Engineering and Planning Report

MASTER ROADWAY AND DRAINAGE PLAN
TAHITIAN VILLAGE

B.C.W.C.I.D. No.2

STATE OF TEXAS
REGISTERED PROFESSIONAL ENGINEER

January, 1992
Project No. 91084

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COPY

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EXECUTIVE SUMMARY

The Bastrop County Water Control Improvement District No. 2 (BCWCID No. 2) Roadway Authority has been determined to encompass approximately 63.1 miles of existing roadways. Of this total, approximately 5.5 miles are within the existing City Limits of Bastrop and the remaining 57.6 miles are within the County of Bastrop.

A "Road Condition Survey and Improvement Program" study was previously performed by Bastrop County concerning the BCWCID No. 2 Road Authority Project Area. Excerpts from the study have been utilized in performing this Roadway Master Plan.

The project consists of verifying the adequacy of the previous study and development of a master plan which complies with House Bill 2902.

In order to determine recommended roadway improvements, scheduling of proposed construction and a financial management plan, the project was divided into Chapter discussions of major topics of consideration.

The recommended roadway master plan is a composite of BCWCID No. 2 Board, City of Bastrop and County of Bastrop suggestions. See comment letters from City and County, Attachment No. 12 and 13 respectively. Cost estimates were developed using current best available data.

The total estimated cost of improvements is approximately $ 5,500,000. Revenue projections for the 20-year plan range from $ 100,000 to $ 800,000 per year, depending on amount of assessment fee and collection rate. Projected annual revenue for the plan is $275,000 per year.

It is anticipated that with minor changes, the proposed master plan will be implemented for future project planning.

INTRODUCTION

In October of 1991, the Bastrop County Water Control Improvement District No. 2 (the District) awarded to Fisher, Hagood & Hejl the task of researching and performing a roadway master plan to service the District.

The BCWCID No. 2 was granted extended road utility district authority through House Bill 2902 (H.B.) effective June 10, 1991 until September 01, 1995. (see Attachment No. 1) H.B. 2902 requires the District to perform a roadway master plan. This project is a response to the above. The District currently has no master roadway plan.

The District made available to Fisher, Hagood & Hejl copies of "Road Condition Survey and Improvement Program" prepared by Bastrop County. The report presents data concerning existing roadway conditions, recommended roadway construction, cost estimates and other considerations.

The Roadway Master Plan is presented in the following chapters.

1. PROJECT AREA - Discussion of the project area limits and characteristics.
2. EXISTING ROADWAY AND DRAINAGE CONDITIONS - Assessment and Classification of proposed roadway and drainage improvements.
3. PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS - Assessment and Classification of proposed roadway and drainage improvements.
4. COST ESTIMATES - Cost estimates to improve road and drainage conditions.
5. PRIORITIZATION OF ROADWAY IMPROVEMENTS - Discussion and ranking of priority of performing improvements.
6. FINANCING ALTERNATIVES - Analysis of revenues, expenditures and a present worth cost analysis concerning bond issues.
7. PROPOSED MASTER PLAN AND SCHEDULE OF IMPROVEMENTS - Proposed master plan and project summary with schedule.

The final chapter accompanied with the Exhibits will present to the District a master plan to serve the BCWCID No. 2 service area.

CHAPTER 1

PROJECT AREA

The area considered for this project is within the BCWCID No. 2 service area. Exhibit No. 1 defines the approximate 5,000 acre Project Area.

The topography of the Project Area is comprised of mild to severely sloping land. Ground elevations in the area range from approximately 500 feet Mean Surface Level (MSL) at the upper end to approximately 320 feet MSL where the District borders the Colorado River. Slopes in the project area are generally greater than five percent with some slopes approaching thirteen to fifteen percent. The natural vegetation consists of native trees and grasses. A majority of the trees are pines with some oak, cedar and pecan. Vegetation is dense and typically perennial throughout most of the area.

Due to the hilly terrain and severe sloping land, the floodplain for the area is well defined. Exhibit No. 1 illustrates the floodplain presented by the Flood Insurance Rate Map (FIRM) published by the Federal Emergency Management Association. At this time, the FEMA map and historical witness accounts are the most comprehensive analysis of the floodplain.

The soils encountered within the Project Area are presented on Exhibit No. 20. The predominate geologic formations in the area exhibit various degrees of suitability concerning roadway construction. Attachment No. 2 is a copy of soils report performed in November, 1990 concerning borings taken at several roadways within the District. Field observations verify the above soil findings where typically sandy, sandy-clay and silty sand soils dominate soil groups encountered in the project area.

Existing utilities in the Project Area were evaluated from available information provided by contacting the utility companies/agencies listed in Attachment No. 3. The existing utilities include electrical, water, telephone and cable TV. The Project Area contains 7267 lots. There are approximately 461 water customers with 143 of this total located within the City Limits of Bastrop. Development in the area will be primarily single family residences. There are limited planned areas of commercial, industrial or dense dwelling units. Due to the fact that no centralized wastewater system exists and that soil conditions are not well suited to facilitate high density on-site wastewater disposal, it is anticipated that the primarily low density residential Project Area will remain that way.

In conclusion, the Project Area has many characteristics which were considered in selecting proposed roadway improvements. Soil conditions, terrain, existing occupied structures, existing utilities, school bus routes, most utilized roadways, emergency 911 traffic routing and access to County Road and State Highway 71 were all considered in developing the Master Plan.

CHAPTER 2

EXISTING ROADWAY AND DRAINAGE CONDITIONS

The existing roadway and drainage conditions in the Project Area were determined by field observation and verification of previous classifications provided in the Bastrop County "Road Condition Survey and Improvement Program" study. As per the study, roadways were classified into the following categories:

1. Approaching City/County Standards
2. Weathered Asphalt with failures
3. Heavily weathered with overgrowth
4. Disintegrated asphalt or gravel only
5. Undeveloped, not in use.

Exhibit No.s 2 through 10 present roadways and their respective classifications. The Project Area has approximately 63.1 miles of roadways. Approximately 5.5 miles of roadway are located within the City Limits of Bastrop with the remaining 57.6 miles located within the County of Bastrop. Attachment No. 4 presents existing roadway and drainage classifications by classification type, linear feet and approximate miles. The attachment delineates City and County totals.

In general, existing roadway and drainage conditions within the city limits of Bastrop are better than those encountered throughout the Project Area. The above can be attributed to the proximity of City property to the entrance of the Project Area with quick access to State Highway 71. Over 30% of the occupied structures (143 out of 461) are located in the City Limits while the percentage of City roadway is approximately 9% (5.5 miles out of 63.1 miles) of the total roadway in the Project Area.

The existing roadways have primarily been maintained by the BCWCID No. 2. The City of Bastrop has within the last two years repaired an intersection within the City's portion of the Project Area.

Existing roadway and drainage conditions are hindered by extreme slopes within the Project Area. Typical slopes range from 2 to 15 percent. Although the slopes facilitate rapid removal of storm water, they also contribute to difficult roadway construction, flash flooding events, severe cut/fill situations, sight distance problems and lot accessibility considerations.

Existing soil conditions exhibit various degrees of roadway construction suitability. The Axtell and Jedd soil series are poor road fill materials. The Patilo and Vernia soil series are good road fill materials. All of these soil classes are encountered in the Project Area.

CHAPTER 3

PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS

The proposed roadway and drainage improvements in the Project Area were determined by thorough analysis of existing conditions, a minimum five to ten year improvement life expectancy, recommendations from meetings with City of Bastrop, County of Bastrop and the BCWCID No. 2 Board, consultant's experience with best practical design technology for the project area and financial limitations for performing improvements.

Roadways were classified into four categories:

R	Residential
C	Collector
A	Arterial
MA	Major Arterial

Residential roadway and drainage areas make up approximately 62% (38 miles out of 63 miles) of the total classifications with 11% Collector, 18% Arterial and 9% Major Arterial.

Attachment No. 5 provides a breakdown of proposed roadway and drainage classifications. Exhibit No.s 11 through 19 present the proposed classifications for each roadway within the Project Area.

The proposed roadway sections are presented on Attachment No. 6. Roadway improvements are proposed to be minimum 20 foot widths with stabilized shoulders and topping. The intent is to develop uniform base thickness throughout the roadway construction so that as the Project Area population and traffic loadings increase, future street maintenance costs will be minimized. The proposed sections facilitate drainage by channelization. Subsurface drainage as in development of curb and gutter sections with inlets and storm sewer pipes have been determined to be too expensive for further consideration.

Other considerations in classifying streets were the school bus route, 911 emergency traffic route, density of existing structures and future development potential within the Project Area.

The proposed roadway sections do not meet current regulations for the City and County. The District, by HB 2902 is not required to met these regulations. However, the proposed sections do exceed roadway construction standards established in 1972 when the Tahitian Village Subdivision was originally created. This is important as the District is required only to meet standards which were in place at the time the Subdivision was created. The District has chosen to propose roadway and drainage improvements which provide a balance of good product versus available funding capacity.

CHAPTER 4

COST ESTIMATES

The construction cost estimates developed for the master plan were based on the proposed roadway and drainage improvement sections, existing roadway and drainage condition, discussions with roadway contractors and consultant's knowledge of current cost estimating practices. Attachment No. 7 provides construction cost estimates to improve the four proposed roadway and drainage sections based on existing classifications. The roadway sections with the lowest class rating (5 on a scale of 1 to 5) will cost the most to improve to their respective classification. Cost estimates were developed per linear foot for ease in calculating totals.

The total estimated construction cost of roadway and drainage improvements is $5,057,890. This cost does not include engineering, soils testing, acquisition, legal or any other contingency costs. These additional non-construction costs will average approximately 10% of the total construction cost. Therefore, the total estimated cost of the roadway improvements is approximately $5,500,000.

The District may consider using and compensating City and/or County forces to perform roadway and drainage improvements in order to reduce costs. The District will contact the State Department of Highways and Public Transportation for any potential assistance with necessary bridge improvements along Wahane Lane and Kaaawa.

The estimates per linear foot provided for in this plan are subject to verification at the time work is actually designed, bid and performed. It is logical to assume that if the District performed more volume of roadway improvements at one time, the unit cost per linear foot would be reduced. Likewise, if a limited scope of work is performed, the cost per linear foot would be higher.

CHAPTER 5

PRIORITIZATION OF ROADWAY IMPROVEMENTS

The prioritization of roadway improvements were based on road classification, density of existing structures, school bus route, existing traffic patterns and contiguous development of improvements.

The District proposes to initially improve the major arterials of Tahitian, Riverside, Akaloa, Kannapali, Kaneho and Moku Manu roadways. After improvement of these major arterials, the District proposes to improve arterial and residential roadways contiguous to the major arterials.

By improving the major arterials first, the District accomplishes several critical goals: Goal No. 1 - These roadways have historically been the most used roads, therefore it is logical to improve them first. Goal No. 2 - These roadways provide access for school bus routes. This is very important to the families with school age children who reside in the Project Area. Goal No. 3 - These roadways facilitate 911 vehicular traffic for access to the most populated areas within the District Goal No. 4 - These roadways offer contiguous development. This is important to both city and county forces for ease in identifying and accessing roadways to be maintained. Goal No. 5 - These roadways provide a looped traffic system which allows for systematic improvements of both arterial and residential roadways contiguous to the major arterials.

Exhibit No. 21 presents a 2, 5, 10 and 20 year roadway and drainage improvement master plan and schedule. This exhibit illustrates the logic in improving the major arterials first.

A major concern associated with this development scenario is that in improving the major arterials first, the roadways will be utilized excessively for access by heavy vehicles used to construct future roadway improvements thereby resulting in premature deterioration. This concern, though well intended, does not adequately justify changing improvement priorities.

The District is exercising common sense in performing roadway and drainage improvements to the areas most frequently used. The proposed prioritization allows for contiguous development of roadway improvements. This item is very important to not only the District, but the City and County as well. These improvements will be the most noticeable and benefit a greater number of residents within the Project Area. A secondary impact of improving the major arterials will be the potential for growth. Growth within the area will add tax dollars to the City and County.

It is anticipated that the improvements to the major arterials would be performed within the first two years of the master plan. After successful implementation of these improvements, the District will concentrate on improving roadways contiguous to the major arterials which directly benefit the most people living in the Project Area. The roadways located within the City Limits are planned to be improved within the five year master plan.

Priorities are subject to review annually, however the District proposes to closely follow the proposed two year implementation plan to initially improve major arterial roadways.

CHAPTER 6

FINANCING ALTERNATIVES

The District has the authority to assess lot owners a fee not to exceed $10.00 per month for roadway and drainage improvements. HB 2902 specifies that 90% of this fee be allocated to fund capital improvement projects. The remaining funds (10%) are allocated to finance administrative costs associated with accounting, collection of fees, management of funds, etc. Attachment No.s 8 and 9 present revenue projections based on $5.00 and $10.00/month assessment fee and varying collection rate percentages. The current assessment fee is $5.00/month. There are 7,267 existing lots. Potential revenue at 100% collection rate is $436,020. Actual collection percentage per previous two years has been approaching 65%. For this master plan, annual revenue of $275,000 is projected.

Assuming the above annual revenue, 90% or approximately $250,000 would be available for capital improvement projects. During the 20 year master plan period, a total estimated revenue of $5,000,000 would be available to fund projects.

The District could fund a project equivalent to approximately $250,000 per year. Based on an estimated $5,500,000 total cost to perform the 63.1 miles of roadway improvements, 22 years would be required to complete the project. However, several factors such as inflation, variance in collection rate, actual maintenance expenses, construction costs, etc. play critical roles in the future successful financing of District projects over this time period.

Bonds are an alternative to performing greater amounts of work by financing capital improvement projects over a set time frame. It is recommended that the term of bond be limited to ten years. The District could issue bonds on the open market or finance through the USDA Farmer's Home Administration. Current bond rates at the USDA FmHA are 6.75%. Terms are recommended to be set at the anticipated design life of the project. Assuming the District desires to finance a bond issue for a ten year term, and assuming 6.75% interest rate with annual payment of $250,000, the amount of potential bond funds would be approximately $1,776,000. This bond issue would hypothetically improve approximately one-third of the total roadways within the Project Area. The advantage to this financing alternative is the expected lower per unit construction cost associated with the economies of scale. In other terms, because the District is buying in greater volume, the unit cost should be lower. The primary disadvantage of this financing alternative is bonded indebtedness the District occurs for a ten-year period.

A present worth economic analysis has been included as Attachment No. 10. This analysis compares two financing alternatives. Alternative No. 1 finances projects annually as funds are available over a ten-year period. Alternative No. 2 finances a larger project by bond issue with payback through annual revenues collected. The present worth economic analysis assumes inflation at 6% and 8%, discount rate at 6.75%, 10-year term and no salvage value. The analysis indicates that at an annual inflation rate of 6% or less Financing Alternative No. 1 would be the preferred method of financing improvements. An annual inflation rate of 8% or more indicates that Financing Alternative No. 2 would be the preferred method of financing. Historical data indicates annual inflation rates of 3 to 4%.

CHAPTER 7

PROPOSED MASTER PLAN AND SCHEDULE OF IMPROVEMENTS

The proposed master plan and schedule of improvements for years 2, 5, 10 and 20 are presented on Exhibit No. 21. The plan was developed by a priority assessment, anticipated revenues, estimated costs of constructing proposed improvements and discussions with the District Board, City of Bastrop and County of Bastrop. The plan and schedule are based on alternative no. 1 financing method.

The District intends to annually evaluate and update the master plan but anticipates that the initial 2-year plan will not change from that presented.

The District has implemented the development of standards for roadway utility cuts and alternatives to routing heavy vehicular traffic through less traveled roadways within the Project Area. These efforts are being made to maintain integrity of the street conditions.

The BCWCID No. 2 Roadway and Drainage Master Plan encompasses many meetings between the Board, the City of Bastrop and the County of Bastrop. Acknowledgements are presented as Attachment No. 11. Without the cooperation and assistance of these groups, the success of this master plan would not have been possible.

ATTACHMENTS

must be equal to or greater than the projected net revenues that would be derived during that period from the excluded territory, as determined by the district's engineer.

SECTION 4. CUMULATIVE EFFECT. This Act is cumulative and in addition to the rights, powers, and authority to exclude territory that is conferred on the district by general law. If a provision of this Act conflicts with or is inconsistent with the general law, this Act prevails.

SECTION 5. EMERGENCY. The importance of this legislation and the crowded condition of the calendars in both houses create an emergency and an imperative public necessity that the constitutional rule requiring bills to be read on three several days in each house be suspended, and this rule is hereby suspended, and that this Act take effect and be in force from and after its passage, and it is so enacted.

Passed by the House on May 17, 1991, by a non-record vote; passed by the Senate on May 25, 1991: Yeas 31, Nays 0.

Filed without signature June 10, 1991.

Effective August 26, 1991, 90 days after date of adjournment.

CHAPTER 323

H.B. No. 2902

AN ACT

relating to the powers and duties of the Bastrop County Water Control and Improvement District No. 2 relating to the administration of a road utility district in Bastrop County.

Be it enacted by the Legislature of the State of Texas:

SECTION 1. Section 1, Chapter 577, Acts of the 71st Legislature, Regular Session, 1989, is amended to read as follows:

Sec. 1. *DEFINITIONS* [~~DEFINITION~~]. In this Act:

(1) "District" [~~, "district"~~] means the Bastrop County Water Control and Improvement District No. 2.

(2) "City" means the city of Bastrop.

(3) "County" means Bastrop County.

SECTION 2. Section 2, Chapter 577, Acts of the 71st Legislature, Regular Session, 1989, is amended by amending Subsection (b) and adding Subsections (e), (f), (g), (h), and (i) to read as follows:

(b) The district *shall convey completed facilities to the city or county, as appropriate, and the city or county shall accept the facilities if the facilities comply with the minimum standards prescribed by the city or county for improvements within its respective jurisdiction. If the jurisdiction of the city and county overlap, the more stringent standards apply* [~~is not required to convey completed facilities to a governmental entity or to submit plans for the construction, acquisition, or improvement of a facility to the State Highways and Public Transportation Commission or any other governmental entity. Sections 4-11 and 38-11, Chapter 13, Acts of the 68th Legislature, 2nd Called Session, 1984 (Article 6674r-1, Vernon's Texas Civil Statutes), do not apply to the district~~].

(e) The district shall submit to the city or county, as appropriate, all road plans and specifications for approval before beginning construction. The plans or specifications are considered approved if the city or county does not disapprove the plans before the 22nd day after the date on which the plans or specifications are submitted. In reviewing the specifications, the city or county shall generally apply as the minimum standard the standard the city or county used to review similar specifications at the time the subdivision was originally created. If specifications exceed those minimum standards, the standard for approval shall depend on good engineering practices relating to items such as vehicle and pedestrian safety, soil and terrain

variables, watershed impacts, projected traffic use, and future maintenance requirements.

(f) In addition to the right to approve specifications provided by Subsection (e) of this section, the city and county are entitled to perform reasonable inspections, sampling, and testing and to require the district and contractor performing work to perform reasonable inspections, sampling, and testing. The district [redacted] include the costs of the testing and inspections in the bid specifications, [redacted] the costs are considered allowable charges for the expenditure of road funds.

(g) If the district fails to comply with the city's or county's design criteria, construction requirements, or product or work testing analyses, the city or county may refuse to accept a road or drainage improvement into the city's or county's system for future maintenance until the substandard conditions have been corrected and the city or county accepts the corrections.

