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**REGIONAL WASTEWATER FACILITY
PLANNING STUDY
EASTERN HAYS COUNTY, TEXAS**

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Acronyms and Abbreviations

CAMPO	Capital Area Metropolitan Planning Organization
CCN	Certificate of Convenience and Necessity
cfs	cubic feet per second
DO	dissolved oxygen
ERDC	Environmental Research and Development Center
GBRA	Guadalupe-Blanco River Authority
GIS	Geographic Information System
gpd	gallons per day
HCISD	Hays Consolidated Independent School District
IH	Interstate Highway
LUE	Living Unit Equivalent
mg/L	milligram per liter
MGD	million gallons per day
NRCS	Natural Resource Conservation Service,
OSSFs	Onsite Sewer Facilities
SWCD	Soil and Water Conservation District
TCEQ	Texas Commission on Environmental Quality
TP	total phosphorus
TSDC	Texas State Data Center
TSZ	Traffic Serial Zone
TWDB	Texas Water Development Board
USACE	U.S. Army Corps of Engineers
USBOC	U.S. Census Bureau's
USGS	U.S. Geological Survey
WES	Waterways Experiment Station
WWTP	wastewater treatment plant

1.0 INTRODUCTION

The Guadalupe-Blanco River Authority (GBRA) retained PBS&J to investigate the opportunities for regionalization of wastewater treatment facilities in the eastern portion of Hays County, Texas. This regional wastewater facility planning study is being partially funded by a Texas Water Development Board (TWDB) Regional Facility Planning Fund Grant. Figure 1-1 shows an overall map of the planning area.

Eastern Hays County is experiencing a sharp increase in growth, particularly near the cities of Buda, Mountain City, Kyle, Niederwald, and Uhland. The increase in growth will cause greater environmental stress on the watersheds of the area due, in part, to an expected increase in both on-site sewage facilities (OSSFs) along with small, individual wastewater treatment plants (WWTPs) and their respective discharges into the associated watersheds. The individual watersheds included in the study area are Elm Creek, Upper Brushy Creek, Brushy Creek, Porter Creek, Bunton Branch, and Plum Creek. Figure 1-2 shows the limits of the various watersheds. All of the individual watersheds eventually converge into Plum Creek, which converges with the San Marcos River, which joins with the Guadalupe River.

GBRA, together with the TWDB and interested communities, is motivated to evaluate all existing and proposed facilities and developments within the planning area to analyze where wastewater facilities may be located in order to have the greatest benefit to water quality, and make the most economic sense. Another goal is to provide for the most practical reuse of the treated effluent in an effort to facilitate reduced discharge to the receiving streams and to reduce the impact of development on the water supply resources.

In order to achieve the objectives of this analysis, the following tasks were performed:

A. Planning Area Description (Section 2)

This task relied heavily upon the Geographic Information System (GIS) to identify several parameters for each subwatershed, and locate them on a variety of maps. The parameters include:

1. Locate all existing WWTPs and outfall locations in the service area. Table 4.1 lists all of the existing wastewater plants.
2. Include all topographic features, soil types, and vegetation.
3. Provide the boundaries of city corporate limits, subdivisions, water and wastewater Certificate of Convenience and Necessity (CCNs), and land use types.
4. Include all infrastructures, including roads, power lines, county boundaries, reservoirs, and creeks, etc.

B. Public Participation (Appendix B)

PBS&J, along with GBRA, is to conduct three public meetings with the stakeholders associated with the study area. The initial meeting presented the study baseline information and the broad objective of the study to the public/stakeholders. The second meeting included a presentation of current water quality conditions and sought input on water quality goals and direction to formulate and obtain consensus on a more specific set of project objectives from the public/stakeholders. These objectives related to development in the immediate watersheds, including analysis of purely regulatory options, the effects of no-action, and a general analysis of regional wastewater planning options. The final meeting will be a presentation of water quality protection alternatives, considering the water quality effects and the fiscal implications of the alternatives, and an opportunity for input on the final report. The minutes of the stakeholder meeting are included in the Appendix B of this report.

C. Population and Wastewater Analysis (Section 3)

Population growth projections were compiled from two sources: The Capital Area Metropolitan Planning Organization (CAMPO) Traffic Serial Zone (TSZ) Data, 2003, and the Hays Consolidated Independent School District (HCISD). Population was compared to the U.S. Census Bureau (USBOC) Decennial Census Estimates for 2000. The population projections were then distributed appropriately within the study area and added to the study area GIS maps.

The analysis then considered three alternatives for wastewater service based on population projections, city corporate boundaries, CCNs, watershed boundaries, effluent reuse demands, and population growth expectations. These alternatives considered different levels of planning and government action.

D. Water Quality Analysis (Section 4)

Each alternative developed in Task C was analyzed regarding its effects on water quality. The BATHTUB model was used to simulate water quality of ponds that would receive WWTP effluent. This model was used because it is well suited to the system of ponds with little calibration data. With the level of wastewater treatment assumed for all alternatives, there would not be an issue with meeting water quality criteria in the creeks and the QUAL-TX model normally used for this purpose would be of limited value. The development of input data for the BATHTUB model and the results of analysis are presented.

E. Regional Water Quality Protection Plan (Section 5)

Economic, socioeconomic, and environmental factors were used to analyze the alternatives for wastewater and reuse management. This section details the alternatives, summarizes the pros and cons for each, and describes the preferred alternative.

F. Implementation Plan (Section 6)

This section describes the process recommended to implement the selected alternative. It includes specific steps that should be taken by governmental units to provide the most cost-effective and environmentally responsive approach to wastewater service.

2.0 PLANNING AREA DESCRIPTION

GBRA selected the boundaries of the planning area to be considered for regional management of water and wastewater resources. The area selected has several components which make it vital to GBRA and the management of their watersheds. These components include the following:

- The planning area contains a number of small, intermittent flowing creeks which converge into Plum Creek, which then converges with the San Marcos River, which, in turn, converges with the Guadalupe River. These creeks include Elm, Upper Brushy, Brushy, Porter, Bunton Branch, and Plum Creeks.
- The eastern section of Hays County has seen, and is expected to continue experiencing rapid growth. As Austin expands, additional development pressures will focus growth outside of the corporate limits. A number of developments are shown proposed in and around the cities of Kyle, Buda, Niederwald, and Uhland. With increase in growth comes the need for water supply and wastewater management.
- Because the anticipated growth is occurring outside corporate limits, there is less control that governing entities have in order to protect the environment. With decisions of wastewater management, reuse opportunities and water quality issues in the hands of individual developers, rather than from regional coordination, there is a greater likelihood that water quality protection and conservation will be neglected.
- It is anticipated that, without regional management of the sewer treatment systems, there is more likelihood that there will be Onsite Sanitary Sewerage Facilities (OSSFs). This Planning Area has soil characteristics which are high in impermeable clays. These types of soils are not ideal for OSSFs, increasing the chance for water quality related issues downstream.

2.1 DEVELOPMENT OF BASELINE INFORMATION

For this study PBS&J developed a series of maps that incorporate pertinent data accumulated to facilitate analyzing the region from a development and water quality perspective. The base line information became the initial tool of accumulated data collection from which to build. This was the foundation for the overall planning study. The following is a brief discussion of some of the parameters which went into the baseline mapping.

2.2 LAND USE AND TOPOGRAPHY

2.2.1 Planning Area

The planning area to be included in this study is the eastern portion of Hays County which includes the communities of Niederwald, Uhland, and portions of Buda, Mountain City, and Kyle. The eastern portion of Hays County can be broken down into six main watersheds: Plum Creek, Burton Branch, Porter Creek,

Elm Creek, Brushy Creek, and Upper Brushy Creek. The boundaries of each can be seen in Figure 1-2. All of these watersheds converge into Plum Creek, which eventually merges with the San Marcos River, and discharges into the Guadalupe River.

Hays County is located southeast of the Central Texas Hill Country on the borders of the southern Black Prairie Region and Edwards Plateau. The county encompasses an area approximately 440,000 acres or 694 square miles, with its center located at 98°00' west longitude and 30°00' north latitude and 23 miles southwest of the City of Austin. The elevation rises from east to west, varying from 600 to over 1,400 feet. The southeastern portions of the county are predominately agricultural plains. In the southeast quarter, multiple streams and some hilly areas can be found throughout the central to northern areas. Present urban growth in the study area is predominantly located adjacent to the Interstate Highway 35 (IH 35) corridor.

The average maximum temperature in July is 96 °F, with an average minimum temperature of 40 °F in January. Hays County has a growing season of 254 days and a mean annual rainfall is 33.75 inches.

2.2.2 Vegetation

The Hays County region is home to an abundant mixture of vegetation. The primary natural grasses found in this area are indiagrass and big bluestem; however, little bluestem, sand lovegrass, meadow dropseed, sand dropseed, Hall's panicum, tall grama, three-awn and yellow indiagrass also can be found within the study area.

The trees commonly associated with this region typically fall into two groupings: those which grow taller than 15 feet, these include pecan, deciduous and live oak, shagbark hickory, sycamore, cedar elm, and mature juniper ash (mountain cedar). The other group, trees which are less than 15 feet, is comprised of species such as young juniper ash, Texas persimmon, mesquite, deciduous yaupon, small live oak, and small juniper.

The remaining flora commonly seen throughout the region is agarita, prickly pear, twist-leaf yucca, beargrass, and thin leaf yucca.

2.2.3 Soils

The soil in the study area varies from thin limestone to black, waxy, chocolate, and gray loam. Presently there are eight main soils found in this study area¹:

1. Austin
2. Brackett

¹ Soil data as reported from Hays County Soil and Water Conservation District (SWCD) #351 Fact Sheet.

-
3. Branyon
 4. Heiden
 5. Krum
 6. Lewisville
 7. Rumble
 8. Sunev clay loam

Austin soil consists of moderately deep, Fine-Silty, Carbonatic, Thermic , and clayey soils on uplands. These soils formed in chalk.

Brackett soil complexes are shallow, loamy and occasionally clayey soils mixed together with limestone bedrock outcroppings. They are fairly alkaline (pH 7.9–8.4) but one of two common variations contains a high proportion of calcium. Throughout the county these soils typically range from 11–17 inches in depth. Brackett soils are well drained, have a moderately slow permeability with very low available water capacity and a shallow rooting zone. Runoff of these soils is rapid and water erosion is a severe hazard. A distinctive feature of these soils is a “benched” or “stair-stepped” appearance due to the bands of rock outcrop.

Branyon soils consist of very deep, moderately well drained, very slowly permeable soils that formed in calcareous clayey sediments. These soils are on nearly level to very gently sloping Pleistocene terraces. Slopes range from 0 to 3 percent. A moderately well drained soil, permeability is very slow. Water enters the soil rapidly when it is dry and cracked and very slowly when it is moist.

Heiden soils consist of deep, clayey soils on uplands. These soils formed in clayey marine sediment and range.

Krum soils consist of very deep, well drained, moderately slowly permeable soils that formed in calcareous clayey sediments. These soils are on nearly level to moderately sloping terraces and lower slopes of valleys. Slopes range from 0 to 8 percent. The Krum soils consisted of 4.16 percent of the Edwards Aquifer Watershed.

Lewisville soils are typically nearly level alluvial soil with silty clay, slow drainage, usually cultivated.

Sunev clay loam is a well drained, deep, gently sloping soil found in valleys and foot slopes. The soil is moderately alkaline and contains high levels of calcium carbonate (lime) on average. Water runoff is medium to rapid, permeability is moderate and available water capacity is moderate. The rooting zone in Sunev clay is deep and water erosion is only a moderate hazard. This soil is well suited for cropland, pastures, and rangeland. This soil is classified in the Clay Loam range site.

2.2.4 Land Use

Eastern Hays County features a diversity of land use types. The four main categories of land use common to this area are:

1. Urban areas
2. Agricultural areas
3. Natural vegetation areas
4. Water and barren areas

These four land use types are also found throughout the study area. Due to overall limited development and therefore limited impervious cover within the study area runoff is currently minimal. Due to many of the drainage basins being associated with in-stream ponds, the ability to retain small fluctuations in runoff in these ponds aids in controlling runoff. However as development increases in and around each watershed the amount of permeable cover will decrease thus increasing typical flows seen through each drainage basin. All other maps identifying current public infrastructure, CCN boundaries, and all maps used for presentations during public meetings can be viewed in the Appendix B.

2.2.5 Mapping

In order to facilitate analyzing the population growth over the study area, PBS&J produced a series of GIS maps which were used as the basis of existing conditions. These maps included land use and topographical features, soil types, water and sewer CCN boundaries, power lines, subdivision boundaries, WWTP and outfalls. Figures 2-1, 2-2, and 2-3 provide this information. These figures were provided as a basis for consideration for anticipated population growth, which is further discussed in Section 3.0: Population and Wastewater Analysis. These figures were also used as discussion items in the stakeholder meeting presented by GBRA and PBS&J, where the study objectives were discussed and formulated to obtain a general consensus from the stakeholders.

3.0 POPULATION AND WASTEWATER ANALYSIS

In order to develop a regional wastewater and water conservation plan, PBS&J assessed the impact of increased growth within the planning area which contributes to the Guadalupe River. As growth from the Austin metro area continues to spillover into unincorporated areas of Hays County, where government land use controls are less stringent. The effect from these individual developments has a greater potential for negative environmental impact. Individual or private development typically will not be designed with water conservation and treated wastewater quality as its primary objectives. These developments are usually cost driven. Individualized discharges or OSSF areas are a concern mostly due to clayey soils found within the study area. These flows along with small developer package plants tend to be less manageable and, therefore, run a greater risk of creating more pollutants within each watershed since they would be less likely motivated to provide wastewater reuse.

To assess the increase in population growth within the planning area, PBS&J analyzed population and housing forecast data published by two agencies: CAMPO, and HCISD. First we collected CAMPO TSZ data for Hays County (CAMPO, 2003). This data provides baseline (year 2000) population data as well as population projections for the years 2017 and 2030 divided into TSZs within the county. The baseline population data is based on the results of the USBOC's 2000 Decennial Census, and the population for the County has been apportioned by CAMPO into TSZs based on 2000 census tract data and land use analysis. The population projections (which are part of the same CAMPO data-set), are also organized by TSZ, and were developed from the population projections for Hays County prepared by the Texas State Data Center (TSDC) for the years 2017 and 2030. The population projections were then apportioned by CAMPO into TSZs based on their land use and development forecasting methods. We then compared this data with projected population and housing data from the HCISD Demographic Update Report (HCISD, 2003). The HCISD report provided forecasting for students in Hays County for a 5-year period.

