■ *Reuse Opportunities Evaluation*

Celery Fields Regional Integrated Water Resources Plan

Prepared for:
Sarasota County Public Works Department

Kimley-Horn and Associates, Inc.

REUSE OPPORTUNITIES EVALUATION INTERIM REPORT

FOR

CELERY FIELDS REGIONAL INTEGRATED WATER RESOURCES PLAN CELERY FIELDS PHASE III

Prepared for:

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I. Introduction

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The Celery Fields Regional Stormwater Facility (CFRSF) is an approximately 560-acre facility east of I-75 and south of Fruitville Road. It is situated in the Phillipi Creek drainage basin and is designed to reduce downstream flooding. The CFRSF includes three cells and potential area of expansion using an additional parcel to the south known as the Walker Parcel. The CFRSF receives inflow from 3,800 +/- acres via the Main C canal. Addition of the Walker Parcel would allow a diversion of waters from approximately 11,330 acres of the northern and eastern sections of the Main A watershed to the CFRSF.

The purpose of this study is to evaluate alternative surface water source opportunities associated with the CFRSF. Available water resources will be evaluated through a water budget based on published information. Using the quantity and variability of the available water, this study will determine a constant yield that could potentially be available for beneficial uses. This study will then investigate using the CFRSF as a surface water reservoir and collection system for an Aquifer Storage and Recovery (ASR) system.

II. Existing and Future Irrigation Water Supply and Demand

Irrigation water demand in Sarasota County is growing with the increase in population. Sarasota County currently provides a number of customers with reclaimed water from their wastewater treatment plants in order to reduce the dependency of potable water supplies. However, the Sarasota County Wastewater Management Plan Final Report (November 2001) states that in general "it requires the wastewater from about four homes to provide the irrigation water for one home". Not enough wastewater is available to satisfy the increasing demands of the existing and new customers. In addition, areas to the north of the project area are located in or adjacent to the "Most Impacted Area" (MIA) of the Southwest Florida Water Management District's (SWFWMD) Southern Water use Caution Area (SWUCA). The MIA of SWUCA has been impacted by ground water pumping from the Floridan Aquifer to the extent that SWFWMD is currently developing a recovery plan to reduce ground water withdrawals. In its place, SWFWMD is promoting alternative water sources such as reclaimed wastewater and excess surface water. Therefore, it is desirable to develop opportunities provided by the Celery Fields for an alternative surface water source that could off-set existing and future ground water withdrawals and/or supplement the reclaimed wastewater supply. Potential uses for surface water from the CFRSF include: (1) reclaimed wastewater irrigation supplement for existing demands; (2) irrigation supplement for future demands; and (3) future potable water supply.

A. Reclaimed Wastewater Irrigation Supplement for Existing Demands:

The Sarasota County report states that there is an unsatisfied demand from existing customers of approximately 8.1 million gallons per day (MGD) for irrigation water. This value is based on the maximum average annual irrigation rate of 0.7 inches per week, as recommended by SWFWMD. It was found that actual irrigation rates vary during the year due to rainfall and other seasonal variations, causing peak demands of as much as 165 percent during the dry season and low demands of 60 percent during the wet season. From a monthly comparison of actual usage of Sarasota County reclaimed water customers, a monthly distribution was generated (see Figure 1 below).

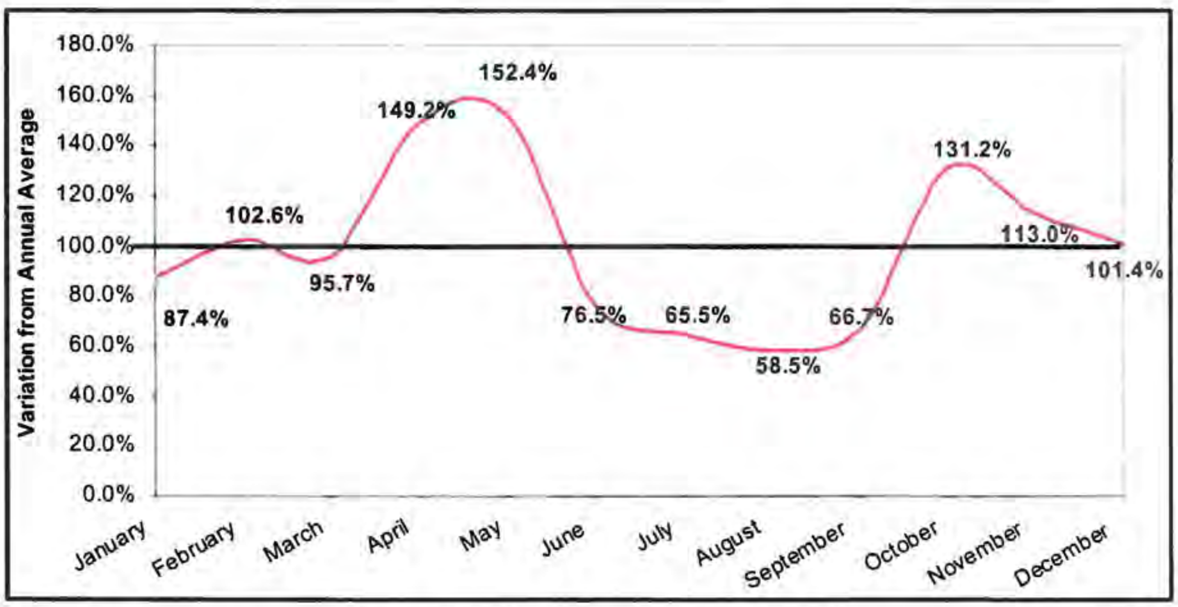


Figure 1: North County Irrigation Water Demand Variation

The demand variation is consistent with the seasonal fluctuation of the Reclaimed Water Graph contained within the Sarasota County Wastewater Management Plan. To meet these demands excess surface water available in the CFRSF could be used to supplement the reclaimed wastewater irrigation supply. However under the existing rules, the surface water irrigation system would need to be independent from the reclaimed wastewater system or meet the same prerequisite treatment requirements.

B. Irrigation Supplement for Future Demands:

Although the County has several locations for irrigation water storage, including reclaimed water ponds, it is expected that future population growth will increase deficiencies. For the North County Area, it is expected the reclaimed water storage system will be insufficient by 2009, as was stated in the North Service Area Reclaimed Water Balance Technical Memorandum by PBS&J (April 2003). Feasibility studies for alternatives to these deficiencies have been carried out, including, as stated in the Sarasota County Reuse Master Plan (1993), "investigations of stormwater as a supplementary source of reuse and the development of storage sites are now underway... with the Phillippi Creek Basin Study and the Main 'C' Regional Stormwater Facility (CFRSF Project)..." The purpose of these studies was to investigate the viability of supplementing the irrigation water system with stormwater.

Two future demand opportunities that should be investigated include the MEC corridor along Fruitville Road, east of I-75 and the SMR Village being planned north of Fruitville Road. The MEC corridor is currently being pursued as a public/private partnership in mixed use and sustainable development. If this plan becomes reality, serving this area with surface water from the CFRSF should be given a high priority. It is anticipated that the SMR Village will be irrigated with reclaimed wastewater. However, excess surface water from the CFRSF could potentially be used to independently supplement this irrigation supply. This could potentially be facilitated by installing a force main north of Fruitville within the future Coburn Road right-of-way to either one of the many lakes already within the SMR Village area or the County's North Metro Lake located west of I-75.

C. Future Potable Water Supply:

In their 2000, Future Water Supply Plan, SWFWMD identified the CFRSF as potentially providing up to 4 mgd of potable water supply. Therefore, excess surface water should potentially be considered for beneficial uses beyond irrigation. With respect to the Fruitville Road MEC area, opportunities should be considered to utilize excess surface water from the CFRSF to off-set potable water demands. Initiatives such as installation of dual plumbing in new building construction could provide for the use of excess surface water from the CFRSF to meet some potable water demands such as toilet flushing.

II. CFRSF Monthly Water Budget

A. Data Obtained

The CFRSF is comprised of three main cells with open-water ponds and is to be expanded to include the Walker Parcel to the south. Open water areas constitute approximately 40% of the total area while the remaining 60% is grasslands and wetlands. The CFRSF receives stormwater from the 3,800-acre partially developed Main C watershed extending north and northeast of the facility. The collection point of this watershed, the Main C Canal, parallels the west side of the CFRSF with a weir diverting water into the facility. A portion of the Main A canal, with a contributing watershed of approximately 11,330 acres, is to be diverged into the southern portion of the CFRSF to further reduce downstream flooding. This will have the added benefit of increasing the amount of available surface water. Exhibit 1 illustrates the resulting watershed areas contributing to the CFRSF. Surface water directed through the CFRSF to allow for sedimentation, wetland hydroperiod maintenance, and increased flood protection for downstream properties.

In order to prepare a monthly water budget, the following information was evaluated:

- Rainfall Data

  Rainfall for Sarasota County was obtained from Southwest Florida Water Management District (SWFWMD) records dating back to 1915. However, due to the limited number of stations available at the time, data was evaluated from records between 1976 and 2003, when most of the existing stations were established. Exhibit 2 shows monthly data analyzed over the period of record to obtain an average for the month of 53.58 inches. Rainfall data for the CFRSF water budget was taken for the water year extending from October to September. The dry season is generally considered to be from October to May, and the wet season generally from June to September. The wet season generally has 50% more rainfall than the dry season. Values, in inches, were applied over the CFRSF area to account for direct inflows into the facility.

  Rainfall data was evaluated to determine an extreme drought year in the period of record, which was found to have occurred from October 2000 to September 2001. During this water year, the dry season rainfall totaled only 10.16 inches, approximately 53% less than the average dry season rainfall.

- Streamflow Data

Data on streamflow into the CFRSF was determined from a comparison with flows from watersheds similar in location and development, but ranging in size. Information on watersheds was obtained from US Geological Survey National Water Information System. The following watersheds were examined: Howard Creek, Walter Creek, Braden River, Hickory Hammock, Cooper Creek, Cedar Creek, Rattlesnake Slough and Nonsense Creek. Watershed sizes ranged from 1 to 20 sq miles with historical streamflow data of a minimum of 12 years.

Streamflow data for the recorded period was averaged to obtain monthly as well as annual values for each stream and later converted from cubic-feet per second (cfs) to acre-feet (acre-ft) per month. Values were graphed to correlate recorded streamflow with watershed size. A linear regression for the data points was developed. The annual analysis, presented in Exhibit 3-A for the Main C watershed and Exhibit 4-A for the Main A watershed, indicated that there was good correlation between the variables, so monthly analyses were carried out. The equations generated from the linear regression were applied to the Main C and Main A watersheds to obtain annual as well as monthly streamflow values. These values represent theoretical inflows into the CFRSF and are assumed to account for rainfall and ground water inflows minus evapotranspiration losses within the watershed. Exhibits 3-B and 4-B present the Monthly Analyses for average conditions. The contributing watershed areas are estimated to produce an annual average of 1,943 acre-ft per month or a total of 23,316 acre-ft per year of water.

Extreme drought year data for both contributing watersheds was also analyzed in Exhibits 5 and 6. The analyses indicate that the total streamflow for the extreme drought year is higher than the annual average. This is due to heavy flows during the wet season, which account for 93% of the year total. During the dry season, certain streams were found to have been dry during these conditions.

Poor statistics during dry yrs

- Groundwater Data

There are three aquifers below the CFRSF area: the Surficial Aquifer, the Intermediate Aquifer and the Floridian Aquifer. The Surficial Aquifer, approximately 25 to 55 feet thick in this area and of moderate to low permeability soils, has flow paths that generally follow topographic contours and discharge into local ponds, streams and canals. Groundwater from the Intermediate Aquifer flows westward, but also discharges into the overlying Surficial Aquifer. The Main C canal serves as an effective interceptor of shallow groundwater flow, therefore it is reasonable to conclude that Surficial groundwater is a positive contributor to the overall water budget of the CFRSF. In order to quantify this contribution, the high and low groundwater table was derived from the Florida Geological Survey water level records from the nearby ROMP (Regional Observation and Monitoring Program) wells. The fluctuations of the water table were correlated with rainfall records, and the relative change in head was used to calculate a monthly contribution to the overall water budget. Losses during the dry season were not included due to the fact that the water level will be artificially maintained during the dry season, or excess groundwater will be withdrawn in order to decrease deficiencies in total available water. Therefore, it is assumed that groundwater will be captured by natural discharge or management objectives. The magnitude of Surficial groundwater contribution, however, is relatively minor and estimated to be in the range of 1 to 2 inches per unit area per year.

- Potential Evapotranspiration

  Potential evapotranspiration (PET) is estimated using values from "Potential Evapotranspiration Probabilities and Distributions in Florida" (Smajstrla, Clark, et. al.). Tampa area values, totaling 54.20 inches per year, were assumed to be applicable to Sarasota County. PET assumes the availability of moisture from open waters (evaporation) and/or vegetation (transpiration). The average PET values were also used in the extreme drought conditions analysis to account for the decrease in transpiration due to diminishing wetland vegetation over the CFRSF.

B. Methodology

The water elevation of the CFRSF is currently permitted at the control level of 14.5 ft. Storage opportunities were only considered above this elevation. For the northern and central cells, this height was established to be 2 ft based on existing wetlands within the facility. For the southern cell and the Walker Parcel the height was determined to be 0.5 ft. This height was determined based on the elevation of existing and proposed U.S. Army Corps of Engineers wetlands within the southern cell of the CFRSF, and the limited ability to inundate the vegetation. Refer to Exhibit 7 for Cross Section of CFRSF. Based on contour lines for these elevations, the total volume of storage within the CFRSF is estimated at 385.5 acre-feet or 125 million gallons (MG). Additional storage may also be possible within the Walker Parcel below the 14.5 ft contour elevation.

Monthly fluctuations of levels were calculated based on a weighted control elevation. The percent of total volume attributed to each cell was multiplied by the level for the cell and added to result in a weighted level of 15.84 ft. At this level, storage with the CFRSF is at a maximum. Levels below the 14.5 ft elevation would indicate withdrawal from the Walker Parcel. Wet season flows are assumed not to be captured because water levels must be maintained at 14.5 ft for flood control purposes.

The CFRSF water budget is presented in various units to normalize the collected data. Rainfall, in inches, was applied over the CFRSF facility which has been excluded from the "contributing watershed" definition. Streamflow data, converted from cfs to acre-ft, is also presented in inches to represent the theoretical rise in the level of open waters within the CFRSF. Horizontal fluctuations of the pond boundaries were not considered. PET, in inches, was applied over the CFRSF area and is assumed to apply to both open water and vegetated areas.

The data collected was entered into a spreadsheet to evaluate the available water from the CFRSF. A second spreadsheet calculates a constant yield that can be extracted for customer use without drawdown below allowable levels. The constant yield calculated is defined as a rate sustainable throughout the dry season that would provide irrigation water to customers from inflows into the CFRSF and deplete any accumulated storage to zero (0) by the start of the wet season. It is assumed, due to high inflows, that the constant yield can be maintained during the wet season without affecting water control levels.

Any excess was shown to be stored with the CFRSF. When the yield exceeds the inflows, onsite storage is depleted to satisfy the customer demand. Inflows exceeding the maximum available storage are shown to have water available for a secondary storage method or for release downstream.

C. Results

The results of the water budget indicate that, based on rainfall, surface water inflows, PET and groundwater movement for an average year, a net annual flow of approximately 57,500 acre-ft could potentially be captured at the CFRSF from the contributing Main A and Main C watersheds. However, only 8% of the volume occurs during the dry season. See Exhibit 8-A for the Average Year CFRSF Water Budget. The available water during this period totals 17,572 acre-ft or an average of 9.22 MGD. Utilizing the available storage at the CFRSF, a constant yield of 8.05 MGD can be sustained throughout the length of the dry season to satisfy customer irrigation demands. See Exhibit 8-B for the Average Year Constant Yield Calculation.

The water budget for the average year shows that the maximum amount of onsite storage is achieved at the start of the water year (October) and remains full throughout January. During this time, excess inflow totaling 213 MG is available for secondary storage methods or for release downstream. Beginning in February, storage levels fluctuate and are depleted by the beginning of the wet season (May).

The extreme drought year analysis indicates that dry season positive inflows into the CFRSF occur only in October, December, March and April and total approximately 989 acre-ft (1.31 MGD). For this analysis, the CFRSF was initially set at full capacity in order to represent the attenuated inflows from the contributing watersheds for the preceding wet season months. This observation can be seen in the generally higher streamflow values for October. See Exhibit 9-A for the Extreme Drought Year CFRSF Water Budget.

With this assumption, it was found that a constant yield of 0.66 MGD could be sustained throughout the dry season however, storage would be depleted by February. Higher inflows for March extend the availability of water with excess storage to be stored at a secondary storage method or released downstream at the start of the wet season. See Exhibit 9-B for the Sustainable Yield Analysis for an Extreme Drought Year.

IV. Alternative Storage Methods

As part of this study, an evaluation of the regulatory, economic and technical feasibility of using ASR to store water from the CFRSF from the wet season to the dry season was carried out. Also evaluated was a system of horizontal wells to indirectly withdraw water from the CFRSF for pumping to the ASR facility. The potential benefit of any alternative storage site will depend upon the demand for additional water. This will continue to create a need for alternative dry weather sources of water to meet the customer irrigation needs.

A. Background Information

The storage capacity of the CFRSF on a one-time-basis is estimated at 125 million gallons (MG). Inflow into the CFRSF during the wet season may exceed 1,600 MG during the wettest month, and, unless some alternative storage system is developed, the excess flow beyond the available storage volume of the ponds will be lost.

This section assesses the regulatory, economic and technical feasibility of using aquifer storage and recovery as a viable alternative to supplement the available surface water storage volume and to provide a method of bridging the availability of excess water during the wet season and the deficiency of water during the dry season.