(h) A road built under this Act is subject to safety and weight regulation by the city and county within their respective jurisdictions.

(i) In addition to the powers provided by this Act, the district may:

(1) select professional and consultant personnel for engineering, legal, and other necessary support services;

(2) select and approve work contractors and subcontractors;

(3) supervise road and drainage work in the district;

(4) contract in accordance with state law to implement the improvements provided by the master plan, including contracts with professionals and contractors;

(5) supervise road and drainage work within the district;

(6) supervise the cost effective use of district funds allotted for permanent improvements; and

(7) approve expenditures for maintenance.

SECTION 3. Chapter 577, Acts of the 71st Legislature, Regular Session, 1989, is amended by adding Sections 3A, 3B, and 3C to read as follows:

Sec. 3A. MASTER PLAN. (a) The district may not spend revenues collected under this Act on or after September 1, 1991, until the district has developed and adopted a master comprehensive road and drainage plan for the entire district. The district shall submit the master plan to the city and county for review before adoption. The city and county shall, not later than the 61st day after the day on which the city and county receive the master plan, review the plan and submit to the district suggested revisions to ensure acceptance of the finished work product. After the district receives the suggested changes, the district shall hold a public hearing to review the master plan and suggested changes. The master plan must be adopted at a public hearing. This subsection does not affect the district's power to take the steps necessary to provide for the development and submission of the master plan.

(b) The master plan must include at least the following:

(1) a map of the district's boundaries that shows the proposed improvements and how the improvements tie into other entities' road and drainage systems; and

(2) a written plan that contains:

(A) general objectives for establishing the various levels of improvements;

(B) the sequencing of the improvements;

(C) the estimated dates of completion of the various phases of the proposed improvements and the cost of each phase;

(D) an analysis of the district's projected revenues compared to the projected costs; and

(E) a proposed timetable for completion of the work identified in the master plan.

(c) The district shall review the master plan annually and shall revise the plan to reflect:

(1) whether the work is ahead of or behind schedule;

(2) the improvement or decline in anticipated revenue projections; and

(3) changes required because of new information relating to the physical qualities of the subdivision or other relevant factors.

(d) The district shall submit the revised master plan to the city and county for review not later than the 31st day before the date on which the revised master plan is adopted and presented to the district's general membership.

(e) The district shall conduct an annual public hearing on the revised master plan to brief the public and to provide an opportunity for public comment. The district shall mail notice of the hearing to each person who owns property in the district.

(f) The district shall use the master plan as a guide to plan and schedule work in a manner that is consistent with the district's needs and ability to fund improvements. The district may deviate from the master plan for cause, but may not present to the city or county a final work product that does not meet the requirements of the city or county.

Sec. 3B. [redacted] *charges directly related to the improvements included in the master plan.*

(b) [redacted] *administrative or financial support services.* [redacted] *shall be used for permanent improvements and associated* [redacted]

(c) [redacted] *this Act before* [redacted] *account* [redacted] *purposes, including* [redacted] *improvements* [redacted] *development of* [redacted] *uses the funds for* [redacted] *improvements, the allocation of funds prescribed by Subsection (b) of this* [redacted]

(d) [redacted] *accredited* [redacted] *develop the requisite* [redacted] *procedures necessary to prepare an annual report of road district* [redacted] *disbursements, fund balances, earnings, performance, and other* [redacted] *The board shall prepare an annual report relating to performance* [redacted] *expenditure of all earnings, fund expenditures, including funds spent on* [redacted] *and other funds that includes:*

(1) a breakdown of major categories of expenditures;

(2) an accounting of each contribution made by the district, city, or county, including each contribution relating to a permanent improvement or the maintenance of an existing road; and

(3) an accounting of each contribution received from any source.

(e) If at any time the district determines that the total revenue on hand or to be received in a fiscal year exceeds by at least 10 percent the total amount projected to be necessary for the work included in the master plan, the district shall discontinue collecting the assessment and shall send notice of that action to each person who owns property in the district. The district may resume collection or may impose a final assessment if the district determines that more money is needed.

Sec. 3C. REPORT TO LEGISLATORS. The district shall annually submit to each state representative and state senator representing the area within the district a report relating to road district activities that includes:

(1) work progress during the preceding year;

(2) revenue expenditures during the preceding year;

(3) any revisions to the master plan;

(4) a complete financial statement that lists all funds, interest earnings, and fund balances and expenditures; and

(5) the report required under Section 3B(d) of this Act.

SECTION 4. Section 5, Chapter 577, Acts of the 71st Legislature, Regular Session, 1989, is amended to read as follows:

Sec. 5. EXPIRATION DATE. This Act expires September 1, *1995* [~~1991~~].

SECTION 5. The importance of this legislation and the crowded condition of the calendars in both houses create an emergency and an imperative public necessity that the constitutional rule requiring bills to be read on three several days in each house be suspended, and this rule is hereby suspended, and that this Act take effect and be in force from and after its passage, and it is so enacted.

Passed by the House on May 22, 1991: Yeas 146, Nays 1, 1 present, not voting; passed by the Senate on May 26, 1991: Yeas 31, Nays 0.

Filed without signature June 10, 1991.

Effective June 10, 1991.

CHAPTER 324

H.B. No. 103

AN ACT

relating to the admission of children to the public free schools.

Be it enacted by the Legislature of the State of Texas:

SECTION 1. Sections 21.031(c) and (d), Education Code, are amended to read as follows:

(c) The board of trustees of any public free school district of this state shall admit into the public free schools of the district free of tuition all persons who are either citizens of the United States or legally admitted aliens and who are over five and not over 21 years of age at the beginning of the scholastic year if:

(1) such person or *either* [~~his~~] parent *of the person* resides within the school district;

(2) such person and his guardian or other person having lawful control of him under an order of a court reside within the school district; [~~or~~]

(3) such person has established a separate residence under Subsection (d) of this section; *or*

(4) such person is homeless, as defined by 42 U.S.C.A. Sec. 11302, regardless of the residence of the person, of either parent of the person, or of the person's guardian or other person having lawful control of him.

(d) In order for a person under the age of 18 years to establish a residence for the purpose of attending the public free schools separate and apart from his parent, guardian, or other person having lawful control of him under an order of a court, it must be established that his presence in the school district is not for the primary purpose of *participation in extracurricular activities* [~~attending the public free schools~~]. The board of trustees shall be responsible for determining whether an applicant for admission is a resident of the school district for purposes of attending the public schools, and may adopt

Raba-Kistner-Brytest
Consultants, Inc.

Engineers, Geologists, Chemists, Water Planners
Hygienists and Environmental Scientists

PAVEMENT DESIGN STUDY

ROAD AUTHORITY IMPROVEMENTS

BASTROP COUNTY, TEXAS WCID NO. 2

Engineers, Geologists, Chemists, Hygienists and Scientist

Raba-Kistner-Brytes
Consultants, Inc.

8200 Cameron Road, Suite 154, Austin, TX 7875
(512) 339-1745 FAX: (512) 339-617

AAA90-054-00
November 15, 1990

Bastrop County Water Control and
Improvement District No. 2
P.O. Box 708
Bastrop, Texas 78602

Attention: Ms. Sharon G. Eaves

RE: Pavement Design Study
Road Authority Improvements
Bastrop County, Texas WCID No. 2

INTRODUCTION

Submitted here is a report of our study of soil conditions for the above referenced project. Also presented are our guidelines pertaining to the pavement sections for this project based on a subsurface and laboratory testing program. This study was authorized by Ms. Sharon G. Eaves of Bastrop County WCID No. 2.

LIMITATIONS

This engineering report has been prepared for the use of Bastrop County WCID No. 2 and Fisher, Hagood, Hamilton & Hejl, Consulting Engineers for design purposes in accordance with generally accepted Geotechnical Engineering practices. This report may not contain sufficient information for purposes of other parties or other uses.

The analyses and recommendations submitted in this report are based on our experience in the area and the soil borings drilled at the site. This report may not reflect the exact soil conditions or their variations across this site. The soil conditions and the extent of any variations across the site may not become evident until construction commences. A qualified inspector should observe the final subgrade to confirm the applicability of the guidelines presented herein.

SOIL BORINGS AND LABORATORY TESTS

Soil conditions at the site were evaluated by fifteen (15) sample borings drilled at the locations shown on the Plan of Borings, Figures 1 and 2. These borings were drilled in accordance with ASTM D 420 procedures to a typical depth of seven (7) feet using a rotary drilling rig; with the exception of Boring No. R-14 which was drilled to 15 feet in a planned cut area on Tahitian Drive.

In the laboratory each sample was examined and classified by a geotechnical engineer. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Collected
Natural Moisture Content	17
Unit Dry Weight	3
Atterberg Limits	14
200-Mesh Sieve	17
Unconfined Compression	3

The results of all laboratory tests are presented in graphical form on the borings logs illustrated on Figures 3 through 17. A key to classification terms and symbols used on the logs is presented on Figures 18 and 19. The station numbers shown on the Logs of Borings are only approximate as are the reference elevations which were extracted from a preliminary plan-profile sheet prepared by Fisher, Hagood, Hamilton & Hejl Engineers.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the client.

GENERAL SUBSURFACE CONDITIONS

Soil Stratigraphy The soils encountered at this site may be grouped into four (4) generalized types with similar physical and engineering properties. The lines designating the interface between soil strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

All of the borings were drilled on the existing streets. The existing pavements consist of 0.5 inches to 0.9 inches of hot mix asphaltic concrete (HMAC) laid over native site soils as the base material; the thickness of which could not be differentiated with any certainty.

The soils encountered at this site are alluvial deposits which vary in type and consistency. The subsurface materials are discussed in detail on the Logs of Borings, but in general terms consist of the following:

CLAY, SANDY CLAY, CLAYEY SAND, and SILTY SAND: red, brown, tan to gray containing varying amounts of iron stains; and trace to some sand and gravel deposits. The in-place condition of the soils ranges from medium dense to very dense in terms of relative density and from firm to hard in relative consistency. The results of the Atterberg limits tests indicate plasticity indices ranging from non-plastic to highly plastic.

KAMAKOA LANE and AKALOA LANE

In general, the soils encountered along KAMAKOA LANE (Borings Nos. R-1 through R-7) and AKALOA LANE (Boring Nos. R-8 through R-11) exhibited similar soil properties. These soils typically are clayey and contain sand and gravel deposits. The soils encountered in Boring No. R-9 appear to be native fill material. The plasticity indices within the affected traffic loading zone are plastic and are substantial enough to warrant consideration for an increased base thickness or lime stabilization.

TAHITIAN DRIVE

The soils encountered along the subject section of TAHITIAN DRIVE (Boring Nos. R-12 through R-15) tended to be sandy, of low plasticity, and very dense. Clay and clayey soils were present in some locations but did not seem to be the predominate soil type. Boring No. R-13 encountered firm red plastic clay from 0.5 to the 4.5-feet depth, but it is our understanding that an approximate 4-foot cut is planned to lower the road elevation at this location.

The nature of the non-plastic silty sand has promoted the pavement shoving that is visually evident in this section by allowing shifting of the soils from traffic loads and water migration; coupled with the steepness of the slope. We recommend the subgrade soils along this section be stabilized with portland cement.

Ground Water Ground water was not observed at the time of our subsurface exploration. However, some water migration may be present during wet seasons.

PAVEMENT RECOMMENDATIONS

Overlaying the existing pavements in lieu of reconstruction was proposed as a possibility for the project. It is our judgment this approach would be inappropriate for design and construction considerations and also for long term cost effectiveness, primarily because of the lack of a quality base material beneath the existing pavements. Therefore, only pavement reconstruction is presented in this report.

It is our understanding that the pavement sections for the streets will be subjected to the following loading and construction conditions:

- Traffic will be limited to light and medium weight vehicles;
- The existing pavement sections will be removed to the subgrade elevation; and
- A design life of 20 years will be considered.

The following recommendations for pavement sections are based on laboratory test results, our past experience with similar subgrade soils, and design procedures recommended by the American Association of State Highway Transportation Officials (AASHTO).

<u>Pavement Sections</u> Pavement sections appropriate for this site were selected on the basis of a Texas Triaxial value of 4.5. Pavement sections which may be considered for this site are presented in the following tables which presents the material thickness for a 20-year design life.

It is highly recommended to extend the lime/cement stabilization and base courses at least 2 feet behind the proposed curb.

FLEXIBLE PAVEMENT SECTION
(KAMAKOA LANE and AKALOA LANE)

Minimum Asphaltic Concrete (in.)	Crushed Limestone Base (in.)	Minimum Lime Stabilized Subgrade (in.)	Percent Minimum Lime (%)
1.5	12	---	---
or			
1.5	8	6	5*

The strength of the plastic subgrade soils will be increased by conventional stabilization of the top 6 inches with hydrated lime. Conventional stabilization of the subgrade soils with sufficient lime also allows for a reduction of the required base course thickness. Proportions of hydrated lime to be added to the subgrade clays for conventional stabilization are typically based on measured quantities required to reduce the plasticity index to 15 or less. *Typically, the addition of 5 to 6 percent hydrated lime (by dry weight of soil) should reduce the plasticity index of the subgrade soils at this site to less than 15.

FLEXIBLE PAVEMENT SECTION
(TAHITIAN DRIVE)

Minimum Asphaltic Concrete (in.)	Crushed Limestone Base (in.)	Minimum Cement Stabilized Subgrade (in.)	Percent Portland Cement
1.5	6	6	8*

The strength of the non-plastic subgrade soils will be increased by conventional stabilization of the top 6 inches with portland cement. Conventional stabilization of the subgrade soils with sufficient portland cement also allows for a reduction of the required base course thickness. *Typically, the addition of 6 to 12 percent portland cement (by dry weight of soil) should stabilize the subgrade soils at this site in order to obtain a minimum compressive strength of 500 psi in 7 days.

SLOPE PROTECTION (AKALOA LANE)

Bank/Slope Stabilization

To the north and south of Borings R-13 and R-14, there exists a cut through a hilltop. The cut was presumably due to the construction of Akaloa Lane. The existing slopes are about 25 to 30 feet high and are presently at about a 0.25(H) : 1(V) slope. We have examined the slope during our October 17, 1990 site visit and have the following comments regarding bank and slope stabilization.

Slope Stabilization/Stability: Examination of the cut faces indicates that the little to moderate erosion that is present and is principally due to rainfall. The top extremes of the cut faces do not exhibit sloughing to any extreme degree. Based upon discussions with the Engineer and Owner, it is anticipated that the lots above each cut will be sold as residential lots. Hence, there exists some concern regarding the slope stability and the ability to construct a single family home above the cut face.

Several factors will affect the stability of the slope if the lot is developed. Some of these factors are:

1. Areal drainage patterns;

2. The location of any subsurface utility cuts;

3. The proximity of the residence to the slope edge;

4. The extent of roadway modifications (i.e. cut, fill) at the toe of the slope;

5. The degree of erosion allowed to proprogate at the toe of the slope; and

6. The extent of erosion with time along the cut face.

Our analysis, conducted simulating a single story residence representing a 1 psi sincharge, indicates that the residence should be located no closer than 50 feet from the slope edge.

Bank Stabilization: Alternatives regarding a method to minimize bank erosion and to provide some type of stability were also analyzed. The goal of this task is to weight the comparative costs of each method with the contributing effects. R-K-BCI is not acutely aware of the relative costs of the following items, but we have commented on the relative benefit of each.

1. CRIB-WALL CONSTRUCTION: These interlocking units can be stacked almost on vertical plane. This method provides the greatest degree of economical erosion protection and slope stabilization.

2. STACKED RAILROAD TIES: These units would need to be stacked in vertical walls of no higher than 15 feet. Subsequent walls would need to be offset back into the slope at least 1 foot. It may also be necessary to use "soil anchors" for each wall unit to retain their

alignment. The soil anchors could consist of 1-inch cable with dumb bells embedded a minimum of 3 feet into the slope. While this method maximizes erosion control, it also contributes a small amount to increase slope stability.

3. SOIL BIOTECHNICAL STABILIZATION: Biotechnical stabilization relies on the use of lime, woody, fibrous-rooted plant material which regenerates quickly. It is installed in semi-structural configurations in order to provide soil reinforcement and surface cover. We have enclosed copies of several case studies regarding this method in the Appendix to this report. This method provides an effective mechanism to control erosion. It does not provide any significant contribution to increasing the slope strength.

The following illustrations are attached and complete this report:

Figures 1 and 2	Plan of Borings
Figures 3 through 17	Logs of Borings
Figures 18 and 19	Key to Terms and Symbols
Attachment	Pavement Construction Guidelines

We appreciate the opportunity to be of service to you on this project. Please call us if we can be of additional assistance during the materials testing-quality control phase of construction.

Very truly yours,

RABA-KISTNER-BRYTEST CONSULTANTS, INC.

Gary W. Raba, D. Eng., P.E.
President

Everett Z. Clements
Project Manager

GWR/EZC:jb

Copies submitted: Above (2)
Fisher, Hagood, Hamilton & Hejl (2)

PAVEMENT CONSTRUCTION GUIDELINES

Drainage Considerations

As with any soil-supported structure, the satisfactory performance of a pavement system is contingent on the provision of adequate surface and subsurface drainage. Insufficient drainage which allows saturation of the pavement subgrade will greatly reduce the performance and service life of the pavement systems, even when the system is constructed using either typical cross section guidelines or design recommendations based on site-specific soils testing. Surface and subsurface drainage considerations crucial to the performance of pavements at this site include (but are not limited to) the following:

1) Any known natural or man-made subsurface seepage at the site which may occur at sufficiently shallow depths as to influence moisture contents within the subgrade should be intercepted by drainage ditches or below grade french drains.

2) All surface drainage should be directed away from the pavement and curbs. Final site grading should eliminate isolated depressions adjacent to curbs which may allow surface water to pond and thus to increase infiltration into the underlying soils. Curbs should be installed to sufficient depth to reduce infiltration of water beneath the curbs.

3) Pavement surfaces should be maintained to minimize surface ponding and to provide rapid sealing of any developing cracks. These measures will help reduce infiltration of surface water downward through the pavement section.

Site Preparation

Areas to support fill or pavements should be stripped of all existing pavement surface courses and/or vegetation. The exposed subgrade should be scarified to a minimum depth of 6 inches. and recompacted to a minimum of 95% percent of maximum density and at optimum moisture plus or minus 3 percent as determined by TSDHPT Tex-113-E compaction test.

Fill Material

Fill material shall be free of organic and other deleterious materials. The fill shall be placed in maximum loose lift of 8 inches. and compacted to a minimum of 95 percent of the maximum density at optimum moisture plus or minus 3 percent as determined by TSDHPT Tex-113-E compaction test.

Lime Treatment of Subgrade

The lime treatment of the subgrade should be in accordance with Texas State Department of Highways and Public Transportation Standard Specification, Item 260. Following mixing operations, the maximum clay particle size should not exceed 3/4-in. The lime treated subgrade soil should be compacted to a minimum of 95-percent of the maximum density as determined by TSDHPT, Tex-113-E. The surface of the prepared subgrade should be kept moist until covered to prevent dusting.