3.1 CAMPO TRAFFIC SERIAL ZONE ANALYSIS

As described above, PBS&J used the TSZ data prepared by CAMPO for years 2017 and 2030. This data was organized by using a GIS to identify those TSZs that were within the planning area boundaries, and to eliminate those TSZs that are outside the boundary or that only had a small portion of their area located within the planning area boundary. Of these TSZs that were partially located within the planning area boundary, most had only small portions within the boundary, and, therefore, could easily be eliminated without skewing the results of the population analysis. Figure 3-1 shows the boundaries of each TSZ within the planning area.

The percent change was determined for the years 2000, 2017, and 2030 based on compiled CAMPO historical and projected population data for each of the TSZs. Next, the TSZs were arranged in descending order in terms of numeric change in population between the years 2000 to 2017, 2017 to 2030, and 2000 to 2030. The TSZs were organized into the following four categories (hereafter numeric

population change tables): highest, high, moderate, and lowest for each time period. The numeric population change tables are organized as follows: Table 3.1 shows numeric population change for 2000 to 2017, Table 3.2 shows 2017 to 2030, and Table 3.3 shows 2000 to 2030.

Maps were then created which graphically depict the numeric change in population for each of the CAMPO study year increments (2000 to 2017, 2017 to 2030, and 2000 to 2030) for use in public meetings with the stakeholders. These maps are done by color code, showing highest to lowest numeric population change for each study year increment (Figures 3-2, 3-3, and 3-4). We also depicted the addition of population for each CAMPO study year (2000, 2017, and 2030) within the planning area by a dot density depiction, with each dot representing 50 people living within a particular TSZ (Figures 3-5, 3-6, and 3-7).

3.2 ANALYSIS OF POPULATION DATA

The CAMPO TSZ results show a significant increase in population within the planning area between 2000 to 2030. The percentages of population growth within the planning area is shown in the table below.

Year	Total Population	% Change
2000	14,467	–
2017	40,354	179
2030	60,650	50

The overall change in the study area population between 2000 and 2030 is more than a four-fold increase. This increase is worthy of the consideration for water quality and water availability.

The results of our study using the CAMPO TSZ method show that the highest overall potential growth occurred more or less along the IH 35 corridor on both the east and west sides. And, the single greatest growth over the 2000 to 2030 study period was TSZ No. 591, with an increase of 6,516 people, and starting with only 200 people living within the TSZ in 2000.

The greatest population change is shown to be in the Kyle and Mountain City city limit boundaries and, to some extent, just east of the City of Buda city limits.

By watersheds, the greatest growth occurs within Upper Brushy Creek, Porter Creek, Bunton Branch, and Plum Creek, with less development occurring in Elm Creek and Brushy Creek. The greatest numeric change in population relative to existing WWTPs is shown to occur within the City of Kyle (Outfall Permit No. 11041-002) and the Winfield Wastewater Treatment Plant (Outfall Permit No. 14377-001).

**TABLE 3.1
 NUMERIC POPULATION CHANGE BY TRAFFIC SERIAL ZONE
 2000 TO 2017**

TSZ #	Population in Year 2000*	Population in Year 2017	Numeric Change (2000 to 2017) - Sorted in Descending Order	Population Growth Category
591	200	5,260	5,060	Highest
589	746	4,999	4,253	Highest
806	3	3,800	3,797	Highest
580	0	2,400	2,400	High
1043	23	2,027	2,004	High
803	384	1,804	1,420	High
818	242	1,650	1,408	High
805	17	1,216	1,199	High
583	1,981	3,024	1,043	High
819	1,646	2,617	971	Moderate
844	85	802	717	Moderate
807	2	660	658	Moderate
814	260	694	434	Moderate
815	947	1,251	304	Moderate
581	392	576	184	Moderate
590	3,018	3,188	170	Moderate
585	1,034	1,125	91	Lowest
804	82	137	55	Lowest
582	917	955	38	Lowest
817	1,417	1,431	14	Lowest
809	25	22	-3	Lowest
584	198	179	-19	Lowest
831	304	160	-144	Lowest
830	544	377	-167	Lowest
Total	14,467	40,354	25,887	

Range of Numeric Changes (2000 to 2017) = -167 to 5060

Lowest Growth = Less than 100
 Moderate Growth = 100 to 999
 High Growth = 1000 to 2499
 Highest Growth = 2500 and above

Source: Capital Area Metropolitan Organization (CAMPO), Traffic Serial Zone Data, 2003.

*Population estimates for the year 2000 were derived from the U.S. Bureau of Census Decennial Census, and were apportioned into the TSZ by CAMPO.

**TABLE 3.2
 NUMERIC POPULATION CHANGE BY TRAFFIC SERIAL ZONE
 2017 TO 2030**

TSZ #	Population in Year 2017	Population in Year 2030	Numeric Change (2017 to 2030) - Sorted in Descending Order	Population Growth Category
581	576	2,480	1,904	High
815	1,251	3,043	1,792	High
583	3,024	4,648	1,624	High
584	179	1,691	1,512	High
591	5,260	6,716	1,456	High
805	1,216	2,560	1,344	High
806	3,800	5,032	1,232	High
580	2,400	3,632	1,232	High
819	2,617	3,793	1,176	High
818	1,650	2,658	1,008	High
582	955	1,963	1,008	High
589	4,999	5,811	812	Moderate
807	660	1,444	784	Moderate
809	22	806	784	Moderate
814	694	1,366	672	Moderate
590	3,188	3,748	560	Moderate
1043	2,027	2,527	500	Moderate
803	1,804	2,196	392	Moderate
844	802	1,138	336	Moderate
804	137	305	168	Moderate
585	1,125	1,125	0	Lowest
817	1,431	1,431	0	Lowest
831	160	160	0	Lowest
830	377	377	0	Lowest
Total	40,354	60,650	20,296	

Range of Numeric Changes (2017 to 2030) = 0 to 1,904

Lowest Growth = less than 100
 Moderate Growth = 100 to 999
 High Growth = 1,000 to 2,499

Source: Capital Area Metropolitan Organization (CAMPO), Traffic Serial Zone Data, 2003.

**TABLE 3.3
 NUMERIC POPULATION CHANGE BY TRAFFIC SERIAL ZONE
 2000 TO 2030**

TSZ #	Population in Year 2000*	Population in Year 2030	Numeric Change (2000 to 2030) - Sorted in Descending Order	Population Growth Category
591	200	6,716	6,516	Highest
589	746	5,811	5,065	Highest
806	3	5,032	5,029	Highest
580	0	3,632	3,632	Highest
583	1,981	4,648	2,667	Highest
805	17	2,560	2,543	Highest
1043	23	2,527	2,504	Highest
818	242	2,658	2,416	High
819	1,646	3,793	2,147	High
815	947	3,043	2,096	High
581	392	2,480	2,088	High
803	384	2,196	1,812	High
584	198	1,691	1,493	Moderate
807	2	1,444	1,442	Moderate
814	260	1,366	1,106	Moderate
844	85	1,138	1,053	Moderate
582	917	1,963	1,046	Moderate
809	25	806	781	Moderate
590	3,018	3,748	730	Moderate
804	82	305	223	Moderate
585	1,034	1,125	91	Lowest
817	1,417	1,431	14	Lowest
831	304	160	-144	Lowest
830	544	377	-167	Lowest
Totals	14,467	60,650	46,183	

Range of Numeric Changes
 (2000 to 2030) = -167 to 6,516
 Lowest Growth = Less than 100
 Moderate Growth = 100 to 1,499
 High Growth = 1,500 to 2,499
 Highest Growth = 2500 and above

Source: Capital Area Metropolitan Organization (CAMPO), Traffic Serial Zone Data, 2003.

*Population estimates for the year 2000 were derived from the U.S. Bureau of Census Decennial Census, and were apportioned into the TSZ by CAMPO.

3.3 HAYS CONSOLIDATED INDEPENDENT SCHOOL DISTRICT ANALYSIS

PBS&J considered population projections provided by the HCISD Demographic Update Report, April, 2003 (HCISD, 2003), and compared them with those results from CAMPO's TSZ projections.

Relating the two separate data sources was challenging. There are several factors discovered in the comparative analysis which should be discussed:

1. The HCISD report was developed for the purpose of determining expected students, not overall population. PBS&J related the student population to overall population based on a person per household unit multiplier of 2.69.
2. The HCISD report data may not be capturing all of the future housing units for each planning unit since the study only is counting subdivisions that are known to be coming online for years 2003 and 2008. So, projected changes in housing units shown between 2008 to 2030 are likely to be inaccurate and incomplete, and do not provide a year-to-year comparison with the CAMPO data.
3. The HCISD report has housing units that do not have the same boundaries as the TSZ. We were able to massage the housing unit boundaries to more-or-less co-relate with the TSZ boundaries. But, in many instances, the co-relation requires gross assumptions about population density within the TSZ.
4. Of the 20 or so TSZ areas found in the CAMPO study for the proposed planning area, the HCISD study data only provides numeric data for eight of these TSZ areas. Therefore, the HCISD study only focuses on a narrow area of the overall planning area.

Considering all of the above-mentioned unavoidable flaws in the comparative analysis between the HCISD study and the CAMPO TSZ study, we concluded that the comparison was grossly inaccurate and invalid. However, interestingly enough, after we made our comparison of the HCISD planning units that more-or-less co-related with ten of the TSZ, in part or whole, we discovered that the difference in the two study methods had population results within 2.5 percent of each other for the year 2017. Certain areas within the planning area were greater and certain areas were lower. More importantly, the assumptions leading up to the results, and the difficulty in comparing the two separate methods have led us to conclude that the CAMPO TSZ data is more comprehensive for our entire planning area, has longer future projections (to year 2030) and has its primary objective more in line with the purpose of the GBRA study.

3.4 REGIONAL WASTEWATER PLANNING

The objective of the Regional Wastewater Planning is to identify and evaluate multiple alternative wastewater collection, treatment and disposal methods for their suitability and cost effectiveness to manage the anticipated increase in population in the planning area.

Three separate alternatives were considered: 1) No-Action, 2) Regional Plants, and 3) Small Multiple Plants. The Regional Plants alternative consists of two regional plants with reuse. The No-Action alternative is where there is no wastewater treatment regionalization, and treatment is left up to each individual development. The Small Multiple Plants alternative consists of five Multiple Small Plants, with each plant serving a portion of the planning area with wastewater collection and reuse. Each of these three models was used to determine collection volume, possible reuse, overall cost, and captured population growth throughout each of the planning area's TSZs.

The capacity of each plant was determined by the use of average flow from all TSZs served at a predetermined capture rate of generated flow for that area. An average flow of 80 gallons per day (gpd)/capita was assumed for calculating average daily flows for each TSZ, with wet and dry weather flow being calculated using a 1.3 and 0.8 multiplier, respectively. Capture rates were determined based on current and anticipated collection rates and OSSF usage within each TSZ. OSSF usage is more common in rural and less developed areas. Therefore, anticipated wastewater collection rates encountered will be lower in more rural areas. Development densities also tend to be less in rural areas, which also leads to wastewater collection in rural areas being more cost prohibitive. For the study collection rates in the models, rural TSZs are calculated to have between 30–50 percent, as compared with 70–95 percent as seen with TSZs bordering the IH 35 corridor. All flow not collected for each TSZ is assumed to be OSSF flow. Each of the three wastewater collection models calculated flows by TSZ can be viewed in each treatment model's flow table.

Wastewater collection calculations for each model utilized a common method throughout the study. A collection main was assumed to originate from the center of each TSZ and flow via gravity main to either the next adjacent TSZ or that region's treatment facility. For areas in a TSZ where a gravity main would not likely work, a force main would be used, and the additional cost of a lift station would be added to the collection cost of the overall model. Costs for lift stations were determined to be \$500,000 per lift station for all models. Calculated pipe sizes and lengths per TSZ can be viewed in each model's cost table. Pipe cost was determined using a cost per linear foot of pipe with labor and material costs included.

Reuse of wastewater effluent was considered for each model. Reuse will serve two primary purposes: 1) it will supplement water supply for irrigation, and, 2) it will reduce discharge to the outfall receiving stream. Reuse was an important component to the Regional Plant alternative. In a regional plant, because the collection distances are much greater than where smaller, more frequent plant scenarios are found, there tends to be fewer Living Unit Equivalents (LUEs) connected to the system, thus decreasing the available amount of treated effluent from the plant for reuse. Also, due to the distance from the regional plants to areas of key reuse (more densely populated TSZs), piping and pumping costs become an issue, making the reuse from a regional plant more difficult, unless specific industrial uses can be identified that can utilize the reuse and justify the cost of conveyance. Such uses might include power plants, cement plants, or agricultural purposes. For distant customers, reuse piping cost would outweigh any cost benefit that would allow a facility to provide distant customers with service.

Maximum demand for reuse water was determined by using turf grass water demand and subtracting average annual rainfall, while assuming limited application due to extended distribution distances. The remaining water needs not met by ambient rainfall were calculated to be the maximum reuse that could be utilized. The maximum demand or amount of potential reuse was calculated to occur in July, with a demand of 4625 gallon/day/acre. Using this as a basis for maximum usage, it was determined that the average annual reuse was 31 percent; calculated monthly usage can be seen in the table below.

Calculated Monthly Reuse

Month	Max demand gpd/acre	Reuse (%)
January	199	4
February	534	12
March	1,539	33
April	1,910	41
May	45	1
June	2,326	50
July	4,625	100
August	3,648	79
September	2,344	51
October	100	2
November	0	0
December	0	0
	Average	31

Reuse calculations for each applicable treatment model used a similar method as those described above for collection. The main difference being only one distribution main for reuse per service area is used, verses one distribution main serving each TSZ. For each plant’s service area all reuse water would be directed to the center of the most populated TSZ, This was done to minimize the cost due to the limited reuse flows generated by each plant, and maximize the benefit of residence able to be served with reuse water.