Aquifer Storage and Recovery Wells, ASR, have the potential to serve as an auxiliary storage system that would supplement the available storage in the CFRSF, and then allow recovery of the excess water for use during the dry season. There are a number of potential hurdles or road blocks that might make this less attractive or impossible as a viable component of the CFRSF. These include technical constraints imposed on the combined CFRSF/ASR system that limit the available water quantity that can be pumped down an ASR well, regulatory constraints that serve to protect underground sources of drinking water but might make it difficult to permit an ASR well, and economic constraints that, even though an ASR system can be designed and permitted, might make the unit cost of water stored in an ASR system too expensive to justify the ASR addition to the CFRSF.

A key requirement is that water injected into an ASR system that is open to an under ground source of drinking water must also meet drinking water quality criteria. Water quality in the CFRSF is of reasonably good quality, but is untreated surface water. Therefore, the ASR system must also include a pre-treatment system between the CFRSF ponds and the ASR well in order for the injected water to meet state and federal drinking water quality criteria.

Bank storage and bank filtration may provide a viable option at a minimum cost, using the natural filtration capability of the underlying soils to for treatment. This would be implemented by constructing a series of horizontal wells below or adjacent to the storage ponds that would capture and enhance infiltration from the ponds and use the intervening soils to act as a passive filter of the raw water prior to pumping from the horizontal wells to the ASR well.

The combined system can then be conceptualized as a storage system consisting of the four ponds, a treatment system consisting of a series of horizontal wells and an ASR system consisting of one or more injection and recovery wells. Given this system, there are a number of questions that must be addressed in order to quantify and assess the overall feasibility. These are:

1. What is the maximum flow rate that must be captured from the storage ponds in order to reduce the amount of water lost to surface water outflow to an acceptable minimum?
2. What is the quality of water within the ponds, and what level of treatment can be expected by infiltration through the underlying soils? Is this sufficient to meet drinking water quality criteria?
3. What are the hydraulic characteristics of the soils, and based on this, what are the design parameters of the horizontal well system necessary to capture the flow volume defined in 1, above.
4. Assuming that questions 1 through 3 are answered, what are the design parameters of the ASR system in order to accept the preferred flow rate from the ponds.
5. What injection zone is appropriate to serve as the storage zone for the ASR system? If this is within an underground source of drinking water, can all required regulatory parameters be met?
6. If injection into an underground source of drinking water is eliminated because of water quality or other operational issues, is there an alternative zone at depth that can serve as a storage and recovery zone? What is the additional incremental cost to construct and operate a well into this deeper zone, and can the same efficiency of treated water recovery be expected?
7. What are the permitting requirements for each of the component systems?
8. What are the costs for each system and does the overall cost for any of the options prohibit one or more of the system components or limit the system as a whole?
9. Is the entire system feasible from a technical, regulatory and economic perspective?

B. Methods of Analysis

Analysis of the above issues proceeded by first defining the physical parameters that must be included in the assessment, then developing the economic costs required by the engineering design dictated by the physical parameters, and finally evaluating whether the proposed system can be permitted. The physical parameters of the proposed system include the hydrology of the watershed and storage ponds, the underlying geology and hydraulic properties of the geologic units that affect the ponds and the horizontal wells and ASR system. These factors have been derived from previous studies of the hydrology of the area and soil borings on and surrounding the site. Integration of these parameters and assessment of their impact on the proposed system will be addressed by construction of a computer model using the USGS model, MODFLOW. This model incorporates precipitation and infiltration, surface water features, geologic characteristics of the subsurface materials and ground water flow in and between the layers.

The following sections present the detailed analysis of each of these areas.

Important Physical Parameters

1. Site Topography and Geology

The CFRSF is located on the southwestern Florida coastal plain, an area of low topographic relief, characterized by sandy to clayey soils, a high water table and numerous wetland areas. The underlying geology, beginning from the land surface, consists of recent and Pleistocene undifferentiated sediments ranging in thickness from a few feet up to 30 feet. Underlying the soils and undifferentiated surface sediments are the formations of the Hawthorne Group. The Hawthorne Group is approximately 400 feet thick in the area of the CFRSF. The upper portions of the Hawthorne Group are predominantly sandy clays, clayey sands and marine clays. The lower portions contain more carbonate rich deposits, and include dolomitic limestones with varying percentages of sand, clays and phosphate. Below the Hawthorne Group are the Ocala Limestone and the units that comprise the Floridan Aquifer.

The **Table** below presents the geologic and hydrogeologic units present in the Sarasota County area of Florida.

<table>
<tr><th>Stratigraphic Unit</th><th>General Lithology</th><th colspan="3">Hydrogeologic Unit</th><th>Hydrogeologic Properties</th></tr>
<tr><td>Undifferentiated Surficial deposits</td><td>Discontinuous sand, clay, shell beds, and limestone</td><td colspan="3">Surficial Aquifer system</td><td>Sand, shell, limestone, and coquina deposits provided local water supplies</td></tr>
<tr><td>Hawthorn Group</td><td>Interbedded phosphatic sand, clay, limestone, and dolomite</td><td colspan="3">Intermediate aquifer and confining unit</td><td>Sand, shell, and carbonate deposits provide limited local water supplies. Low permeability clay serve as the principle confining beds for the Floridian aquifer system below</td></tr>
<tr><td>Ocala Limestone</td><td>Massive fossiliferous chalky to granular marine limestone</td><td rowspan="5">Floridian aquifer system</td><td colspan="2">Upper Floridian aquifer</td><td>Principal source of ground water. High permeability overall. Water from some wells shows increasing salinity.</td></tr>
<tr><td rowspan="2">Avon Park Formation</td><td rowspan="4">Alternating beds of massive granular and chalky limestone and dense dolomite</td><td colspan="2">Middle semiconfining unit</td><td>Low permeability limestone and dolomite.</td></tr>
<tr><td rowspan="3">Lower Floridian aquifer</td><td>Upper zone</td><td>Principal source of ground water. Water from some wells shows increasing salinity.</td></tr>
<tr><td rowspan="2">Oldsmar Formation</td><td>Semiconfining unit</td><td>Low permeability limestone and dolomite.</td></tr>
<tr><td>Fernandina permeable zone</td><td>High permeability; salinity increases with depth.</td></tr>
</table>

A number of shallow borings and four deep borings were installed across the site to define the subsurface geology. **Exhibit 10** presents a north-south geologic cross-section of the geologic units encountered in the top 100 feet of the site.

In general, the area is characterized by near surface sandy units in the upper 15 feet, underlain by tight clays with occasional limestone beds that are not consistent across the site.

Ideally, for the planned design of the ponds and horizontal wells, thicker sequences of sandy units would have been much more desirable. The thick sequences of low permeability clay units at depths greater than 15 feet will severely limit the effectiveness of horizontal wells to capture or increase infiltration from the ponds. This issue will be addressed in greater detail during the modeling phase.

2. Hydrology

The previous analysis presents the comprehensive water budget for the site. Results from the analysis indicate the availability of water resources from the CFRSF.

3. Hydrogeology

There are three principal aquifer systems underlying the CFRSF. The Surficial Aquifer system includes the surface sands and upper permeable units within the Hawthorne Group. This water table aquifer is normally considered to be approximately 50 to 75 feet in thickness and will yield sufficient water to wells for local domestic use and irrigation. The Intermediate Aquifer consists of limestone or sandy units within the middle zone of the Hawthorne Group. This aquifer is separated from the overlying Surficial Aquifer and the underlying Floridan Aquifer by clay beds of low permeability. The aquifer responds as a confined aquifer when subjected to pumping. During the wet season, high water levels in the Surficial Aquifer may reverse the vertical gradient between the Surficial Aquifer and the Intermediate Aquifer. The Intermediate Aquifer will yield good quality water to wells ranging in depth from 120 feet to 350 feet at rates that may approach 150 gpm.

Underlying the Intermediate Aquifer at a depth of approximately 425 feet from ground surface is the Floridan Aquifer. The upper portions of the Floridan Aquifer yield high volumes of good quality water to production wells. Salinity increases with depth, however, and the middle and deeper portions of the aquifer are unusable as a primary source of drinking water without treatment.

C. Technical Feasibility

1. Analysis of the Physical and Hydrological System Characteristics

As stated earlier, this section assesses the economic, regulatory and technical feasibility of using horizontal wells to capture excess flow from the CFRSF and inject it underground via an aquifer storage and recovery system for later re-use. The complex properties of each component of the system make it advantageous to construct a computer model that can simultaneously analyze all components of the system. Figure 2 illustrates the conceptual system to be assessed.

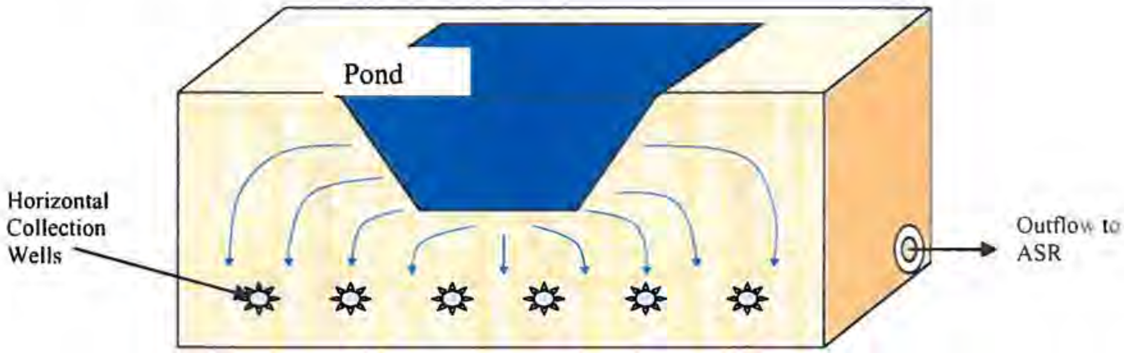


Figure 2 Schematic Illustration of CFRSF pond and underlying horizontal wells

2. Model Analysis

The USGS finite difference model, MODFLOW, was selected for the project. A proprietary version of the model provided by Environmental Simulations, Inc., that includes a pre- and post-processing package for ease of use was applied to the site. The USGS provides the following description of the history and capabilities of the model:

"MODFLOW is a three-dimensional finite-difference ground water model that was first published in 1984. It has a modular structure that allows it to be easily modified to adapt the code for a particular application. MODFLOW-2000 is the latest version.

MODFLOW-2000 simulates steady and non-steady flow in an irregularly shaped flow system in which aquifer layers can be confined, unconfined, or a combination of confined and unconfined. Flow from external stresses, such as flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through river beds, can be simulated. Hydraulic conductivities or transmissivities for any layer may differ spatially and be anisotropic (restricted to having the principal directions aligned with the grid axes), and the storage coefficient may be heterogeneous. Specified head and specified flux boundaries can be simulated as can a head dependent flux across the model's outer boundary that allows water to be supplied to a boundary block in the modeled area at a rate proportional to the current head difference between a "source" of water outside the modeled area and the boundary block. MODFLOW is currently the most used numerical model in the U.S. Geological Survey for ground water flow problems."

a. MODFLOW Grid

The model was constructed covering an area of 10,000 ft by 10,000 ft with a 100 column by 100-row grid with equal spacing of 100 ft. The model consists of a two layers, a single layer representing the Surficial Aquifer with a second layer overlying the sediments in which the ponds are located. Underlying layers exhibit sufficiently low hydraulic conductivity to be considered aquitards. The thickness of the Surficial Aquifer, based on the geotechnical borings shown in Exhibit 10 was selected as 15 feet.

b. Aquifer Characteristic and Input Parameters

Review of the geotechnical borings found that the Surficial Aquifer on the CFRSF site is predominantly clayey and silty sands. Hydraulic conductivity values for these types of sediments range from 10^{-5} cm/sec to 10^{-3} cm/sec or from 2.83 ft/day to .028 ft/day. As an initial assumption a hydraulic conductivity (K) value for the Surficial Aquifer was assumed to be 2.83 ft/day (10^{-3} cm/sec). This higher value for hydraulic conductivity was selected for the first model runs based on experience with similar environments, and an assumption that if the available water volume that could be captured from the horizontal well system was small, compared to the excess water volume being lost by outflow during the wet season, then the entire approach of using horizontal wells as a component of the storage and treatment system might not be viable. It is important to note that a hydraulic conductivity value of 2.83 ft/day is the highest value that could be anticipated for a relatively clean, fine sand aquifer. In reality, a more representative value for the soils and shallow sediments underlying the CFRSF area is lower by a factor of 10, i.e., 0.283 ft/day.

The values of K for the model are assumed to be equal in the x and y direction of the model (horizontal) but are assumed to be 0.10 of the horizontal K value for the z direction (vertical) of the model. This lower value for vertical hydraulic conductivity is selected based on the bedded nature of the sediments.

Boundary conditions for the model consisted of two constant head boundary conditions at the west and east sides of the model. Potentiometric data for wells present on the site, as well as average Surficial Aquifer system groundwater elevations from the United States Geological Survey (USGS) were used to calculate constant head boundary conditions (USGS, 2003). The resultant calculated groundwater elevation gradient across the site was 4.39 x 10^{-4} ft/ft. Based on the above gradient, the boundary condition groundwater elevation on the east and west edge of the 10,000 ft wide model domain were 18.7 and 14.3 ft NGVD, respectively.

Evaluation of effects on the storage impoundments utilized the Lake model package in Groundwater Vistas (Version 4.0) MODFLOW 2000. Four separate square impoundments were included (North, Central, South, and Walker), based upon design of the CFRSF. For simulations in which the lake levels were not recharged and allowed to change with groundwater withdrawals, the North and Central impoundments were allowed to fluctuate between water surface elevations of 16.5 ft and a minimum elevation of 14.5 ft. The South and Walker impoundments were allowed to fluctuate between maximum water surface elevations of 15.0 ft, with minimum elevations of 14.5. Pond bottom and sides hydraulic conductivity was set to 2.83 ft/day, the value utilized for the shallow aquifer x and y direction flow, as it was expected that the ponds would laterally contribute groundwater to the soil as well as vertical infiltration.

c. Withdrawal Assumptions and Iterations

The initial model runs, were completed with only one horizontal well to extract shallow groundwater from the pond and shallow aquifer storage system. This scenario modeled recharge of the shallow groundwater by lateral and vertical pond seepage. Groundwater flowing laterally and vertically into the horizontal well would then be pumped from the well into the ASR system.

The horizontal wells were modeled by installing a closely spaced series of vertical wells along a continuous north-south horizontal line. The model was not able to be configured with a horizontal well located within the Surficial Aquifer without having the well behave as if it was a vertical drain fully penetrating the entire aquifer thickness. By using a series of closely spaced vertical wells, the effect of a horizontal well was simulated.

The model results are most sensitive to hydraulic conductivity, but also to the depth of burial of the horizontal well or head difference between the water level in the ponds and the horizontal well, and the lateral distance between the horizontal well and the pond boundary. In reality, these parameters, with the exception of the hydraulic conductivity, will be dependent on the site layout, and may be optimized somewhat to maximize the flow to the wells. However, for analysis purposes, the system was simplified as much as possible while still being able to address the most important parameters of interest.

After the model was initially configured and a steady-state run completed with the ponds in place, the linear line of wells was enabled and an optimum pumping rate determined by trial and error methods. The goal was to find the maximum volume of water that could be extracted from the wells, while avoiding dewatering of the Surficial Aquifer and pond layer. It was also important to establish the radius of influence of each well in order to then assess the optimum spacing of the wells. The base, steady state case, and the optimum well production case are illustrated below.