Portland Cement Treatment of Subgrade

The portland cement treatment of the subgrade should be in accordance with Texas State Department of Highways and Public Transportation Standard Specification, Item 270. The portland cement treated subgrade soil should be compacted to a minimum of 95-percent of the maximum density as determined by TSDHPT, Tex-113-E. The surface of the prepared subgrade should be kept moist until covered to prevent dusting.

Flexible Base Course

Materials used for flexible base should be crushed limestone conforming to Texas State Department of Highways and Public Transportation, TSDHPT, Standard Specifications, Item 248, Type A, Grade 1, with a maximum liquid limit of 35 and a plasticity index of 10. The base course shall be placed in maximum loose lifts of 8 inches. and compacted to 95 percent of the maximum density as determined by TSDHPT Tex-113-E.

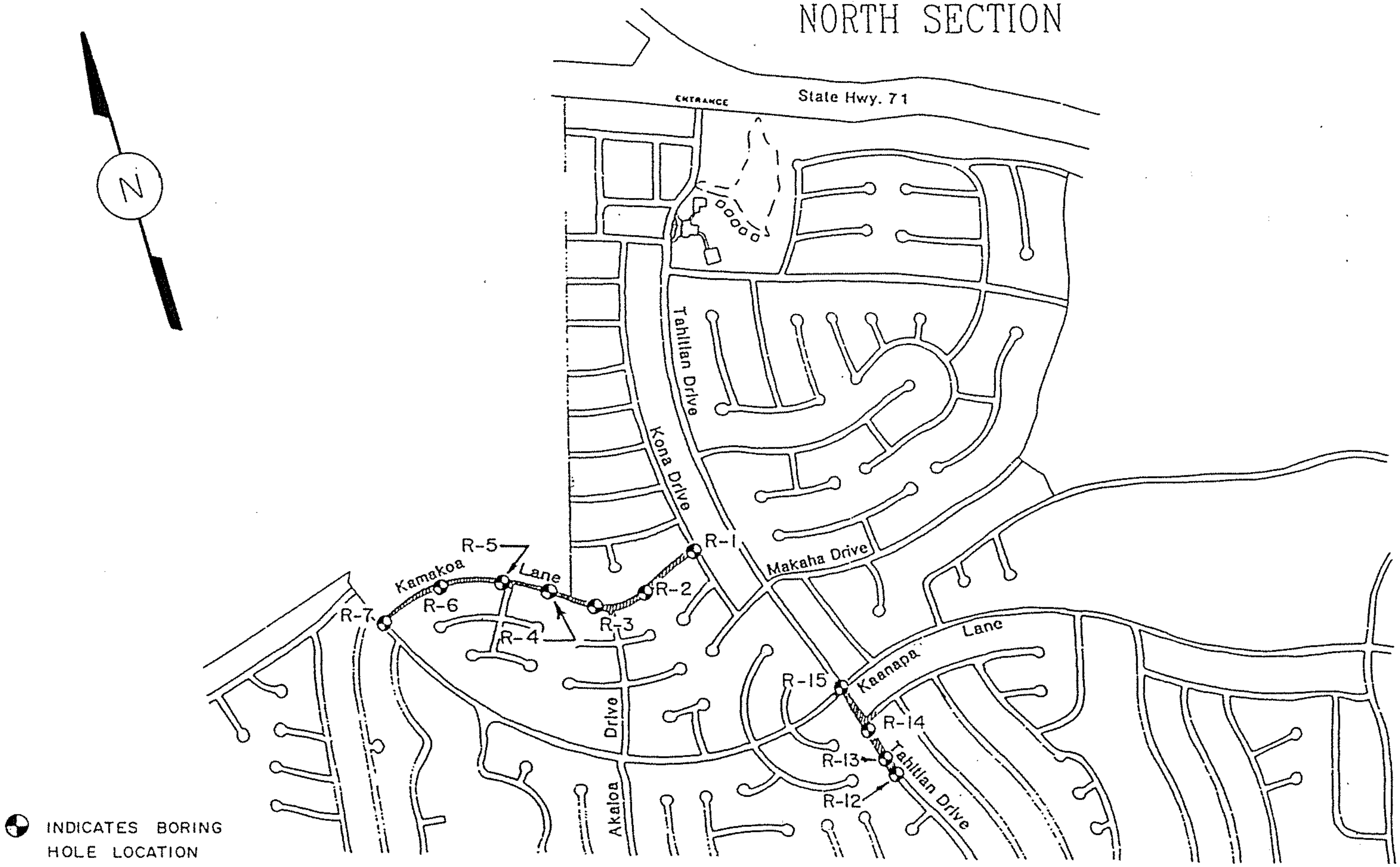
Asphaltic Concrete

The hot mixed, hot-laid asphaltic concrete surface course should conform to TSDHPT Standard Specifications, Item 340, Type D and should be compacted to a minimum of 98 percent of the laboratory density.

I L L U S T R A T I O N S

TAHITIAN VILLAGE OVERALL MAP

NORTH SECTION



Raba-Kistner-Brytest Consultants, Inc.

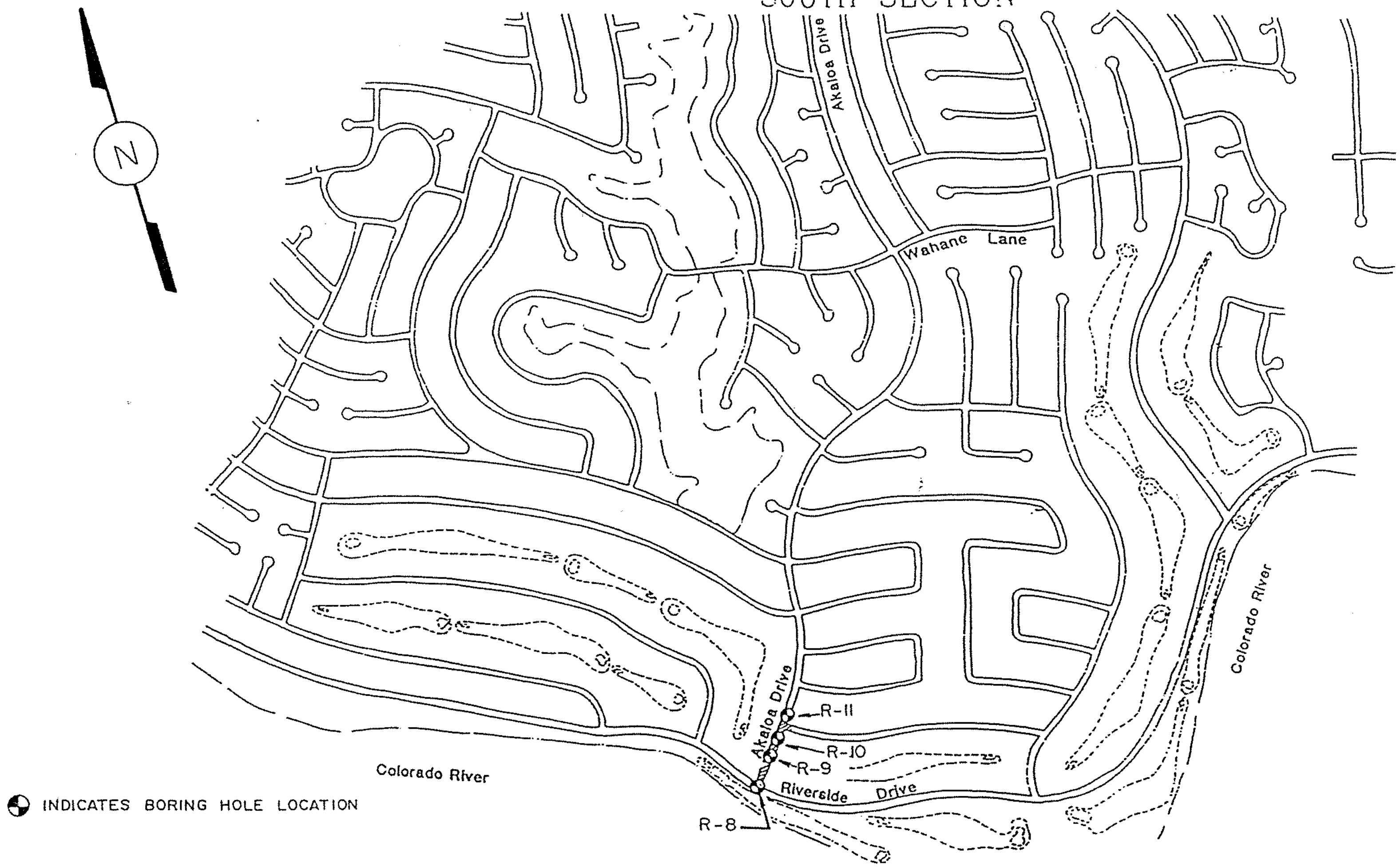
Engineers, Geologists, Chemists, Hygienists and Scientists

ROAD AUTHORITY IMPROVEMENTS
BASTROP COUNTY, TEXAS WCID NO. 2
PLAN OF BORINGS

JOB NO. AAA90-054-00 | DATE - NOVEMBER 1990 | FIGURE 1

TAHITIAN VILLAGE OVERALL MAP

SOUTH SECTION



Raba-Kistner-Brytest Consultants, Inc.

Engineers, Geologists, Chemists, Hygienists and Scientists

ROAD AUTHORITY IMPROVEMENTS
BASTROP COUNTY, TEXAS WCID NO. 2
PLAN OF BORINGS

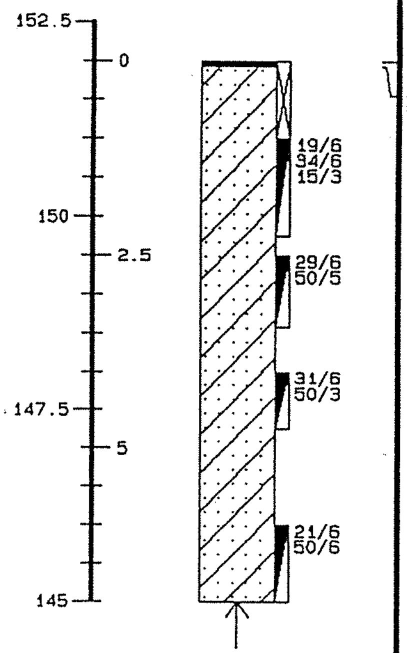
JOB NO. AAA90-054-00 DATE - NOVEMBER 1990 FIGURE 2

LOG OF BORING

BORING R-1

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-1 Sta. No. 21+26 Elevation: 152 ft. (Ref.)
Date Drilled: 10-29-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-29-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		CLAYEY SAND, red-brown & gray with some clay, sand & gravel deposits		5	46	21	25	21			



More clay; less and smaller gravel beginning @ 4.5 feet.

-Refer to text for discussion of boring contents.

Figure No. 3

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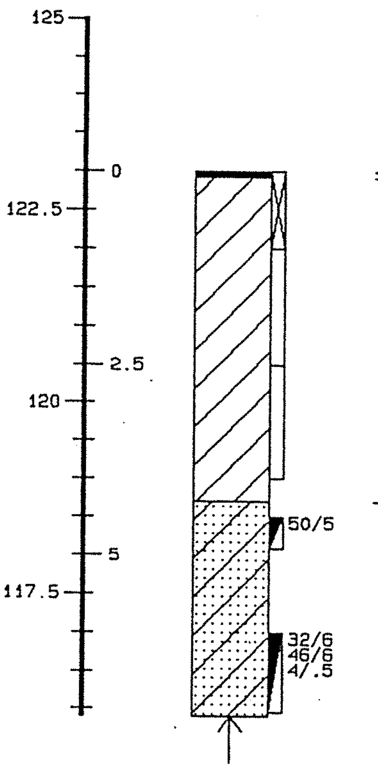
LOG OF BORING

BORING R-2

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-2 Sta. No. 24+00 Elevation: 123 ft. (Ref.)
Date Drilled: 10-29-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-29-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		SANDY CLAY, red-brown with iron stains & trace gravel									4.5+
			121	12	45	20	25	48	10		4.5+
	50/5	CLAYEY SAND, red-tan & gray with iron stains, sand & gravel deposits									
	32/6 46/6 4/.5										



-Refer to text for discussion of boring contents.

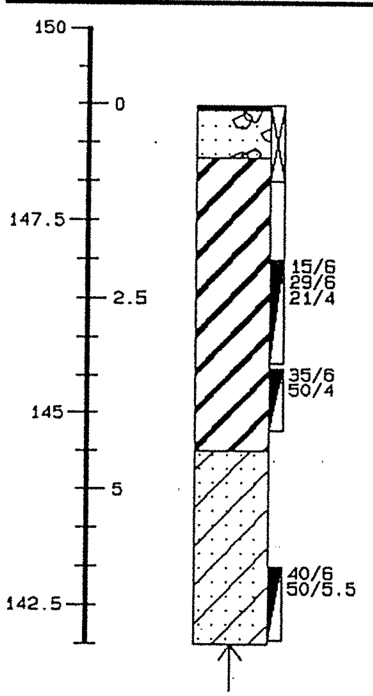
Figure No. 4

LOG OF BORING

BORING R-3

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-3 Sta. No. 19+00 Elevation: 149 ft. (Ref.)
Date Drilled: 10-29-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-29-90

ELEV / DEPTH — SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
SILTY SAND, red-brown w/ gravel & clay deposits									
CLAY, red-brown & gray with iron stains and some sand & gravel		17	62	20	42	44			
CLAYEY SAND, red-brown & gray with little gravel & sand deposits		9	51	25	26	22			

-Refer to text for discussion of boring contents.

Figure No. 5

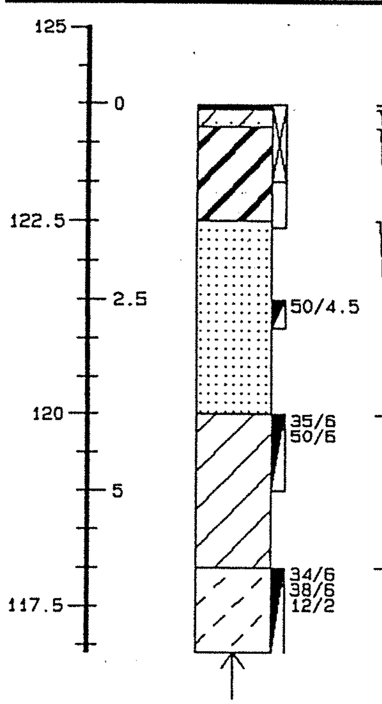
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-4

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-4 Sta. No. 15+00 Elevation: 124 ft. (Ref.)
Date Drilled: 10-29-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-29-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
124 / 0		ASPHALTIC CONCRETE									
		CLAYEY SAND, red with trace gravel									4.5+
		CLAY, red-brown & gray with iron stains and some sand & gravel									
	50/4.5	SILTY SAND, red-tan with trace gravel & clay deposits									
	35/6 50/6	SANDY CLAY, red-tan & gray with iron stains & sand deposits									
	34/6 38/6 12/2	SANDY CLAY, light gray with iron stains & sand deposits		15	49	21	28	63			



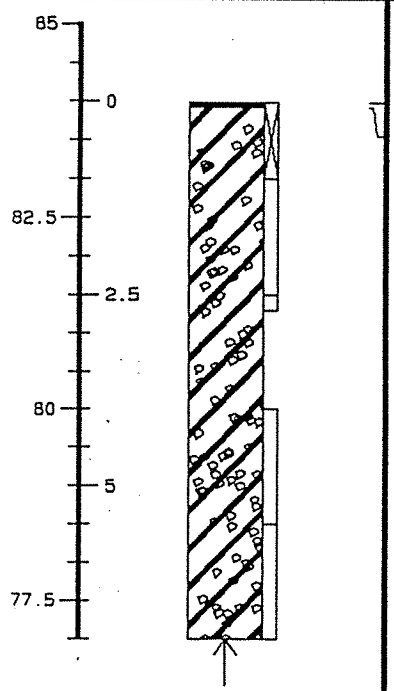
-Refer to text for discussion of boring contents.

Figure No. 6

LOG OF BORING

BORING R-5

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-5 Sta. No. 11+00 Elevation: 84 ft. (Ref.)
Date Drilled: 10-29-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-29-90



ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		CLAY, brown with iron stains, some gravel & silty sand seams									4.5+
			100	20	64	25	39	64	3.8		4.5+
											4.5+
											4.5+

-Refer to text for discussion of boring contents.

Figure No. 7

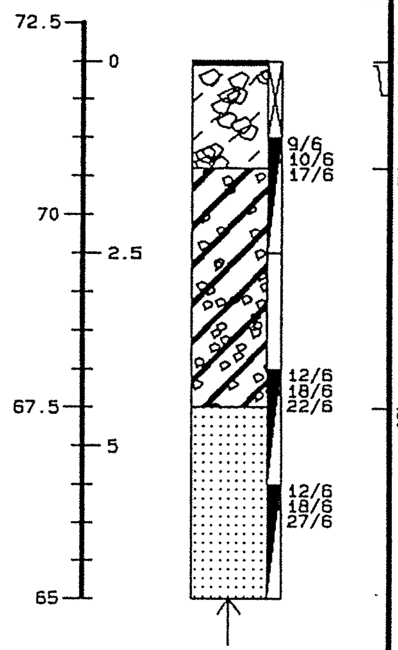
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-6

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-6 Sta. No. 5+00 Elevation: 72 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		CLAYEY SAND & GRAVEL, brn									
		CLAY, brown with iron stains, some gravel & silty sand seams		15	43	19	24	66			4.5+
		SILTY SAND, tan with iron stains									



-Refer to text for discussion of boring contents.

Figure No. 8

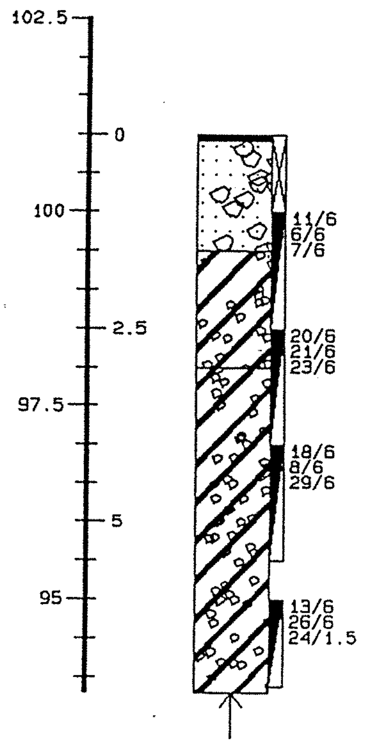
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-7

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Kamakoa Lane) Job No: AAA90-054-00
Boring No.: R-7 Sta. No. 0+00 Elevation: 101 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH — SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
SILTY SAND & GRAVEL, brn.									
CLAY, brown with iron stains, some gravel & silty sand seams									
CLAY, gray with iron stains, sand & gravel		7	48	18	30	18			

-Refer to text for discussion of boring contents.

Figure No. 9

Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-8

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2

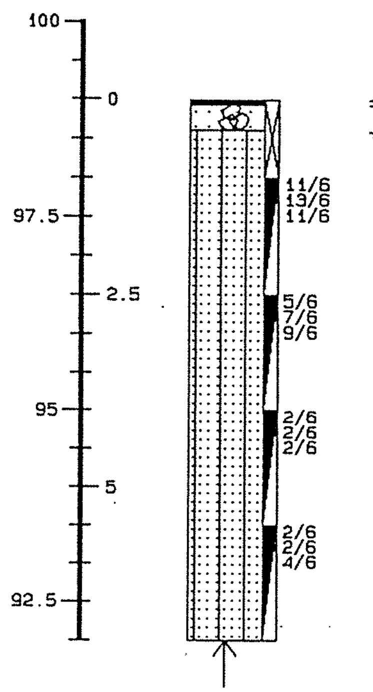
Location: Tahitian Village (Akaloa Lane) Job No: AAA90-054-00

Boring No.: R-8 Sta. No. 0+00 Elevation: 99 ft. (Ref.)