Density of development tends to be much lower overall in eastern Hays County, as compared with similar parts of the nearby Austin area. This may be due to a variety of factors, including, but not limited to, environmental impacts to receiving streams controls, real estate preferences, and any determined natural preserve areas. Traditionally, as development density is reduced, the costs for providing centralized collection and treatment tend to increase. Thus, the need to consider either individual (OSSF) or cluster-type onsite treatment and disposal systems becomes evident. However, it must also be noted that individual OSSF systems typically range from four to eight thousand dollars, with some units ranging as high as \$20,000 or more dollars depending on treatment quality, site conditions, and other environmental constraints.

3.4.1 No-Action

No-Action is a model in which there is no regionalization, and treatment is left up to each individual development. A greater number of TSZs will be served by OSSFs. PBS&J selected plants each serving an area generating no more than 266,000 gpd. A total of 17 plants are used in this model, with plant capacities ranging from 275,000 gpd to 75,000 gpd being the smallest. All plants within this model are 275,000 gallons or smaller to better represent those built by individual communities. TSZs served by each plant can be seen in Figure 3-8.

The capacity of each plant was determined by using a 80 gpd/capita multiplier as described in Section 3.0. Capture rates, as discussed below, were determined based on current and anticipated collection rates and

TABLE 3.4
FLOW ANALYSIS
NO-ACTION

Plant Size (X1000 gal)	TSZ #	% Area	% Captured	Population 2000 ¹	Population 2030 ²	Numeric Change (2000 to 2030)	Flow Avg (gpd)	OSSF (gpd)	% Captured Avg (gpd)	Discharge Avg (gpd)
300	580	100%	70%	0	3,632	3,632	290,560	87,168	203,392	203,392
	total			0	3,632	3,632	290,560	87,168	203,392	203,392
275	581	100%	50%	392	2,480	2,088	167,040	83,520	83,520	83,520
	583	100%	50%	1,981	4,648	2,667	213,360	106,680	106,680	106,680
	total			2,373	7,128	4,755	380,400	190,200	190,200	190,200
250 2 plants	591	100%	70%	200	6,716	6,516	521,280	156,384	364,896	364,896
	total			200	6,716	6,516	521,280	156,384	364,896	364,896
	each			100	3,358	3,258	260,640	78,192	182,448	182,448
250	819	100%	50%	1,646	3,793	2,147	171,760	85,880	85,880	85,880
	815	6%	70%	947	3,043	2,096	10,061	3,018	7,043	7,043
	815	94%	50%	947	3,043	2,096	157,619	78,810	78,810	78,810
	total			3,540	6,836	4,243	339,440	167,708	171,732	171,732
200	589	100%	70%	746	5,811	5,065	405,200	121,560	283,640	283,640
	831	100%	70%	304	160	-144	0	0	0	0
	830	100%	70%	544	377	-167	0	0	0	0
	826	100%	70%	782	380	-402	0	0	0	0
	817	100%	70%	1,417	1,431	14	1,120	336	784	784
	805	100%	70%	17	2,560	2,543	203,440	61,032	142,408	142,408
	total			3,810	10,719	6,909	609,760	182,928	426,832	426,832
200	804	100%	70%	82	305	223	17,840	5,352	12,488	12,488
	809	100%	70%	25	806	781	62,480	18,744	43,736	43,736
	584	100%	70%	198	1,691	1,493	119,440	35,832	83,608	83,608
	total			305	2,802	2,497	199,760	59,928	139,832	139,832
200 2 plants	806	20%	50%	3	5,032	5,029	80,464	40,232	40,232	40,232
	806	80%	70%	3	5,032	5,029	321,856	96,557	225,299	225,299
	total			6	5,032	5,029	402,320	136,789	265,531	265,531
	each			3	2,516	2,515	201,160	68,394	132,766	132,766
150	803	100%	50%	384	2,196	1,812	144,960	72,480	72,480	72,480
	590	100%	30%	3,018	3,748	730	58,400	40,880	17,520	17,520
	total			3,402	5,944	2,542	203,360	113,360	90,000	90,000
150	1043	88%	70%	23	2,527	2,504	176,282	52,884	123,397	123,397
	1043	12%	70%	23	2,527	2,504	24,038	7,212	16,827	16,827
	total			46	2,527	2,504	200,320	60,096	140,224	140,224
175	818	50%	70%	242	2,658	2,416	96,640	28,992	67,648	67,648
	818	50%	50%	242	2,658	2,416	96,640	48,320	48,320	48,320
	total			484	2,658	2,416	193,280	77,312	115,968	115,968
125	814	100%	50%	260	1,366	1,106	88,480	44,240	44,240	44,240
	844	100%	50%	85	1,138	1,053	84,240	42,120	42,120	42,120
	total			345	2,504	2,159	172,720	86,360	86,360	86,360
75	582	100%	50%	917	1,963	1,046	83,680	41,840	41,840	41,840
	total			917	1,963	1,046	83,680	41,840	41,840	41,840
Buda	585	100%	100%	1,034	1,125	91	7,280	0	7,280	7,280
	807	100%	100%	2	1,444	1,442	115,360	0	115,360	115,360
	total			1,036	2,569	1,533	122,640	0	122,640	122,640
Total		91%	63%	15,249	61,030	45,781	3,719,520	1,360,073	2,236,807	2,236,807

¹U.S. Census Bureau - Decennial Census Estimates 2000.

²Population Projections by TSZ developed by CAMPO using Texas State Data Center (TSDC) Population Projections Developed for Hays County.

**Table 3.5
Cost Analysis
No Action**

Plant Size (X1000 gal)	TSZ #	Ave Flow (gpd)	Ave Flow (gpd)X5	Cost per gal	Plant Cost	Type	Design Line	Line Length (ft)	Line Cost	Collection Cost
225	580	203,392	1016960							
	total	203,392	1,331,400	\$4.50	\$1,012,500.00	G	12	13200	\$35.00	\$462,000.00
200	581	83,520	417600							
	583	106,680	533400							
	total	190,200	951,000	\$4.50	\$900,000.00	G	10	17160	\$32.00	\$549,120.00
250	591	364,896	1824480							
2 plants	total	364,896	1,824,480		\$2,250,000.00					
	<i>each</i>	182,448	912,240	\$4.50	\$1,125,000.00	G	10	11550	\$32.00	\$369,600.00
175	819	85,880	429400							
	815	7,043	35212.8							
	815	78,810	394048							
	total	171,732	858,661	\$4.50	\$787,500.00	G	10	16830	\$32.00	\$538,560.00
450	589	283,640	1418200							
	831	0	0							
	830	0	0							
	817	0	0							
	805	784	3920							
	826	142,408	712040							
	total	426,832	2,134,160	\$4.50	\$1,920,744.00	G	14	16830	\$32.00	\$538,560.00
150	804	12,488	62440							
	809	43,736	218680							
	584	83,608	418040							
	total	139,832	699,160	\$4.50	\$675,000.00	G	8	16830	\$28.00	\$471,240.00
150	806	40,232	201160							
2 plants	806	225,299	1126496							
	total	265,531	1,327,656		\$1,350,000.00					
	<i>each</i>	132,766	663,828	\$4.50	\$675,000.00	G	8	13200	\$28.00	\$369,600.00
125	803	72,480	362400							
	590	17,520	87600							
	total	90,000	450,000	\$4.50	\$562,500.00	G	8	17820	\$28.00	\$498,960.00
150	1043	123,397	616985.6							
	1043	16,827	84134.4							
	total	140,224	701,120	\$4.50	\$675,000.00	G	8	13860	\$28.00	\$388,080.00
125	818	67,648	338240							
	818	48,320	241600							
	total	115,968	579,840	\$4.50	\$562,500.00	G	8	8580	\$28.00	\$240,240.00
100	814	44,240	221200							
	844	42,120	210600							
	total	86,360	431,800	\$4.50	\$450,000.00	G	6	19800	\$28.00	\$554,400.00
50	582	41,840	209200							
	total	41,840	209,200	\$4.50	\$225,000.00	G	4	14190	\$28.00	\$397,320.00
Buda ¹	585	7,280								
	807	115,360								
	total	122,640		N/A				0		
Total		2,236,807	11,498,477		\$11,370,744.00					\$4,839,120.00

¹ Cost analysis was not conducted on the Buda plant expansion

OSSF usage within each TSZ. For the No-Action plant model, these flow calculations can be seen in Table 3.4.

Due to the lack of regional wastewater collection management and high rates of OSSF use associated with this model, regulation of effluent and receiving stream water quality control would be greatly diminished. Unregulated development creates the possibility of a great amount of flow entering a single watershed verses limiting the flow to two watersheds, as seen in the regional model, or selected streams, as seen by the multiple plant model.

For the No-Action model, the term “No-Action” refers to no central planning for wastewater collection being in place. In this model, all wastewater collection would be determined by the developer(s) on a case-by-case basis. Many of the new developments would utilize OSSF due to lower development costs associated with alternative treatments. TSZs are expected to bear wastewater collection rates of 30–70%, with the remaining wastewater being treated by OSSF. TSZs located along the IH 35 corridor would possess the higher collection values, whereas the more rural zones would rely more upon OSSFs. Using the growth estimates and typical small plant sizes of 275,000 gpd and less, a total of 17 plants would be developed to accommodate the 2.4 MGD production within the TSZs.

No reuse was assumed for this model due to no incentive for reuse. This assumption is based upon the construction cost of running additional lines for reuse distribution lines would be less attractive to individual developers. Because no reuse is assumed, all 2.4 MGD, which is treated by the model’s wastewater plants, would be discharged into the six main watersheds. Depending on the outfall locations of the 17 assumed plants, eutrophic conditions could arise in receiving streams and ponds during periods of low stream flow and high evaporation. Table 3.5 shows a cost analysis of the No-Action model. The calculated cost per LUE served was calculated to be \$1,566, making this No-Action alternative the second most expensive of the three alternatives.

3.4.2 Regional Plants

In our model, PBS&J considered two plants, each serving a portion of the study area with collection and reuse. The two plant models utilized the future Winfield Plant and the existing Kyle Plant for wastewater treatment which are separated by a ridgeline dividing the planning area. The dividing line between the two regions begins at the northern portion of the study area adjacent to IH 35 and the north most point of TSZ 583 and ends at the southeastern corner of TSZ 814. All TSZs to the east of this line would be served by the Winfield Plant (Permit No. 14377-001). All TSZs located to the west of this line would be served by the Kyle Plant (Permit No. 11041-002). TSZs 585 and 807 would be served by the Buda plant (Permit No. 11060-001). TSZs served by each plant can be seen in Figure 3-9. For the regional plant model, capture rate calculations can be seen in Table 3.6.

By managing regional wastewater collection and treatment within the study area, the use of OSSF throughout the region could be reduced. Regional management of wastewater collection within the study

TABLE 3.6
FLOW ANALYSIS
REGIONAL PLANTS

Region	TSZ #	% Area	% Captured	Population 2000 ¹	Population 2030 ²	Numeric Change (2000 to 2030)	Flow Avg (gpd)	OSSF (gpd)	% Captured Avg (gpd)	% Reuse ³	% Reuse Avg (gpd)	% Outfall Avg (gpd)
Winfield	809	100%	80%	25	806	781	62,480	12,496	49,984	15.50%	7,748	42,236
	582	100%	55%	917	1,963	1,046	83,680	37,656	46,024	15.50%	7,134	38,890
	584	100%	80%	198	1,691	1,493	119,440	23,888	95,552	15.50%	14,811	80,741
	804	100%	80%	82	305	223	17,840	3,568	14,272	15.50%	2,212	12,060
	580	100%	80%	0	3,632	3,632	290,560	58,112	232,448	15.50%	36,029	196,419
	583	100%	55%	1,981	4,648	2,667	213,360	96,012	117,348	15.50%	18,189	99,159
	590	50%	40%	3,018	3,748	730	29,200	17,520	11,680	15.50%	1,810	9,870
	590	50%	40%	3,018	3,748	730	29,200	17,520	11,680	15.50%	1,810	9,870
	581	100%	55%	392	2,480	2,088	167,040	75,168	91,872	15.50%	14,240	77,632
	803	100%	55%	384	2,196	1,812	144,960	65,232	79,728	15.50%	12,358	67,370
	Total		62%		5,016	21,469	14,472	1,157,760	407,172	750,588	15.50%	116,341
Kyle	591	100%	80%	200	6,716	6,516	521,280	104,256	417,024	15.50%	64,639	352,385
	589	100%	80%	746	5,811	5,065	405,200	81,040	324,160	15.50%	50,245	273,915
	806	20%	55%	3	5,032	5,029	80,464	36,209	44,255	15.50%	6,860	37,396
	806	80%	80%	3	5,032	5,029	321,856	64,371	257,485	15.50%	39,910	217,575
	1043	88%	55%	23	2,527	2,504	176,282	79,327	96,955	15.50%	15,028	81,927
	1043	12%	80%	23	2,527	2,504	24,038	4,808	19,231	15.50%	2,981	16,250
	818	50%	80%	242	2,658	2,416	96,640	19,328	77,312	15.50%	11,983	65,329
	818	50%	55%	242	2,658	2,416	96,640	43,488	53,152	15.50%	8,239	44,913
	805	100%	80%	17	2,560	2,543	203,440	40,688	162,752	15.50%	25,227	137,525
	819	100%	55%	1,646	3,793	2,147	171,760	77,292	94,468	15.50%	14,643	79,825
	844	100%	55%	85	1,138	1,053	84,240	37,908	46,332	15.50%	7,181	39,151
	814	85%	55%	260	1,366	1,106	75,208	33,844	41,364	15.50%	6,411	34,953
	814	15%	55%	260	1,366	1,106	13,272	5,972	7,300	15.50%	1,131	6,168
	815	6%	80%	947	3,043	2,096	10,061	2,012	8,049	15.50%	1,248	6,801
	815	94%	55%	947	3,043	2,096	157,619	70,929	86,691	15.50%	13,437	73,254
	817	100%	80%	1,417	1,431	14	1,120	224	896	15.50%	139	757
	831	100%	80%	304	160	-144	0	0	0	15.50%	0	0
	830	100%	80%	544	377	-167	0	0	0	15.50%	0	0
826	100%	80%	782	380	-402	0	0	0	15.50%	0	0	
Total		74%	69%	7,216	36,992	29,776	2,439,120	701,695	1,737,425	15.50%	269,301	1,468,124
Buda	585	100%	100%	1,034	1,125	91	7,280	0	7,280	15.50%	1,128	6,152
	807	100%	100%	2	1,444	1,442	115,360	0	115,360	15.50%	17,881	97,479
	Total			1,036	2,569	1,533	122,640	0	122,640	15.50%	19,009	103,631
Total		67%	13,268	61,030	45,781	3,719,520	1,108,867	2,610,653	15.50%	404,651	2,206,002	

¹U.S. Census Bureau - Decennial Census Estimates 2000.