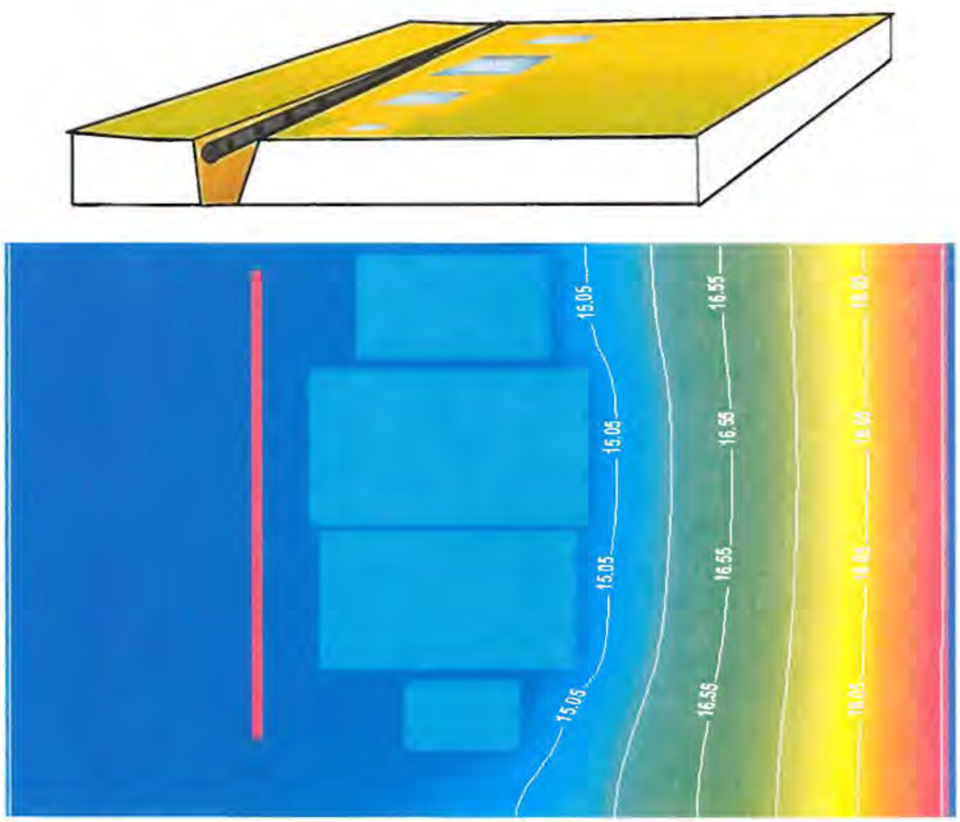


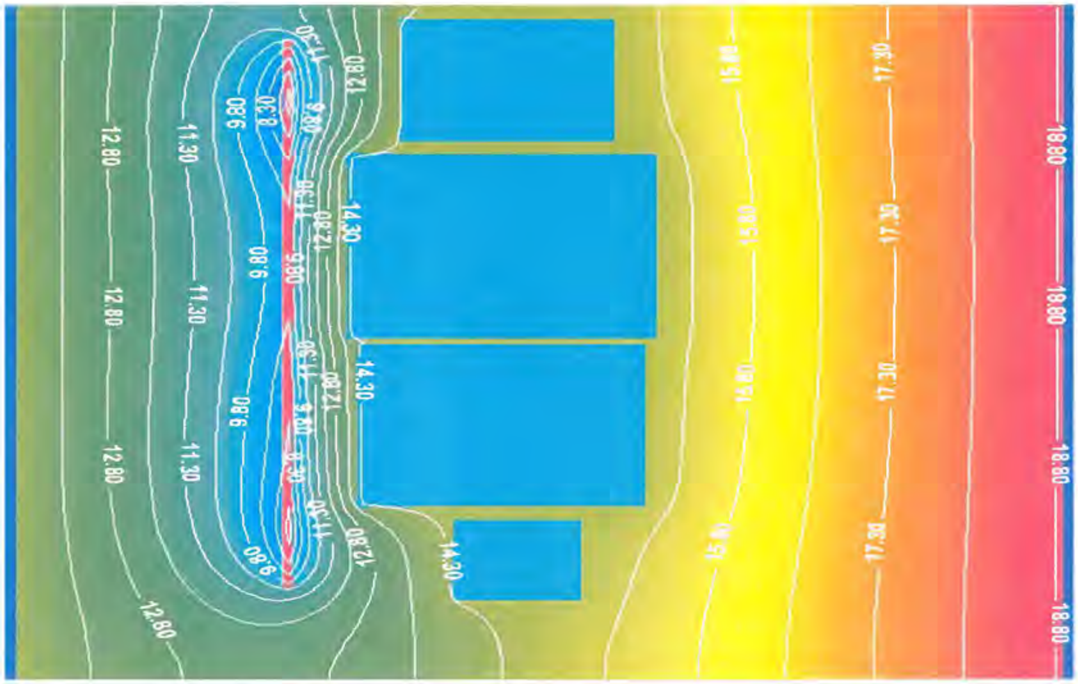
Figure 3: Ponds and one well illustration of initial analysis, perspective and plan view.

3. Model Results

Based upon the design illustrated in Figure 3, groundwater flow into the well was iteratively determined by maximizing the withdrawal rate without dewatering the aquifer in the vicinity of the well. A range of yield values was derived, with the extreme values of the range being between nearly 300 gallons per minute as a high to a low of 1 gallon per minute. The extremes of the range are, however, not particularly useful as they required a combination of possible but collectively unlikely parameters. The table below presents the results from varying the hydraulic conductivity and distance of the well from the ponds for from 1 to 6 wells.

K (gpd/ft^2)	Distance of Well from Pond	Yield from a Horizontal Well (in gallons per minute) Length of well set at 5,000 feet				
		1 WELL	**2 WELLS**	**3 WELLS**	**4 WELLS**	**6 WELLS**
21.2	50	294	589	883	1,178	1,767
2.12	50	**29**	**59**	**88**	**118**	**177**
0.212	50	3	6	9	12	18
21.2	100	147	294	442	589	883
2.12	100	**15**	**29**	**44**	**59**	**88**
0.212	100	1	3	4	6	9
21.2	150	98	196	294	393	589
2.12	150	**10**	**20**	**29**	**39**	**59**
0.212	150	1	2	3	4	6

Because of the limited thickness of the aquifer, it would not be possible to add additional wells below the ponds, but another well could be added on the east side of the ponds, thereby doubling the available supply. The water table configuration output from the model with optimum flow is shown in the figure below:



For the simulation illustrated in the above figure, impoundments were maintained at a constant level of 16.5 ft NGVD to reflect recharge via surface drainage to the ponds onsite.

Although the model allowed the examination of a number of different scenarios, it is important to consider how these various results approach the actual site conditions, and, for decision-making, which of the scenarios provide realistic yield numbers.

Within the constraints of the site, the lateral distance of the well from the pond can be controlled. Ideally, the distance needs to be close enough to maximize flow between the pond and the well but far enough away from the pond to allow the intervening soils to filter out unwanted water quality parameters. This distance needs to be determined by actual site investigations. For this assessment, a minimum distance of 50 feet appears to be reasonable.

The length of the horizontal well also determines the yield. There are a number of different configurations, including north-south wells, east-west wells and many different configurations between these options. For analysis purposes, a linear distance of 5,000 feet for the base case analysis was assumed, with the wells running parallel with the long axis of the property and parallel to the ponds layout. Because of the shallow Surficial Aquifer in this area, two wells of 5,000 feet length, one on each side of the ponds is a reasonable configuration. Additional wells below or parallel with the ponds are not constructible or would create interference between the wells without substantially increasing the combined yield.

The yield is most sensitive to the hydraulic conductivity of the aquifer. Although the sediments are expected to have a range of hydraulic conductivities from 21.2 to 0.21 gpd/ft^2, from a macroscopic perspective, the most probable value for the site as a whole is 2.12 gpd/ft^2.

Using the above parameters, the model indicates that the most probable yield, using 2 wells 50 feet from the pond boundaries and of 5,000 foot length, with an average soil hydraulic conductivity of 2.12 gpm/ft^2 is approximately 60 gallons per minute or approximately 2.5 million gallons per month. Actual yields could range upward by a factor of 10, to 25 million gallons per month or be lower by a factor of 2, to 1.25 million gallons per month. For analysis of the permitting and economic feasibility, the realistic yield value of 2.5 million gallons per month will be used.

Is this complex system of horizontal wells and an ASR system technically feasible? The answer is yes, there are no technical constraints that would prohibit the construction of the system. However, the efficiency of the system is in question, as will be addressed in the following sections. A rather complex system of multiple wells, untested treatment capability and an ASR well that yields at best, 25 million gallons per month, and may only yield 2.5 million gallons per month may not be economically attractive.

ECONOMIC FEASIBILITY

Costs to implement the proposed treatment system, consisting of two 5,000 horizontal collection wells and a storage system consisting of an ASR well are considered in this section. The American Association of Cost Engineers defines an "order of magnitude cost estimate" as being a preliminary estimate that can be consider to be approximately accurate within a range of plus 50 percent or minus 30 percent. Although this assessment is obviously preliminary, it is the goal of the assessment to fall within this range. Actual field data and pilot tests would be necessary before a design could be completed in sufficient detail to provide a more realistic estimate of costs. The greatest uncertainty lies in the costs for permitting and in the ASR system.

The following tables present the major elements to be considered in preparing the cost estimate of feasibility:

Comments on Key Components of Horizontal Wells and ASR System		
	Horizontal Collection Wells	ASR System
Design	Relatively straight forward but pilot testing is required to determine the ability of effluent water to meet drinking water quality criteria.	Significant exploration and testing before final design could be undertaken.
Permitting	SWFWMD WUP permit, County Construction Permit ERP	EPA, FDEP, SWFWMD permits, construction and testing permits, operation permits, significant monitoring requirements. Permitting normally requires in excess of 1 year.
Construction labor and materials	10,000 linear feet of 4 inch diameter perforated pipe, pumps, valves, sampling ports.	Depth is unknown but estimated at 750 feet of 14 inch outer casing, 10 inch inner casing.
Testing and Certification	Definitive testing of insitu hydraulic conductivity is necessary. Pilot testing will be required to assess ability to meet drinking water quality regulations.	Significant exploration and pre-design testing is required. Cycle testing required for operational permits and methods normally requires 6 months.
Operation and Maintenance(5 years)	Normal O&M plus continued monitoring of water quality.	Close monitoring of performance, water quality and efficiency is required by permits.

Costs for the proposed installation, including design and permitting have initially been addressed by the team of Carollo Engineers and ASR Systems, inc., in their February, 2004 report. They did not have available the results of the computer modeling conducted as part of this task so although the unit costs they assumed are reasonable, the total costs will differ because of the difference in sizing of the components. The table below provides the major component costs.

Estimated Costs for Combined System[1]		
Component Elements	Horizontal Collection Wells	ASR System
Screen, pipe, pumps, controls, materials and installation	$1,700,000	$800,000
Design, permitting, testing	$500,000	$500,000
Contingency (30%)	660,000	$390,000
Total Capital Cost	$2,860,000	$1,690,000
O&M	$10,000/year	$100,000/year

[1] Costs modified from ***Technical Memorandum, Storm water Resource Feasibility and Site Screening Analysis***, February, 2004. Prepared by Carollo Engineers and ASR Systems, Inc. for Sarasota County.

Based on these assessments, the capital cost and one year O&M for the combined horizontal collection wells and ASR well is approximately $4.7 million. Considering that this investment will produce approximately 2.5 million gallons per month to potentially 25 million gallons per month, this translates into an annual cost of $0.15 to $0.016 per gallon. Existing reuse water is priced at $0.45 per 1,000 gallons. Comparing this with the costs for the additional storage volume at the CFRSF using the proposed system indicates that the unit costs would range from $150/1000 gallons to $16/1000 gallons. This comparison indicates that the proposed system is not economically feasible.

REGULATORY FEASIBILITY

The technical and economic feasibility of the proposed system is thwarted by the low permeability sediments and limited thickness of the Surficial Aquifer. However, with these constraints, the system may still be permittable. There is one key constraint the might make this difficult to permit:

The technical and economic feasibility of the proposed system is constrained by the low permeability sediments and limited thickness of the Surficial Aquifer. However, with these constraints, the system may still be permittable. The most critical factor for this approach is the quality of water that should be recovered through the proposed horizontal well system. Poor water quality from the horizontal wells would require, at a minimum, some form of an exemption or variance, or was a worst case scenario, treatment prior to be discharged into the ASR well.

The issue can only be resolved by direct pilot testing of the bank filtration process on the proposed site with native water. Costs for this type of testing are included in the above cost estimate, but the results of the testing will determine if the approach is possible to be permitted.

SUMMARY AND CONCLUSIONS

The proceeding sections have provided an assessment of the technical, economic and regulatory feasibility of the proposed alternative storage system for the CFRSF. This alternative assessed the utility of using horizontal wells to capture additional excess storm water during the wet season, treat the water by using a bank infiltration approach, and then store the excess water in an ASR well.

Although the process is technically feasible, low permeability sediments of limited thickness below the CFRSF area limit the rate and volume of water that is capable of being captured. In addition, there is an uncertainty in whether or not the bank filtration system can produce adequate quality water for the ASR well, and to resolve this uncertainty would require a site specific pilot test of at least 6 months duration.

From an economic standpoint, the unit cost of the additional water made available by this process is significantly greater than other methods of supplementing the supply. Therefore, it is concluded that the process is not economically feasible.

Regulatory concerns can be addressed, and therefore, if the results of the pilot test indicate that the bank filtration system provides adequate quality water for the ASR well, then the proposed system is permittable.

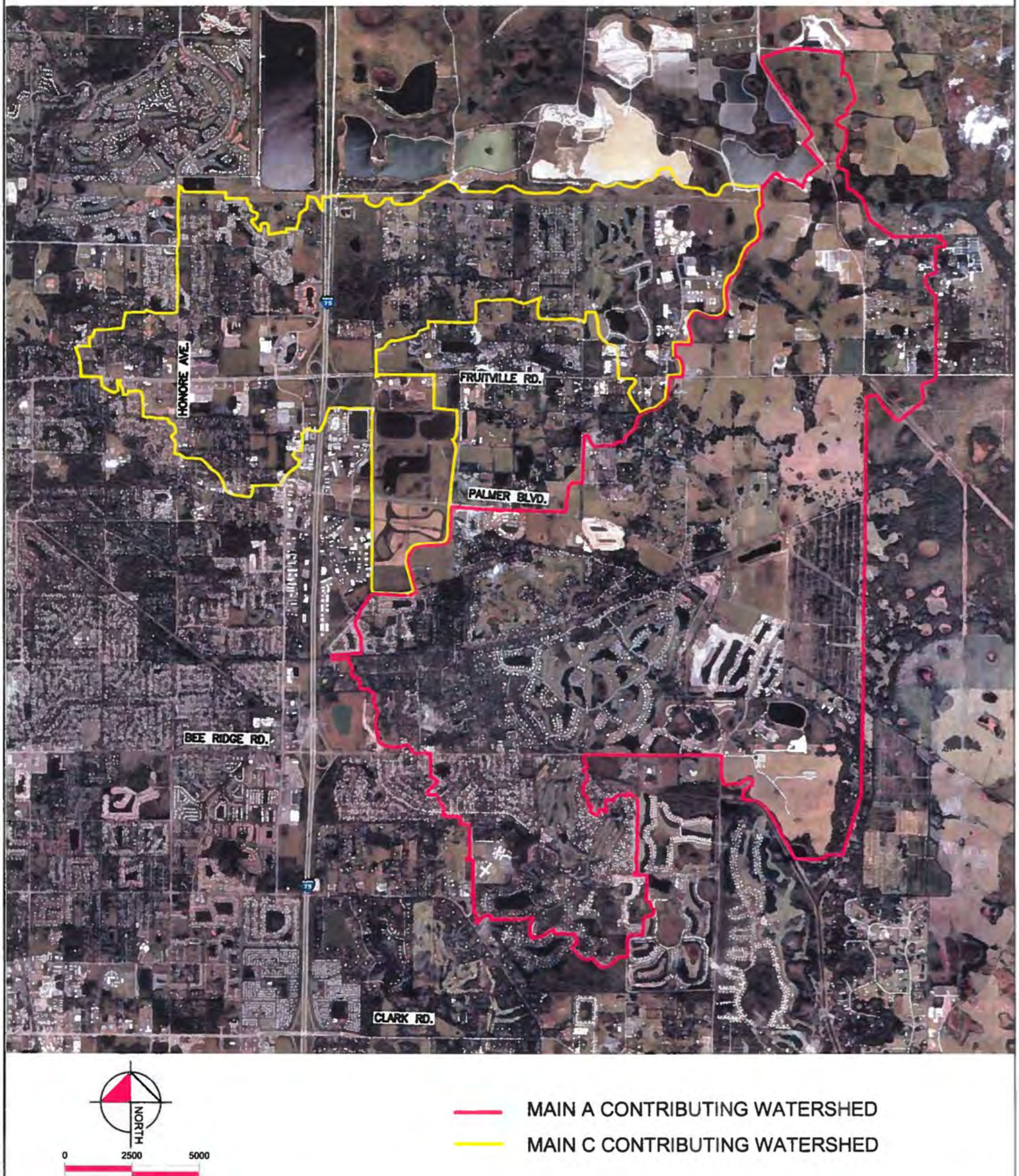
Overall, however, because of the poor geology of the site, and subsequent excessive cost of the proposed system, horizontal wells and an ASR well to provide additional storm water capture capabilities for the CFRSF Regional Storage Facility are not recommended.

References:

USGS. 2003. Water Resources Data Florida, Year 2003. Volume 3B: Southwest Florida Ground Water. Water-Data Report FL-03-3B. United States Geological Survey.