Date Drilled: 10-30-90 Scale: 2.5

Drill Methods: HSA/SHELBY/SPT Water Encountered: No

Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		SILTY SAND & GRAVEL, brn.									
		SILTY SAND, light brown with brown clay layers (Alternating)									
				17	25	14	11	57			

-Refer to text for discussion of boring contents.

Figure No. 10

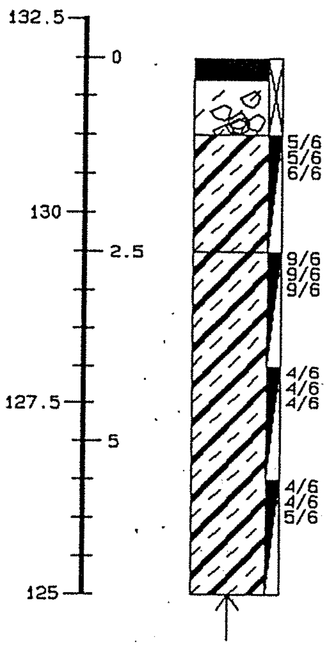
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-9

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Akaloa Lane) Job No: AAA90-054-00
Boring No.: R-9 Sta. No. 3+00 Elevation: 132 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		CLAYEY SAND, brown with some gravel (FILL)									
	5/6 5/6 6/6	CLAY, brown & tan with trace gravel (FILL)									
	9/6 9/6 9/6	CLAY, red-tan & gray with iron stains, sand & gravel (FILL)									
	4/6 4/6 4/6			12	48	19	27	35			
	4/6 4/6 5/6										



-Refer to text for discussion of boring contents.

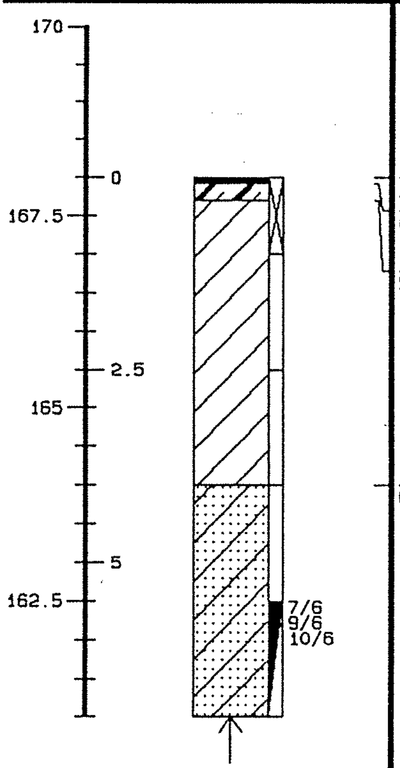
Figure No. 11

LOG OF BORING

BORING R-10

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Akaloa Lane) Job No: AAA90-054-00
Boring No.: R-10 Sta. No. 5+00 Elevation: 168 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
CLAY, brown, tan & gray with sand & gravel									
SANDY CLAY, brown & gray with iron stains	114	15	30	14	16	53	2.5		4.5+
CLAYEY SAND, brown & gray with iron stains									4.5+

-Refer to text for discussion of boring contents. Figure No. 12

LOG OF BORING

BORING R-11

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2

Location: Tahitian Village (Akaloa Lane) Job No: AAA90-054-00

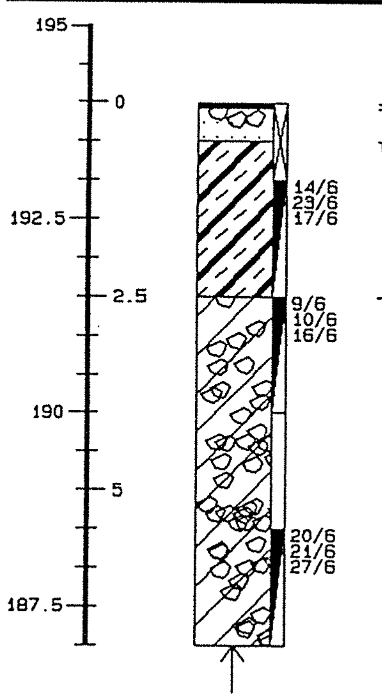
Boring No.: R-11 Sta. No. 7+00 Elevation: 194 ft. (Ref.)

Date Drilled: 10-30-90 Scale: 2.5

Drill Methods: HSA/SHELBY/SPT Water Encountered: No

Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
SILTY SAND, brown with some gravel									
CLAY, light brown with sand & gravel									
SANDY CLAY, red, tan & gray with iron stains sand & gravel									
		7	34	13	21	33			4.5+

-Refer to text for discussion of boring contents.

Figure No. 13

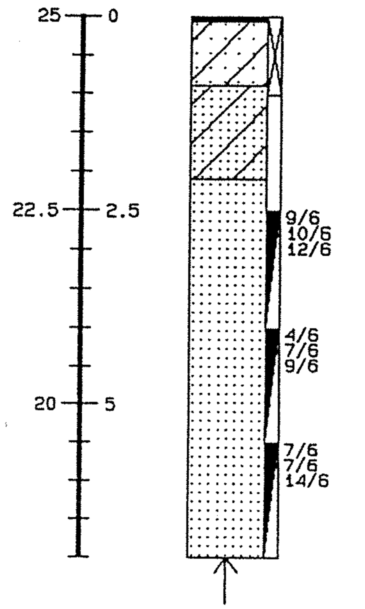
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-12

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Tahitian Drive) Job No: AAA90-054-00
Boring No.: R-12 Sta. No. (-) 2+00 Elevation: 25 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
		ASPHALTIC CONCRETE									
		CLAYEY SAND, red with sand & gravel									
		SANDY CLAY, red-brown & with iron stains & sand deposits									4.5+
		SILTY SAND, light tan -clay deposits @ 6.5'-7'									
				4	NP		NP	17			



-Refer to text for discussion of boring contents.

Figure No. 14

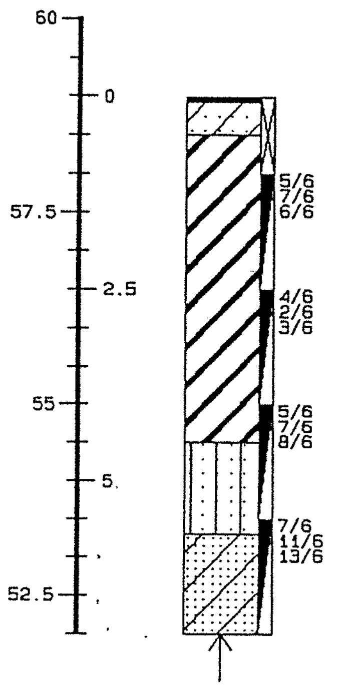
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-13

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Tahitian Drive) Job No: AAA90-054-00
Boring No.: R-13 Sta. No. 0+25 Elevation: 59 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH | SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
CLAYEY SAND, red with sand & gravel									
CLAY, red with some sand & gravel some sand & gravel		19	56	25	31	41			
SILTY SAND, dark brown with clay deposits & some gravel									
CLAYEY SAND, red & tan with iron stains & sand layers									

-Refer to text for discussion of boring contents.

Figure No. 15

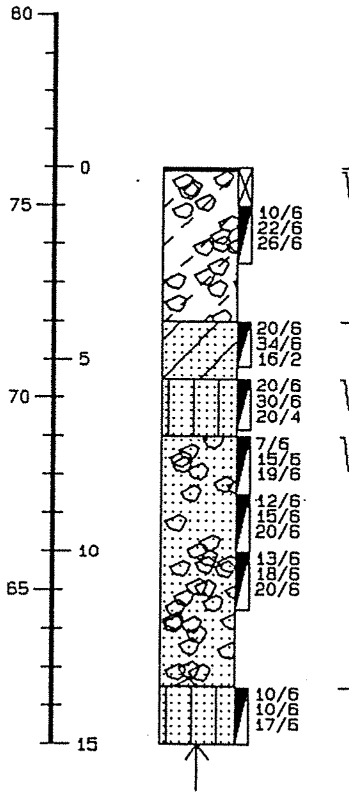
Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-14

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Tahitian Drive) Job No: AAA90-054-00
Boring No.: R-14 Sta. No. 3+00 Elevation: 76 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90

ELEV / DEPTH | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
CLAYEY SAND, red-tan with some gravel									
CLAYEY SAND, lt.red & tan with iron stains & sand layers		8	28	19	9	42			
SILTY SAND, light red & yellow-tan									
SILTY SAND, yellow-tan with trace gravel		8	NP		NP	19			
SILTY SAND, light red & yellow-tan									

-Refer to text for discussion of boring contents.

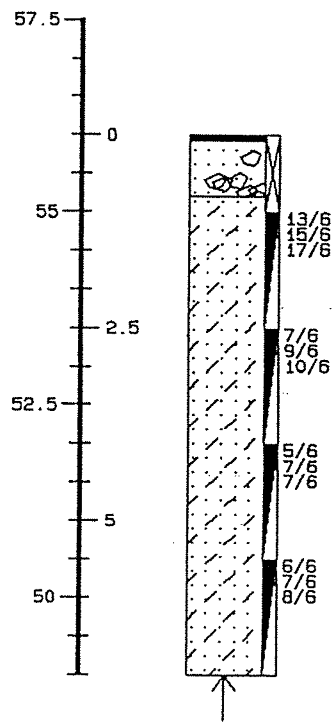
Figure No. 16

Raba-Kistner-Brytest Consultants, Inc.

LOG OF BORING

BORING R-15

Project: ROAD AUTHORITY IMPROVEMENTS - BASTROP COUNTY, TEXAS WCID#2
Location: Tahitian Village (Tahitian Drive) Job No: AAA90-054-00
Boring No.: R-15 Sta. No. 7+20 Elevation: 56 ft. (Ref.)
Date Drilled: 10-30-90 Scale: 2.5
Drill Methods: HSA/SHELBY/SPT Water Encountered: No
Depth to - Water: Caving: NA Date Checked: 10-30-90



Material Description	DD pcf	MC %	LL %	PL %	PI %	-200 %	Qu tsf	RQD %	PP tsf
ASPHALTIC CONCRETE									
SILTY SAND, red-brown with some gravel									
SILTY SAND, dk.tan & tan with iron stains & clayey sand layers									
		7	NP		NP	19			

-Refer to text for discussion of boring contents. Figure No. 17

Raba-Kistner-Brytest Consultants, Inc.

Legend:

Symbol:	Description:
	ASPHALTIC CONCRETE
	SANDY CLAY, red-brown with iron stains & trace gravel
	SILTY SAND, red-brown w/ gravel & clay deposits
	CLAYEY SAND, red with trace gravel
	SANDY CLAY, light gray with iron stains & sand deposits
	CLAYEY SAND & GRAVEL, brn
	SILTY SAND & GRAVEL, brn.
	CLAY, gray with iron stains, sand & gravel
	CLAY, brown & tan with trace gravel (FILL)
	SANDY CLAY, red, tan & gray with iron stains sand & gravel
	SILTY SAND, yellow-tan with trace gravel
	Bulk sample taken from auger flights
	Undisturbed thin wall Shelby tube
	Depth of water at the time of drilling.

Symbol:	Description:
	CLAYEY SAND, red-brown & gray with some clay, sand & gravel deposits
	CLAYEY SAND, red-tan & gray with iron stains, sand & gravel deposits
	CLAY, red-brown & gray with iron stains and some sand & gravel
	SILTY SAND, red-tan with trace gravel & clay deposits
	CLAY, brown with iron stains, some gravel & silty sand seams
	SILTY SAND, light brown with brown clay layers (Alternating)
	CLAY, red-tan & gray with iron stains, sand & gravel (FILL)
	SILTY SAND, dark brown with clay deposits & some gravel
	SILTY SAND, dk.tan & tan with iron stains & clayey sand layers
7/6 5/6	Standard penetration test. 140 lb. hammer dropped 30"
	Depth to which the boring caved.
	Boring terminated

Project No. AAA90-054-00

Figure No. 18

Raba-Kistner-Brytest Consultants, Inc.

Notes:

1. These logs are subject to the limitations, conclusions, and recommendations in this report.

2. Results of tests conducted on samples recovered are reported on the logs. Abbreviations used are:

DD = natural dry density (pcf)	MC = natural moisture content
LL = Liquid Limit	PI = Plasticity Index
-200 = percent passing #200 sieve (%)	Qu = unconfined strength (tsf)
PR - Percent Recovered (%)	RQD - Rock Quality Designation
PP = pocket penetrometer	

TERMS DESCRIBING CONSISTENCY, CONDITION, OR TEXTURE

Terms used in this report to describe soils with regard to their consistency or condition are in general accordance with the discussion presented in Article 45 of SOIL MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, using the most reliable information available from the field and laboratory observations. Terms used to describe soils according to their texture and grain size are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM (USCS).

A P P E N D I X

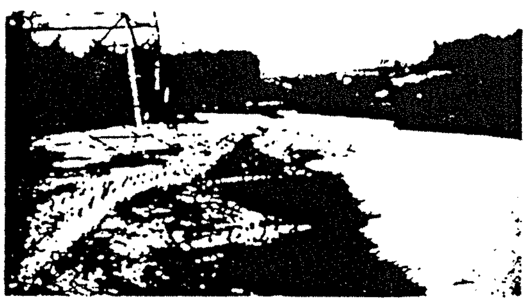
Soil Bioengineering at Raccoon Creek

CASE STUDY: Georgia Power Company Transmission Tower Raccoon Creek, Paulding County, Georgia
Drainage Area: approx. 30 sq. Miles
Average Flow: 45 cubic feet per second

Soil bioengineering work at Raccoon Creek focused on stabilizing a transmission tower foundation threatened by bank erosion due to frequent floods with flows 10 to 15 feet above normal. Previous measures, including sheet piling, riprap and stream realignment, had not been effective; their failure had deposited more than 1000 cubic yards of fill and rock into the stream.

Working with a hydrologist/engineer (Rindt McDuff Assoc.), we designed a system of brushmattresses, live cribwalls, and crib booms (or dikes) to stabilize the bank and divert water to the center of the stream. Within 30 miles of the site, we located black willow and red twigged dogwood, which the adjacent landowners gave permission to harvest for no cost. We provided daily supervision for the local contractor, who used unskilled workmen to harvest the live material and install the systems. First, untreated timbers were used to construct the cribbing, which was filled with layers of live brush. Brush mattresses were then secured above the cribs with live fascine bundles. The live

Sheet piling and riprap fail to prevent scour at the base of a 500 kv transmission tower. Raccoon Creek, Paulding County, Ga.



Crib deflectors, cribwalls, brush packing and brush mattresses shortly after installation on the same site.

A dense thicket of willow effectively protect the tower from bank failure.

stakes were tamped in above the mattress to give the system deep rooting and consolidation into the parent slope.

A week after construction, the site flooded with no damage to the installation. In fact, flood water, rather than further destroying the bank, now deposits silt into the brush. This rebuilds the bank. The design takes advantage of the live qualities of the land. It will sustain itself as it continues to move, to change, and to grow. This project clearly demonstrates the enormous potential in this country for the soil bioengineering/biotechnical techniques already established in Europe. This distinctive approach can help solve many problems associated with moisture and shallow mass wasting of soils. These systems are compatible with classical engineering, but on sites where engineering solutions do not function well, are uneconomical, or are visually incompatible with the surrounding environment, my knowledge and experience with these techniques have provided an exciting, responsible and naturally beautiful approach to land stabilization.

Robbin B. Sotir is President of Soil Bioengineering Corporation International and Biotechnical Land Stabilization Limited, Inc., in Marietta, Georgia. Robbin has a 1974 degree in landscape architecture from the University of Guelph, and credits much of her knowledge, interest, and commitment to the subject to Dr. Hugo Schiechtl of Innsbruck, Austria.

A CUMBERLAND GAP TUNNEL PROJECT HIGHLIGHT:

Controlled Testing of New Construction Technologies

Workers on the Cumberland Gap Tunnel Project site place live fascines (bundles of living plant material) on the live boom, a soil bio-engineering project which is being constructed to redirect the stream of Little Yellow Creek. Alton Simms, (left, background), Vice President of the Soil Bio Engineering Corp., and Barry Carnes, field inspector with Vaughn & Melton, oversee the work.

SOIL BIO ENGINEERING

The Cumberland Gap Tunnel project is one of the first applications of soil bio-engineering in federal highway construction, and it is also the first project in a national park. The methods used in soil bio-engineering have been used for centuries in Europe, according to Alton Simms, Vice President of the Bio Engineering Corporation of Marietta, GA. Simms stated that three-quarters of the European country, Holland, is land reclaimed out of the North Sea. "This is how they did it," said Simms. He added that these methods were also used in the U.S. in the early 30's by the Soil Conservation Service, but were abandoned, mostly because of the "high tech" solutions that had started to come about since World War II. Now, this old way of stabilizing land using natural materials is again gaining recognition as the technology has been further developed and refined in the U.S.

The methods of bio-engineering use native plant materials cut in the vicinity of the project. The cuttings must be capable of rooting themselves, and work must be done during the plant's dormant season. After the system takes hold, it requires very low to no maintenance, and is capable of self repair. The systems used are site specific, according to Simms.

"You can't really take any one of these things and put it someplace else without considering where you're putting it and why, and what you're trying to achieve," he stated. Some of the bio-engineering systems being used on the Cumberland Gap Tunnel Project are: live stakes, live fascines, brush mattressing, joint plantings and a live boom. Live stakes are sticks that have been cut and pruned from living plant material. Live fascines are bundles of live cut branches grouped together in a sausage like structure with the growing tips all oriented in the same direction. A brushmattress is a construction of living branches placed close together to form a

Joint plantings are live stakes tamped in between riprap rocks. A live boom is a dyke or groin-like structure which is built of cut living plant material. It is used to divert and/or control water flow.

The way these bio-engineering systems work is really quite simple. In the case of the joint plantings, the live stakes root themselves, making a live root network that functions to consolidate the soil underneath the rock and transpire the moisture out of it. In cases of an overwash, the stream bank that has been prepared with joint planting will dry out much faster than a natural bank would. The root system of the native willow used in the Cumberland Gap project are much deeper than a grass, legume or weed, and they will grow into bushes, eventually covering the rock.

Within two to three years a natural stabilization of the soil as well as a natural ground cover should

A live boom was constructed at the project site for the purpose of redirecting Little Yellow Creek. The live boom is made of many layers of live fascines placed at right angles to each other and staked down. Riprap rock was hand placed on the face of it, which will take the brunt of the force of the stream. Although living material is used throughout the structure, the material below the stream bed is intended to rot, promoting life for that which is above.

The live boom is intended to function as a living structure. According to Simms, one major limitation of these systems is that they are vulnerable to damage initially because they have not yet developed roots. Soil bio-engineering is also very labor-intensive work, but its benefits are lasting. "once it starts to take root and grow, there's no stopping it," stated Simms.