²Population Projections by TSZ developed by CAMPO using Texas State Data Center (TSDC) Population Projections Developed for Hays County.

³Reuse flow assumed to serve 681 acres based on average peak month turfgrass watering requirements

Table 3.7
Cost Analysis
Regional Plants

Region	TSZ #	Ave Flow (gpd)	Ave Flow (gpd)X5	Line Flow	Cost per gal	Plant Cost	Type	Design Line	Line Length	Line Cost per linear ft	Collection Cost	% Reuse Ave (gpd) ¹	Line Length	Line Size	Line Cost	Distribution Cost	Lift Station Cost
Winfield	809	49984	249,920	249,920			G	6.0	7,920	\$28	\$221,760.00	7,748					
	582	46024	230,120	230,120			G	6.0	10,890	\$32	\$348,480.00	7,134					
	584	95552	477,760	799,040			G	10.0	6,600	\$32	\$211,200.00	14,811					
	804	14272	71,360	321,280			G	6.0	5,940	\$28	\$166,320.00	2,212					
	580	232448	1,162,240	1,162,240			G	12.0	6,600	\$35	\$231,000.00	36,029	6,600	4	\$22.00	\$145,200.00	
	583	117348	586,740	586,740			G	4.0	12,870	\$28	\$360,360.00	5,639					
	590	23360	116,800	116,800			G	4.0	16,500	\$28	\$462,000.00	3,621					
	581	91872	459,360	1,204,920			F	12.0	10,560	\$35	\$369,600.00	14,240					\$500,000.00
	803	79728	398,640	745,560			F	10.0	21,450	\$32	\$686,400.00	12,358					\$500,000.00
	Total	750588	3752940			\$3.00	\$2,251,764.00			99,330.00		\$3,057,120.00	103,791	6,600			\$145,200.00
Kyle	591	417024	2,085,120	6,613,788			G	24	5,610	\$70	\$392,700.00	64,639	5,610	6	\$26.00	\$145,860.00	
	589	324160	1,620,800	1,620,800			G	12	8,580	\$35	\$300,300.00	50,245					
	806	301740	1,508,700	2,089,628			G	16	9,900	\$70	\$693,000.00	46,770					
	1043	116186	580,928	580,928			F	8	11,220	\$28	\$314,160.00	18,009					\$500,000.00
	818	130464	652,320	652,320			G	8	19,800	\$28	\$554,400.00	20,222					
	805	162752	813,760	4,524,188			G	21	11,550	\$70	\$808,500.00	25,227					
	819	94468	472,340	472,340			G	8	17,160	\$28	\$480,480.00	14,643					
	844	46332	231,660	474,980			F	8	12,540	\$28	\$351,120.00	7,181					\$500,000.00
	814	48664	243,320	243,320			F	6	11,550	\$28	\$323,400.00	7,542					\$500,000.00
	815	94739	473,696	946,036			G	10	10,560	\$32	\$337,920.00	14,685					
	817	896	4,480	4,528,668			G	21	13,200	\$70	\$924,000.00	139					
	831	0	0				G		0	\$32	\$0.00	0					
	830	0	0				G	4	8,250	\$28	\$231,000.00	0					
	826	0	0				G		0	\$32	\$0.00	0					
Total	1737425	8,687,124			\$3.00	\$5,212,274.52			139,920		\$5,710,980.00	269,301	5,610			\$145,860.00	\$1,500,000.00
Buda ²	585		14,560									1,128					
	807		230,720									17,881					
	Total		245,280									19,009					
Total		2,488,013	12,440,064			\$7,464,038.52			239,250		\$8,768,100.00	373,092	12,210			\$291,060.00	\$2,500,000.00

¹ Reuse flow assumed to serve 681 acres based on average peak month turfgrass watering requirements

² Cost analysis was not conducted on the Buda plant expansion

area would also reduce the number of developer package plants. This would give the region greater potential control over receiving stream water quality by limiting the number of treatment facilities located on the streams. Limiting the amount of discharge points is crucial in minimizing potential adverse environmental effects upon the existing ecosystems. One such cause of these adverse effects could be caused by excess nutrients being discharged into multiple low flowing receiving bodies.

For the regional plant model, TSZs are expected to provide wastewater collection rates of 40–80 percent, with the remaining wastewater being treated by OSSFs. As explained in Section 3.3, TSZs located along the IH 35 corridor would possess the higher collection values, whereas the more rural zones would rely more upon OSSFs. Using the anticipated population growth, the Winfield plant would treat 700,000 gpd, and the Kyle plant would treat a calculated 1.8 million gallons per day (MGD). Total anticipated collection of 2.6 MGD is anticipated for the study area. 15.5 percent reuse was assumed for this model, based on anticipated flows and OSSF usage patterns. With reuse measures in place, an assumed 2.2 MGD would still be discharged into the study area. However, by having only two plants discharging, the water quality impacts upon the six watersheds could be minimized, thus further protecting them from pollution and/or eutrophic conditions. For this model, cost per LUE was calculated at \$1,705, as seen in Table 3.7, which was the most costly of the three models analyzed.

3.4.3 Multiple Plants

Multiple Small Plants is a five-plant model, with each plant serving a portion of the planning area with wastewater collection and reuse. The five developed regions are color-coded, and can be viewed in Figure 3-10. Flow calculations for each region, which are shown to the right of each plant name, can be seen in detail in Table 3.8.

- Winfield Plant: 629,000 gpd, NE Section (Yellow)
- Porter Plant: 581,000 gpd, Central Section (Blue)
- Kyle Plant: 1.5 MGD, NW Section (Green)
- Sweetwater Plant: 175,000 gpd, SE Section (DK Green)
- Uhland Plant: 135,000 gpd, SW Section (Orange)

Through the use of proper water management within the regional wastewater collection areas, the use of OSSFs throughout the region could be reduced. The smaller, multiple plants alternative allows for management of wastewater collection within the planning area, reducing the number of developer package plants seen in the “No-Action” model and reducing the number of residents relying upon OSSFs.

Effluent reuse would be more readily utilized in the multiple plant alternative than in the regional plant alternative due to the reduced capital necessary per treated MGD in order to distribute the reused effluent. The five regions alternative within this model of 84 percent of service units would be connected to the system. The remaining 16 percent would still use OSSF. However this represents only .57 MGD of OSSF

**TABLE 3.8
FLOW ANALYSIS
MULTIPLE PLANTS**

Plant	TSZ #	% Area	% Captured	Population 2000 ¹	Population 2030 ²	Numeric Change (2000 to 2030)	Average Flow (gpd)	OSSF (gpd)	% Captured Avg (gpd)	% Reuse ³	% Reuse Avg (gpd)	% Outfall Avg (gpd)
Winfield	581	100%	70%	392	2,480	2,088	167,040	50,112	116,928	31.00%	36,248	80,680
	580	100%	95%	0	3,632	3,632	290,560	14,528	276,032	31.00%	85,570	190,462
	804	100%	95%	82	305	223	17,840	892	16,948	31.00%	5,254	11,694
	584	100%	95%	198	1,691	1,493	119,440	5,972	113,468	31.00%	35,175	78,293
	583	31%	70%	1,981	4,648	2,667	66,142	19,842	46,299	31.00%	14,353	31,946
	809	100%	95%	25	806	781	62,480	3,124	59,356	31.00%	18,400	40,956
	Total	89%	87%	2,678	13,562	10,884	723,502	94,470	629,031		195,000	434,031
Porter	583	69%	70%	1,981	4,648	2,667	147,218	44,166	103,053	31.00%	31,946	71,106
	815	94%	70%	947	3,043	2,096	157,619	47,286	110,333	31.00%	34,203	76,130
	819	100%	70%	1,646	3,793	2,147	171,760	51,528	120,232	31.00%	37,272	82,960
	1043	88%	70%	23	2,527	2,504	176,282	52,884	123,397	31.00%	38,253	85,144
	806	20%	70%	3	5,032	5,029	80,464	24,139	56,325	31.00%	17,461	38,864
	818	50%	70%	242	2,658	2,416	96,640	28,992	67,648	31.00%	29,958	37,690
	Total	70%	70%	4,842	21,701	16,859	829,983	248,995	580,988		189,094	391,894
Kyle	591	100%	95%	200	6,716	6,516	521,280	26,064	495,216	31.00%	153,517	341,699
	589	100%	95%	746	5,811	5,065	405,200	20,260	384,940	31.00%	119,331	265,609
	831	100%	95%	304	160	-144	0	0	0	31.00%	0	0
	830	100%	95%	544	377	-167	0	0	0	31.00%	0	0
	815	6%	95%	947	3,043	2,096	10,061	503	9,558	31.00%	2,963	6,595
	826	100%	95%	782	380	-402	0	0	0	31.00%	0	0
	805	100%	95%	17	2,560	2,543	203,440	10,172	193,268	31.00%	59,913	133,355
	817	100%	95%	1,417	1,431	14	1,120	56	1,064	31.00%	330	734
	1043	12%	95%	23	2,527	2,504	24,038	1,202	22,836	31.00%	7,079	15,757
	818	50%	95%	242	2,658	2,416	96,640	4,832	91,808	31.00%	28,460	63,348
	806	80%	95%	3	5,032	5,029	321,856	16,093	305,763	31.00%	94,787	210,977
	Total	77%	95%	5,225	30,695	25,470	1,583,635	79,182	1,504,453		466,381	1,038,073
	Uland	844	100%	70%	85	1,138	1,053	84,240	25,272	58,968	31.00%	18,280
814		100%	70%	260	1,366	1,106	88,480	26,544	61,936	31.00%	19,200	42,736
590		50%	50%	3,018	3,748	730	29,200	14,600	14,600	31.00%	4,526	10,074
Total		83%	63%	3,363	6,252	2,889	201,920	66,416	135,504		42,006	93,498
SW	803	100%	70%	384	2,196	1,812	144,960	43,488	101,472	31.00%	31,456	70,016
	582	100%	70%	917	1,963	1,046	83,680	25,104	58,576	31.00%	18,159	40,417
	590	50%	50%	3,018	3,748	730	29,200	14,600	14,600	31.00%	4,526	10,074
	Total	83%	63%	4,319	7,907	3,588	257,840	83,192	174,648		54,141	120,507
Buda	807	100%	100%	2	1,444	1,442	115,360	0	115,360	31.00%	35,762	79,598
	585	100%	100%	1,034	1,125	91	7,280	0	7,280	31.00%	2,257	5,023
	Total	100%	100%	1,036	2,569	1,533	122,640	0	122,640		38,018	84,622
Total			14,989	61,030	45,781	3,719,520	572,255	3,147,265	31%	984,640	2,162,625	

¹U.S. Census Bureau - Decennial Census Estimates 2000.

²Population Projections by TSZ developed by CAMPO using Texas State Data Center (TSDC) Population Projections Developed for Hays County.

³Reuse flow assumed to serve 681 acres based on annual average peak month turf grass watering requirements

Table 3.9
Cost Analysis
Multiple Plants

Plant	TSZ #	Ave Flow (gpd)	Ave Flow (gpd)X5	Calculated Flow	Cost per gal	Plant Cost	Type	Line Length	Design Line	Line Cost	Collection Cost	% Reuse Ave (gpd) ¹	Line Length	Line Size	Line Cost	Distribution Cost	Lift Station Cost	
Winfield	581	116928	584,640	584,640			F	10,560	8	\$28.00	\$295,680.00	36,248					\$500,000.00	
	580	276032	1,380,160	1,380,160			G	6,600	12	\$35.00	\$231,000.00	85,570	6,600	4	\$22.00	\$145,200.00		
	804	16948	84,740	84,740			G	12,870	4	\$28.00	\$360,360.00	5,254						
	584	113468	567,340	948,860			G	6,600	10	\$32.00	\$211,200.00	35,175						
	583	46299	231,496	231,496			G	12,870	6	\$28.00	\$360,360.00	14,353						
	809	59356	296,780	296,780			G	6,600	6	\$28.00	\$184,800.00	18,400						
	Total	629,031	3,145,156			\$3.00	\$1,887,093.36		56,100			\$1,643,400.00	195,000	6,600		\$22.00	\$145,200.00	\$500,000.00
Porter	583	103053	515,264	515,264			G	10,890	8	\$28.00	\$304,920.00	31,946						
	815	110333	551,667	551,667			G	1,650	8	\$28.00	\$46,200.00	34,203						
	819	120232	601,160	1,838,010			G	14,520	16	\$70.00	\$1,016,400.00	37,272						
	1043	123397	616,986	898,610			G	15,510	10	\$32.00	\$496,320.00	38,253	15,510	4	\$22.00	\$341,220.00		
	806	56325	281,624	281,624			G	5,940	6	\$28.00	\$166,320.00	17,461						
	818	67648	338,240	338,240			G	11,220	6	\$28.00	\$314,160.00	29,958						
	Total	580,988	2,904,941			\$3.00	\$1,742,964.72		59,730			\$2,344,320.00	191,974	15,510			\$341,220.00	
Kyle	591	495216	2,476,080	5,046,187			G	5,610	24	\$74.00	\$415,140.00	153,517	5,610	6	\$26.00	\$145,860.00		
	589	384940	1,924,700	1,924,700			G	7,260	16	\$70.00	\$508,200.00	119,331						
	831	0	0				G	0		\$28.00	\$0.00	0						
	830	0	0				G	0		\$28.00	\$0.00	0						
	815	9558	47,789	506,829			G	6,600	8	\$28.00	\$184,800.00	2,963						
	826	0	0				G	7,260	4	\$28.00	\$203,280.00	0						
	805	193268	966,340	4,534,038			G	9,240	21	\$74.00	\$683,760.00	59,913						
	817	1064	5,320	4,539,358			G	11,880	21	\$74.00	\$879,120.00	330						
	1043	22836	114,182	114,182			G	6,600	4	\$28.00	\$184,800.00	7,079						
	818	91808	459,040	459,040			G	7,590	8	\$28.00	\$212,520.00	28,460						
	806	305763	1,528,816	1,528,816			G	10,230	12	\$35.00	\$358,050.00	94,787						
	Total	1,504,453	7,522,267			\$3.00	\$4,513,360.32		72,270			\$3,629,670.00	466,381	5,610			\$145,860.00	
	Uland	844	58968	294,840	294,840			G	9,900	6	\$28.00	\$277,200.00	18,280			\$22.00	\$0.00	
814		61936	309,680	677,520			G	4,620	8	\$28.00	\$129,360.00	16,320						
590		14600	73,000	73,000			G	16,500	4	\$28.00	\$462,000.00	4,526						
Total		135,504	677,520			\$4.50	\$609,768.00		31,020			\$868,560.00	39,126	0			\$0.00	
SW	803	101472	507,360	800,240			G	10,230	10	\$32.00	\$327,360.00	31,456			\$22.00	\$0.00		
	582	58576	292,880	292,880			G	9,240	6	\$28.00	\$258,720.00	18,159						
	590	14600	73,000	73,000			G	6,600	4	\$28.00	\$184,800.00	4,526						
Total	174,648	873,240			\$4.50	\$785,916.00		26,070			770,880	54,141	0			\$0.00		
Buda ²	807		576,800									35,762						
	585		36,400									2,257						
	Total	0	613,200									38,018						
Total		3,024,625	15,123,124			\$9,539,102.40		245,190			\$9,256,830.00	946,621	27,720			\$632,280	\$500,000	

¹ Reuse flow assumed to serve 681 acres based on average peak month turfgrass watering requirements

² Cost analysis was not conducted on the Buda plant expansion

flow, which is half of the flow seen in the regional model. This additional collection would increase the available amount of reuse from each plant, which would be made available for redistribution residential and industrial uses. All calculated flows for this model can be seen in Table 3.8.