EXHIBIT 1

WATERSHEDS CONTRIBUTING TO THE CFRSF



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		PROJECT NO. 048048021	© COPYWRITE 2004 2601 Cattlemen Road, Suite 500, Sarasota, FL 34232 (941) 922-8187 CA 00000696
	FLORIDA REGISTRATION NUMBER: 46711	SCALE 1"=5000'	
		DESIGNED BY	
		DRAWN BY MKH	EXHIBIT 1
		CHECKED BY	

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EXHIBIT 2

SARASOTA COUNTY RAINFALL DATA

EXHIBIT 2

Average Rainfall (in inches) for Sarasota County

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Water Year Total	Dry Season Total
	1976	0.90	0.80	0.58	1.13	7.93	9.70	7.20	7.92	7.73	1.83	2.97	1.87	--	--
	1977	2.51	1.07	0.31	0.95	2.45	4.99	8.73	8.22	9.13	0.65	2.24	4.77	45.03	13.96
	1978	3.37	4.99	3.47	0.10	2.59	9.97	8.49	6.96	5.29	1.60	0.82	3.58	52.89	22.18
	1979	7.72	1.49	1.59	1.16	4.24	3.12	5.98	10.79	13.71	1.22	1.00	3.37	55.80	22.20
	1980	2.91	1.99	2.01	3.68	3.55	2.22	6.63	10.66	7.37	1.27	4.43	0.88	46.61	19.73
	1981	0.66	4.96	1.04	0.03	2.46	8.96	6.47	16.98	4.54	1.24	2.47	1.04	52.68	15.73
	1982	1.62	2.07	5.48	3.91	3.17	11.59	8.80	7.96	9.37	6.20	0.96	0.90	58.72	21.00
	1983	3.08	9.29	7.96	2.49	1.54	8.56	7.15	8.30	10.70	5.50	4.73	6.09	67.13	32.42
	1984	1.12	3.02	5.17	3.93	3.78	3.29	10.77	5.25	3.36	1.32	2.33	0.22	56.01	33.34
	1985	1.46	0.91	2.93	2.41	0.95	4.16	6.92	7.37	6.04	2.99	2.18	0.71	37.02	12.53
	1986	1.68	1.88	5.03	0.70	1.98	9.20	7.19	7.52	3.36	5.51	1.68	5.64	44.42	17.15
	1987	3.02	1.68	10.14	0.14	4.73	7.96	9.88	6.52	5.95	2.66	3.40	0.54	62.85	32.54
	1988	2.94	2.37	6.12	2.85	1.11	2.92	5.91	11.28	11.04	1.56	3.60	1.34	53.14	21.99
	1989	2.30	0.25	2.18	0.84	1.02	7.68	7.19	5.30	8.02	2.01	1.17	3.39	41.28	13.09
	1990	0.11	3.00	1.34	0.79	3.31	4.90	8.87	6.01	3.56	4.83	0.58	0.77	38.46	15.12
	1991	5.73	2.60	4.22	3.60	10.11	6.26	11.90	5.90	5.38	2.31	0.15	0.12	61.88	32.44
	1992	0.77	4.78	2.56	3.32	1.16	22.45	5.16	8.38	7.08	3.65	0.95	0.85	58.24	15.17
	1993	6.62	2.85	5.25	5.25	3.09	5.03	6.50	7.31	4.91	7.12	0.31	1.11	52.26	28.51
	1994	3.71	0.81	2.52	4.31	0.40	6.41	9.96	10.52	11.25	4.83	1.39	2.44	58.43	20.29
	1995	3.12	2.33	1.42	3.88	0.65	18.45	16.05	12.26	9.75	10.05	1.32	1.20	76.57	20.06
	1996	3.86	1.10	4.93	1.90	5.21	5.44	3.88	5.45	4.90	5.11	0.48	1.72	49.24	29.57
	1997	1.60	0.99	2.00	7.85	3.30	4.55	8.17	5.49	11.04	2.18	6.71	9.29	52.30	23.05
	1998	5.48	7.75	9.75	0.24	1.81	2.63	6.64	6.46	9.73	1.40	3.65	1.15	68.67	43.21
	1999	4.35	0.11	1.62	0.56	2.06	9.18	7.58	14.79	7.36	5.04	0.72	1.76	53.81	14.90
Extreme Drought Year 2000-2001	**2000**	1.07	0.39	1.43	1.93	0.63	6.89	7.54	6.95	6.89	**0.29**	**0.72**	**0.85**	41.24	12.97
	2001	**0.19**	**0.01**	**6.93**	**0.23**	**0.94**	**8.85**	**13.55**	**5.36**	**12.73**	1.63	0.10	0.52	**50.65**	**10.16**
	2002	2.40	4.36	0.34	1.88	2.87	8.36	6.20	11.58	4.48	1.66	4.33	6.41	44.72	14.10
	2003	0.05	1.18	2.44	3.70	3.24	16.45	6.14	13.75	10.64	1.01	1.00	3.87	69.99	23.01
Average Year	**MEAN**	**2.66**	**2.47**	**3.60**	**2.28**	**2.87**	**7.86**	**8.05**	**8.62**	**7.69**	**3.10**	**2.01**	**2.37**	**53.56**	**21.50**

EXHIBIT 3

AVERAGE YEAR
MAIN C CONTRIBUTING WATERSHED
STREAMFLOW DATA

EXHIBIT 3-A

AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Annual Streamflow Data Analysis for Neighboring Creeks

Creek	Watershed Area		Flow	
	(sq miles)	(acres)	(acre-ft)	(MGD)
Cedar Creek	0.94	602	2,154	22.64
Nonsense Creek	1.14	730	1,880	19.76
Hickory Hammock	2.40	1,536	2,347	24.67
Rattlesnake Slough	3.78	2,419	3,820	40.15
Walker Creek	4.91	3,142	5,060	53.18
Cooper Creek	9.33	5,971	6,794	71.41
Braden River	25.80	16,512	29,292	307.88
Howard Creek	20.00	12,800	15,850	166.59
Main C	5.94	3,802	5,821	61.18

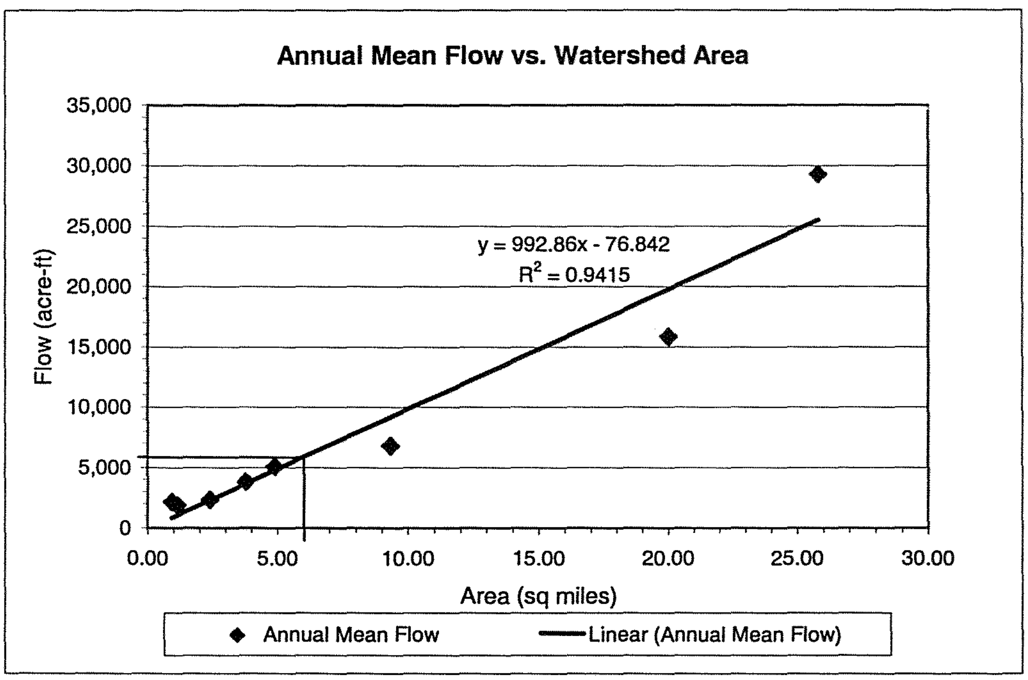
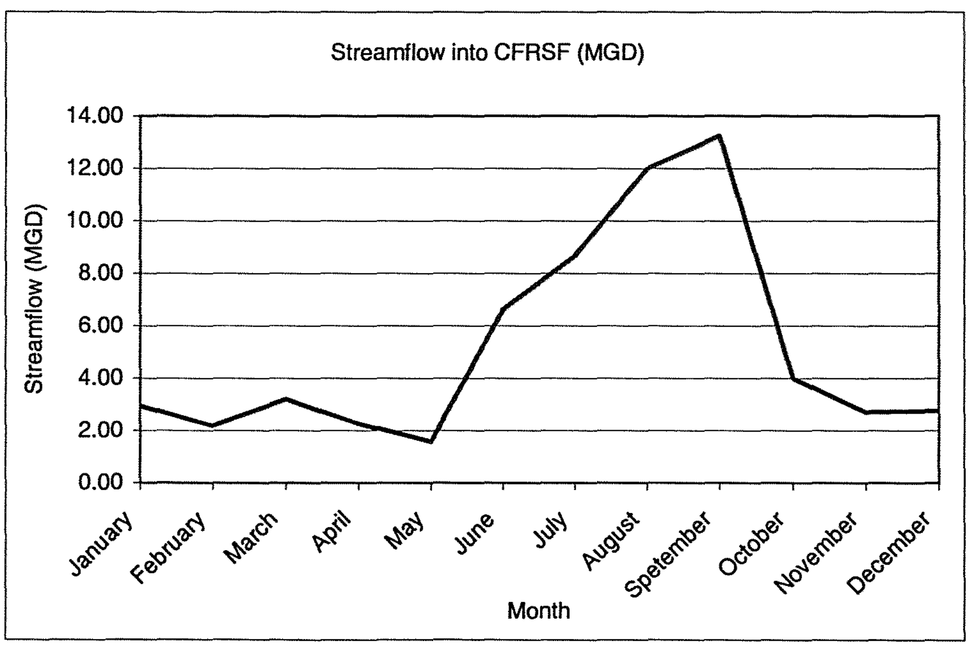


EXHIBIT 3-B

AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Month	Streamflow	
	(acre-ft)	(MGD)
Jan	280	2.94
Feb	188	2.19
Mar	305	3.21
Apr	208	2.26
May	151	1.59
Jun	610	6.63
Jul	826	8.68
Aug	1,141	11.99
Sep	1,220	13.25
Oct	379	3.98
Nov	250	2.72
Dec	263	2.76
Annual Average	485	5.18

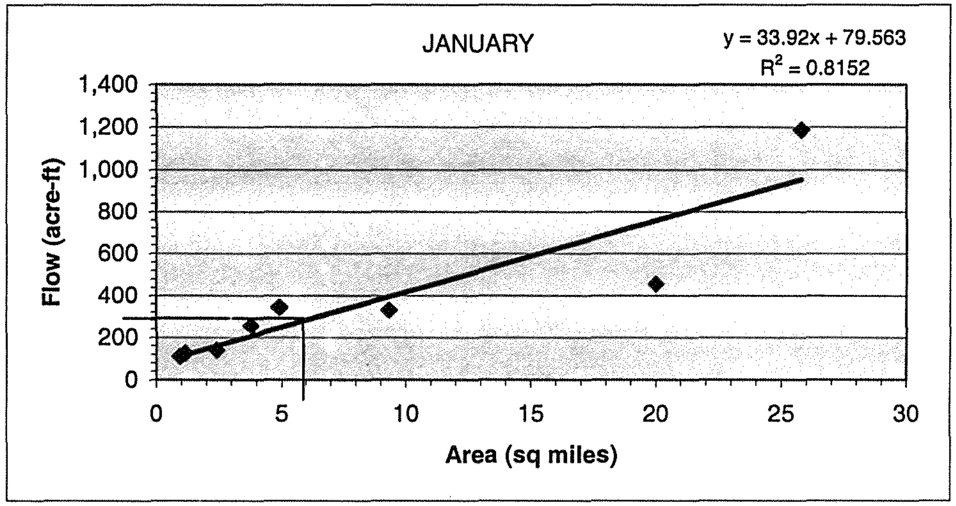


AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

JANUARY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	458
Walker Creek	4.91	3,142	346
Braden River	25.8	16,512	1,187
Hickory Hammock	2.4	1,536	141
Cooper Creek	9.33	5,971	330
Cedar Creek	0.94	602	111
Rattlesnake Slough	3.78	2,419	255
Nonsense Creek	1.14	730	125
Main C	**5.94**	**3,800**	**280**

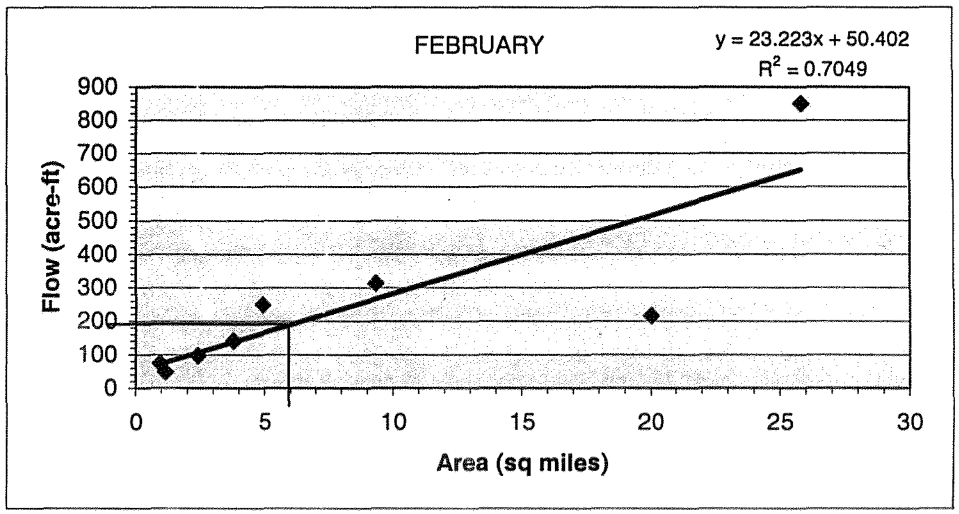
2.94 MGD



FEBRUARY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	217
Walker Creek	4.91	3,142	248
Braden River	25.8	16,512	850
Hickory Hammock	2.4	1,536	97
Cooper Creek	9.33	5,971	313
Cedar Creek	0.94	602	74
Rattlesnake Slough	3.78	2,419	141
Nonsense Creek	1.14	730	49
Main C	**5.94**	**3,800**	**188**

2.19 MGD

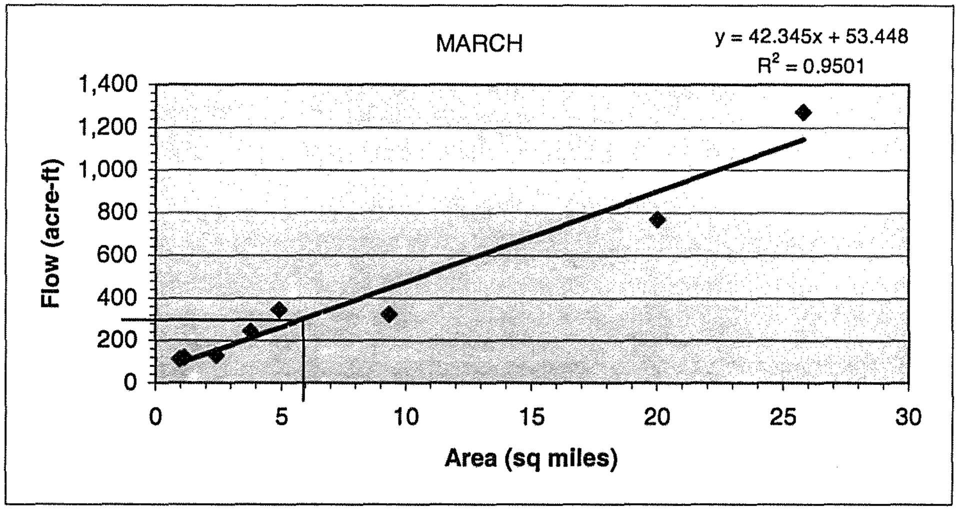


AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MARCH

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	769
Walker Creek	4.91	3,142	345
Braden River	25.8	16,512	1,273
Hickory Hammock	2.4	1,536	130
Cooper Creek	9.33	5,971	325
Cedar Creek	0.94	602	112
Rattlesnake Slough	3.78	2,419	246
Nonsense Creek	1.14	730	120
Main C	**5.94**	**3,800**	**305**

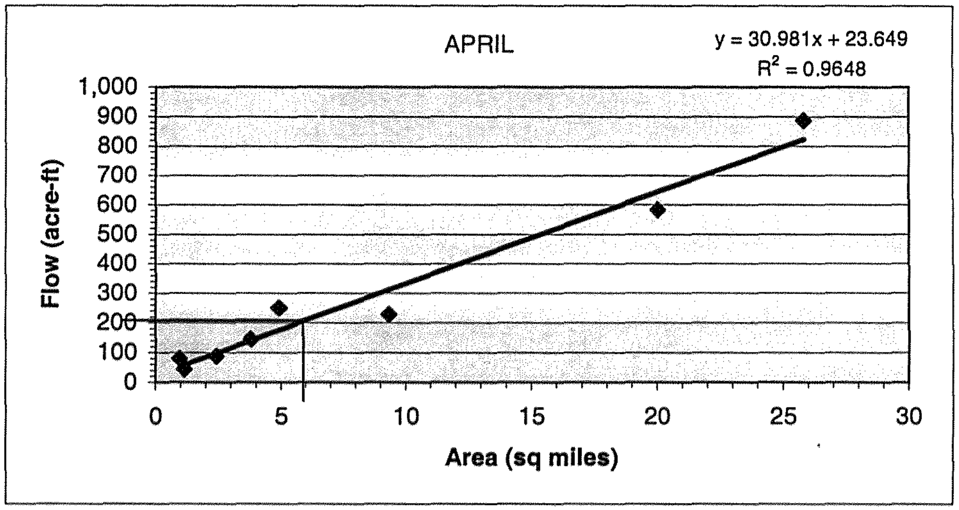
3.21 MGD



APRIL

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	582
Walker Creek	4.91	3,142	251
Braden River	25.8	16,512	887
Hickory Hammock	2.4	1,536	89
Cooper Creek	9.33	5,971	228
Cedar Creek	0.94	602	80
Rattlesnake Slough	3.78	2,419	145
Nonsense Creek	1.14	730	44
Main C	**5.94**	**3,800**	**208**

2.26 MGD

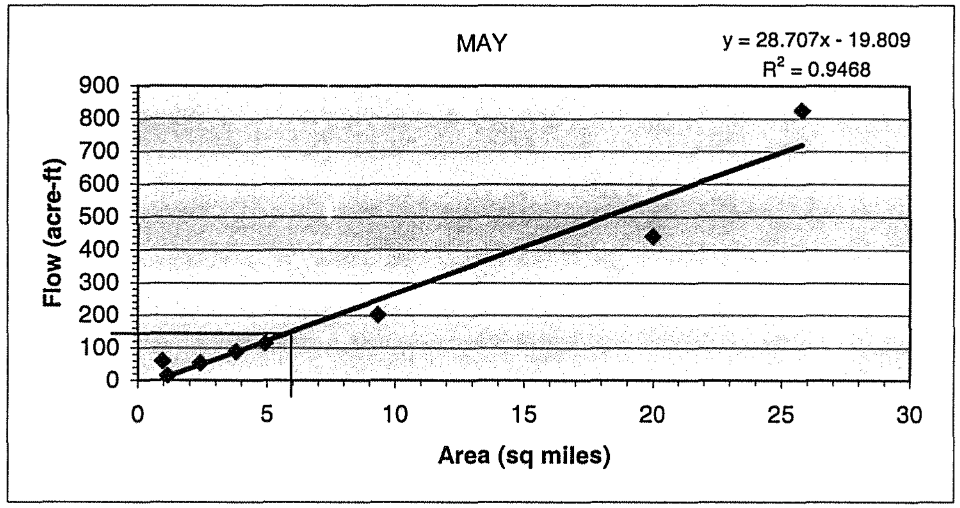


AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MAY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	441
Walker Creek	4.91	3,142	116
Braden River	25.8	16,512	824
Hickory Hammock	2.4	1,536	55
Cooper Creek	9.33	5,971	202
Cedar Creek	0.94	602	60
Rattlesnake Slough	3.78	2,419	89
Nonsense Creek	1.14	730	16
Main C	**5.94**	**3,800**	**151**