CREEK CURRENTS
NEWSLETTER OF THE URBAN CREEKS COUNCIL

OLUME 2, NO. 3

AUTUMN ISSUE, 1987

SOIL BIOENGINEERING, AN ALTERNATIVE TO THE USE OF CONCRETE AND RIPRAP ON DIFFICULT STREAM BANK PROBLEMS

Robbin Sotir, president of Soil Bioengineering Corporation, tlanta, Georgia, presented a slide show in Oakland this fall to embers of the Urban Creeks Council, staff of the East Bay egional Parks District, visitors from the University of California, erkeley, and the Alameda County Flood Control District. Ms. otir was brought to Oakland at the request of the Urban reeks Council by the California Departments of Water esources, and Parks and Recreation to introduce the methods stream restoration by soil bioengineering techniques and escribe a restoration plan for Sausal Creek. Robbin did some eliminary evaluation of some erosion and unstable bank oblems in a portion of Sausal Creek. Ms. Sotir studied in ustria with Hans Schiechtl, an internationally known expert in osion control. Schiechtl has synthesized and developed chniques of the system referred to as "Bioengineering." In ontrast to conventional engineering "hard-fix" solutions that npose upon natural processes, bioengineering uses natural ocesses to allow problem situations to repair themselves. By ilizing a combination of living plants and inert materials, a ynamic self-repairing system can be constructed.

Ms. Sotir presented a slide show illustrating some of the techiques devised by Schiechtl and now used by Sotir in her interational consulting business. She illustrated the re-establishment f creek bank vegetation using live stakes of plants (such as illow) that easily root. Some bank restoration designs use ood or rock as a temporary structure for the purpose of suporting the bank until the vegetation matures and provides the ong term stability. Illustrations were presented of slope reegetation using brush layering and live fascine methods. Brush yering involves laying live brush branches in terraced trenches long a slope. By using species that readily root, the new plants vill eventually produce a root network that will hold the soil. nitially, the cuttings slow water and soil movement down ope. In areas where soil water saturation has the potential to ause landslides, the planting of water-loving plants with this nethod can reduce the excess load of water through the rapid vapo-transpiration typical of these plants.

Live fascine, commonly referred to as wattling in the U.S., uses bundles of live branches which are partially buried in trenches. These perform similar functions to the brush layering technique. Bioengineering techniques are generally more labor-intensive as opposed to capital-intensive concrete and riprap solutions more typically used. In many cases it is the best solution where access is difficult, and environmental, aesthetic considerations and economy are important. Ms. Sotir has been promoting her "soft-fix" solutions to stream bank and slope problems for a number of years and has gained an international reputation. Her clients include Georgia Power and Light and several districts of the Army Corps of Engineers.

Submitted by Michael Marangio

Members of the Urban Creeks Council, staff of the East Bay Regional Parks District, visitors from the University of California, Berkeley, and the Alameda County Flood Control District meet with Soil Bioengineer, Robbin Sotir at Sausal Creek, Oakland.

E&S Bulletin

Number 24 | Virginia Erosion & Sediment Control Program | Fall–Winter, 1984–85

"Soil Bioengineering" gaining steam

Have you ever noticed that no matter how hard you try to ignore a good idea, it simply won't go away?

In a national sense, that seems to be what is happening in the U.S. regarding "soil bio-engineering." At the turn of the 20th century this country almost completely abandoned this science in favor of hi-tech, concrete and stone structural alternatives. Now this pesky little good idea is back and gaining steam daily.

In short, soil bioengineering is the practice of combining live plant materials (usually woody) with "dead" structural measures in order to stabilize a slope or a bank. The dead material (wood, brush, stone, etc.) is usually installed to support the live materials during establishment. Often the dead material is designed to rot away. The live parts, of course, are meant to reinforce soil, block its movement and slow water velocity.

While soil bioengineering is not new (Europeans were using it in the 16th century), its modern methods are sophisticated. Native plant cuttings are criss-cross layered and anchored in a way that they take root and grow. The living material, once established, forms an almost indestructible network that protects steep slopes and banks from erosion.

Living Advantages

A biotechnical erosion control system has many advantages over structural measures. First of all, no matter how well earth is sealed, it still moves. A living stabilization system can also move and will absorb the movement of soil. Conventional structural systems must eventually break up as the natural surface beneath changes.

Robbin Sotir, president of Soil Bioengineering Corporation put it this way: "Land is alive. It is always moving so it makes sense to use a live, dynamic system to protect it."

A live system also is normally self repairing whereas a structural system degrades with time. Rather than falling apart, a live system expands and becomes more structurally sound with time. In this way, live systems are actually more permanent than conventional structures.

Live, vegetative structures exhibit another engineering advantage over conventional systems. Because vegetation transpires, water is absorbed from the soil by roots and is pumped back into the atmosphere. This removal of soil moisture reduces the weight of the soil mass thereby lessening the chance of slope failure.

Besides Engineering

European countries have been sold on the concept of soil bioengineering for centuries. Reasons for this vary but they are not always based on pure, logical engineering advantages. In fact, one of the major reasons living materials are preferred to static, structural measures is that they just plain look better. In many European projects, banks are actually lined with flowering plants, such as the Iris.

The live system improves water quality and provides cover and food for fish and wildlife. On banks, biotechnical systems serve as filters which catch eroded soil from upstream and this actually

- *continued p. 2*

"Land is alive. It is always moving so it makes sense to use a live, dynamic system to protect it."

Biotechnical "a more responsible" way?

- continued

builds a stronger, expanding bank rather than simply a static one.

Costs for live systems seem to be very competitive. On an erosion control project in Atwood Water Park, Monticello, Ga., an estimate of $275,000 was given for conventional structures. The cost using soil bioengineering techniques was less than one-third that figure and, although evaluation of the site is ongoing, success is predicted.

Most of the costs involved in soil bioengineering are tied up in unskilled labor and management. Little or no heavy equipment is required and energy costs are correspondingly low. Since cuttings of native plants are used, they are obtained nearby so transportation costs are very low. The plants also are usually obtained at no cost.

Sotir said her company has never paid for a single cutting. She said, "People are often happy to have you take cuttings from their lands because their vegetation improves the next year." She also said that they seldom use fertilizers on their projects.

Disadvantages

Of course, live systems have disadvantages. Soil bioengeering requires good management and is labor intensive. Biotechnical elements with names like fascines, wattles, brush mattresses and live soft gabions must be installed in precisely the right place and position. Live systems also can only be installed during the dormant season, from January through March.

"I am not offering this as a panacea," said Sotir, adding, "In fact, it doesn't work everywhere. It works in so many places that I think it's a shame we're not using it more."

The biggest obstacle facing biotechnical stabilization may not be any of those listed above. Perhaps the greatest disadvantage it faces here is that it is "new." While the systems have been used here before and have been applied successfully elsewhere for some time, the concept is practically new in America and minds will have to accept it before its potential can be achieved.

"....More Responsible"

Sotir said that aside from her belief that soil bioengineering is more permanent and "environmentally aesthetic, it is possibly a more responsible way to protect land." After all, the erosion-controlling system eventually leaves the land in a natural state and nature very seldom behaves irresponsibly.

Hugo Schiechtl, one of the world's most experienced bioengineers, was once asked how he knew when a biotechnical project was done. He said, "A bioengineering project can be regarded as complete only when it is no longer obviously man-made, but appears rather to be a work of nature."

This may take three or four years, of course, but maybe it's worth the wait.

IECA REPORT

Dedicated to protecting, reclaiming and restoring land disturbed by man

Bulletin of international erosion control association

Vol. 18, No. 3 Fall 1986

Bulletin of the International Erosion Control Association

An Introduction to . . .
Soil Bioengineering

Robbin B. Sotir

Soil Bioengineering/biotechnical Land Stabilization is an applied science which combines biological, engineering and ecological concepts to construct living structures. It is a highly developed and distinctively different technology that offers an alternative to solving many shallow mass waste erosion and sedimentation problems, often with more immediacy and permanence than conventional stabilization methods. It is a wonderful, exciting method of land stabilization. In addition, these live systems work well with classical conventional engineering, often providing a more permanent, aesthetic, and environmentally responsible product.

The term, "biological engineering," was first formulated at the end of the 1930's and since then has come to be used to cover aspects of classical works which emphasize techniques based on the science of biology, particularly using the knowledge gained through biological and ecological studies of landscapes in the securing of unstable lands. Characteristic of these measures is that plants or parts of plants are utilized as living construction materials which, in the course of growing together with earth, rock and groundwater, afford the greatest contribution to the permanent protection and preservation of the whole.

Soil Bioengineering may be used in a wide range of situations including the revegetation in the repair of highway roadsides, cut and fill slopes, dredge disposal sites, streambanks, floodplains, dams, transmission line right-of-ways, gullies, shorelines, bluffs, earthslides, slumps, stream bank erosion, and streambed degradation. These systems may be used on mining, transportation and transmission corridors, recreation, forestry, commercial, agricultural, wildlife, and wetlands habitats.

Live systems, as is true of any system, are not usable for all land instability problems, but are very useful in areas where classical engineering may be uneconomical, unsuitable, or ineffective. Soil Bioengineering goes a step beyond classical engineering. It investigates the live qualities of land and addresses them with living structures. This is the central and perhaps the most important concept in understanding something about Soil Bioengineering. Land is always changing and moving, to different degrees of course, but it is always in some state of change or with that potential. The simplest example that can be cited is that of moisture. Moisture often represents one of the greatest land instability problems, whether this is associated with cut and fill sites or banks on river and stream systems. So it makes sense to respect that quality and respond to it with live dynamic, flexible, self-repairing, natural units, which are sensitive and work with the fragile balance of land and water.

Responding to the land's changing nature, biotechnical methods offer a live approach intended to restore land. Rather than creating an artificial static state by imposing rigid systems, soil bioengineering enables the land to recover to a natural state which will become as self-supporting and as self-maintaining as possible. Biotechnical methods follow the principles of nature by utilizing the inherent strengths of the site to protect itself, rather than addressing only the weaknesses in the site. Dr. Hugo Schiechtl, a prominent Austrian soil bioengineer, has said:

"Man must learn to protect himself and his environment by calling in nature as his working partner."

Soil Bioengineering uses largely native plants collected in the immediate vicinity. This

Three years after construction at Racoon Creek.

assures that the plant material will be well adapted to the specific site conditions. While a selected few species may be installed for immediate protection, the ultimate goal is the natural invasion of a diverse plant community. Typically, pioneer plants are installed. Herbaceous and (especially) woody pioneer species able to root from cuttings form the major portion of biotechnical systems. These are intended to meet the needs of the land and are intended to stabilize and improve the soils to prepare the site for natural invasion.

Intensive site assessment, careful species selection, exacting design and proper installation of these fragile live units are very important to the success of Soil Bioengineering projects. What may seem most unique to you, however, will be the methods of installation.

Soil Bioengineering uses plant parts as the major structural or engineering component. Unrooted live vegetation installed in various systems acts as structural members, which provide direct mechanical soil stabilization, covered soil protection and water velocity reducing units. In time, shoots and roots develop to form a permanent vegetative cover and root reinforcing matrix. Live plants excel in stabilizing soils. Top growth intercepts raindrops, filters sediments out of runoff, enriches the soil and increases infiltration. Roots mechanically reinforce and restrain soil by providing arching and buttressing structures.

Soil Bioengineering has been used worldwide for hundreds of years. Today it is used in over 30 countries in the world. Some of the first written works of this type of construction date back to the 1500's. It had some of its first beginnings in the mountain areas of Europe, where avalanche and mud slides were ever present, and on the mountain rivers which were used for navigation. This live system was used in the United States in the 1930's and 1940's by the Soil Conservation Service in an abbreviated form. After World War II, these systems were abandoned as high tech solutions were developed to solve problems. Today, with high energy costs, with depleting resources, with the recognition that all problems *can not* be solved using conventional methods alone and with the new environmental land ethic, Soil Bioengineering/Biotechnical Land Stabilization is experiencing a rebirth as a viable technology. The Europeans recognized the live qualities of land and water and continued to use and develop this technology. They recognized that many problems could not be solved with conventional engineering methods alone. Soil bioengineering, being a live system, investigates both the technical and the biological problems in the land and solves them in a more complete and permanent manner. Unlike inanimate parts, they are completely live dynamic systems capable of self-repair. Even under very stressful conditions, land can be kept self-supporting. This has been substantiated by research that has been done and is ongoing in Europe, Japan and the United States. Correctly chosen biotechnically capable plants can stabilize certain land instability problems through soil particle consolidation and can remove water through transpiration. Research has proven that the development of strong intensive and extensive root systems consolidates soils into unitary masses. The flexible root fibers are imbedded around the soil particles. Live roots will promote a friction transfer along their length which will serve to add strength to the soil system. Roots, by their very live nature, respond to the stress conditions at the site. These could be topographic or hydrologic. They respond to these stresses in a self-corrective manner. They have built-in bioadaptive processes. Root systems can reshape and reorientate. This capability further serves to increase the stability of the soil in the overall slope. Vegetative slopes can modify the moisture condition of the soil through transpiration.

It is a more complicated, sophisticated and complete approach which is sensitive and realistic in that *it follows the principles of Nature.*

This effective live system is labor-skill intensive rather than capital-energy intensive. It is a practical, cost effective, rapid recovery system that offers low long term maintenance and beautiful products.

Soil Bioengineering *works closely with nature to cause land to become its own self-supporting structure.* It is a responsible and sound approach to land stabilization, which *produces products that grow stronger and more beautiful with age.*

Robbin Sotir, the president of Soil Bioengineering Corporation, of Marietta, Georgia has successfully completed over 140 projects in North and Central America, Europe, and S.E. Asia. She has studied specialized European soil bioengineering techniques, and is probably the only European trained soil bioengineer practicing in the United States. She has developed comprehensive soil bioengineering/biotechnical construction specifications for the North American continent.

UTILITY AGENCIES

		CONTACT	PHONE NO.
1.	BASTROP COUNTY WATER CONTROL IMPROVEMENT DISTRICT NO. 2	Mrs. Sharon Eaves General Manager	512/321-1688
2.	SOUTHWESTERN BELL TELEPHONE Austin, Texas	Mike Prokop Mgr. Eng. Design	512/870-5214
3.	BLUEBONNET ELECTRIC COOP. P.O. Box 731, Bastrop, Texas	Wayne Long Service Manager	512/321-3917
4.	BASTROP CABLEVISION CO. 1112 Main St., Bastrop, Texas	Barry Threadgill Owner/Service	512/321-6864 512/321-0275

ATTACHMENT NO. 4

BASTROP COUNTY WATER CONTROL IMPROVEMENT DISTRICT NO. 2
MASTER ROADWAY PLAN IMPROVEMENTS - REVISED 11/25/91

STREETS BY EXISTING CONSTRUCTION

LEGEND:

A = Arterial
MA = Major Arterial
C = Collector
R = Residential

1 = Approaching City/County Standards
2 = Weathered Asphalt with Failures
3 = Heavily Weathered with Overgrowth
4 = Disintegrated Asphalt on Gravel
5 = Undeveloped, Not in Use

LINEAL FOOTAGE	STREET NAME	BLOCK #(S)	PROPOSED CLASS	EXISTING CONST.
	CLASS 1			
850	HILO COURT	19	R	1
1,760	KONA	3-4-5	C	1
1,440	KONA DRIVE	6-7-8-10-11	C	1
800	KUKUI COURT	19	R	1
2,650	MAUNA KEA LANE	12-16-17-19	A	1
700	MAUNA KEA LANE	12-16-19	A	1
1,050	MOKALAU DRIVE	19	R	1
5,700	RIVERSIDE DRIVE	3-15	MA	1
2,350	TAHITIAN DRIVE	3-16	MA	1
3,050	TAHITIAN DRIVE	11-20-23-24	MA	1
2,250	TAHITIAN DRIVE	10	MA	1
2,800	TAHITIAN DRIVE+(1000'New Co.)	8-9-10-13-15-16	MA	1
25,400	TOTAL LINEAL FEET - CLASS 1			
	CLASS 2			
900	AHUMOA DRIVE	13-14A	R	2
450	AKALA LANE	3-4	R	2
1,250	AKALOA DRIVE	9-10	A	2
5,070	AKALOA DRIVE	1-2-3-6-7-8-11-12-15	MA	2
2,600	AKALOA DRIVE	1-2-15-16	MA	2
1,100	ALOHA LANE	16-17-18	C	2
1,150	ALOHA LANE	16-17-19	C	2
850	AWEHI COURT	11	R	2
550	CORPORATE DRIVE	20-21-23	C	2
700	HAWEA COURT	19	R	2
1,500	HELEAKALA CT	16	R	2
650	HOMONU COURT	17	R	2
650	HONOPU DRIVE	17-16-19-12	R	2
1,030	HONOPU DRIVE	17-16-19-12	R	2
280	HULU COURT	12-19	C	2
400	IAO COURT	5	R	2
1,000	INDUSTRIAL	21-22-23-24	C	2
3,150	KAANAPALI LANE	29-27-28-26	A	2
2,050	KAANAPALI LANE	10	MA	2
2,050	KAANAPALI LANE	4-3-2-16-13-8-17	A	2
4,350	KAANAPALI LANE	9-13-14A-14B	A	2
1,740	KAAPAHU DRIVE	10-11	R	2
800	KAENAPAPA	16	R	2

2,930	KAHALULU DRIVE	5-6-7	R	2
750	KAILUA LANE	7-6	R	2
1,600	KAINALU LANE	5-6-7-17	R	2
2,700	KAMAKOA	8-9-10	C	2
400	KANI LANE	1-2	R	2
400	KIMO COURT	10	R	2
1,200	KOALI DRIVE	8-13	R	2
500	KOHOLA LANE	4-5	R	2
260	KOI COURT	19	R	2
160	KOU CT	14	R	2
250	KUIKUI COURT	1	R	2
220	LAE COURT	19	R	2
400	LEI COURT	10	R	2
2,300	MAHALO COURT	12	C	2
180	MAHALO COURT	19	C	2
2,000	MAHALUA LANE	12-19	C	2
500	MAKAHA DRIVE	10	C	2
5,100	MAKAHA DRIVE	11-12-16	C	2
750	MAUNA LOA LANE	1-20-22	C	2
950	MOKOLEA LANE	7-8	R	2
450	MOKU COURT	16	R	2
360	MOKUAUIA COURT	27	R	2
2,500	MOLOKINI DRIVE	4	R	2
900	NAILALELE LANE	5-6-7-8	R	2
950	OLAA DRIVE	17	C	2
250	OLAI CT	12	R	2
750	PAHALA COURT	17	R	2
1,640	PAHOIKI LANE	14A-14B	R	2
850	PAPALOA LANE	7-8	R	2
760	PARKWAY	20-21-22	C	2
220	PELE COURT	8	R	2
350	PULEHU COURT	13	R	2
400	PUNA LANE	2-3	R	2
280	PUU COURT	9	R	2
600	RIVERSIDE DRIVE	12	A	2
450	SCHOOL HOUSE ROAD	21-23	C	2
320	UMIPAA LANE	1-2	R	2
500	UPOLU COURT	14A	R	2
2,100	WAHANE LANE	1-2-3-14-15-16	C	2
180	WAIHII COURT	1	R	2
2,600	WAINEE DRIVE	3-4	C	2
75,230	TOTAL LINEAL FEET - CLASS 2			