For the Multiple Plants model, TSZs are expected to provide wastewater collection rates of 50–95 percent, with the remaining wastewater being treated by OSSFs. TSZs located along the IH 35 corridor would possess the higher collection values, whereas the more rural zones would rely more upon OSSFs, as discussed in Section 3.3.

Total anticipated collection of 3.15 MGD is anticipated for the planning area. Reuse of 31 percent was assumed for this model, based on anticipated flows and OSSF usage patterns and an increase in residential clusters. With reuse measures in place, an assumed 2.4 MGD would still be discharged into the study area. However, almost 1 MGD would be recovered for reuse within local industry and residential landscapes. The calculated cost per LUE for this model was \$1,467, the least costly of all the models. A breakdown of these costs can be viewed in Table 3.9.

3.5 REUSE REQUIREMENTS

For reuse to be accomplished, the study area must be able to produce what is referred to as Type I or Type II effluent, depending on the intended purpose. The table below displays the types, standards and reuse applications for wastewater reuse as specified by 30 TAC Ch. 210.31-36.

The main objectives for reuse are water conservation, water quality preservation, and generation of income, which should be the goals of any government organization. By reusing WWTP effluent, the study area will utilize up to 1 MG of irrigation water per day, which will aid in decreasing peak water demands. This supply of reuse water will continue to increase in flow as the study area grows, making it more cost effective to extend service.

The TWDB states three main benefits of wastewater effluent reuse:

1. It is a relatively drought-proof water resource.
2. It is the only source of water that automatically increases with economic and population growth.
3. The need for the treated wastewater/effluent is usually near the source, rather than at a remote location, thereby reducing transportation costs.

Type of Effluent	Reuse Applications	Required Quality	Required Monitoring	Setback Distances
Type I Disinfected Tertiary	Urban reuse Food crop irrigation Recreational Impoundments	pH = 6 – 9 BOD5 ≤ 10 milligram per liter (mg/L) Turb. ≤ 2 NTU E. Coli = 0 Res. Cl2 ≥ 1 mg/L	pH = weekly BOD5 = weekly Turb. = cont. E. Coli = daily Res. Cl2 = cont.	15 meters (50 feet) to potable water supply wells
Type II Disinfected Secondary	Restricted access irrigation Food crop irrigation (commercially processed) Non food crop irrigation Landscape impoundments (restricted access) Construction Wetlands Habitat	pH = 6 – 9 BOD5 ≤ 30 mg/L TSS ≤ 30 mg/L E. Coli ≤ 200/100 mL Res. Cl2 ≥ 1 mg/L	pH = weekly BOD5 = weekly Turb. = daily E. Coli = daily Res. Cl2 = cont.	30 meters (100 feet) to areas accessible to the public (if spray irrigation) 90 meters (300 feet) to potable water supply wells

4.0 WATER QUALITY ANALYSIS

As described in the previous section, three wastewater alternatives are considered:

1. Continued individual development with no provision for public wastewater service, i.e., No-Action;
2. Two larger regional wastewater facilities, with limited reuse, and
3. Five smaller regional wastewater facilities “Multiple Plants” with reuse being emphasized.

This section analyzes the likely water quality effects of each alternative. Before going into the effects analysis, the subwatersheds are described.

4.1 WATERSHED DESCRIPTIONS

Subwatersheds of the tributaries of Plum Creek in the study area were delineated as shown in Figure 1-2. In a southwest to northeast direction, the subwatersheds are Plum Creek, Bunton Branch, Porter Creek, Brushy Creek, Upper Brushy Creek, and Elm Creek. For the purpose of this analysis, the downstream limit of the watershed is at the confluence of Plum Creek and Elm Creek. Also shown on Figure 1-2 is the location of existing wastewater outfalls. Table 4.1 presents a summary of the existing wastewater facilities including size, effluent permit limits, and current status.

An important point from a water quality perspective is that the study area is at the upper end of the Plum Creek watershed, and all of the contributing subwatersheds are too small to have a sustained flow. All are intermittent streams and do not appear to have naturally occurring perennial pools that would indicate support of aquatic life uses, as defined by the Texas Commission on Environmental Quality (TCEQ). This is potentially important because streams that do not support aquatic life uses have lower or less demanding water quality criteria and typically do not require as high a level of wastewater treatment as discharges to streams that do support aquatic life uses. Lower treatment requirements can translate into easier permitting. On the other hand, the man-made reservoirs that have been constructed (see below) may be interpreted as perennial pools.

To facilitate a comparison of the subwatersheds, Table 4.2 presents the characteristics of each. The data include watershed area, length and average slope of the main stream, land use/land cover, vegetation, number of ponds, number of wastewater outfalls and permitted discharge flow rate, and CCN areas. The land use/land cover and vegetation data are somewhat dated. Each subwatershed is shown to consist largely of cropland and pasture. A more recent land use characterization would probably indicate the bulk of the land is in pasture rather than cropland, with a higher percentage of residential use.

One significant difference among the subwatersheds is that Bunton Branch and Elm Creek currently have no wastewater discharges. One component of wastewater planning will be to avoid discharge to these

TABLE 4.1
OUTFALL INFORMATION

Permit #	Name	Facility category	Permit limits ¹								Outfall status ¹	Permit status ²
			Flow (MGD)	CBOD5 (mg/L)	NH3-N (mg/L)	DO (mg/L)	min pH (SU)	max pH (SU)	TSS (mg/L)	TP (mg/L)		
11041	City of Kyle	Municipal	1.5	10	3	5	6	9	15		Active	Issued
11060	City of Buda	Municipal	0.6	10	3	4	6	9	15	2	Active	Amending (major)
13293	Aquasource Utility Inc	Municipal	0.0424	10	3	4	6	9	15		Active	Renewing
14060	Aus-Tex Parts & Services Ltd	Municipal	0.0225	10		2	6	9	15		Active	Issued
14094	Sweetwater Utility LLC	Municipal	0.026	20	2	2	6	9	20		Inactive	Issued
14165	Railyard GP LLC	Municipal	0.08	10		2	6	9	15		Inactive	Renewing
14377	Athena Equity Partners Hays LP and GBRA ³	Municipal	0.25 ⁵	5	2	4	6	9	5	1	Inactive	Issued
14439	Uhland 405 Partners LP ⁴	Municipal	0.7									New, not yet issued

¹ From EPA Permit Compliance System (PCS) Database, as of 9/30/04.

² From TCEQ web site for Industrial and Municipal Wastewater Permit Applications Query, as of 9/30/04.

³ Proposed Winfield Plant.

⁴ No data in EPA PCS for this discharger.

⁵ Initial phase. Final phase 0.99 mgd.

TABLE 4.2
SUBWATERSHED CHARACTERISTICS

	Plum Creek	Bunton Branch	Porter Creek	Brushy Creek	Upper Brushy Creek	Elm Creek
Watershed area (sq. miles)	33.7	8.2	11.4	12.6	12.9	34.2
Main stream length (miles)	22.4	11.5	15.4	12.7	8.8	13.7
Main stream average slope	0.0034	0.0031	0.0023	0.0033	0.0019	0.0042
Land Use/Land Cover ¹						
Commercial Services	0.4%	0.2%				
Cropland and Pasture	94.0%	93.2%	94.1%	90.5%	95.4%	83.8%
Deciduous Forest Land	0.5%					
Herbaceous Rangeland				0.0%		0.5%
Mixed Rangeland	1.2%	0.2%				3.1%
Reservoirs	0.4%	0.6%	0.8%	0.9%	2.1%	0.7%
Residential	1.9%	0.6%	0.9%	1.7%	1.9%	1.1%
Shrub and Brush Rangeland	0.8%				0.6%	10.7%
Strip Mines, Quarries, and Gravel Pits		3.7%	0.0%			
Transitional Areas			2.4%	6.9%		
Transportation, Communications	1.0%	1.5%	1.7%			0.0%
Vegetation ²						
Crops	67.4%	9.6%	0.3%	21.5%	25.1%	92.9%
Live Oak Ash-Juniper Wood	1.6%	3.2%				
Live Oak Mesquite Ash Juniper Parks		11.0%	1.0%			
Post Oak Woodland Forest Grassland						0.0%
Post-Oak Woods Forest						0.5%
Other (Pasture)	31.0%	76.2%	98.7%	78.5%	74.9%	6.6%
Number of ponds ³	7	1	1	1	3	4
Wastewater treatment plants						
Outfall	11041-002		11060-001	13293-001 14060-001 14165-001 ⁴	14377-001 ⁴ 14094-001 ⁴	
Total permitted discharge ⁵ (MGD)	1.5	0	0.6	0.145	0.276	0
CCN-Water ⁶ (sq. miles)	18.5	7.1	11.4	9.5	11.9	7.7
CCN-Wastewater ⁶ (sq. miles)	13.6	6.4	0.7	3.2	4.9	7.9

¹ Data publication date is 1990. Data collected in 70s or 80s.

² Data acquired between 1972 and 1976.

³ Ponds managed by Plum Creek Conservation District.

⁴ Inactive.

⁵ From EPA Permit Compliance System Database.

⁶ In Hays County.

streams. Although the Bunton Branch subwatershed would see a substantial increase in population, this population could be served by one or more WWTPs that discharged into an adjacent subwatershed.

Another salient feature of the subwatersheds in the study area is the reservoirs, frequently referred to as ponds. Reservoirs or ponds are potentially important because they can exhibit adverse reactions to wastewater discharges more easily than open stream reaches. It is possible that TCEQ will interpret these structures as perennial pools. If that is done, the receiving streams would be afforded higher dissolved oxygen (DO) criteria, and the ponds themselves might be viewed as lakes, with still higher DO criteria. Figure 4-1 shows the locations of 17 ponds constructed under the auspices of the U.S. Soil Conservation Service (now Natural Resource Conservation Service [NRCS]) and private landowners mainly during the 1950s and 1960s. This was during a time when most of the study area was being farmed. Details of the ponds are shown on Table 4.3. The pond numbering system was assigned by the Plum Creek Conservation Association, which supplied the data on the ponds. Ponds 9, 13, and 19 are either outside of the study area or were not constructed.

The ponds shown were constructed to serve both flood detention and soil retention functions. They vary in size substantially. The smallest pond watershed is only 0.87 square mile, while the largest, #14, drains over 15 square miles. These ponds are designed to impound a substantial volume of water during heavy rains and release it slowly following the rains. There are two surface areas listed for the ponds in Table 4.3. These are illustrated in Figure 4-2. One is the area of the sediment pool. This is the pond area at the elevation of the top of the standpipe or riser that drains water from the floodwater pool. The area of the floodwater pool area is substantially larger than the sediment pool. Typically water is retained in the sediment pool, but during prolonged dry periods this part of the pool can go dry unless there is some other source of water, such as a spring or wastewater discharge.

Another dimension that needs to be recognized with the ponds is the location of the upstream boundary. As can be seen, these ponds are designed to vary in size with the amount of runoff flow. The boundary between the stream and lake would be the boundary between stream and lake DO criteria. Establishing this boundary can be a technical challenge. If they are considered to be lakes, the higher DO criteria that apply can make it more difficult for a wastewater discharger to demonstrate attainment of DO criteria in the stream leading to the “lake.”

The above discussion is not intended to suggest that the ponds are water quality problems, but rather to alert the reader to potential issues that may arise in the water quality analysis process. The ponds were built as flood control and sediment retention structures, but may ultimately be viewed as environmental enhancements that need to be protected. The analysis of water quality effects that follows is designed to treat all the ponds in an equal fashion, without getting into the details of possible permit hearing situations. But the reader should be aware that the permitting process can produce some surprises when rules designed for rivers and lakes are applied to smaller intermittent streams and ponds.