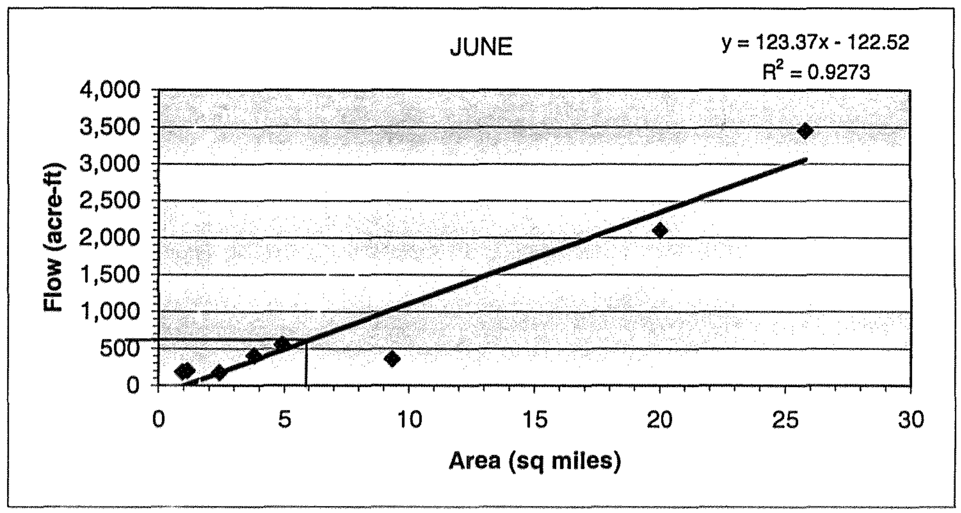
1.59	**MGD**



JUNE

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	2,100
Walker Creek	4.91	3,142	556
Braden River	25.8	16,512	3,451
Hickory Hammock	2.4	1,536	178
Cooper Creek	9.33	5,971	364
Cedar Creek	0.94	602	184
Rattlesnake Slough	3.78	2,419	406
Nonsense Creek	1.14	730	205
Main C	**5.94**	**3,800**	**610**

6.63	**MGD**

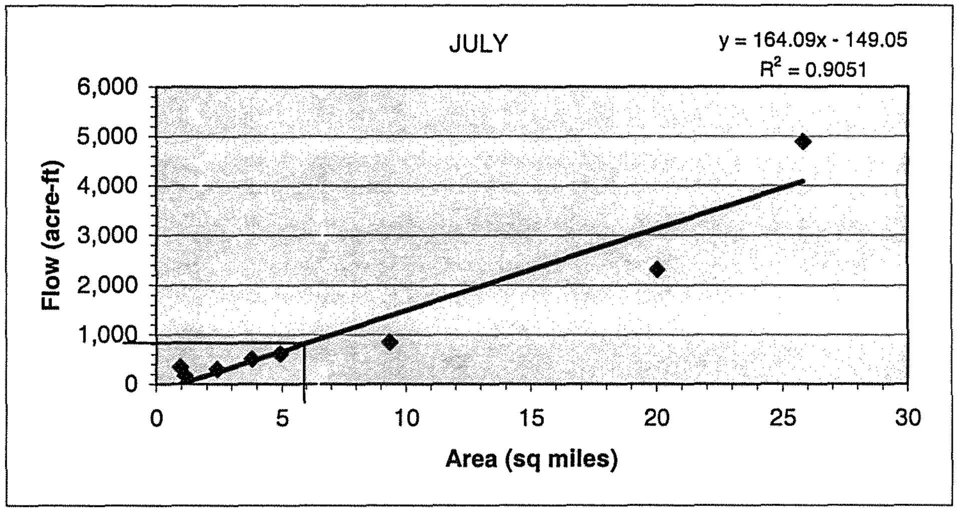


AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

JULY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	2,312
Walker Creek	4.91	3,142	621
Braden River	25.8	16,512	4,888
Hickory Hammock	2.4	1,536	306
Cooper Creek	9.33	5,971	855
Cedar Creek	0.94	602	346
Rattlesnake Slough	3.78	2,419	511
Nonsense Creek	1.14	730	176
Main C	**5.94**	**3,800**	**826**

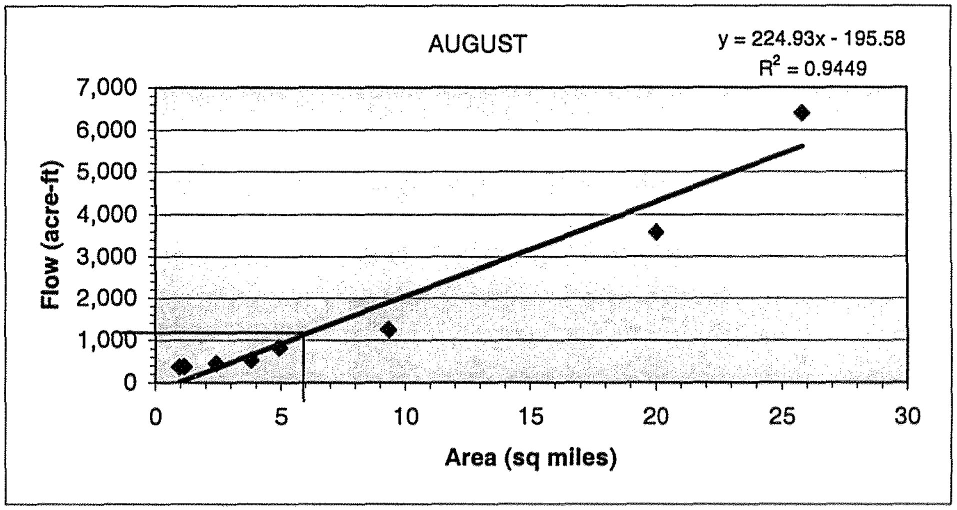
8.68 MGD



AUGUST

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	3,585
Walker Creek	4.91	3,142	830
Braden River	25.8	16,512	6,395
Hickory Hammock	2.4	1,536	454
Cooper Creek	9.33	5,971	1,254
Cedar Creek	0.94	602	373
Rattlesnake Slough	3.78	2,419	532
Nonsense Creek	1.14	730	376
Main C	**5.94**	**3,800**	**1,141**

11.99 MGD

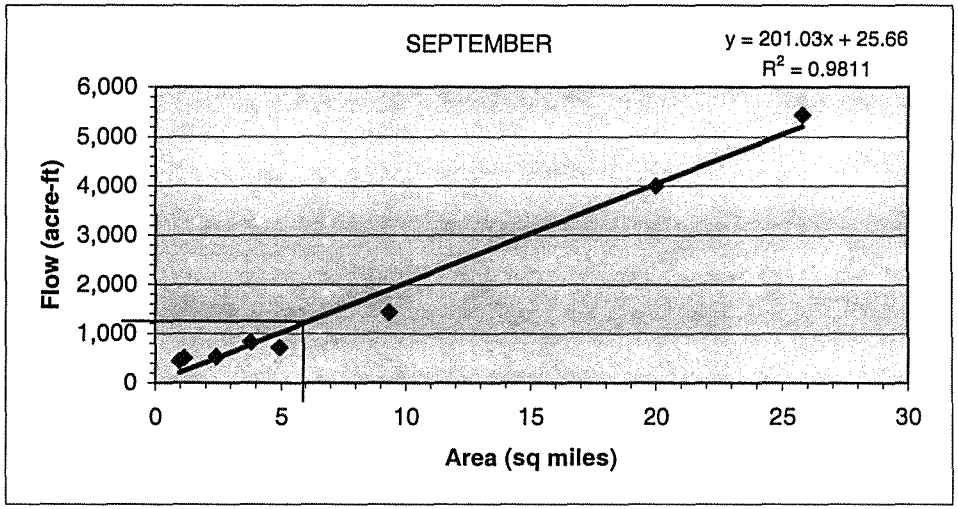


AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

SEPTEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	4,005
Walker Creek	4.91	3,142	726
Braden River	25.8	16,512	5,439
Hickory Hammock	2.4	1,536	536
Cooper Creek	9.33	5,971	1,434
Cedar Creek	0.94	602	451
Rattlesnake Slough	3.78	2,419	833
Nonsense Creek	1.14	730	513
Main C	**5.94**	**3,800**	**1,220**

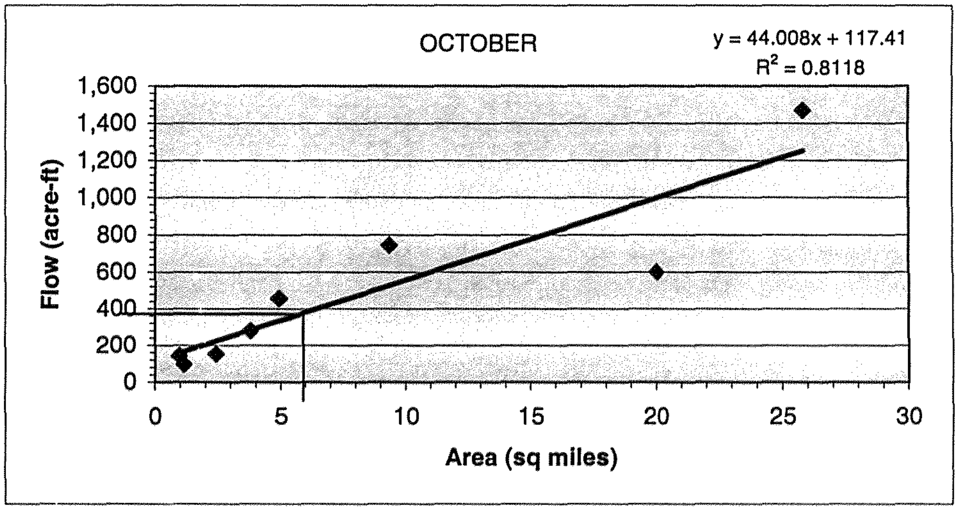
13.25 MGD



OCTOBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	601
Walker Creek	4.91	3,142	457
Braden River	25.8	16,512	1,470
Hickory Hammock	2.4	1,536	154
Cooper Creek	9.33	5,971	744
Cedar Creek	0.94	602	144
Rattlesnake Slough	3.78	2,419	279
Nonsense Creek	1.14	730	97
Main C	**5.94**	**3,800**	**379**

3.98 MGD

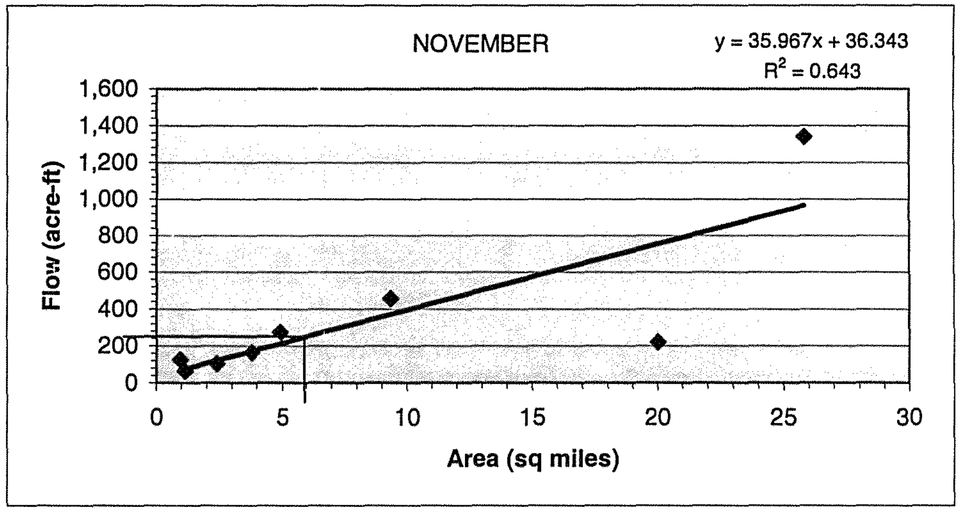


AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

NOVEMBER

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	220
Walker Creek	4.91	3,142	274
Braden River	25.8	16,512	1,339
Hickory Hammock	2.4	1,536	104
Cooper Creek	9.33	5,971	457
Cedar Creek	0.94	602	125
Rattlesnake Slough	3.78	2,419	165
Nonsense Creek	1.14	730	64
Main C	**5.94**	**3,800**	**250**

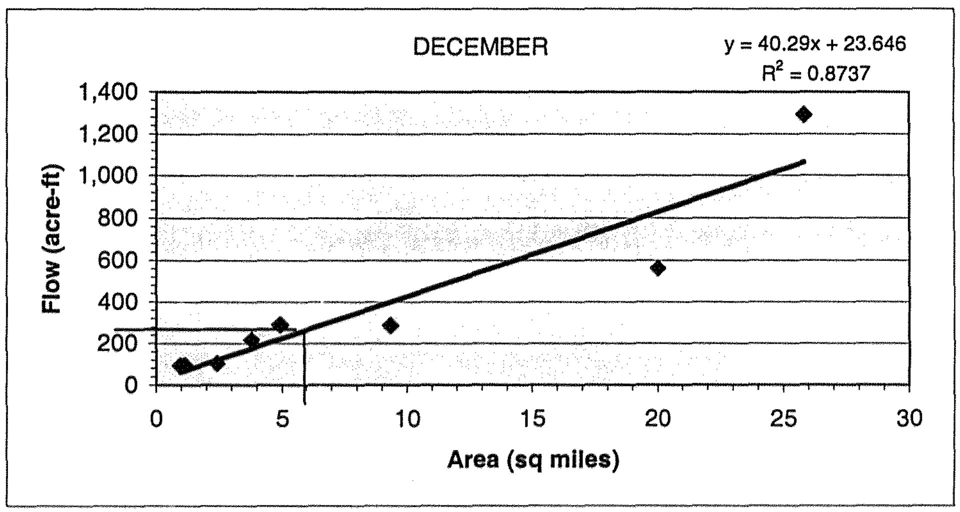
2.72 MGD



DECEMBER

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	562
Walker Creek	4.91	3,142	290
Braden River	25.8	16,512	1,291
Hickory Hammock	2.4	1,536	105
Cooper Creek	9.33	5,971	287
Cedar Creek	0.94	602	93
Rattlesnake Slough	3.78	2,419	217
Nonsense Creek	1.14	730	96
Main C	**5.94**	**3,800**	**263**

2.76 MGD



AVERAGE YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Main C

Month	Streamflow (acre-ft)	Streamflow (MGD)
January	280	2.94
February	188	2.19
March	305	3.21
April	208	2.26
May	151	1.59
June	610	6.63
July	826	8.68
August	1,141	11.99
Spetember	1,220	13.25
October	379	3.98
November	250	2.72
December	263	2.76

Annual Average = 5.18 MGD

Minimum (May) = 69.4% Below Average

Maximum (Sept) = 155.7% Above Average

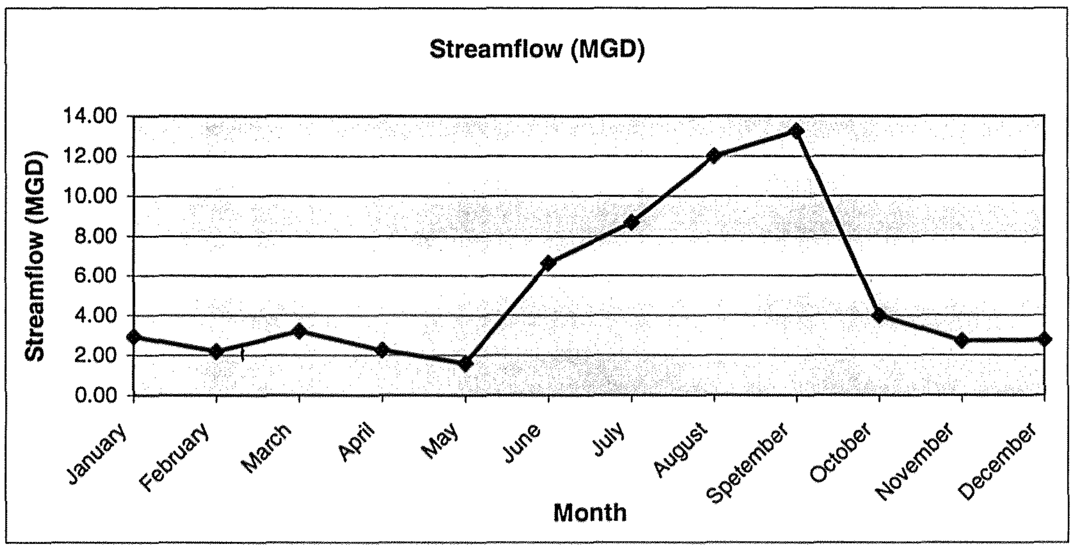


EXHIBIT 4

AVERAGE YEAR
MAIN A CONTRIBUTING WATERSHED
STREAMFLOW DATA

EXHIBIT 4-A

AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Annual Streamflow Data Analysis for Neighboring Creeks