CLASS 3

400	AIEA COURT	9	R	3
160	ALAU COURT	8	R	3
3,150	ALELE DRIVE	8-10-11-12-13	C	3
900	ANAHULU LANE	21	R	3
200	AUAU	2	R	3
3,350	DIAMOND HEAD DRIVE	3-6-8-10	C	3
200	EKE COURT	2	R	3
320	EWA COURT	12	R	3
250	HANA COURT	9	R	3
3,450	HEKILI COURT	2-3	R	3

3,200	HELEAKALA DRIVE	5/8-16-17-18 4/10	R	3
350	HUELO COURT	1	R	3
4,150	KAAAWA LANE (Wash out)	11	C	3
1,250	KAAAWA LANE(See Ut.4 Washout)	6-7-8	C	3
300	KAALA DRIVE	1	R	3
5,350	KAELEPULU DRIVE	2-1	R	3
800	KAENA LANE	16	R	3
2,850	KAHANA LANE	1-2-3-4	R	3
3,700	KAHANA LANE	13-14	R	3
400	KAHUKU COURT	7-27	R	3
520	KAIMUKI COURT	27	R	3
850	KALAMA DRIVE	16-17-18	R	3
360	KALIU COURT	14B	R	3
830	KAMOI COURT	9	R	3
1,440	KANAIO DRIVE	15-16	R	3
1,420	KANEOHE LANE	2-3	MA	3
1,220	KAOHIKAIPU DRIVE	3	R	3
130	KAPAPA COURT	27	R	3
450	KAUAI COURT	7	R	3
400	KAUPA COURT	7	R	3
2,120	KAUPO DRIVE	15-16	R	3
550	KAWELA DRIVE	9	R	3
600	KAWELA LANE	5-6	R	3
800	KEAAU COURT	7	R	3
2,100	KEANAHALULULU LANE	24-27	R	3
3,450	KEANAHALULULU LANE	22-23-24-25-26	A	3
530	KEOKEA COURT	17	R	3
120	KEOKEA COURT	17	R	3
480	KEOKEO COURT	10	R	3
3,910	KIPAHULU DRIVE	5-6	R	3
650	KOA COURT	9-10	R	3
450	KOKO COURT	7	R	3
330	KOKO COURT	12	R	3
350	KOLO COURT	16	R	3
2,060	KOLOIKI LANE	14-15-16	C	3
2,120	KONAHUANUI LANE	1-15	R	3
2,090	KOULUA DRIVE	14-16	R	3
250	KULA COURT	17	R	3
350	KULA COURT	17	R	3
850	KULUA COURT	10	R	3
650	LAAU COURT	16	R	3
550	LAI COURT	9	R	3
9,540	LAMALOA LANE	11-13-14-17-18	C	3
760	LANAI COURT	16	R	3
160	LOPA COURT	3	R	3
360	LUA COURT	10	R	3
240	MALA COURT	16	R	3
2,600	MAMALU DRIVE	8-9	R	3
200	MANANA COURT	19	R	3
3,380	MANAWIANUI DRIVE	5-7-8-17	R	3
550	MAUI COURT (On Private Prop.)	19	R	3
550	MOKOLII COURT	27	R	3
3,650	MOKU MANU DRIVE	1-2-3-5-15	MA	3
1,000	MOKU MANU DRIVE	3	R	3
2,550	MOKULEIA CIRCLE	1-6	R	3
1,950	MOKULUA LANE	11-12	R	3

1,250	NANAKULI DRIVE	7-8	R	3
2,100	NUUANU LNAE	14-19-23-24	R	3
200	OAH COURT	8	R	3
220	OAHU COURT	12	R	3
1,200	OAHU COURT	12	R	3
950	OKOE COURT	9-10	R	3
350	OLOMANA COURT	27	R	3
1,000	ONINI COURT	16	R	3
600	OTANI COURT	5	R	3
1,600	PAHALAWE DRIVE	10-11-12-13	C	3
2,050	PAHIHI DRIVE	14-15-16	R	3
300	PAIA	3	R	3
150	PAIA COURT	12	R	3
2,430	PAPAWAI DRIVE	12	R	3
200	PEAHI COURT	12	R	3
2,100	POHAKEA DRIVE	2-3	R	3
3,000	POHAKULOA DRIVE	2-3-5-6-9-10-12-13	R	3
2,400	PU WAA WAA	13-14	R	3
450	PUKOO DRIVE	18-19	R	3
350	PUU KAUA COURT	27	R	3
1,300	RIVERSIDE DRIVE	16	C	3
4,200	ULUPAU CIRCLE	16-17-18	R	3
280	UPIA COOURT	27	R	3
730	WAHANE LANE	17	C	3
2,450	WAHANE LANE (Major Washout)	7-8-9-10	C	3
320	WAIALEE COURT	27	R	3
2,550	WAILUPE CIRCLE	1-4	R	3
420	WAIMALU COURT	19	R	3
1,350	WAIMEA COURT	12	R	3
220	WAIPIO COURT	27	R	3
131,920	TOTAL LINEAL FEET - CLASS 3			

CLASS 4

1,320	AWEHI LANE	14-16	R	4
200	HALAWA COURT	14	R	4
4,000	HANAUMA DRIVE	8-9	R	4
3,300	HELEMANO DRIVE	10-9	R	4
800	HILEA COURT	8	R	4
2,950	HONOLULU CIRCLE	14-15-16-18-19	R	4
350	HOWI LNAE	16-18	R	4
1,830	KAELEKU	7-8-10-11	R	4
150	KAI COURT	7	R	4
500	KAIWI COURT	9	R	4
2,350	KAMAIKI DRIVE	27-28-24	C	4
4,300	KAUKONAHUA LANE	12-13	R	4
950	KAWANUI DRIVE	15-16	R	4
760	KEAMUKU COURT	12	R	4
7,100	KEANALALULULU LANE	1-2-3-4-5-7-8-9-11	A	4
4,300	KEAWAKAPU	10-11-17-24	R	4
220	KOAE COURT	1	R	4
4,250	KOLEKOLE LANE	11-12	R	4
3,680	KOLEKOLE LANE	2-3-4-5-6-7	R	4
250	KOOLAU COURT	19	R	4
1,700	LAMALOA LANE	8-9-10-19-23-24	C	4
450	LANIKAI	19	R	4

1,010	LAUMAIA LANE	1-2	R	4
100	LLIO COURT	4	R	4
240	MAKUA	27	R	4
180	MAUNALOA DRIVE	26-27-29	R	4
1,280	MOKULUA LANE	5-6-8-9-12	R	4
200	NEW ROAD WCID	18	A	4
250	PALI COURT	18	R	4
1,900	PALIKEA CIRCLE	2-5	R	4
180	POI COURT	18	R	4
4,550	RIVERSIDE DRIVE	1-11-13-14	A	4
2,850	RIVERSIDE DRIVE	1-11	A	4
3,800	RIVERSIDE DRIVE	11-15-16-18-20-21-22	A	4
550	WAIALUA COURT	27	R	4
3,850	WAIKAKAAUA DRIVE	1-2-5-11-12-13	R	4
500	WAIKIKI DRIVE	4-7	R	4
1,100	WAIKIKI DRIVE	11-12-13	R	4
2,850	WAIMANALO	8-10-13-15-16	R	4
71,100	TOTAL LINEAL FEET - CLASS 4			

CLASS 5

1,150	AHUPU LANE	3-4	R	5
1,700	HALIIMAILE	3-4	R	5
450	HAOU COURT	22	R	5
450	HAUULA COURT	4	R	5
200	HAWAII COURT (Not Cut In)	18	R	5
800	HAWEI LANE	1-13	R	5
2,060	KALALEA	4-5-7	R	5
250	KALIHI COURT	4	R	5
2,650	KAWAINUI LANE	8-9-10	R	5
200	KEAHI COURT	12	R	5
150	KEEHI COURT	26	R	5
1,500	KEOMUKU	2-3	R	5
1,300	KIKIPUA LANE	2-3	R	5
420	KIPAPA COURT	12	R	5
920	KOELE COURT	11	R	5
1,360	KOKOMO LANE	2-3	R	5
450	LIPOA DRIVE	11-16-17	R	5
1,700	MAUNALUA DRIVE	20-21	R	5
1,020	NAALEHU COURT	11	R	5
640	NINOLE COURT	11	R	5
190	NUU COURT	9	R	5
650	PAHOA LANE	5-7	R	5
360	PAIA LANE	13	R	5
2,100	PAUWELA DRIVE	5-6	R	5
980	UPOLA COURT	11-16	R	5
850	WAIANAE COURT	11	R	5
1,050	WAIEHU LANE	3-4	R	5
700	WAIMALU COURT	12	R	5
3,100	WAIPAHOEHOE DRIVE	19-10-21	R	5
29,350	TOTAL LINEAL FEET - CLASS 5			

333,000 GRAND TOTAL LINEAL FEET - ALL CLASSES

EXISTING STREET & ROAD CLASSIFICATION

CITY		LINEAL FOOT	LINEAL MILE
Type #1	Approaching City Standards	10,150	1.922
Type #2	Weathered Asphalt w/Failures	15,200	2.879
Type #3	Heavily Weathered w/Overgrowth	3,780	0.716
Type #4	Disintegrated Asphalt on Gravel	0	
Type #5	Undeveloped, Not in Use	0	
	Sub Totals	29,130	5.517

COUNTY		LINEAL FOOT	LINEAL MILE
Type #1	Approaching County Standards	16,060	3.042
Type #2	Weathered Asphalt w/Failures	59,430	11.256
Type #3	Heavily Weathered w/Overgrowth	128,328	24.303
Type #4	Disintegrated Asphalt on Gravel	70,702	13.391
Type #5	Undeveloped, Not in Use	29,350	5.559
	Sub Totals	303,870	57.551
	CUMULATIVE TOTALS	333,000	63.068

ATTACHMENT NO. 5

BASTROP COUNTY WATER CONTROL IMPROVEMENT DISTRICT NO. 2
MASTER ROADWAY PLAN IMPROVEMENTS - REVISED 11/25/91

STREETS BY PROPOSED CLASS

LEGEND:

A = Arterial
MA = Major Arterial
C = Collector
R = Residential

1 = Approaching City/County Standards
2 = Weathered Asphalt with Failures
3 = Heavily Weathered with Overgrowth
4 = Disintegrated Asphalt on Gravel
5 = Undeveloped, Not in Use

LINEAL FOOTAGE	STREET NAME	BLOCK #(S)	PROPOSED CLASS	EXISTING CONST.
	CLASS "A"			
1,250	AKALOA DRIVE	9-10	A	2
3,150	KAANAPALI LANE	29-27-28-26	A	2
4,350	KAANAPALI LANE	9-13-14A-14B	A	2
2,050	KAANAPALI LANE	4-3-2-16-13-8-17	A	2
3,450	KEANAHALULULU LANE	22-23-24-25-26	A	3
7,100	KEANALALULULU LANE	1-2-3-4-5-7-8-9-11	A	4
2,650	MAUNA KEA LANE	12-16-17-19	A	1
700	MAUNA KEA LANE	12-16-19	A	1
200	NEW ROAD WCID	18	A	4
600	RIVERSIDE DRIVE	12	A	2
4,550	RIVERSIDE DRIVE	1-11-13-14	A	4
2,850	RIVERSIDE DRIVE	1-11	A	4
3,800	RIVERSIDE DRIVE	11-15-16-18-20-21-22	A	4
36,700	TOTAL LINEAL FEET - CLASS "A"			
	CLASS "MA"			
2,600	AKALOA DRIVE	1-2-15-16	MA	2
5,070	AKALOA DRIVE	1-2-3-6-7-8-11-12-15	MA	2
2,050	KAANAPALI LANE	10	MA	2
1,420	KANEOHE LANE	2-3	MA	3
3,650	MOKU MANU DRIVE	1-2-3-5-15	MA	3
5,700	RIVERSIDE DRIVE	3-15	MA	1
3,050	TAHITIAN DRIVE	11-20-23-24	MA	1
2,250	TAHITIAN DRIVE	10	MA	1
2,350	TAHITIAN DRIVE	3-16	MA	1
2,800	TAHITIAN DRIVE+(1000'New Co.)	8-9-10-13-15-16	MA	1
30,940	TOTAL LINEAL FEET - CLASS "MA"			
	CLASS "C"			
3,150	ALELE DRIVE	8-10-11-12-13	C	3
1,100	ALOHA LANE	16-17-18	C	2
1,150	ALOHA LANE	16-17-19	C	2
550	CORPORATE DRIVE	20-21-23	C	2
3,350	DIAMOND HEAD DRIVE	3-6-8-10	C	3
280	HULU COURT	12-19	C	2
1,000	INDUSTRIAL	21-22-23-24	C	2

4,150	KAAAWA LANE (Wash out)	11	C	3
1,250	KAAAWA LANE(See Ut.4 Washout)	6-7-8	C	3
2,350	KAMAIKI DRIVE	27-28-24	C	4
2,700	KAMAKOA	8-9-10	C	2
2,060	KOLOIKI LANE	14-15-16	C	3
1,760	KONA	3-4-5	C	1
1,440	KONA DRIVE	6-7-8-10-11	C	1
1,700	LAMALOA LANE	8-9-10-19-23-24	C	4
9,540	LAMALOA LANE	11-13-14-17-18	C	3
180	MAHALO COURT	19	C	2
2,300	MAHALO COURT	12	C	2
2,000	MAHALUA LANE	12-19	C	2
5,100	MAKAHA DRIVE	11-12-16	C	2
500	MAKAHA DRIVE	10	C	2
750	MAUNA LOA LANE	1-20-22	C	2
950	OLAA DRIVE	17	C	2
1,600	PAHALAWE DRIVE	10-11-12-13	C	3
760	PARKWAY	20-21-22	C	2
1,300	RIVERSIDE DRIVE	16	C	3
450	SCHOOL HOUSE ROAD	21-23	C	2
2,100	WAHANE LANE	1-2-3-14-15-16	C	2
730	WAHANE LANE	17	C	3
2,450	WAHANE LANE (Major Washout)	7-8-9-10	C	3
2,600	WAINEE DRIVE	3-4	C	2
61,300	TOTAL LINEAL FEET - CLASS "C"			

CLASS "R"

900	AHUMOA DRIVE	13-14A	R	2
1,150	AHUPU LANE	3-4	R	5
400	AIEA COURT	9	R	3
450	AKALA LANE	3-4	R	2
160	ALAU COURT	8	R	3
900	ANAHULU LANE	21	R	3
200	AUAU	2	R	3
850	AWEHI COURT	11	R	2
1,320	AWEHI LANE	14-16	R	4
200	EKE COURT	2	R	3
320	EWA COURT	12	R	3
200	HALAWA COURT	14	R	4
1,700	HALIIMAILE	3-4	R	5
250	HANA COURT	9	R	3
4,000	HANAUMA DRIVE	8-9	R	4
450	HAOU COURT	22	R	5
450	HAUULA COURT	4	R	5
200	HAWAII COURT (Not Cut In)	18	R	5
700	HAWEA COURT	19	R	2
800	HAWEI LANE	1-13	R	5
3,450	HEKILI COURT	2-3	R	3
1,500	HELEAKALA CT	16	R	2
3,200	HELEAKALA DRIVE	5/8-16-17-18 4/10	R	3
3,300	HELEMANO DRIVE	10-9	R	4
800	HILEA COURT	8	R	4
850	HILO COURT	19	R	1
650	HOMONU COURT	17	R	2

2,950	HONOLULU CIRCLE	14-15-16-18-19	R	4
650	HONOPU DRIVE	17-16-19-12	R	2
1,030	HONOPU DRIVE	17-16-19-12	R	2
350	HOWI LNAE	16-18	R	4
350	HUELO COURT	1	R	3
400	IAO COURT	5	R	2
300	KAALA DRIVE	1	R	3
1,740	KAAPAHU DRIVE	10-11	R	2
1,830	KAELEKU	7-8-10-11	R	4
5,350	KAELEPULU DRIVE	2-1	R	3
800	KAENA LANE	16	R	3
800	KAENAPAPA	16	R	2
2,930	KAHALULU DRIVE	5-6-7	R	2
3,700	KAHANA LANE	13-14	R	3
2,850	KAHANA LANE	1-2-3-4	R	3
400	KAHUKU COURT	7-27	R	3
150	KAI COURT	7	R	4
750	KAILUA LANE	7-6	R	2
520	KAIMUKI COURT	27	R	3
1,600	KAINALU LANE	5-6-7-17	R	2
500	KAIWI COURT	9	R	4
2,060	KALALEA	4-5-7	R	5
850	KALAMA DRIVE	16-17-18	R	3
250	KALIHI COURT	4	R	5
360	KALIU COURT	14B	R	3
830	KAMOI COURT	9	R	3
1,440	KANAIO DRIVE	15-16	R	3
400	KANI LANE	1-2	R	2
1,220	KAOHIKAIPU DRIVE	3	R	3
130	KAPAPA COURT	27	R	3
450	KAUAI COURT	7	R	3
4,300	KAUKONAHUA LANE	12-13	R	4
400	KAUPA COURT	7	R	3
2,120	KAUPO DRIVE	15-16	R	3
2,650	KAWAINUI LANE	8-9-10	R	5
950	KAWANUI DRIVE	15-16	R	4
550	KAWELA DRIVE	9	R	3
600	KAWELA LANE	5-6	R	3
800	KEAAU COURT	7	R	3
200	KEAHI COURT	12	R	5
760	KEAMUKU COURT	12	R	4
2,100	KEANAHALULULU LANE	24-27	R	3
4,300	KEAWAKAPU	10-11-17-24	R	4
150	KEEHI COURT	26	R	5
120	KEOKEA COURT	17	R	3
530	KEOKEA COURT	17	R	3
480	KEOKEO COURT	10	R	3
1,500	KEOMUKU	2-3	R	5
1,300	KIKIPUA LANE	2-3	R	5
400	KIMO COURT	10	R	2
3,910	KIPAHULU DRIVE	5-6	R	3
420	KIPAPA COURT	12	R	5
650	KOA COURT	9-10	R	3
220	KOAE COURT	1	R	4
1,200	KOALI DRIVE	8-13	R	2
920	KOELE COURT	11	R	5