TABLE 4.3
STRUCTURE DATA – FLOODWATER RETARDING STRUCTURES
Plum Creek Watershed, Texas
(Data provided by Plum Creek Conservation District)

Item	Unit	1	2	3	4	5	6	7	8	10	11	12	14	15	16	17	18	20
Drainage Area	Sq. Mi.	2.14	2.81	0.48	0.87	6.17	8.40	0.77	2.07	1.89	3.86	1/ 3.62	1/15.11	1.50	5.05	8.56	2.53	1.95
Storage Capacity																		
Sediment Pool (200 AC. or Less)	Ac. Ft.	91	199	64	93	197	197	86	166	181	200	199	193	112	199	196	198	166
Sediment Reserve Below Riser	Ac. Ft.	0	41	0	0	230	833	0	0	0	47	187	1,177	0	232	580	31	0
Sediment in Detention Pool	Ac. Ft.	12	30	8	9	66	90	12	22	20	41	58	161	16	54	91	27	21
Floodwater	Ac. Ft.	885	764	154	267	1,777	2,643	243	596	575	1,132	1,139	4,206	448	1,845	2,552	769	593
Total	Ac. Ft.	988	1,034	226	369	2,270	3,763	341	784	776	1,420	1,583	5,737	576	2,330	3,419	1,025	780
Surface Area																		
Sediment Pool <u>2/</u>	Acre	27	43	11	12	71	167	11	22	34	48	89	177	15	73	152	44	26
Floodwater Pool	Acre	106	120	32	32	197	355	32	63	96	136	228	435	43	229	375	120	70
Volume of Fill	Cu. Yd.	205,400	147,400	43,500	78,200	177,200	241,400	83,300	140,500	95,500	150,400	105,600	319,000	124,600	226,600	95,200	116,900	122,400
Elevation Top of Dam	Foot	763.7	662.7	662.6	621.0	668.0	642.6	606.3	561.9	685.6	645.9	619.8	541.0	515.6	558.8	548.9	540.4	493.3
Principal Spillway Elevation	Foot	744.6	647.6	652.2	602.8	644.7	620.0	590.6	541.3	671.9	626.4	604.7	510.8	494.0	537.0	527.9	524.7	474.9
Maximum Height of Dam	Foot	32	35	25	37	33	36	35	41	34	33	27	42	46	50	32	35	34
Emergency Spillway																		
Crest Elevation	Foot	758.5	658.5	660.0	617.0	663.0	638.5	603.0	557.0	681.0	641.0	615.0	536.0	511.0	554.0	544.0	535.5	488.5
Bottom Width	Foot	150	150	100	80	310	350	100	110	100	220	400	750	120	450	340	140	120
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use <u>3/</u>	-	1.27	3.33	2.50	2.77	2.88	2.33	2.63	3.03	3.13	3.24	2.82	3.39	3.31	1.85	3.03	3.08	2.94
Average Curve No. - Condition II		81	81	81	81	82	81	81	81	81	81	81	81	83	83	83	83	83
Emergency Spillway Hydrograph																		
Storm Rainfall (6-Hour) <u>4/</u>	Inch	10.97	7.25	7.64	7.53	6.97	6.84	7.65	7.33	7.35	7.14	6.28	6.54	7.42	10.58	6.83	7.27	7.35
Storm Runoff	Inch	8.58	5.04	5.40	5.30	4.88	4.65	5.33	5.11	5.12	4.94	4.14	4.38	5.42	8.46	4.87	5.28	5.36
Velocity of Flow (Vc) <u>5/</u>	Ft. / Sec.	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	0.0	1.3	1.8	2.5	1.2	1.3	1.1
Discharge Rate <u>6/</u>	c.f.s.	218	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138	326	0.0	1,047	280	1,999	415	196	92
Maximum Water Surface Elev. <u>6/</u>	Foot	759.6	-	-	-	-	-	-	-	681.9	642.0	-	537.1	512.3	555.8	545.0	536.6	489.2
Freeboard Hydrograph																		
Storm Rainfall (6-Hour) <u>7/</u>	Inch	25.24	17.75	18.72	18.45	17.08	16.76	18.52	17.96	18.00	17.49	15.39	15.39	18.17	24.34	16.72	17.81	18.00
Storm Runoff	Inch	22.45	15.21	16.17	15.91	15.00	14.23	15.97	15.42	15.46	14.95	12.88	12.88	15.92	21.55	14.49	15.57	15.75
Velocity of Flow (Vc) <u>8/</u>	Ft. / Sec.	9.7	8.6	6.5	8.4	9.4	8.4	7.5	9.5	9.2	9.4	8.9	9.2	9.2	9.3	9.3	9.3	9.3
Discharge Rate <u>6/</u>	c.f.s.	4,423	3,065	847	1,520	8,093	6,421	1,405	2,950	2,478	5,816	8,990	18,747	3,000	11,110	8,755	3,604	3,082
Maximum Water Surface Elev. <u>6/</u>	Foot	763.7	662.7	662.6	621.0	668.0	642.6	606.3	561.9	685.6	645.9	619.8	541.0	515.6	558.8	548.9	540.4	493.3
Principal Spillway																		
Capacity - (Maximum)	c.f.s.	27	35	8	11	77	104	10	26	12	24	59	153	10	41	55	16	18
Capacity Equivalents																		
Sediment Volume (200 Ac. or Less)	Inch	0.80	1.33	2.50	2.00	0.60	0.44	2.10	1.50	1.80	0.97	1.03	0.24	1.40	0.74	0.43	1.47	1.60
Sediment Reserve Below Riser	Inch	xx	0.27	xx	xx	0.70	1.86	xx	xx	xx	0.23	0.97	1.46	xx	0.86	1.27	0.23	xx
Sediment in Detention Pool	Inch	0.10	0.20	0.30	0.20	0.20	0.20	0.30	0.20	0.20	0.20	0.30	0.20	0.20	0.20	0.20	0.20	0.20
Detention Volume	Inch	7.75	5.10	6.03	5.75	5.40	5.90	5.40	5.90	5.40	5.70	5.50	5.22	5.60	6.85	5.59	5.70	5.70
Spillway Storage	Inch	5.60	3.90	3.77	3.15	3.34	3.70	2.85	2.25	5.05	3.90	6.95	2.88	2.80	4.80	4.56	5.00	3.50
Class of Structure	-	B	A	A	A	A	A	A	A	A	A	A	A	A	B	A	A	A

1/ Excluding the area from which runoff is controlled by other structures.

2/ Surface area to the top of the riser.

3/ Is the percent chance that the emergency spillway will function in any given year.

4/ For Class A structures 0.5 x P of the 6-hour rainfall shown by figure 3.21 - 1, NEH-4, Supplement A, and 0.75 x P for Class B structures.

5/ Where velocity is shown it was obtained from the formula $V = Q/A$ and was determined from the routed Hp and Q. Critical velocity was not attained by outflow of the emergency spillway hydrographs.

6/ Values obtained from routing.

7/ For Class A structures 1.23 x P, Class B structures 1.73 x P, for 6-hour rainfall shown on figure 3.21-1, NEH, Sec. 4, Suppl. A.

8/ Obtained from curves drawn from figure 4-R-11472 revised 3/59 and ES 98 dated 4-27-55, based on flows obtained from graphical routing of Freeboard Hydrograph

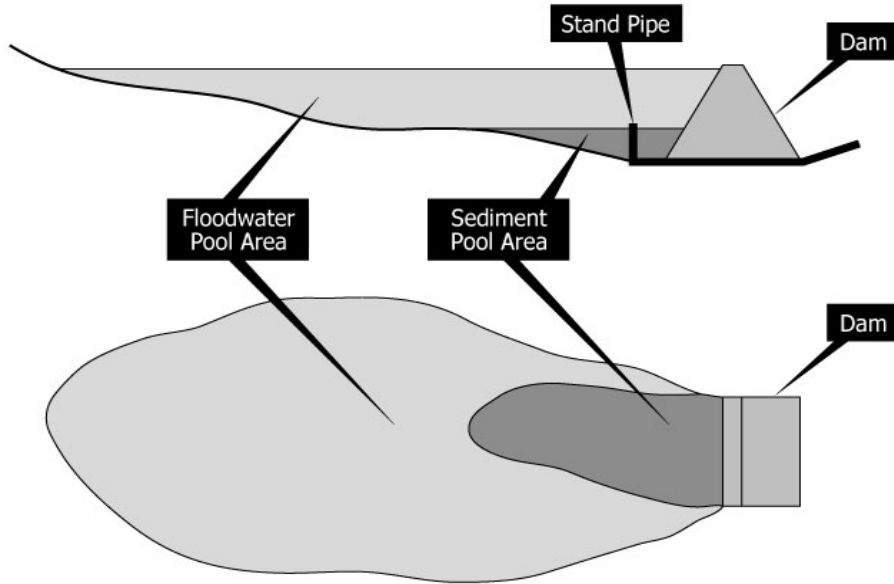


Figure 4-2: Schematic of Ponds in Study Area

4.2 ALTERNATIVE DESCRIPTIONS

As noted at the beginning of the section, three alternatives are considered in this wastewater facilities planning study, no-action, two larger regional facilities, and five smaller regional facilities that emphasize wastewater reuse. A critical element of the wastewater analysis is wastewater reuse, and how this can best be encouraged. One reason for the emphasis on reuse is the overall shortage of water in the planning area and the need to conserve. A second reason is that to the extent that wastewater is reused, it is not discharged and thus has less water quality impact.

Table 4.4 summarizes the population growth and wastewater flows for each scenario. In each scenario the population growth and increase in wastewater flow is the same. The scenarios differ in the amount of wastewater handled by OSSFs and in the amount of reuse. Details of these aspects are discussed under each scenario.

The traditional way to evaluate water quality effects of wastewater discharge alternatives is to use the QUAL-TX model. It is designed to simulate steady-state DO concentrations downstream of proposed discharges under critical (low flow, warm weather) conditions. QUAL-TX simulation results are typically employed in determining needed wastewater permit limits. This is not done for this study because with the level of wastewater treatment typical today, there would be no problem meeting the DO criterion for intermittent streams in the study area. Even with the no-action scenario it is unlikely that a permit applicant would propose a treatment level that would not meet the 2 mg/L criterion for an intermittent stream.

TABLE 4.4
WASTEWATER FLOW ANALYSIS FOR PROJECTED POPULATION GROWTH FROM 2000 TO 2030

Plant ¹	Population increase in service area	Estimated Increase in Annual Ave WW Flow (gpd)	Estimated Annual Average OSSF Flow (gpd)	Estimated Annual Average Reuse (gpd)	Estimated Annual Average Plant Discharge (gpd)	Estimated Jun-Sep Average Reuse (gpd)	Estimated Jun-Sep Average Plant Discharge (gpd)	Receiving Pond
No-Action								
A	3,632	290,560	24,280	0	266,280	0	266,280	10
B	4,755	380,400	190,200	0	190,200	0	190,200	12
C	3,258	260,640	78,192	0	182,448	0	182,448	
D	3,258	260,640	78,192	0	182,448	0	182,448	
E	4,243	339,440	167,708	0	171,732	0	171,732	6
F	2,176	202,600	60,780	0	141,820	0	141,820	
G	2,176	202,600	60,780	0	141,820	0	141,820	
H	2,497	199,760	59,928	0	139,832	0	139,832	6
I	2,515	201,160	68,394	0	132,766	0	132,766	5
J	2,515	201,160	68,394	0	132,766	0	132,766	5
K	2,557	204,560	61,368	0	143,192	0	143,192	
L	2,542	203,360	113,360	0	90,000	0	90,000	16
M	2,504	200,320	60,096	0	140,224	0	140,224	5
N	2,416	193,280	77,312	0	115,968	0	115,968	
O	2,159	172,720	86,360	0	86,360	0	86,360	
P	1,046	83,680	41,840	0	41,840	0	41,840	
Buda	1,533	122,640	0	0	122,640	0	122,640	6
Total	45,781	3,719,520	1,297,185	0	2,422,335	0	2,422,335	
Regional Plants								
Winfield	14,472	1,157,760	407,172	116,341	634,247	262,706	487,882	10
Kyle	29,776	2,439,120	701,695	269,301	1,468,124	608,099	1,129,326	
Buda	1,533	122,640	0	19,009	103,631	42,924	79,716	6
Total	45,781	3,719,520	1,108,867	404,651	2,206,002	913,728	1,696,924	
Multiple Plants								
Winfield	9,044	723,502	94,470	195,000	434,031	440,322	188,709	10
Buda	1,533	122,640	0	38,018	84,622	85,848	36,792	6
Porter	10,375	829,983	248,995	189,094	391,894	406,692	174,296	
Kyle	19,082	1,583,635	79,182	466,381	1,038,073	1,053,117	451,336	
Uhland	2,524	201,920	66,416	42,006	93,498	94,853	40,651	
Sweetwater	3,223	257,840	83,192	54,141	120,507	122,254	52,394	14
Total	45,781	3,719,520	572,255	984,640	2,162,625	2,203,085	944,179	

¹ Refer to Tables 3.4, 3.6 and 3.8 for TSZ served.

The water quality issues that are much more likely to occur are with the ponds. While QUAL-TX could be used to simulate ponds, it is not designed for that use and a great deal of site-specific data that are not available would be needed. To evaluate the effect of the wastewater discharges on the ponds, the BATHTUB model, designed specifically for lakes, is employed. In the following sections, each of the three alternatives is discussed in more detail, followed by a discussion of the modeling and results.

4.2.1 No-Action

If no wastewater facility planning action is taken, it is still reasonable to expect continued growth in the study area in a similar fashion to recent developments. The characteristics of this development would include:

- More 1-acre lots with OSSFs,
- Where smaller lots are needed, wastewater provided by private or special district plants,
- Existing permitted facilities given moderate usage.

The exact percentages of these two methods of wastewater service are not easily predictable, but in the absence of planning, the same percentages that currently exist can be expected to continue. That is the basis of the estimates made in Section 3.0 and shown in Table 4.4.

With relatively large lots and proper enforcement of reasonable installation regulations, OSSFs can function well to protect surface water quality, at least in the short run. At some time, failures can be expected due to age and lack of maintenance. But perhaps the bigger negative aspects of large-scale OSSF use are the lost opportunities for beneficial reuse. These lost opportunities translate to greater water demands for the same population, and greater overall water supply costs.

The other dimension to the “No-Action” scenario is more subdivision-specific wastewater facilities. With no management by an established governmental unit with an overall interest in water quality, such facilities can be expected to have a measure of operational problems. Like OSSF developments, there would be no impetus to require such facilities to supply high quality (Type I) effluent for reuse. The lost reuse opportunity will translate to greater water demands for the same population and greater water supply costs. Finally, these smaller facilities will tend to have a somewhat larger impact on receiving streams and ponds because they would typically not have as high a level of treatment as would be required for reuse. In Section 3.0, it was assumed that most of these facilities would be permitted at the 10-15-2 level (10 mg/L CBOD₅, 15 mg/L TSS, 2 mg/L NH₃-N), rather than the more stringent level that might apply to planned facilities. Exceptions include the already permitted facilities that have more stringent permitting limits. Also, they would be discharging in dry conditions when their effect of changing the stream is greatest. As noted earlier, all of the streams in the study area are normally dry in dry weather, so the addition of water at that time would cause a significant ecological change.