Creek	Watershed Area		Flow	
	(sq miles)	(acres)	(acre-ft)	(MGD)
Cedar Creek	0.94	602	2,154	22.64
Nonsense Creek	1.14	730	1,880	19.76
Hickory Hammock	2.40	1,536	2,347	24.67
Rattlesnake Slough	3.78	2,419	3,820	40.15
Walker Creek	4.91	3,142	5,060	53.18
Cooper Creek	9.33	5,971	6,794	71.41
Braden River	25.80	16,512	29,292	307.88
Howard Creek	20.00	12,800	15,850	166.59
Main A	17.71	11,334	17,506	184.00

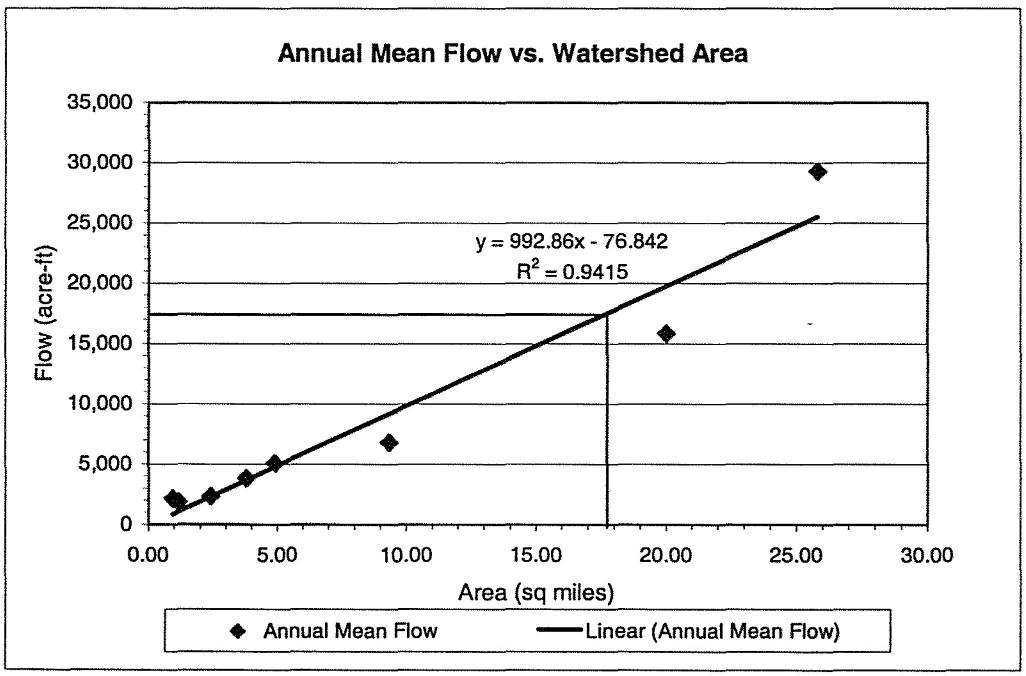
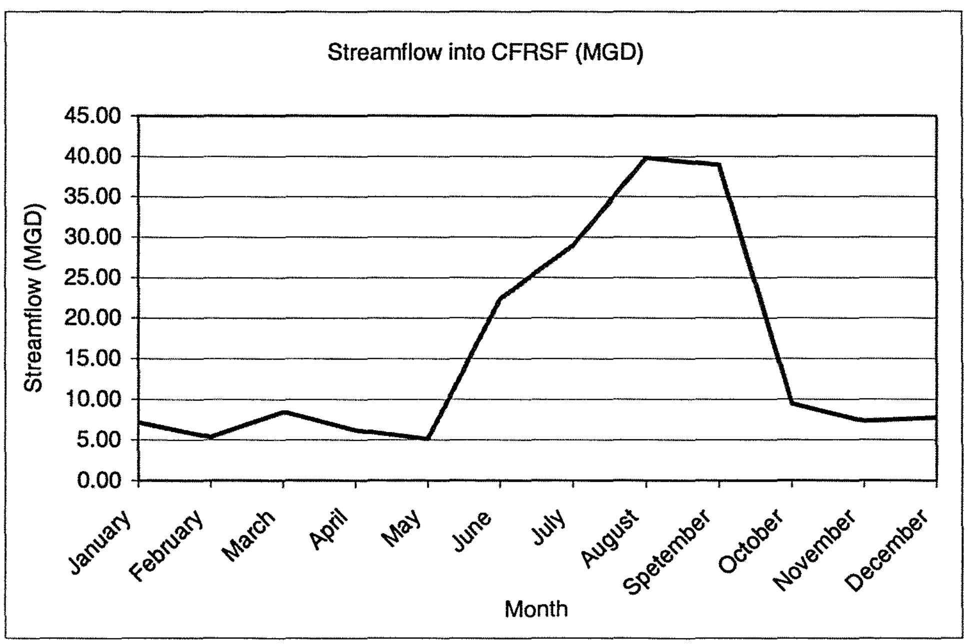


EXHIBIT 4-B

AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

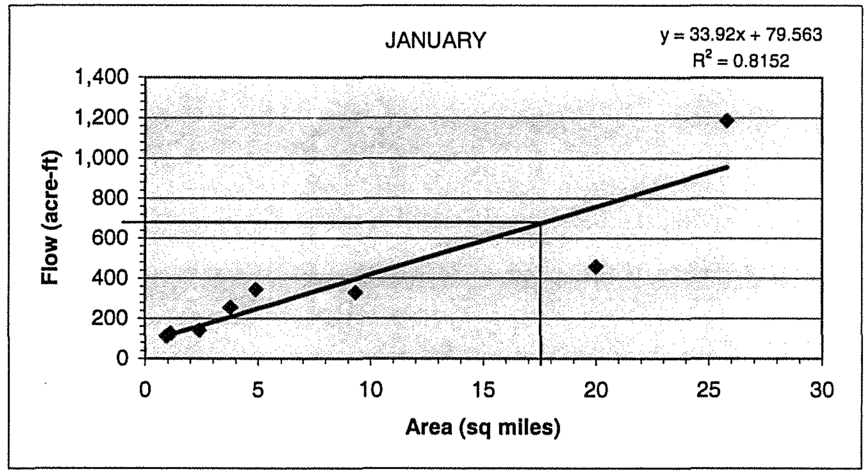
Month	Streamflow	
	(acre-ft)	(MGD)
Jan	680	7.15
Feb	461	5.36
Mar	803	8.44
Apr	572	6.21
May	488	5.13
Jun	2,062	22.40
Jul	2,756	28.97
Aug	3,787	39.80
Sep	3,585	38.94
Oct	896	9.42
Nov	673	7.31
Dec	737	7.75
Annual Average	1,458	15.57



AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

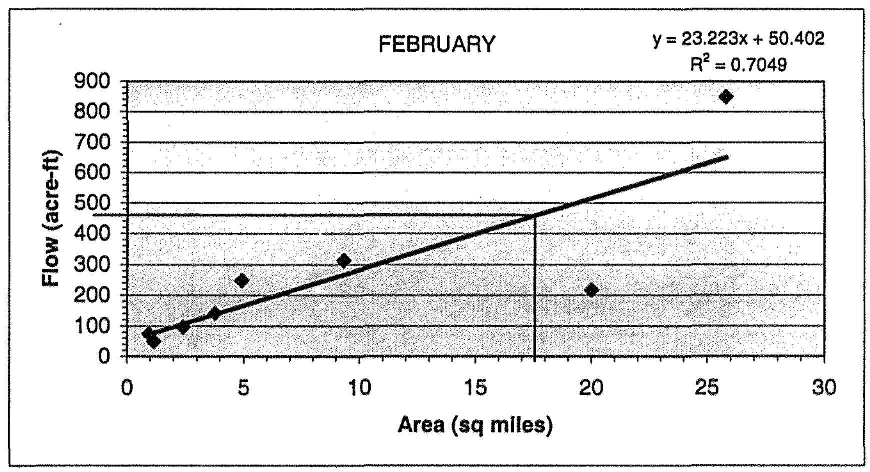
JANUARY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	458
Walker Creek	4.91	3,142	346
Braden River	25.8	16,512	1,187
Hickory Hammock	2.4	1,536	141
Cooper Creek	9.33	5,971	330
Cedar Creek	0.94	602	111
Rattlesnake Slough	3.78	2,419	255
Nonsense Creek	1.14	730	125
Main A	**17.71**	**11,334**	**680**
			7.15 MGD



FEBRUARY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	217
Walker Creek	4.91	3,142	248
Braden River	25.8	16,512	850
Hickory Hammock	2.4	1,536	97
Cooper Creek	9.33	5,971	313
Cedar Creek	0.94	602	74
Rattlesnake Slough	3.78	2,419	141
Nonsense Creek	1.14	730	49
Main A	**17.71**	**11,334**	**461**
			5.36 MGD

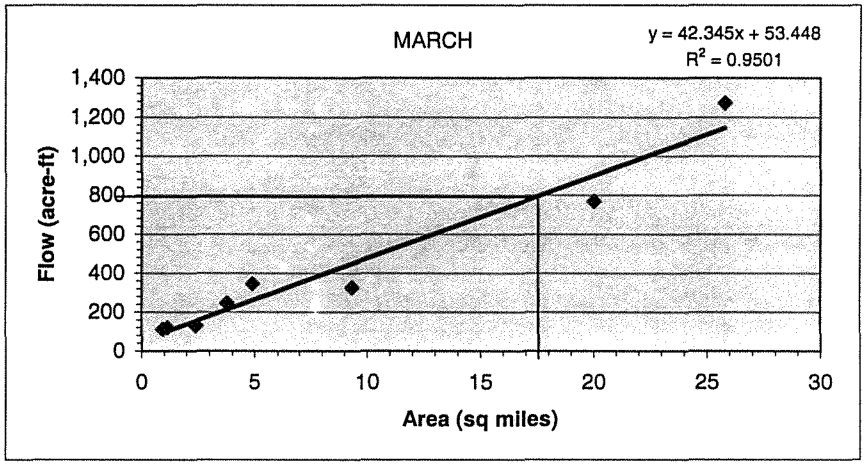


AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MARCH

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	769
Walker Creek	4.91	3,142	345
Braden River	25.8	16,512	1,273
Hickory Hammock	2.4	1,536	130
Cooper Creek	9.33	5,971	325
Cedar Creek	0.94	602	112
Rattlesnake Slough	3.78	2,419	246
Nonsense Creek	1.14	730	120
Main A	**17.71**	**11,334**	**803**

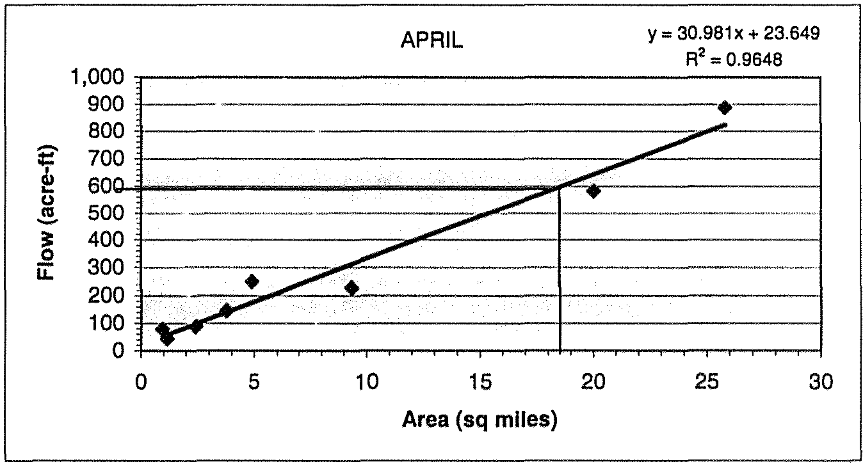
8.44 MGD



APRIL

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	582
Walker Creek	4.91	3,142	251
Braden River	25.8	16,512	887
Hickory Hammock	2.4	1,536	89
Cooper Creek	9.33	5,971	228
Cedar Creek	0.94	602	80
Rattlesnake Slough	3.78	2,419	145
Nonsense Creek	1.14	730	44
Main A	**17.71**	**11,334**	**572**

6.21 MGD

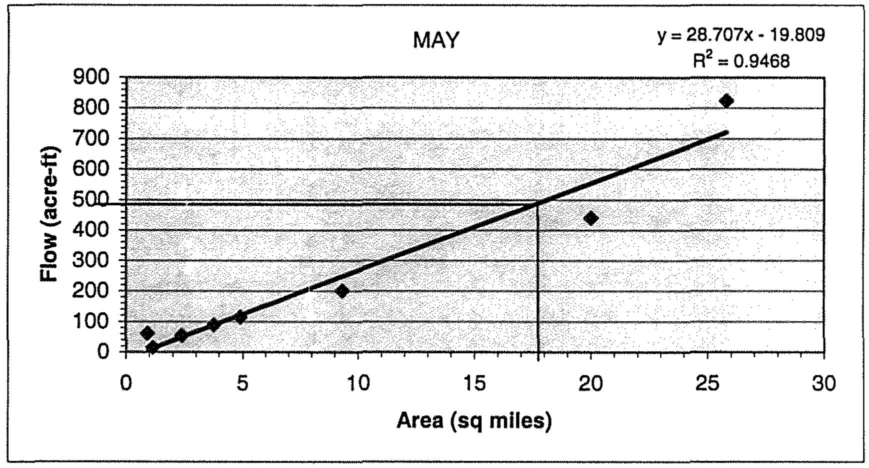


AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MAY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	441
Walker Creek	4.91	3,142	116
Braden River	25.8	16,512	824
Hickory Hammock	2.4	1,536	55
Cooper Creek	9.33	5,971	202
Cedar Creek	0.94	602	60
Rattlesnake Slough	3.78	2,419	89
Nonsense Creek	1.14	730	16
Main A	**17.71**	**11,334**	**488**

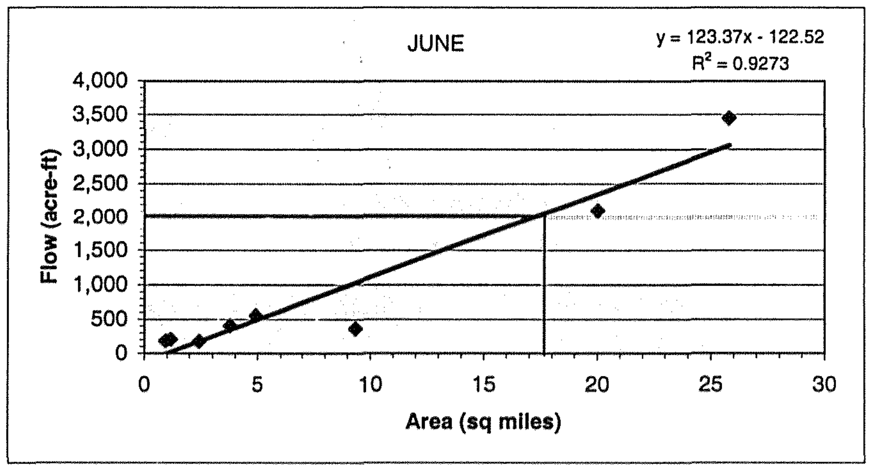
5.13 MGD



JUNE

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	2,100
Walker Creek	4.91	3,142	556
Braden River	25.8	16,512	3,451
Hickory Hammock	2.4	1,536	178
Cooper Creek	9.33	5,971	364
Cedar Creek	0.94	602	184
Rattlesnake Slough	3.78	2,419	406
Nonsense Creek	1.14	730	205
Main A	**17.71**	**11,334**	**2,062**

22.40 MGD



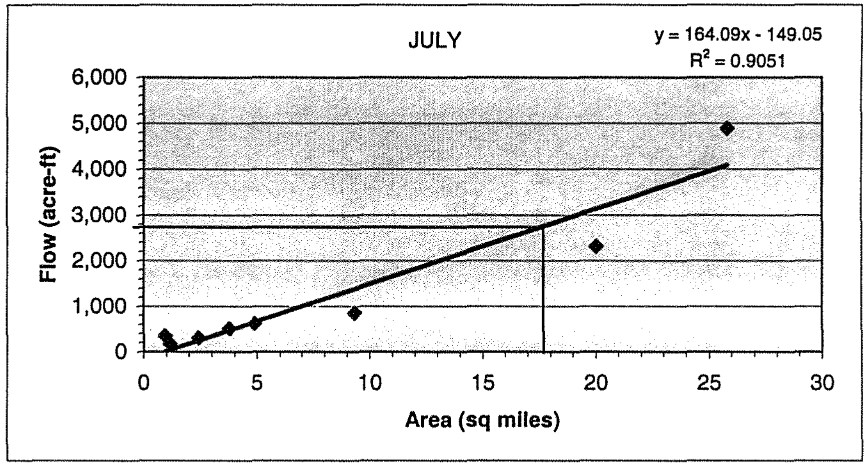
AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED

Monthly Streamflow Analysis

JULY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	2,312
Walker Creek	4.91	3,142	621
Braden River	25.8	16,512	4,888
Hickory Hammock	2.4	1,536	306
Cooper Creek	9.33	5,971	855
Cedar Creek	0.94	602	346
Rattlesnake Slough	3.78	2,419	511
Nonsense Creek	1.14	730	176
Main A	**17.71**	**11,334**	**2,756**