500 KOHOLA LANE	4-5	R	2
260 KOI COURT	19	R	2
330 KOKO COURT	12	R	3
450 KOKO COURT	7	R	3
1,360 KOKOMO LANE	2-3	R	5
3,680 KOLEKOLE LANE	2-3-4-5-6-7	R	4
4,250 KOLEKOLE LANE	11-12	R	4
350 KOLO COURT	16	R	3
2,120 KONAHUANUI LANE	1-15	R	3
250 KOOLAU COURT	19	R	4
160 KOU CT	14	R	2
2,090 KOULUA DRIVE	14-16	R	3
250 KUIKUI COURT	1	R	2
800 KUKUI COURT	19	R	1
350 KULA COURT	17	R	3
250 KULA COURT	17	R	3
850 KULUA COURT	10	R	3
650 LAAU COURT	16	R	3
220 LAE COURT	19	R	2
550 LAI COURT	9	R	3
760 LANAI COURT	16	R	3
450 LANIKAI	19	R	4
1,010 LAUMAIA LANE	1-2	R	4
400 LEI COURT	10	R	2
450 LIPOA DRIVE	11-16-17	R	5
100 LLIO COURT	4	R	4
160 LOPA COURT	3	R	3
360 LUA COURT	10	R	3
240 MAKUA	27	R	4
240 MALA COURT	16	R	3
2,600 MAMALU DRIVE	8-9	R	3
200 MANANA COURT	19	R	3
3,380 MANAWIANUI DRIVE	5-7-8-17	R	3
550 MAUI COURT (On Private Prop.)	19	R	3
180 MAUNALOA DRIVE	26-27-29	R	4
1,700 MAUNALUA DRIVE	20-21	R	5
1,050 MOKALAU DRIVE	19	R	1
950 MOKOLEA LANE	7-8	R	2
550 MOKOLII COURT	27	R	3
450 MOKU COURT	16	R	2
1,000 MOKU MANU DRIVE	3	R	3
360 MOKUAUIA COURT	27	R	2
2,550 MOKULEIA CIRCLE	1-6	R	3
1,950 MOKULUA LANE	11-12	R	3
1,280 MOKULUA LANE	5-6-8-9-12	R	4
2,500 MOLOKINI DRIVE	4	R	2
1,020 NAALEHU COURT	11	R	5
900 NAILALELE LANE	5-6-7-8	R	2
1,250 NANAKULI DRIVE	7-8	R	3
640 NINOLE COURT	11	R	5
190 NUU COURT	9	R	5
2,100 NUUANU LNAE	14-19-23-24	R	3
200 OAH COURT	8	R	3
1,200 OAHU COURT	12	R	3
220 OAHU COURT	12	R	3
950 OKOE COURT	9-10	R	3

250	OLAI CT	12	R	2
350	OLOMANA COURT	27	R	3
1,000	ONINI COURT	16	R	3
600	OTANI COURT	5	R	3
750	PAHALA COURT	17	R	2
2,050	PAHIHI DRIVE	14-15-16	R	3
650	PAHOA LANE	5-7	R	5
1,640	PAHOIKI LANE	14A-14B	R	2
300	PAIA	3	R	3
150	PAIA COURT	12	R	3
360	PAIA LANE	13	R	5
250	PALI COURT	18	R	4
1,900	PALIKEA CIRCLE	2-5	R	4
850	PAPALOA LANE	7-8	R	2
2,430	PAPAWAI DRIVE	12	R	3
2,100	PAUWELA DRIVE	5-6	R	5
200	PEAHI COURT	12	R	3
220	PELE COURT	8	R	2
2,100	POHAKEA DRIVE	2-3	R	3
3,000	POHAKULOA DRIVE	2-3-5-6-9-10-12-13	R	3
180	POI COURT	18	R	4
2,400	PU WAA WAA	13-14	R	3
450	PUKOO DRIVE	18-19	R	3
350	PULEHU COURT	13	R	2
400	PUNA LANE	2-3	R	2
280	PUU COURT	9	R	2
350	PUU KAUA COURT	27	R	3
4,200	ULUPAU CIRCLE	16-17-18	R	3
320	UMIPAA LANE	1-2	R	2
280	UPIA COOURT	27	R	3
980	UPOLA COURT	11-16	R	5
500	UPOLU COURT	14A	R	2
320	WAIALEE COURT	27	R	3
550	WAIALUA COURT	27	R	4
850	WAIANAE COURT	11	R	5
1,050	WAIEHU LANE	3-4	R	5
180	WAIHII COURT	1	R	2
3,850	WAIKAKAAUA DRIVE	1-2-5-11-12-13	R	4
500	WAIKIKI DRIVE	4-7	R	4
1,100	WAIKIKI DRIVE	11-12-13	R	4
2,550	WAILUPE CIRCLE	1-4	R	3
700	WAIMALU COURT	12	R	5
420	WAIMALU COURT	19	R	3
2,850	WAIMANALO	8-10-13-15-16	R	4
1,350	WAIMEA COURT	12	R	3
3,100	WAIPAHOEHOE DRIVE	19-10-21	R	5
220	WAIPIO COURT	27	R	3
204,060	TOTAL LINEAL FEET - CLASS "R"			

333,000 GRAND TOTAL LINEAL FEET - ALL CLASSES

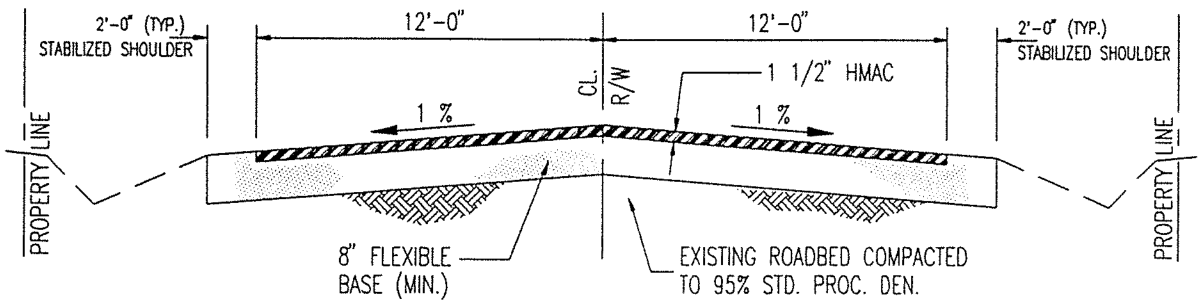
PROPOSED STREET & ROAD TRAFFIC CLASSIFICATIONS

CITY	CLASS	FOOTAGE	CONSTR. CLASS FOOTAGE	LINEAL MILES
	Major Arterial	3,040		
			5,690	1.078
	Arterial	2,650		
	Major Collector	0		
			12,400	2.348
	Collector	12,400		
	Residential	11,040	11,040	2.091
	TOTALS	29,130	29,130	5.517

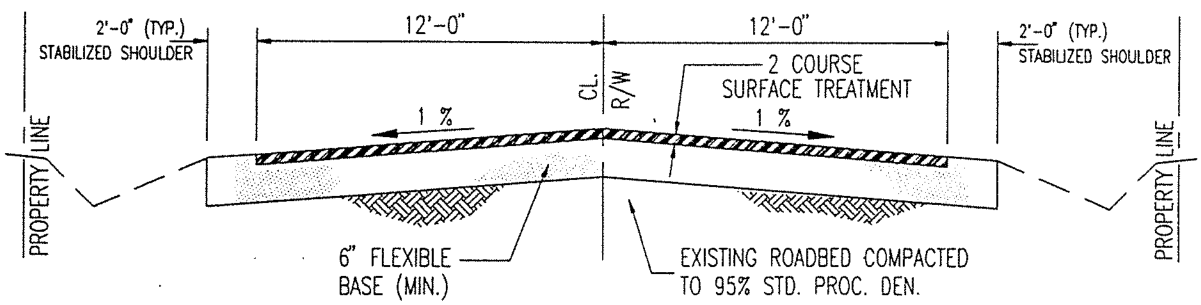
COUNTY	CLASS	FOOTAGE	CONSTR. CLASS FOOTAGE	LINEAL MILES
	Major Arterial	47,330		
			60,880	11.53
	Arterial	13,550		
	Major Collector	5,280		
			46,960	8.894
	Collector	41,680		
	Residential	196,030	196,030	37.127
	TOTALS	303,870	303,870	57.551
	CUMULATIVE TOTALS	333,000	333,000	63.068

PROPOSED ROADWAY SECTIONS

ATTACHMENT NO. 6

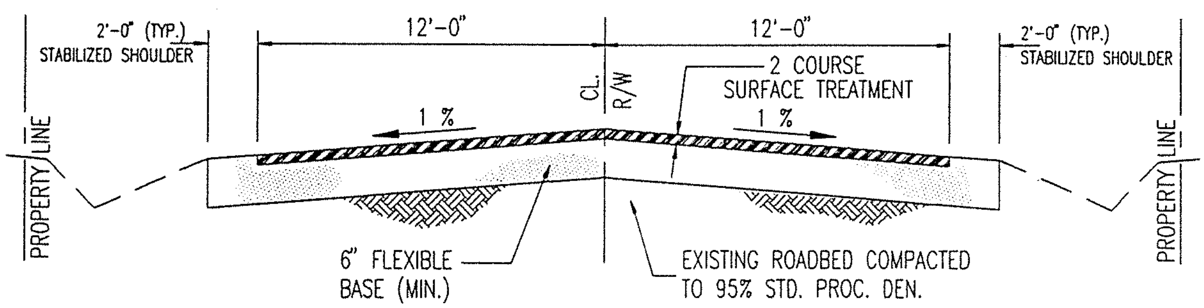


MAJOR ARTERIAL

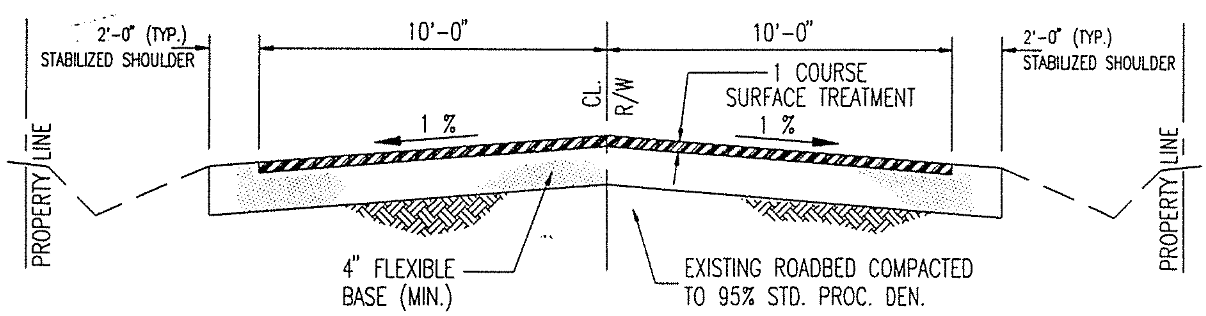


ARTERIAL

NOTE: DEPTH OF FLEX. BASE MAY INCREASE AND SURFACE TREATMENT MAY CHANGE TO 1 1/2" HMAC DUE TO STEEP SLOPES OR HEAVY TRAFFIC PATTERNS.



COLLECTOR



RESIDENTIAL

NOTE: LIME/CEMENT STABILIZATION OF SUBGRADE IS RECOMMENDED BUT NOT INCLUDED IN COST ESTIMATE PREPARATION.

Fisher, Hagood, & Hejl
CIVIL & STRUCTURAL ENGINEERS
301 Hesters Crossing, Suite 110
Round Rock, Texas 78681
(512) 244-1546
FAX: 388-3698

JOB NO.: JOBNO

EXISTING CONSTRUCTION

EXISTING CONSTR. CLASS	COUNTY SUMMARY	ROAD DISTRICT UNITS					
	DESCRIPTION	1	2	3	4	5	TOTAL
1	Approaching County Standards	4,390	2,800	0	8,050	0	15,240
2	Weathered Asphalt with Failures	23,880	24,750	850	6,620	3,510	59,610
3	Heavily Weathered with Overgrowth	8,930	37,840	0	46,660	35,260	128,690
4	Disintegrated Asphalt or Gravel	760	1,640	19,940	24,480	24,280	71,100
5	Undeveloped, Not in Use	0	190	15,340	0	13,820	29,350
	TOTAL LINEAL FEET	37,960	67,220	36,130	85,810	76,870	303,990

EXISTING CONSTR. CLASS	CITY SUMMARY	ROAD DIST. UNIT
	DESCRIPTION	1
1	Approaching County Standards	10,160
2	Weathered Asphalt with Failures	15,620
3	Heavily Weathered with Overgrowth	3,230
4	Disintegrated Asphalt or Gravel	0
5	Undeveloped, Not in Use	0
	TOTAL LINEAL FEET	29,010

PROPOSED CONSTRUCTION

PROPOSED CONSTR. CLASS	COUNTY SUMMARY	ROAD DISTRICT UNITS					
	DESCRIPTION	1	2	3	4	5	TOTAL
MA	Major Arterial	4,300	5,400	0	18,190	0	27,890
A	Arterial	6,300	2,050	11,100	5,150	9,450	34,050
C	Collector	10,570	11,510	1,700	7,900	17,220	48,900
R	Residential	16,790	48,260	23,330	54,570	50,200	193,150
	TOTAL LINEAL FEET	37,960	67,220	36,130	85,810	76,870	303,990

PROPOSED CONSTR. CLASS	CITY SUMMARY	ROAD DIST. UNIT
	DESCRIPTION	1
MA	Major Arterial	3,050
A	Arterial	2,650
C	Collector	12,400
R	Residential	10,910
	TOTAL LINEAL FEET	29,010

PROPOSED/EXISTING

PROPOSED CONSTR. CLASS	COUNTY SUMMARY	EXISTING CONSTRUCTION CLASSIFICATIONS					
	DESCRIPTION	1	2	3	4	5	TOTAL
MA	Major Arterial	13,100	9,720	5,070	0	0	27,890
A	Arterial	700	11,400	3,450	18,500	0	34,050
C	Collector	1,440	13,830	29,580	4,050	0	48,900
R	Residential	0	24,660	90,590	48,550	29,350	193,150
	TOTAL LINEAL FEET	15,240	59,610	128,690	71,100	29,350	303,990

PROPOSED CONSTR. CLASS	CITY SUMMARY	EXISTING CONSTRUCTION CLASSIFICATIONS					
	DESCRIPTION	1	2	3	4	5	TOTAL
MA	Major Arterial	3,050	0	0	0	0	3,050
A	Arterial	2,650	0	0	0	0	2,650
C	Collector	1,760	10,640	0	0	0	12,400
R	Residential	2,700	4,980	3,230	0	0	10,910
	TOTAL LINEAL FEET	10,160	15,620	3,230	0	0	29,010

BASTROP COUNTY WATER CONTROL IMPROVEMENT DISTRICT NO. 2
MASTER ROADWAY PLAN IMPROVEMENTS - REVISED 11/21/91

LINEAL FOOTAGE	STREET NAME	PROPOSED CLASS	EXISTING CONST.	PRICE PER LF	TOTAL EST. COST
	CITY - SORT PROPOSED/EXISTING				
3,050	TAHITIAN DRIVE	MA	1	$12.00	$36,600.00
2,650	MAUNA KEA LANE	A	1	$9.00	$23,850.00
1,760	KONA	C	1	$9.00	$15,840.00
2,000	MAHALUA LANE	C	2		
500	MAKAHA DRIVE	C	2		
750	MAUNA LOA LANE	C	2		
1,000	INDUSTRIAL	C	2		
1,100	ALOHA LANE	C	2		
950	OLAA DRIVE	C	2		
280	HULU COURT	C	2		
550	CORPORATE DRIVE	C	2		
450	SCHOOL HOUSE ROAD	C	2		
760	PARKWAY	C	2		
2,300	MAHALO COURT	C	2		
10,640	TOTAL			$11.00	$117,040.00
850	HILO COURT	R	1		
800	KUKUI COURT	R	1		
1,050	MOKALAU DRIVE	R	1		
2,700	TOTAL			$8.00	$21,600.00
450	AKALA LANE	R	2		
400	KANI LANE	R	2		
650	HOMONU COURT	R	2		
750	PAHALA COURT	R	2		
700	HAWEA COURT	R	2		
400	PUNA LANE	R	2		
500	KOHOLA LANE	R	2		
260	KOI COURT	R	2		
220	LAE COURT	R	2		
650	HONOPU DRIVE	R	2		
4,980	TOTAL			$11.00	$54,780.00
550	MAUI COURT (On Private Prop.)	R	3		
1,200	OAHU COURT	R	3		
350	KULA COURT	R	3		
530	KEOKEA COURT	R	3		
600	KAWELA LANE	R	3		
3,230	TOTAL			$15.00	$48,450.00
29,010	**GRAND TOTAL CITY UNIT 1**				**$318,160.00**

COUNTY - SORT PROPOSED/EXISTING

5,700	RIVERSIDE DRIVE	MA	1		
2,800	TAHITIAN DRIVE+(1000'New Co.)	MA	1		
2,350	TAHITIAN DRIVE	MA	1		
2,250	TAHITIAN DRIVE	MA	1		
13,100	TOTAL			$12.00	$157,200.00
5,070	AKALOA DRIVE	MA	2		
2,600	AKALOA DRIVE	MA	2		
2,050	KAANAPALI LANE	MA	2		
9,720	TOTAL			$15.00	$145,800.00
1,420	KANEOHE LANE	MA	3		
3,650	MOKU MANU DRIVE	MA	3		
5,070	TOTAL			$20.00	$101,400.00
700	MAUNA KEA LANE	A	1	$9.00	$6,300.00
4,350	KAANAPALI LANE	A	2		
1,250	AKALOA DRIVE	A	2		
2,050	KAANAPALI LANE	A	2		
600	RIVERSIDE DRIVE	A	2		
3,150	KAANAPALI LANE	A	2		
11,400	TOTAL			$11.00	$125,400.00
3,450	KEANAHALULULU LANE	A	3	$16.00	$55,200.00
4,550	RIVERSIDE DRIVE	A	4		
3,800	RIVERSIDE DRIVE	A	4		
7,100	KEANAHALULULU LANE	A	4		
200	NEW ROAD WCID	A	4		
2,850	RIVERSIDE DRIVE	A	4		
18,500	TOTAL			$25.00	$462,500.00
1,440	KONA DRIVE	C	1	$9.00	$12,960.00
180	MAHALO COURT	C	2		
2,700	KAMAKOA	C	2		
2,600	WAINEE DRIVE	C	2		
2,100	WAHANE LANE	C	2		
1,150	ALOHA LANE	C	2		
5,100	MAKAHA DRIVE	C	2		
13,830	TOTAL			$11.00	$152,130.00