The estimated increases in wastewater flow due to the projected population growth are shown in Table 4.4. As discussed above, part of this wastewater will be treated by OSSFs and the other part by

existing permitted plants, private or special district plants. Note that the numbers for the Buda Plant refer to the population and wastewater increases within the planning area. A significant part of the Buda Plant service area is outside the planning area. Plans exist to reuse a substantial portion of the existing Buda effluent.

Table 4.4 also shows the ponds that would receive wastewater, the annual average flow and the average flow from June to September. In the No-Action alternative, no reuse was assumed. Therefore, the average flow from June to September is the same as the annual average flow.

4.2.2 Regional Plants

For many years the state environmental agency has encouraged larger regional wastewater treatment facilities, based on achieving a higher level of treatment and reliability with larger plants than smaller, frequently privately (or special district) owned and operated facilities.

To implement this historic policy in the study area, Section 3 describes two WWTPs being the large regional providers. One is assumed to be the Kyle WWTP (Permit 11041-002) at the southwest end of the area and the other the Winfield plant (Permit 14377-001) at the northeast end of the area. The increases in wastewater flow due to the projected population growth are shown in Table 4.4. The amount of OSSF flow is expected to be less than in the No-Action scenario. Some of the wastewater flow may be used for irrigation and/or supplies to users such as the cement facility in Buda. The estimated increases in annual average wastewater discharge for the Winfield Plant and Kyle Plant are 0.63 and 1.47 MGD, respectively. In summer, the reuse rate is higher so that the wastewater discharges are less. While the annual average discharge is only a small percentage less than with the No-Action scenario, the summer discharge would be 70 percent of the No-Action amount.

To achieve reuse, these facilities are assumed to be treated to a higher level (5-5-2-1, with the 1 referring to 1 mg/L of Total Phosphorus [TP]) and have no problem meeting water quality criteria for intermittent streams (DO criterion of 2 mg/L). However, the continuous discharge from Winfield would flow downstream until it reached Pond 10. In this case, the effect on the pond may be important. The Kyle Plant discharges to Plum Creek and there is no pond on the creek downstream in the study area.

4.2.3 Multiple Plants

This alternative would provide wastewater service to the same area, but instead of pumping the sewage to one of two larger regional plants, the flow would be treated with five smaller regional plants located in closer proximity to the developments. These plants were located as shown in Figure 3-10. They are distributed along the high growth corridors, with the restriction that no facility would discharge to Bunton Branch. As with the regional plants, public ownership and operation would be essential. Also, the level of treatment, the concentration limits in the permits, would be the same as for the larger regional plant alternative.

The main feature distinguishing this alternative is that most of the effluent (estimated to be about 31 percent annually) would be reused, primarily to replace potable water for irrigation, during dry weather in the growing season. The summer wastewater discharge would be only 39 percent of that with the No-Action scenario. While the summer discharge is lower, during wet or colder weather, when there was little irrigation demand, the plants would have to discharge all or most of their effluent, unless an industrial reuse was obtained where seasonal fluctuations are minimal. The effect of this discharge would be reduced because it would be diluted by runoff flows and because the cooler conditions would tend to not support excessive algal growth.

4.3 BATHTUB MODEL DESCRIPTION AND DATA DEVELOPMENT

BATHTUB is a steady-state empirical model developed by the Environmental Research and Development Center (ERDC), formerly Waterways Experiment Station (WES) of the U.S. Army Corps of Engineers (USACE) for eutrophication modeling of lakes and reservoirs. The program performs water and nutrient balance calculations in a spatially segmented hydraulic network that accounts for advective and diffusive transport, and nutrient sedimentation. Lake processes, such as nutrient sedimentation and algal response to flushing, light, and nutrient concentrations are modeled with statistical relationships developed from data of the USACE reservoirs.

The statistical relationships could be adjusted to suit local conditions. Since there are no observed water quality data of the ponds for calibration, the default statistical relationships and parameters provided in BATHTUB were used in this study. As such, the results should be useful for comparing relative changes of water quality parameters between scenarios, but are not intended for accurate prediction of their actual concentrations. The morphometry of the ponds were based on the data in Table 4.3. The ponds were assumed to be at the level of the risers.

4.3.1 Inflows

Simulations were performed for an average year and a dry period (June to September). For the water balance, BATHTUB requires inputs of precipitation, evaporation, and tributary inflows. TWDB provides lake evaporation and precipitation rates for each one-degree quadrangle in Texas. Most of the study area is located in QUAD 710. Monthly precipitations are available from 1940 to 2002 and monthly evaporations are available from 1954 to 2002. Table 4.5 shows the average monthly evaporation and precipitation values.

The tributary inflow to a pond was estimated from the U.S. Geological Survey (USGS) daily flow record at gage 08172400 (Plum Creek at Lockhart) based on the ratio of the pond drainage area to the gage drainage area. The drainage area of this gage is 112 square miles and includes the study area. Therefore, the flow record should be representative of the hydrology of the study area. Data from May 1, 1959 to September 30, 2003 are available on the USGS web site. More recent data are also available but are provisional and therefore not used. The record obtained is already sufficient for our purpose. Table 4.6

TABLE 4.5
AVERAGE MONTHLY PRECIPITATION AND EVAPORATION

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Precipitation, 1940-2002 (in)	2.05	2.41	2.12	3.01	4.04	3.28	1.84	2.18	3.30	3.45	2.69	2.46	32.84
Evaporation, 1954-2002 (in)	2.09	2.47	3.70	4.36	4.60	6.10	7.51	6.92	5.35	4.42	2.98	2.20	52.69

Source: TWDB, <http://hyper20.twdb.state.tx.us/Evaporation/evap.html>

TABLE 4.6
SUMMARY OF FLOW DATA AT USGS GAGE 08172400, PLUM CREEK AT LOCKHART

	Annual volume (ac-ft/yr)	Number of days without flow	Avg flow (cfs) (based on number of days in the year)	Avg flow (cfs) (based on number of days with flow)
1960	78,783	36	108.5	120.4
1961	38,079	55	52.6	61.9
1962	8,222	128	11.4	17.5
1963	4,161	240	5.7	16.8
1964	5,753	278	7.9	33.0
1965	54,027	129	74.6	115.4
1966	10,084	125	13.9	21.2
1967	12,282	198	17.0	37.1
1968	48,874	102	67.3	93.3
1969	39,061	121	54.0	80.7
1970	40,738	161	56.3	100.7
1971	2,019	307	2.8	17.6
1972	3,356	209	4.6	10.8
1973	53,560	20	74.0	78.3
1974	76,569	39	105.8	118.4
1975	78,762	28	108.8	117.8
1976	81,813	32	112.7	123.5
1977	30,152	172	41.6	78.8
1978	3,513	235	4.9	13.6
1979	33,607	158	46.4	81.9
1980	9,490	261	13.1	45.6
1981	62,026	119	85.7	127.1
1982	18,463	132	25.5	40.0
1983	27,071	57	37.4	44.3
1984	934	235	1.3	3.6
1985	73,984	68	102.2	125.6
1986	45,916	63	63.4	76.7
1987	62,571	115	86.4	126.2
1988	730	201	1.0	2.2
1989	4,187	322	5.8	49.1
1990	571	321	0.8	6.5
1991	69,751	152	96.3	165.1
1992	135,659	157	186.9	327.2
1993	16,698	182	23.1	46.0
1994	12,782	228	17.7	47.0
1995	30,156	172	41.7	78.8
1996	1,548	300	2.1	11.8
1997	52,562	79	72.6	92.7
1998	124,209	135	171.6	272.3
1999	2,352	189	3.2	6.7
2000	14,281	268	19.7	73.5
2001	38,681	98	53.4	73.0
2002	46,595	65	64.4	78.3

presents a summary of the flow data. It is evident from the data that the creek is dry for a significant amount of time.

Since the USGS gage is downstream of the Kyle Plant, a question arose whether the plant discharge had changed the natural flow pattern significantly. Figure 4-3 shows the 10th, 25th, 50th and 75th percentiles of flow for each year for the period of record. The Kyle Plant discharge became significant since the 1990s but the flow pattern does not seem to have changed significantly since the 1990.

Table 4.7 shows various percentiles of the annual flow volumes. For the average year, the median (50th percentile) was used to estimate the tributary inflow to a pond. For the dry period, the flow volumes from June to September were analyzed. A value of 2,500 acre-feet was used that was about the 52nd percentile of the yearly June to September flow volume. The median was not used in this case because the median flow was not enough and one of the ponds went dry in the simulation.

4.3.2 Phosphorus Concentrations

Another input required for BATHTUB is the TP concentration of the inflows. Figure 4-4 shows the variation of TP concentration with flow at the Plum Creek sampling station at Plum Creek Road. The data were obtained from the TCEQ Surface Water Quality Monitoring data web site. At low flows, the TP concentration at this location is likely to be significantly influenced by the Kyle plant discharge. However, at higher flows the concentration should reflect phosphorus loading from the watershed. The average TP concentration of the data at flows above 4 cubic feet per second (cfs) is 0.37 mg/L. This value was used as the tributary inflow concentration in BATHTUB.

The TP concentration in effluent was assumed to be 2 mg/L in the No-Action scenario. A higher treatment level was assumed for the planned facilities in the other two scenarios, with 1 mg/L TP used in the modeling, except for the Kyle effluent. Currently, the City of Kyle permit requires 10-15-3, with no TP limit. The choice of limits is not a factor in this evaluation because there are no ponds in the study area downstream of Kyle. The TCEQ has employed a QUAL-TX model on the Kyle permit, and would undoubtedly employ the same model to evaluate higher flows that might be needed in the future, particularly if the larger regional scenario is implemented.

4.4 EFFECTS ANALYSIS WITH BATHTUB

As shown in Table 4.4, the ponds that would receive discharges are Ponds 5, 6, 10, 12, 14, and 16. Pond 6 receives discharge from the Buda Plant. However, a significant portion of the service area of the Buda Plant is not within the study area. The projected wastewater flow for Buda in Table 4.4 is only for those areas within the study limits. Therefore, Pond 6 is not modeled. Ponds 10, 12, and 14 are all on Brushy Creek and are modeled in series in BATHTUB.

FIGURE 4-3
ANNUAL FLOW PERCENTILES AT USGS GAGE 08172400, PLUM CREEK AT LOCKHART

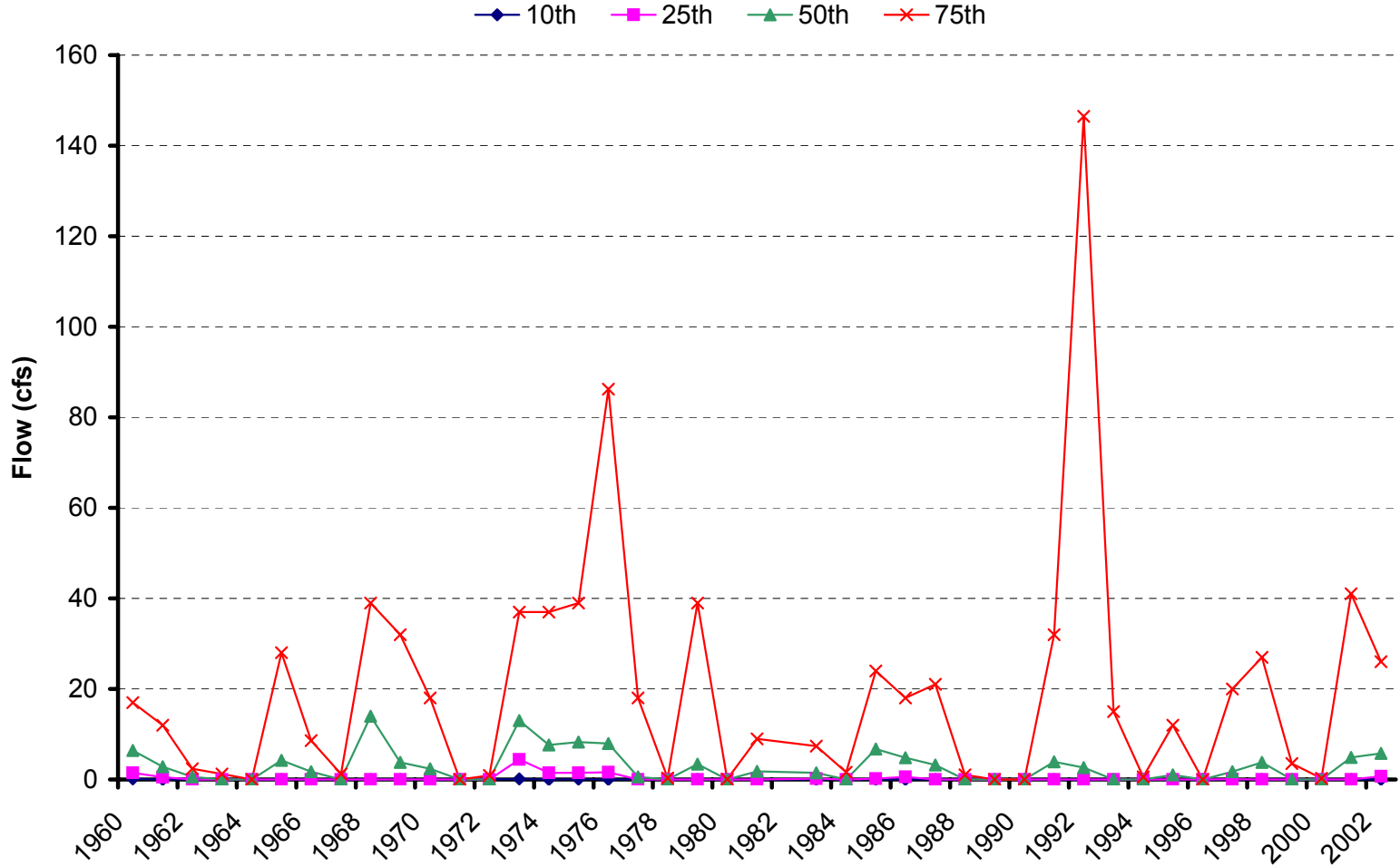
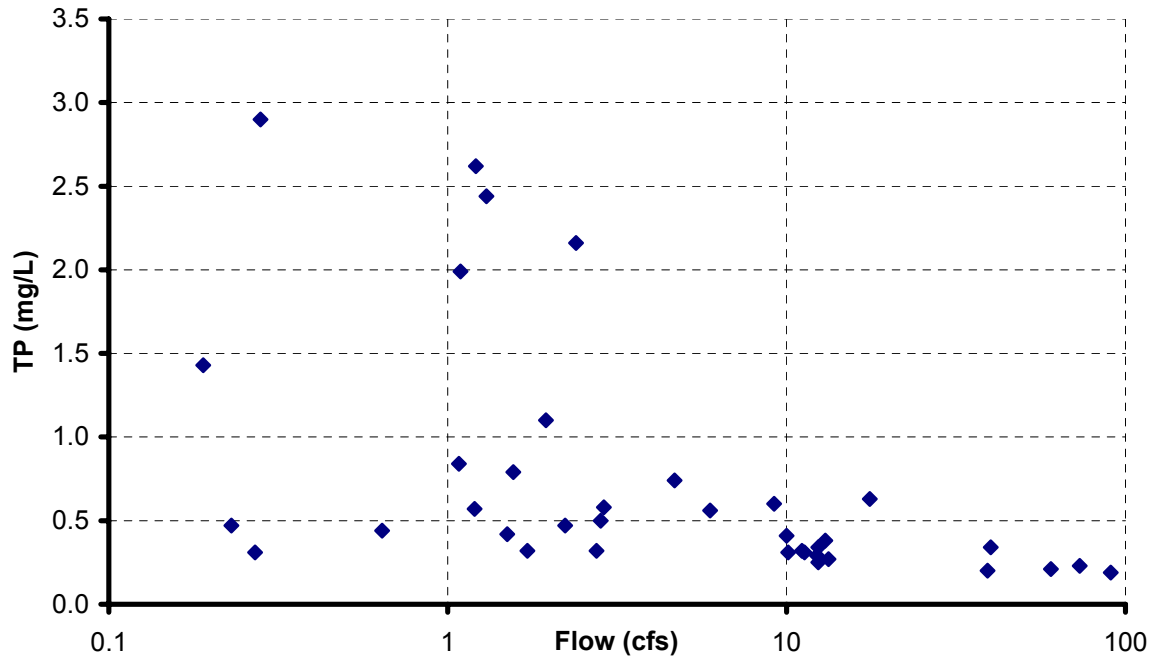