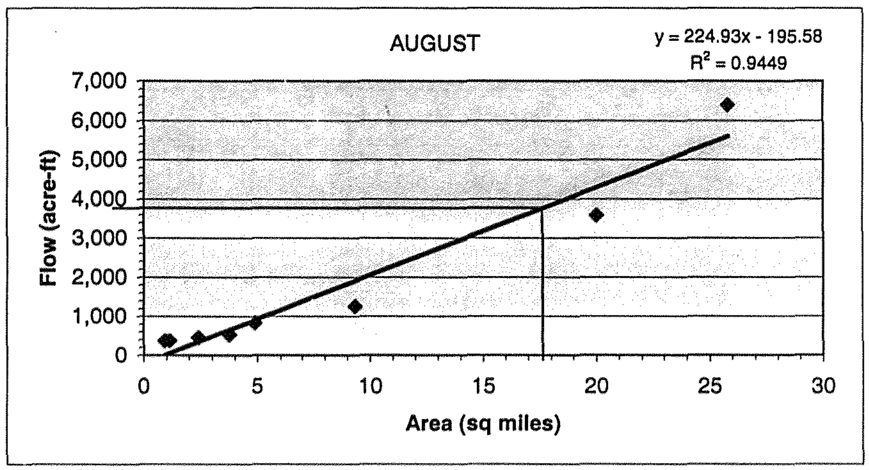
28.97 MGD



AUGUST

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	3,585
Walker Creek	4.91	3,142	830
Braden River	25.8	16,512	6,395
Hickory Hammock	2.4	1,536	454
Cooper Creek	9.33	5,971	1,254
Cedar Creek	0.94	602	373
Rattlesnake Slough	3.78	2,419	532
Nonsense Creek	1.14	730	376
Main A	**17.71**	**11,334**	**3,787**

39.80 MGD

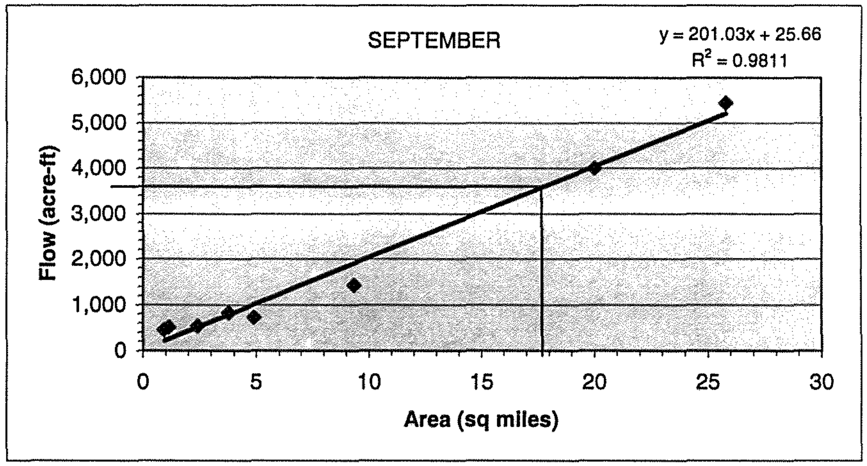


AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

SEPTEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	4,005
Walker Creek	4.91	3,142	726
Braden River	25.8	16,512	5,439
Hickory Hammock	2.4	1,536	536
Cooper Creek	9.33	5,971	1,434
Cedar Creek	0.94	602	451
Rattlesnake Slough	3.78	2,419	833
Nonsense Creek	1.14	730	513
Main A	**17.71**	**11,334**	**3,585**

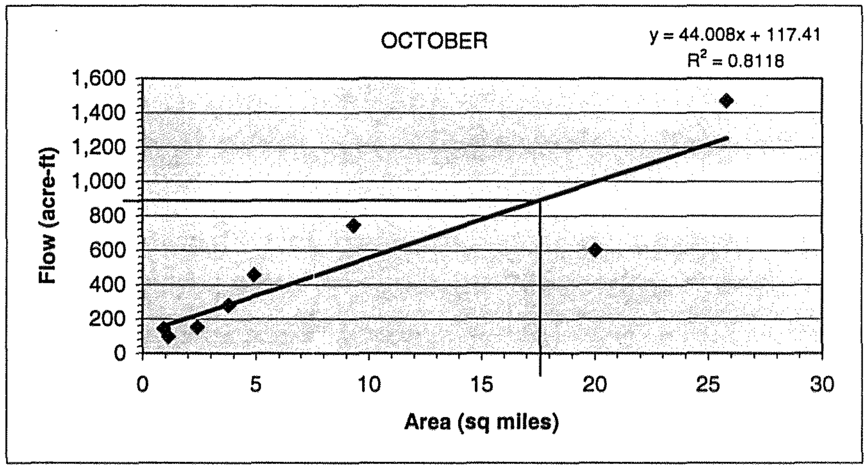
38.94 MGD



OCTOBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	601
Walker Creek	4.91	3,142	457
Braden River	25.8	16,512	1,470
Hickory Hammock	2.4	1,536	154
Cooper Creek	9.33	5,971	744
Cedar Creek	0.94	602	144
Rattlesnake Slough	3.78	2,419	279
Nonsense Creek	1.14	730	97
Main A	**17.71**	**11,334**	**896**

9.42 MGD

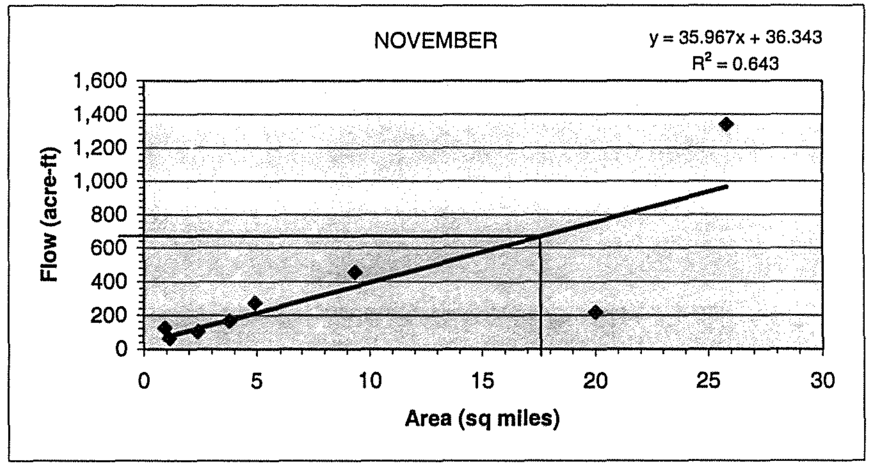


AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

NOVEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	220
Walker Creek	4.91	3,142	274
Braden River	25.8	16,512	1,339
Hickory Hammock	2.4	1,536	104
Cooper Creek	9.33	5,971	457
Cedar Creek	0.94	602	125
Rattlesnake Slough	3.78	2,419	165
Nonsense Creek	1.14	730	64
Main A	**17.71**	**11,334**	**673**

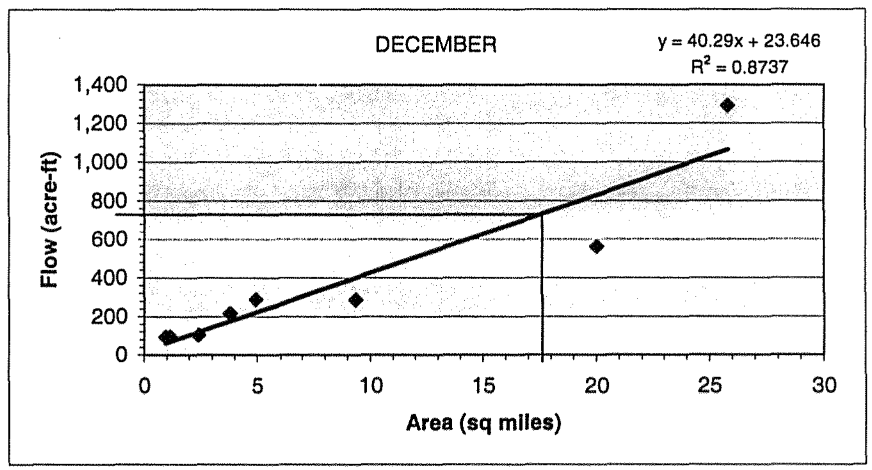
7.31 MGD



DECEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	562
Walker Creek	4.91	3,142	290
Braden River	25.8	16,512	1,291
Hickory Hammock	2.4	1,536	105
Cooper Creek	9.33	5,971	287
Cedar Creek	0.94	602	93
Rattlesnake Slough	3.78	2,419	217
Nonsense Creek	1.14	730	96
Main A	**17.71**	**11,334**	**737**

7.75 MGD



AVERAGE YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Main A

Month	Streamflow (acre-ft)	Streamflow (MGD)
January	680	7.15
February	461	5.36
March	803	8.44
April	572	6.21
May	488	5.13
June	2,062	22.40
July	2,756	28.97
August	3,787	39.80
Spetember	3,585	38.94
October	896	9.42
November	673	7.31
December	737	7.75

Annual Average = 15.57 MGD

Minimum (May) = 67.1% Below Average

Maximum (Sept) = 150.0% Above Average

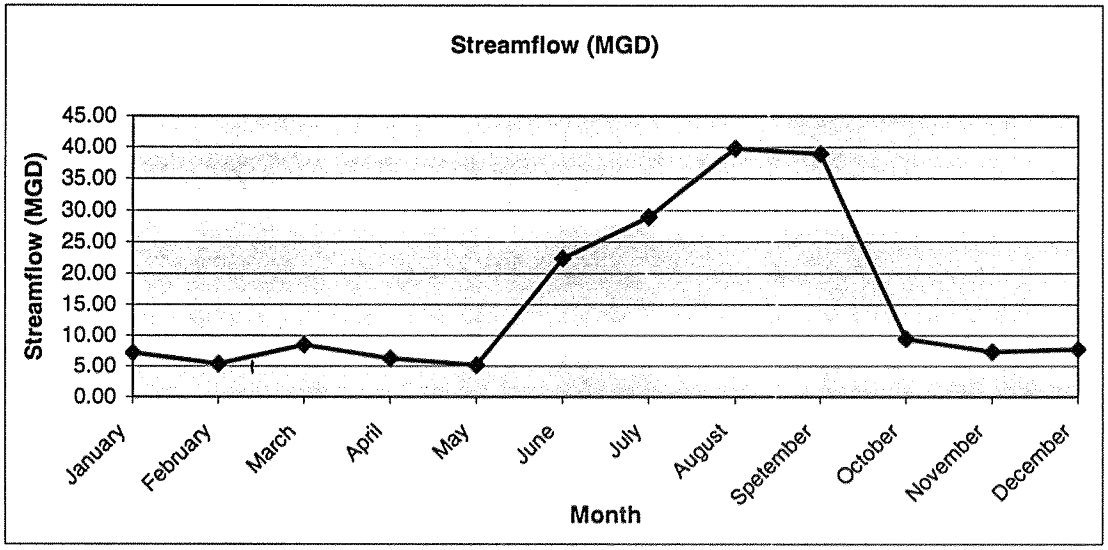


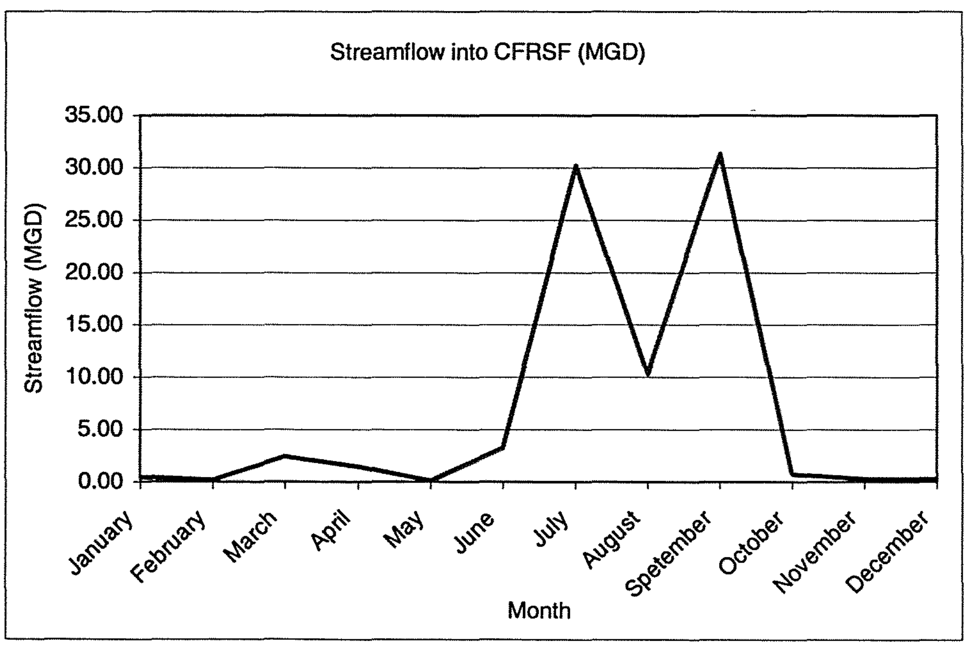
EXHIBIT 5

EXTREME DROUGHT YEAR
MAIN C CONTRIBUTING WATERSHED
STREAMFLOW DATA

EXHIBIT 5

EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Month	Streamflow (acre-ft)	Streamflow (MGD)
Jan	43	0.45
Feb	17	0.20
Mar	232	2.44
Apr	135	1.47
May	13	0.13
Jun	300	3.25
Jul	2,873	30.20
Aug	981	10.31
Sep	2,886	31.35
Oct	71	0.75
Nov	29	0.30
Dec	30	0.31
Annual Average	634	6.76

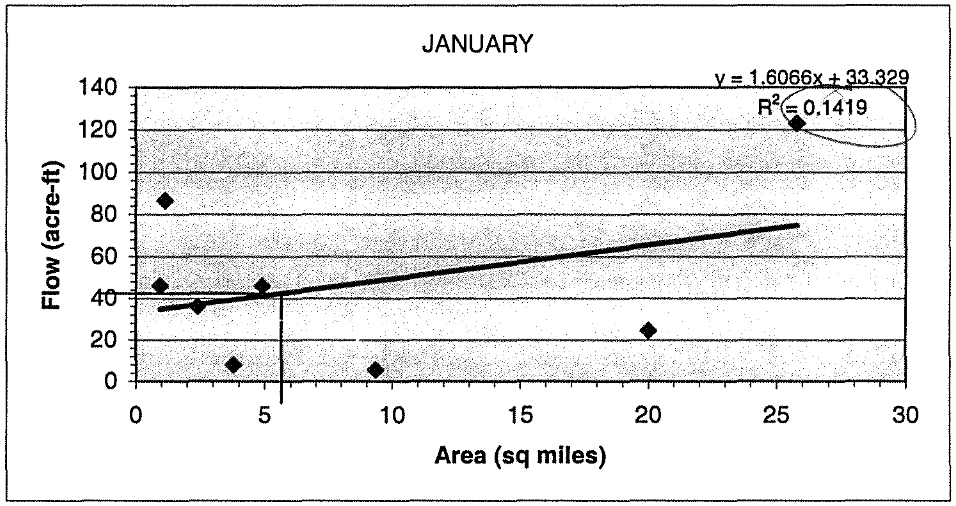


EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

JANUARY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	24.60
Walker Creek	4.91	3,142	46.12
Braden River	25.8	16,512	122.98
Hickory Hammock	2.4	1,536	36.28
Cooper Creek	9.33	5,971	5.60
Cedar Creek	0.94	602	46.12
Rattlesnake Slough	3.78	2,419	7.99
Nonsense Creek	1.14	730	86.70
Main C	**5.94**	**3,800**	**43**

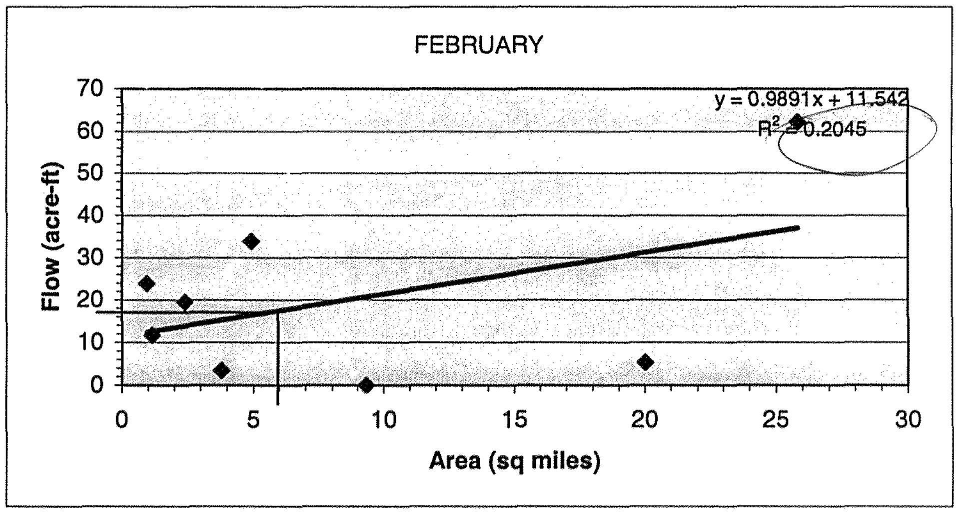
0.45 MGD



FEBRUARY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	5.39
Walker Creek	4.91	3,142	33.88
Braden River	25.8	16,512	62.20
Hickory Hammock	2.4	1,536	19.44
Cooper Creek	9.33	5,971	0.00
Cedar Creek	0.94	602	23.88
Rattlesnake Slough	3.78	2,419	3.44
Nonsense Creek	1.14	730	11.66
Main C	**5.94**	**3,800**	**17**