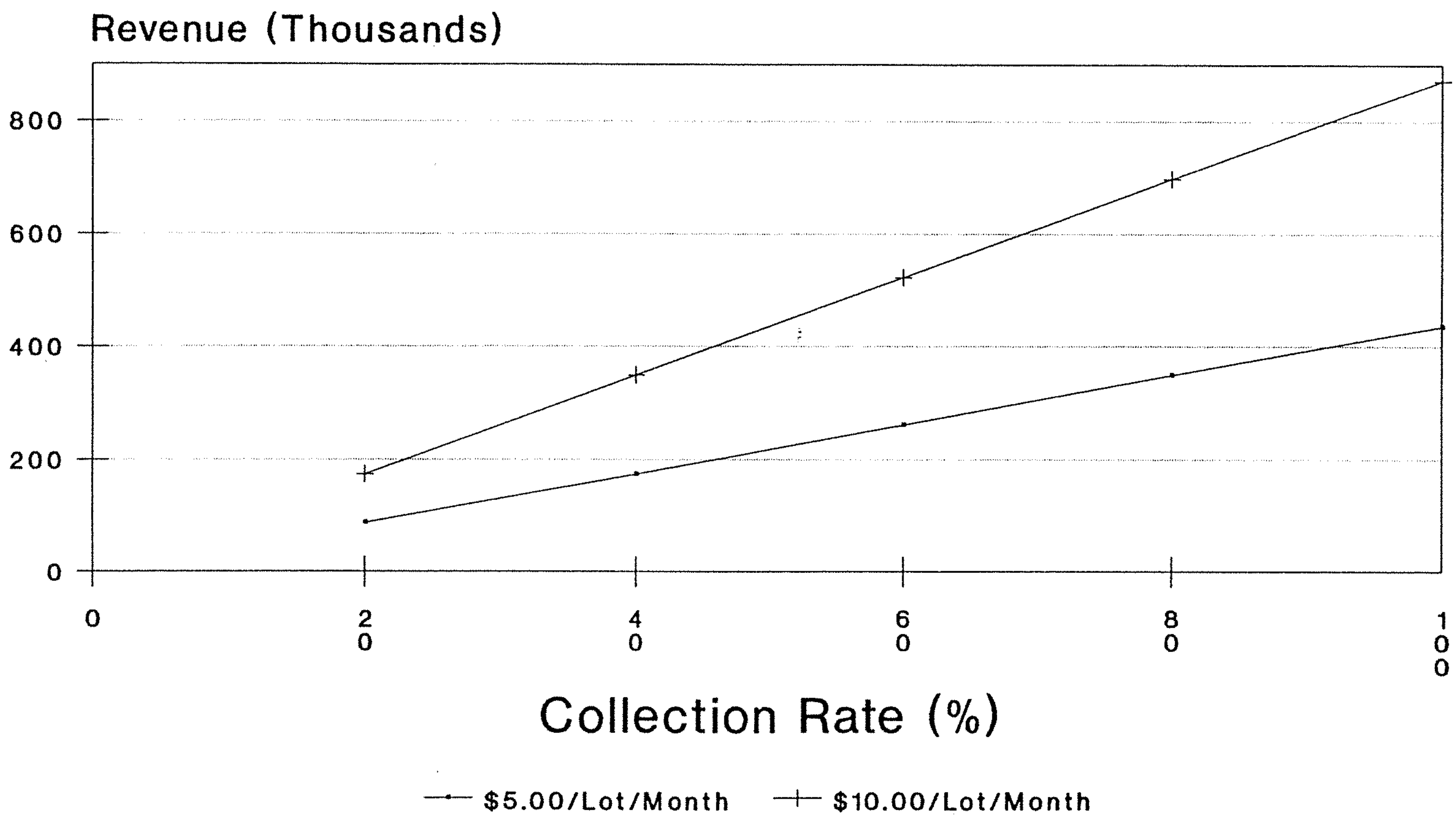
1,250	KAAAWA LANE(See Ut.4 Washout)	C	3		
4,150	KAAAWA LANE (Wash out)	C	3		
1,300	RIVERSIDE DRIVE	C	3		
2,450	WAHANE LANE (Major Washout)	C	3		
1,600	PAHALAWE DRIVE	C	3		
3,350	DIAMOND HEAD DRIVE	C	3		
9,540	LAMALOA LANE	C	3		
730	WAHANE LANE	C	3		
2,060	KOLOIKI LANE	C	3		
3,150	ALELE DRIVE	C	3		
29,580	TOTAL			$16.00	$473,280.00
1,700	LAMALOA LANE	C	4		
2,350	KAMAIKI DRIVE	C	4		
4,050	TOTAL			$23.00	$93,150.00
1,200	KOALI DRIVE	R	2		
500	UPOLU COURT	R	2		
850	AWEHI COURT	R	2		
1,600	KAINALU LANE	R	2		
1,500	HELEAKALA CT	R	2		
250	KUIKUI COURT	R	2		
950	MOKOLEA LANE	R	2		
800	KAENAPAPA	R	2		
250	OLAI CT	R	2		
850	PAPALOA LANE	R	2		
220	PELE COURT	R	2		
400	IAO COURT	R	2		
1,640	PAHOIKI LANE	R	2		
450	MOKU COURT	R	2		
400	LEI COURT	R	2		
900	NAILALELE LANE	R	2		
900	AHUMOA DRIVE	R	2		
2,930	KAHALULU DRIVE	R	2		
350	PULEHU COURT	R	2		
1,740	KAAPAHU DRIVE	R	2		
280	PUU COURT	R	2		
750	KAILUA LANE	R	2		
320	UMIPAA LANE	R	2		
160	KOU CT	R	2		
400	KIMO COURT	R	2		
360	MOKUAUIA COURT	R	2		
1,030	HONOPU DRIVE	R	2		
2,500	MOLOKINI DRIVE	R	2		
180	WAIHII COURT	R	2		
24,660	TOTAL			$11.00	$271,260.00
2,400	PU WAA WAA	R	3		
3,200	HELEAKALA DRIVE	R	3		
200	AUAU	R	3		
400	KAHUKU COURT	R	3		
200	PEAHI COURT	R	3		
1,350	WAIMEA COURT	R	3		

150	PAIA COURT	R	3
5,350	KAELEPULU DRIVE	R	3
600	OTANI COURT	R	3
3,700	KAHANA LANE	R	3
650	KOA COURT	R	3
2,850	KAHANA LANE	R	3
450	PUKOO DRIVE	R	3
350	HUELO COURT	R	3
320	EWA COURT	R	3
850	KALAMA DRIVE	R	3
3,000	POHAKULOA DRIVE	R	3
3,450	HEKILI COURT	R	3
2,100	NUUANU LNAE	R	3
1,220	KAOHIKAIPU DRIVE	R	3
2,600	MAMALU DRIVE	R	3
450	KAUAI COURT	R	3
200	MANANA COURT	R	3
300	KAALA DRIVE	R	3
160	LOPA COURT	R	3
400	KAUPA COURT	R	3
950	OKOE COURT	R	3
800	KEAAU COURT	R	3
130	KAPAPA COURT	R	3
450	KOKO COURT	R	3
250	KULA COURT	R	3
250	HANA COURT	R	3
350	KOLO COURT	R	3
2,120	KONAHUANUI LANE	R	3
3,910	KIPAHULU DRIVE	R	3
200	EKE COURT	R	3
1,440	KANAIO DRIVE	R	3
2,550	MOKULEIA CIRCLE	R	3
800	KAENA LANE	R	3
420	WAIMALU COURT	R	3
360	LUA COURT	R	3
1,000	MOKU MANU DRIVE	R	3
2,430	PAPAWAI DRIVE	R	3
1,250	NANAKULI DRIVE	R	3
1,000	ONINI COURT	R	3
200	OAH COURT	R	3
280	UPIA COOURT	R	3
550	KAWELA DRIVE	R	3
350	OLOMANA COURT	R	3
160	ALAU COURT	R	3
550	MOKOLII COURT	R	3
2,100	POHAKEA DRIVE	R	3
2,100	KEANAHALULULU LANE	R	3
220	WAIPIO COURT	R	3
2,090	KOULUA DRIVE	R	3
360	KALIU COURT	R	3
320	WAIALEE COURT	R	3
330	KOKO COURT	R	3
400	AIEA COURT	R	3
850	KULUA COURT	R	3
300	PAIA	R	3
120	KEOKEA COURT	R	3

350	PUU KAUA COURT	R	3		
550	LAI COURT	R	3		
3,380	MANAWIANUI DRIVE	R	3		
4,200	ULUPAU CIRCLE	R	3		
650	LAAU COURT	R	3		
220	OAHU COURT	R	3		
2,120	KAUPO DRIVE	R	3		
830	KAMOI COURT	R	3		
2,050	PAHIHI DRIVE	R	3		
2,550	WAILUPE CIRCLE	R	3		
240	MALA COURT	R	3		
480	KEOKEO COURT	R	3		
900	ANAHULU LANE	R	3		
520	KAIMUKI COURT	R	3		
1,950	MOKULUA LANE	R	3		
760	LANAI COURT	R	3		
90,590	TOTAL			$15.00	$1,358,850.00
4,000	HANAUMA DRIVE	R	4		
250	KOOLAU COURT	R	4		
1,100	WAIKIKI DRIVE	R	4		
500	WAIKIKI DRIVE	R	4		
450	LANIKAI	R	4		
3,850	WAIKAKAAUA DRIVE	R	4		
250	PALI COURT	R	4		
550	WAIALUA COURT	R	4		
760	KEAMUKU COURT	R	4		
220	KOAE COURT	R	4		
800	HILEA COURT	R	4		
950	KAWANUI DRIVE	R	4		
350	HOWI LNAE	R	4		
100	LLIO COURT	R	4		
4,300	KAUKONAHUA LANE	R	4		
1,830	KAELEKU	R	4		
150	KAI COURT	R	4		
4,300	KEAWAKAPU	R	4		
1,320	AWEHI LANE	R	4		
1,280	MOKULUA LANE	R	4		
200	HALAWA COURT	R	4		
1,010	LAUMAIA LANE	R	4		
2,950	HONOLULU CIRCLE	R	4		
180	MAUNALOA DRIVE	R	4		
500	KAIWI COURT	R	4		
240	MAKUA	R	4		
1,900	PALIKEA CIRCLE	R	4		
3,680	KOLEKOLE LANE	R	4		
4,250	KOLEKOLE LANE	R	4		
2,850	WAIMANALO	R	4		
3,300	HELEMANO DRIVE	R	4		
180	POI COURT	R	4		
48,550	TOTAL			$17.00	$825,350.00
650	PAHOA LANE	R	5		
2,060	KALALEA	R	5		

640	NINOLE COURT	R	5		
800	HAWEI LANE	R	5		
420	KIPAPA COURT	R	5		
450	HAOU COURT	R	5		
1,300	KIKIPUA LANE	R	5		
190	NUU COURT	R	5		
450	LIPOA DRIVE	R	5		
200	KEAHI COURT	R	5		
150	KEEHI COURT	R	5		
2,650	KAWAINUI LANE	R	5		
920	KOELE COURT	R	5		
850	WAIANAE COURT	R	5		
360	PAIA LANE	R	5		
1,050	WAIEHU LANE	R	5		
1,150	AHUPU LANE	R	5		
3,100	WAIPAHOEHOE DRIVE	R	5		
1,700	MAUNALUA DRIVE	R	5		
250	KALIHI COURT	R	5		
1,360	KOKOMO LANE	R	5		
700	WAIMALU COURT	R	5		
980	UPOLA COURT	R	5		
1,700	HALIIMAILE	R	5		
1,500	KEOMUKU	R	5		
1,020	NAALEHU COURT	R	5		
2,100	PAUWELA DRIVE	R	5		
200	HAWAII COURT (Not Cut In)	R	5		
450	HAUULA COURT	R	5		
29,350	TOTAL			$17.00	$498,950.00
303,990	**GRAND TOTAL - COUNTY - ALL UNITS**				**$4,739,730.00**
333,000	**GRAND TOTAL ALL CITY + COUNTY**				**$5,057,890.00**

BCWCID NO. 2
ROADWAY ASSESSMENT FEE COLLECTION DATA
7,267 Existing Lots



Historical Collection Data
1990-$283,000
1991-$250,000

90%-Capital Improvement Fund
10%-Administrative Fees

$5.00/LOT/MONTH

% COLLECTION RATE	TOTAL $ REVENUE
20	$87,204
40	$174,408
60	$261,612
80	$348,816
100	$436,020

$10.00/LOT/MONTH

% COLLECTION RATE	TOTAL $ REVENUE
20	$174,408
40	$348,816
60	$523,224
80	$697,632
100	$872,040

PRESENT WORTH ECONOMIC ANALYSIS

FINANCING ALTERNATIVE NO. 1

Description: District to finance roadway improvements with $250,000 on an annual basis.

Assume: Discount Rate 6.75%
Length of Term Analyzed - 10 years
Salvage Value - $0.00

Calculate: Present Worth of Ten Year Annual Investment on Projects

Inflation Rate 6%

Year No. 1	Present Worth of Cost = $250.000 =	$250,000
Year No. 2	Present Worth of Cost = $250.000 (0.9434) =	$235,850
Year No. 3	Present Worth of Cost = $250.000 (0.8900) =	$222,500
Year No. 4	Present Worth of Cost = $250.000 (0.8396) =	$209,900
Year No. 5	Present Worth of Cost = $250.000 (0.7921) =	$198,025
Year No. 6	Present Worth of Cost = $250.000 (0.7473) =	$186,825
Year No. 7	Present Worth of Cost = $250.000 (0.7050) =	$176,250
Year No. 8	Present Worth of Cost = $250.000 (0.6651) =	$166,275
Year No. 9	Present Worth of Cost = $250.000 (0.6274) =	$156,850
Year No. 10	Present Worth of Cost = $250.000 (0.5919) =	$147,975
	Present Worth of Annual Investments	$1,950,450

Inflation Rate 8%

Year No. 1	Present Worth of Cost = $250.000 =	$250,000
Year No. 2	Present Worth of Cost = $250.000 (0.9259) =	$231,475
Year No. 3	Present Worth of Cost = $250.000 (0.8573) =	$214,325
Year No. 4	Present Worth of Cost = $250.000 (0.7938) =	$198,450
Year No. 5	Present Worth of Cost = $250.000 (0.7350) =	$183,750
Year No. 6	Present Worth of Cost = $250.000 (0.6806) =	$170,150
Year No. 7	Present Worth of Cost = $250.000 (0.6302) =	$157,550
Year No. 8	Present Worth of Cost = $250.000 (0.5835) =	$145,875
Year No. 9	Present Worth of Cost = $250.000 (0.5403) =	$135,075
Year No. 10	Present Worth of Cost = $250.000 (0.5002) =	$125,050
	Present Worth of Annual Investments	$1,561,700

FINANCING ALTERNATIVE NO. 2

Calculate Current Investment Bond Value based on 6.75% interest rate and 10 year term at annual payment of $250,000

Present Worth = $1,776,368

ACKNOWLEDGEMENTS

CITY OF BASTROP

Mayor David Lock
Mr. Marvin Patterson, Director of Public Works

Special Appreciation to: Mr. Joel Wilkinson, P.E.
City Engineer, City of Bastrop

COUNTY OF BASTROP

Johnny Sanders, Commissioner Precinct 1
Mr. Monroe Wilhelm, Road Superintendent

BASTROP COUNTY WCID NO.2

Mr. Norman D. Hansen, President
Mr. Tom Clayton, Vice-President
Mr. William T. Sanders, Secretary
Mr. Angelo Schena, Director
Mr. James J. Bain, Sr., Director

Special Appreciation to: Ms. Sharon Eaves, General Manager and Staff
Ms. JoAnne Flynt
Ms. Susan Runkle

ATTACHMENT NO. 12

NEPTUNE-WILKINSON ASSOCIATES, INC.
CONSULTING ENGINEERS

4010 MANCHACA ROAD AUSTIN, TEXAS 78704 (512) 462-3373

January 15, 1992

Bastrop County Water Control & Improvement District No. 2
Road Authority
P.O. Box 708
Bastrop, Texas 78602

Attn: Sharon Eaves, Manager

Re: Master Roadway and Drainage Plan
NWA# 1073-142

Dear Mrs. Eaves:

Enclosed is a copy of my review comments presented to the City Council last evening. The last sentence of the first paragraph on page 2 should be amended by adding the words placed within brackets and should then read:

> It is my recommendation that the residential streets also have two course surface treatment [and a base thickness of 6 inches].

From comments offered at the meeting, it is my understanding that consideration has been given to ways of directing construction traffic (material haul trucks and equipment) to reduce travel over previously reconstructed roadways. To help in obtaining compliance with this objective, the construction plans should include the route to which such travel is to be limited.

It is my understanding that the City Council requested that these comments be considered in the review process prior to adoption of a final plan.

If you or the District's engineer have any questions regarding these comments, please feel free to contact our office.

Sincerely,

Joel D. Wilkinson

Joel D. Wilkinson, P.E.

Enclosure
JDW:jp

xc: JoAnn Wilcoxen, City Manager

MEMORANDUM

TO: JoAnn Wilcoxen, City Manager
City of Bastrop

FROM: Joel D. Wilkinson, P.E. JDW
Neptune-Wilkinson Associates, Inc.

DATE: January 10, 1992

SUBJECT: MASTER ROADWAY AND DRAINAGE PLAN
TAHITIAN VILLAGE - B.C.W.C.I.D. NO. 2
NWA# 1073-142

PURPOSE

I have reviewed the Engineering and Planning Report dated November, 1991 relating to the above referenced subject. The Report was accompanied by map exhibits. This memorandum provides my comments relative to this review and is limited to the area within the City of Bastrop.

ANALYSIS

Exhibit 21 presents the roadway improvement plan to be accomplished within two, five, ten and twenty year periods. Within the two-year period, Tahitian Drive will be reconstructed. Within the five-year period, all remaining streets within the City will be reconditioned.

Exhibit 2 identifies existing roadway conditions. It is my recommendation that Kukui Court, Hilo Court and Mokalau Drive be requested to be reclassified from "Approaching County Standards" to "Weathered Asphalt with Failures".

Exhibit 11 designated the roadways according to use. Tahitian Drive and Mauna Kea Lane are designated as major arterial and would have a travel width of 24 feet with 2 foot shoulders constructed of road base. These streets would have 8 inches of base material and the travel surface would be of 1 1/2 inch hot mix asphaltic concrete.

All other within City streets are designated as either collector or residential. It is my recomendation that the designation of Honopo Drive (both north and south of Manua Kea Lane) and Mokalau Drive be changed from residential to collector.

A collector street would also have a travel width of 24 feet with 2 foot wide base shoulders. The base thickness would be 6 inches with two course surface treatment.

A residential street would have a travel width of 20 feet with 2 foot wide base shoulders. The base thickness would be 4 inches with single course surface treatment. It is my recommendation that the residential streets also have two course surface treatment.

The projected cost to reconstruct the roadways within the City is given as $318,610. No independent cost evaluation has been made. Based upon the estimated price per foot given on the cost summary page, the above recommendations do not have a significant cost impact.

The planning Report is general and does not give detail design information. Final design is subject to final review and approval by the City prior to implementation.

ATTACHMENT NO. 1

BASTROP COUNTY

JOHNNY SANDERS
P. O. BOX 446
BASTROP, TEXAS 78602

COMMISSIONER
PRECINCT 1

OLD JAIL BUILDING
(512) 321-1818

January 13, 1992

Mr. Norman D. Hansen
President
Bastrop County Water Control Improvement District No.2
P. O. Box 708
Bastrop, Texas 78602

RE: BCWCID No. 2
Tahitian Village Master Roadway & Drainage Study

Dear Mr. Hansen:

As requested by you, I have reviewed the above study and provided the following comments:

1. During design phase, the County would appreciate the District's consideration given to comments concerning construction of roadways especially along terrain with severe slopes.

2. During construction phase, the County believes it essential the District provide daily inspection of work.

3. The County would like to participate in the contractor's "punch list" schedule site inspection conducted prior to construction and at the annual inspection conducted prior to the one-year maintenance bond expiration. The County will accept for operation and maintenance the project when the one-year maintenance period has expired and all items which may have been identified in the inspection have been satisfactorily completed.

4. Particular attention to existing drainage ways and structures must be made during design and construction phases. If an area within the proposed project requires new culverts, drainage channel construction, etc. the County wishes to ensure the appropriate work is performed.

In conclusion, except for the above concern items, I generally agree with the plan specifically the phasing scenario outlined. It is prudent to perform the major arterial work first to maximize benefits and provide for contiguous roadway development.

On behalf of the County, I appreciate the consideration provided by the District to date, and look forward to a continued strengthening of our working relationship.

Respectfully,

COUNTY OF BASTROP

Johnny Sanders, Commissioner

cc: Judge Randy Fritz, County of Bastrop
Mayor David Lock, City of Bastrop

EXHIBITS