TABLE 4.7
PERCENTILE OF ANNUAL FLOW VOLUME (ACRE-FEET) AT USGS GAGE 08172400, PLUM CREEK AT LOCKHART

10%	20%	25%	30%	40%	50%	60%	70%	75%	80%	90%	100%
2,086	4,172	6,988	9,846	16,215	30,156	39,396	50,349	53,793	62,353	78,323	135,659

FIGURE 4-4
RELATIONSHIP BETWEEN FLOW AND TP,
PLUM CREEK AT PLUM CREEK ROAD



The model inputs of wastewater flows to the ponds are the flows generated by the projected population growth between 2000 and 2030. The wastewater due to the existing population is not included because of uncertainties such as whether the existing population would continue to be served by OSSFs, or by a facility not discharging to the pond under consideration. Moreover, the existing population is a relatively small portion of the projected 2030 population.

Results of the BATHTUB modeling are shown in Tables 4.8 and 4.9 for the average year and dry period simulation respectively. The dry period results in Table 4.9 have higher TP and chlorophyll *a* concentrations than the average condition results because the wastewater inputs are a higher proportion of the runoff inflows. In most cases, the TP and chlorophyll *a* concentrations are highest and Secchi depths are lowest in the No-Action scenario. However, except for Pond 5 and Pond 12, the differences are small. The regional and smaller plants scenarios have essentially the same results. Tables 4.10 and 4.11 show the phosphorus loads for the average year and dry period, respectively. The model results of the three alternatives are similar to no-action for a number of reasons. In some cases (e.g., Pond 14), the runoff is a significant factor in determining the pond water quality. The ponds receive runoff from pasture land that data suggest has a substantial amount of TP. The wastewater flows for the different scenarios are not radically different and are a small part of the total TP loads for the affected ponds. For Pond 16 in dry condition, the phosphorus load in the No-Action scenario is more than double the load in the regional or smaller plant scenarios. However, the wastewater flow has also somewhat offset the concentrating effect of evaporation. As a result, the TP and chlorophyll *a* concentrations in the No-Action scenario are the same as the other scenarios. Another reason for similar results between scenarios is the nonlinear relationship between TP and chlorophyll *a* concentrations. At high level of TP, the chlorophyll *a* concentration tends to become light limited and is less responsive to changes in TP concentration.

The results for Pond 5 provides some support to the wastewater planning goal of avoiding discharge to Bunton Branch. With the No-Action scenario, there would be wastewater discharges to Bunton Branch. The planned facilities that avoid Bunton Branch result in Pond 5 having lower chlorophyll *a* concentrations.

4.5 CONCLUSIONS OF EFFECTS ANALYSIS

From the standpoint of effects on ponds in the study area, the No-Action scenario appears to be the least desirable, as it produces higher chlorophyll *a* concentrations in the ponds and more ponds would be impacted. The difference between the two regional and five smaller plant scenarios is small due to reasons discussed above or the fact that the loads are not radically different.

Despite the fact that the differences shown with BATHTUB are small, it is reasonable to expect that there would be differences. The smaller multiple plants should be able to accommodate more reuse than the two larger regional, larger plants, simply because pumping distances and costs would be less. Greater wastewater reuse means smaller wastewater discharge, which presumably would reduce impact to the

TABLE 4.8
BATHTUB MODELING RESULTS (AVERAGE CONDITION)

Pond	No-Action			Regional Plants			Multiple Plants		
	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	Secchi depth (m)	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	Secchi depth (m)	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	Secchi depth (m)
5	199	74	0.52	131	63	0.61	131	63	0.61
10	254	91	0.42	253	91	0.42	223	87	0.44
12	183	93	0.42	138	79	0.49	131	76	0.50
14	127	53	0.72	123	52	0.73	128	53	0.72
16	152	69	0.56	129	63	0.60	129	63	0.60

TABLE 4.9
BATHTUB MODELING RESULTS (DRY CONDITION)

Pond	No-Action			Regional Plants			Multiple Plants		
	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	Secchi depth (m)	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	Secchi depth (m)	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	Secchi depth (m)
5	277	87	0.44	199	80	0.48	199	80	0.48
10	540	113	0.34	449	110	0.35	394	107	0.36
12	384	127	0.31	247	110	0.35	245	110	0.35
14	179	63	0.60	165	61	0.62	204	66	0.58
16	283	90	0.43	283	91	0.43	283	91	0.43

710013/050017

TABLE 4.10
PHOSPHORUS LOADS (AVERAGE CONDITION)

Pond	No-Action			Regional Plants			Multiple Plants		
	Background (kg/yr)	Upstream pond (kg/yr)	WW (kg/yr)	Background (kg/yr)	Upstream pond (kg/yr)	WW (kg/yr)	Background (kg/yr)	Upstream pond (kg/yr)	WW (kg/yr)
5	759	0	1,120	759	0	0	759	0	0
10	233	0	736	233	0	876	233	0	600
12	444	236	526	444	364	0	444	259	0
14	1,857	403	0	1,857	338	0	1,857	285	167
16	622	0	248	622	0	0	622	0	0

TABLE 4.11
PHOSPHORUS LOADS (DRY CONDITION)

4-20

Pond	No-Action			Regional Plants			Multiple Plants		
	Background (kg/yr)	Upstream pond (kg/yr)	WW (kg/yr)	Background (kg/yr)	Upstream pond (kg/yr)	WW (kg/yr)	Background (kg/yr)	Upstream pond (kg/yr)	WW (kg/yr)
5	189	0	1,120	189	0	0	189	0	0
10	59	0	736	59	0	674	59	0	261
12	111	198	526	111	302	0	111	102	0
14	463	195	0	463	136	0	463	34	72
16	155	0	248	155	0	0	155	0	0

ponds and overall waters of the study area. Another environmental benefit of the smaller regional plant alternative, with greater reuse, will be to more closely match natural or baseline conditions. As noted earlier, the streams in the study area are all intermittent. The scenario that minimizes the discharge of wastewater will be the one that is the most natural and, therefore, ecologically desirable.

5.0 WATER QUALITY PROTECTION PLAN

In the previous sections, several aspects of wastewater infrastructure and water quality were addressed. This section analyzes the results of this work and describes the process of selecting a water quality protection plan, considering economic, environmental and policy aspects. The key elements of the selected plan are summarized at the end of the section.

5.1 COST ANALYSIS

Cost comparisons of all three alternatives can be seen in Table 5.1. This table displays all anticipated flow and cost data for the three models. From the table it can be seen that Alternative 3 Smaller Multiple Plants model provided the lowest cost per housing unit (\$1,466), as well as highest amount of reuse (964,621 gallons per day). The greater potential for reuse with the Multiple Plant Model will also aid in lowering peak demands and therefore reducing the cost of providing a given supply of water to the study area.

5.2 ENVIRONMENTAL AND PUBLIC POLICY ANALYSIS

Some of the major findings of the water quality analysis in Section 4.0 were:

- The study area is the upstream portion of a watershed, and all the streams in the area are intermittent.
- The water quality criterion established for intermittent streams (those that do not support aquatic life) is a relatively low 2 mg/L of DO. With the level of treatment typically employed today, there would be no problem meeting this criterion downstream of a discharger.
- The ponds that have been constructed for flood control and sediment retention may be viewed as perennial pools or as lakes, resulting in a higher level of water quality concern. Accordingly, the water quality analysis focused on the ponds.

Evaluating the wastewater treatment alternatives on the ponds, No-Action is the least desirable from a water quality perspective because it is likely to result in more, smaller WWTPs, some of which would discharge to ponds. The level of treatment (P removal) may not be as high as is proposed for the two alternatives that involve governmental planning and operation. Two other negative aspects of the No-Action alternative are that it would do the least to minimize the number of homes served by OSSFs and their attendant longer-range water quality concerns, and it would do the least to foster the public stewardship role in providing water quality. While wastewater discharge permits specify a required minimum level of performance, a public entity is more likely to be responsive to public water quality concerns than would a private or special district operator. Clearly exceptions to this idea can be found, but

**Table 5.1
Cost Comparison**

Comparison Sheet	No Action	Regional Plants	Multiple Plants
Average Percent Served	64%	69%	84%
Population Served	29300	31589	38456
LUE	10540	11363	13833
Water Collected	2,236,807	2,488,013	3,024,625
Water Reused	0	373,092	946,621
Plant Cost	\$11,370,744.00	\$7,464,038.52	\$9,539,102.40
Collection Cost	\$4,839,120.00	\$8,768,100.00	\$9,256,830.00
Reuse Cost	\$0.00	\$291,060.00	\$632,280.00
Lift Station Cost	\$0.00	\$2,500,000.00	\$500,000.00
Total Cost	\$16,209,864.00	\$19,023,198.52	\$19,928,212.40
Cost per LUE	\$1,538.01	\$1,674.15	\$1,440.62

Study Area Population
45781

it is felt that over the longer term, the pressure of public accountability is likely to produce a higher quality of wastewater operation than would be achieved in the absence of this accountability.

Of the two regional alternatives there is little difference in terms of effects on ponds. The smaller Multiple Plant alternative is more desirable because it would produce a higher level of wastewater reuse and also result in fewer homes served by OSSFs.

5.3 RECOMMENDED REGIONAL WATER QUALITY PROTECTION PLAN

The recommended regional water quality protection plan has four main elements:

- Smaller regional facilities that minimize the cost of wastewater pumping and providing service to more locations thus minimizing the number of OSSFs required,
- Treatment to a higher level (5-5-2-1) than would normally be required for discharge to intermittent streams in the area,
- An emphasis on wastewater reuse to both minimize downstream effects on ponds and maintain the receiving creeks in their natural dry state as much as possible and also to minimize potable water demands, and
- Public operation to provide a high level of confidence that the regional facilities will be well operated and maintained.

6.0 IMPLEMENTATION OF RECOMMENDED PLAN

If there is agreement among the major stakeholders on the recommended plan for wastewater service to the area, the next step is defining a pathway for implementation. That pathway could involve the following two components:

1. An agreement or “Wastewater Compact” between the major governmental entities in the study area (City of Buda, Hays County, GBRA, and possibly City of Kyle) that sets expectations for dealing with new development.
2. A letter of endorsement of the Compact goals and procedures by the TCEQ.

The compact or agreement between the major governmental entities would formalize the goals or vision for addressing wastewater issues, and provide guidance to implementation. The letter of endorsement from TCEQ would reinforce the agreement in the event that a party elected to disregard the agreed upon plan, but would not be essential for routine operation.

The Compact would recognize that the exact location of future wastewater facilities will be substantially driven by plans of developers. The wastewater Compact would lay out a set of expectations for dealing with these developer plans that include the four main points of the recommended plan (e.g. encouraging coordination with existing or planned wastewater facilities, and provisions for wastewater reuse (purple pipe). A desirable feature of the agreement would be to state the intention that if a developer elects to have a new WWTP, a member of the Compact could be a co-permittee with the project developer in the application process. The Compact could have the option to approve the plan, proposed level of treatment and conceptual design. However, the developer would assume the cost of the permit application process. It would also be desirable for the Compact to state that when a new plant is permitted and constructed, it may be operated by one of the members of the Compact. Details of plant ownership, inspections, and maintenance should be defined in a contract between the Compact and the developer.

The Compact should also address what to do if a developer elected to act contrary to the principles of the Compact (e.g., applied independently for a permit in the planning area without meeting the treatment level or reuse goals of the plan). In that case, the Compact members could agree to oppose that application. The letter of endorsement of the plan and Compact by the TCEQ, if it could be obtained, could be important in defending the plan.

In effect, the Compact would be the basis for guiding development of wastewater facilities in the study area, while still relying on the private sector to assume the profit potential and risk for new development. The Compact would allow for members to take different roles, depending on the location of new development and specific conditions.

The Compact could also initiate regional rate studies and solicit participation and stakeholder meetings to facilitate permitting of proposed wastewater treatment facilities that are consistent with the recommended plan.

7.0 REFERENCES

Capital Area Metropolitan Planning Organization (CAMPO). 2003. Traffic Serial Zone data 2000 to 2030.

Hays Consolidated Independent School District (HCISD). 2003. Demographic Update Report. Prepared by the Population and Survey Analysts (PASA). April.