) Each district may accept for transmission to the board applications for cost sharing under Subchapter E of this chapter and may examine and assist the applicant in assembling the application in proper form before the application is submitted to the board.

(b) Before a district submits an application to the board, it shall examine the application to assure that it complies with rules of the board and that it includes all information and exhibits necessary for the board to pass on the application.

© At the time that the district examines the application, it shall prepare comments and recommendations relating to the application and the district board may provide comments and recommendations before they are submitted to the board.

(d) After reviewing the application, the district board shall submit to the board the application and the comments and recommendations.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.104. Supervision of Projects.

(a) Each district on behalf of the board may inspect and supervise projects within its jurisdiction in which state money is provided under Subchapter E of this chapter.

(b) Each district board exercising the duties under Subsection (a) of this section shall periodically report to the board relating to this inspection and supervision in the manner provided by board rules.

© The board may direct a district to manage any problem that arises under a cost-sharing contract for brush control in that district and to report to the board.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

SUBCHAPTER E. COST SHARING FOR BRUSH CONTROL

Sec. 203.151. Creation of Cost-Sharing Program.

As part of the brush control program, a cost-sharing program is created to be administered under this chapter and rules adopted by the board.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.152. Brush Control Fund.

(a) The brush control fund is a special fund created in the State Treasury to be used as provided by this subchapter.

(b) The brush control fund consists of legislative appropriations, money transferred to that fund from other funds by law, and other money required by law to be deposited in the brush control fund.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.153. Use of Money in Brush Control Fund.

Money deposited to the credit of the brush control fund shall be used by the board to provide the state's share of the cost of brush control projects approved under this subchapter and other necessary expenditures as provided by the General Appropriations Act.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.154. Limit on Cost-Sharing Participation.

(a) Not more than 80 percent of the total cost of a single brush control project may be made available as the state's share in cost sharing.

(b) A person is not eligible to participate in the state brush control program or to receive money from the state brush control program if the person is simultaneously receiving any cost-share money for brush control on the same acreage from a federal government program.

(c) The board may grant an exception to Subsection (b) of this section if the board finds that joint participation of the state brush control program and any federal brush control program will:

(1) enhance the efficiency and effectiveness of a project; and

(2) lessen the state's financial commitment to the project.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.
Amended by Acts, 76th Leg, eff. Sep.1, 1999.

Sec. 203.155. Limit to Critical Areas and Approved Methods.

Cost sharing under this subchapter is available only for projects that:

(1) are implemented in critical areas as designated by the board; and

(2) use a method of brush control approved under Section 203.055 of this code.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.156. Application for Cost Sharing.

A person who desires to participate with the state in a brush control project and to obtain cost-sharing participation by the state shall file an application with the district board in the district in which the land on which the project is to be accomplished is located. The application must be in the form provided by board rules.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.157. Considerations in Passing on Application.

In passing on an application for cost sharing, the board shall consider:

(1) whether the project is to be carried out in a critical area;

(2) the method of control that is to be used by the project applicant;

(3) the plans for revegetation;

(4) the total cost of the project;

(5) the amount of land to be included in the project;

(6) whether the applicant for the project is financially able to provide his share of the money for the project;

(7) the cost-share percentage, if an applicant agrees to a higher degree of financial commitment;

(8) any comments and recommendations of the Parks and Wildlife Department; and

(9) any other pertinent information considered necessary by the board.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.158. Approval of Application.

The board may approve an application if, after considering the factors listed in Section 203.157 of this code and any other relevant factors, the board finds:

(1) the owner of the land fully agrees to cooperate in the project;

(2) the method of eradication is a method approved by the board under Section 203.055 of this code; and

(3) the project is to be carried out in a critical area designated under the board's plan.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.159. Priority of Projects.

(a) If the demand for funds under the cost-sharing program is greater than funds available, the board may establish priorities favoring the areas with the most critical water conservation needs and projects that will be most likely to produce substantial water conservation.

(b) The board shall give more favorable consideration to a particular project if the applicants individually or collectively agree to increase the percentage share of costs under the cost-share arrangement.

(c) The amount of land dedicated to the project that will produce significant water conservation from the

eradication of brush is a priority.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.160. Contract for Cost Sharing.

(a) On approval of an application by the board, the board or the governing board of the

designated district shall negotiate contracts with the successful applicants in the project area.

(b) The board or designated district board shall negotiate a contract with the successful applicant subject to:

(1) the conditions established by the board in approving the application;

(2) any specified instructions provided by the board; and

(3) board rules.

(c) On completion of the negotiations by the district board, it shall submit the proposed contract to the board for approval.

(d) The board shall examine the contract and if the board finds that the contract meets all the conditions of the board's resolution, instructions, and rules, it shall approve the contract and provide to the individual on completion of the project the money that constitutes the state's share of the project.

(e) The board may develop guidelines to allow partial payment of the state's share of a brush control project as certain portions or percentages of contracted work are completed, but state money may not be provided in advance for work remaining to be done.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.

Sec. 203.161. Administration of Expenditures.

The district board may administer expenditure of the state's share of the money required by a cost-sharing contract and shall report periodically to the board on the expenditure of those funds in the manner required by the board.

Added by Acts 1985, 69th Leg., ch. 655, Sec. 1, eff. Aug. 26, 1985.