0.20 MGD

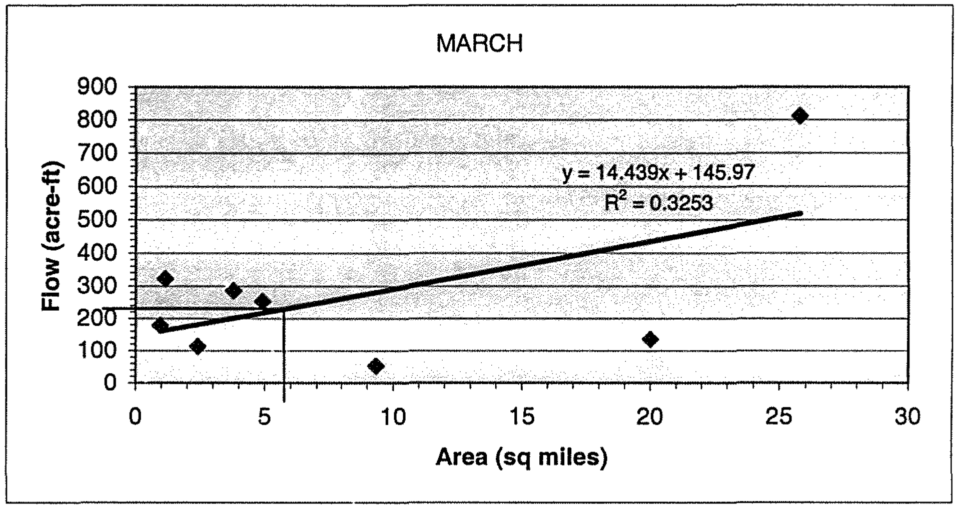


EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MARCH

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	135.89
Walker Creek	4.91	3,142	252.71
Braden River	25.8	16,512	811.64
Hickory Hammock	2.4	1,536	113.14
Cooper Creek	9.33	5,971	52.88
Cedar Creek	0.94	602	178.93
Rattlesnake Slough	3.78	2,419	286.53
Nonsense Creek	1.14	730	322.20
Main C	**5.94**	**3,800**	**232**

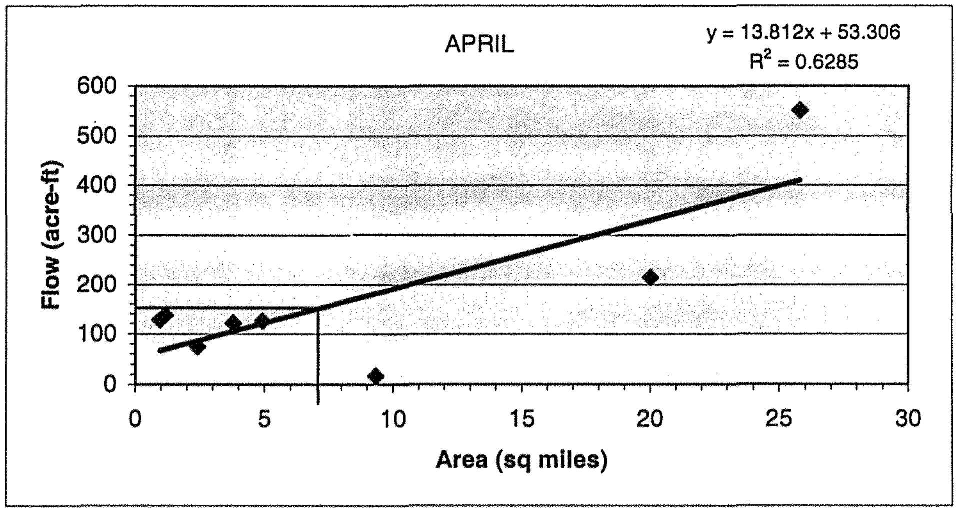
2.44 MGD



APRIL

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	214.81
Walker Creek	4.91	3,142	126.15
Braden River	25.8	16,512	551.01
Hickory Hammock	2.4	1,536	74.38
Cooper Creek	9.33	5,971	16.66
Cedar Creek	0.94	602	127.93
Rattlesnake Slough	3.78	2,419	121.39
Nonsense Creek	1.14	730	137.45
Main C	**5.94**	**3,800**	**135**

1.47 MGD

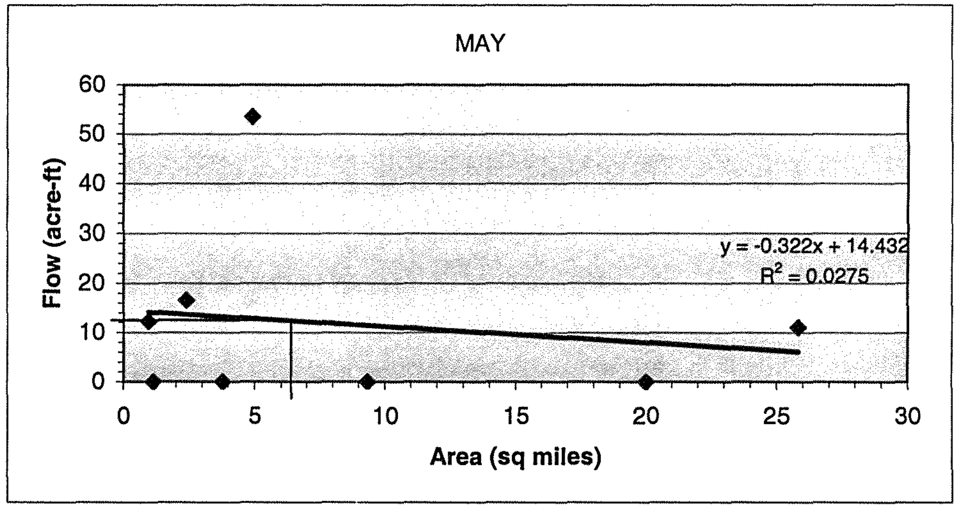


EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MAY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	0.00
Walker Creek	4.91	3,142	53.49
Braden River	25.8	16,512	11.07
Hickory Hammock	2.4	1,536	16.60
Cooper Creek	9.33	5,971	0.00
Cedar Creek	0.94	602	12.30
Rattlesnake Slough	3.78	2,419	0.00
Nonsense Creek	1.14	730	0.00
Main C	**5.94**	**3,800**	**13**

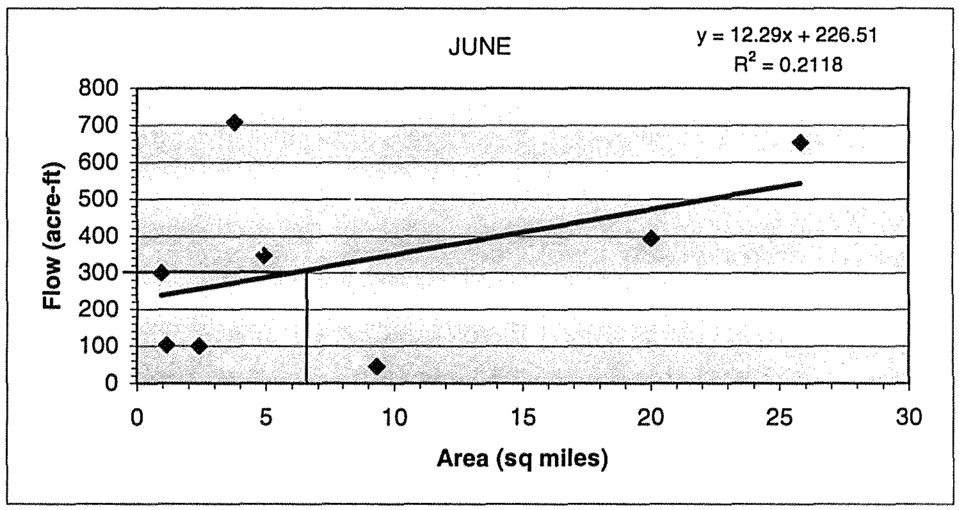
0.13 MGD



JUNE

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	393.92
Walker Creek	4.91	3,142	346.91
Braden River	25.8	16,512	654.55
Hickory Hammock	2.4	1,536	99.97
Cooper Creek	9.33	5,971	45.22
Cedar Creek	0.94	602	299.90
Rattlesnake Slough	3.78	2,419	708.10
Nonsense Creek	1.14	730	102.94
Main C	**5.94**	**3,800**	**300**

3.25 MGD

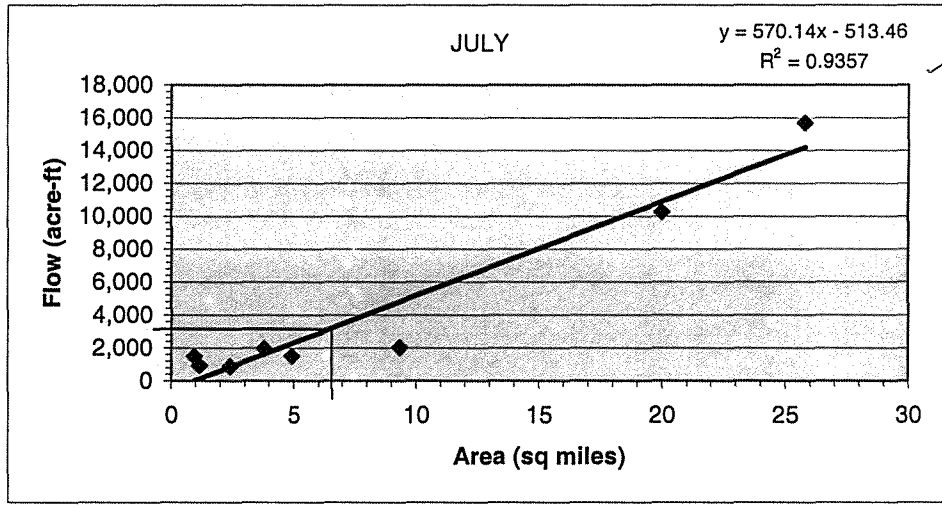


EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

JULY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	10,268.43
Walker Creek	4.91	3,142	1,524.89
Braden River	25.8	16,512	15,679.34
Hickory Hammock	2.4	1,536	879.27
Cooper Creek	9.33	5,971	2,047.54
Cedar Creek	0.94	602	1,512.60
Rattlesnake Slough	3.78	2,419	1,967.60
Nonsense Creek	1.14	730	953.06
Main C	**5.94**	**3,800**	**2,873**

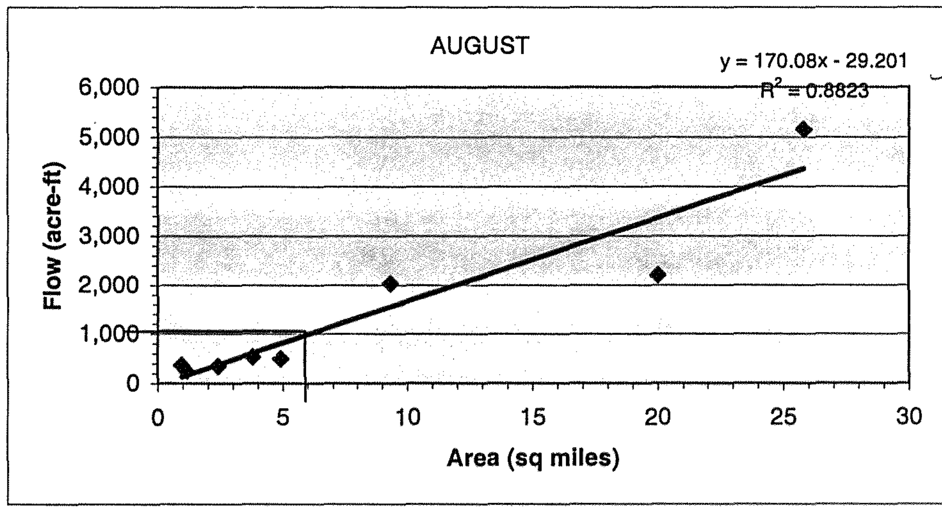
30.20 MGD



AUGUST

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	2,207.40
Walker Creek	4.91	3,142	497.43
Braden River	25.8	16,512	5,152.66
Hickory Hammock	2.4	1,536	348.02
Cooper Creek	9.33	5,971	2,029.09
Cedar Creek	0.94	602	368.93
Rattlesnake Slough	3.78	2,419	530.64
Nonsense Creek	1.14	730	248.41
Main C	**5.94**	**3,800**	**981**

10.31 MGD

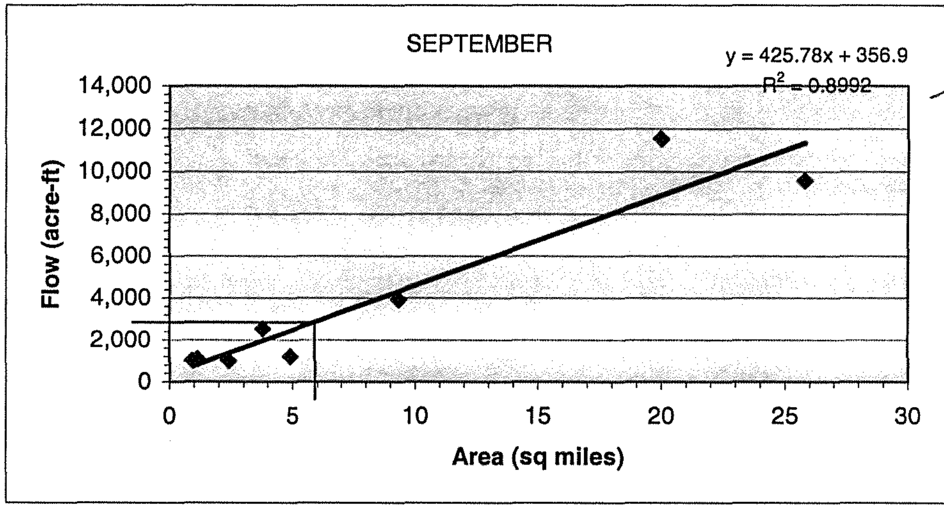


EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

SEPTEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	11,543.80
Walker Creek	4.91	3,142	1,213.88
Braden River	25.8	16,512	9,580.17
Hickory Hammock	2.4	1,536	1,017.52
Cooper Creek	9.33	5,971	3,927.27
Cedar Creek	0.94	602	1,017.52
Rattlesnake Slough	3.78	2,419	2,540.83
Nonsense Creek	1.14	730	1,094.88
Main C	**5.94**	**3,800**	**2,886**

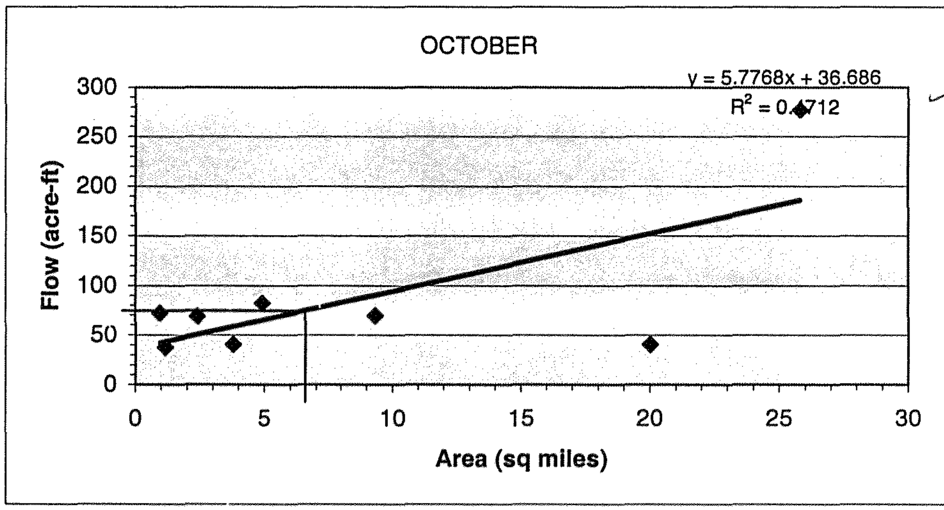
31.35 MGD



OCTOBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	40.58
Walker Creek	4.91	3,142	82.39
Braden River	25.8	16,512	276.69
Hickory Hammock	2.4	1,536	68.87
Cooper Creek	9.33	5,971	69.48
Cedar Creek	0.94	602	71.94
Rattlesnake Slough	3.78	2,419	40.58
Nonsense Creek	1.14	730	37.51
Main C	**5.94**	**3,800**	**71**

0.75 MGD

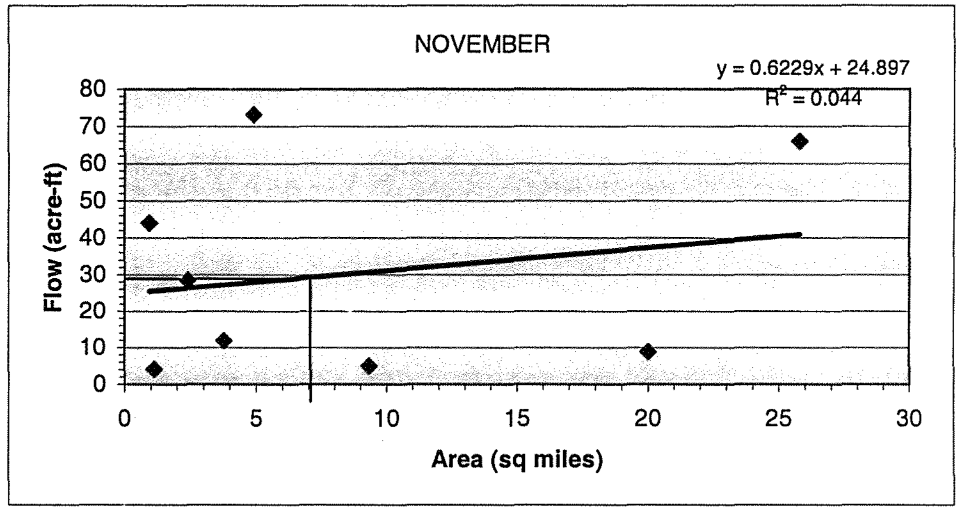


EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

NOVEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	8.89
Walker Creek	4.91	3,142	73.19
Braden River	25.8	16,512	66.05
Hickory Hammock	2.4	1,536	28.56
Cooper Creek	9.33	5,971	5.00
Cedar Creek	0.94	602	44.03
Rattlesnake Slough	3.78	2,419	11.90
Nonsense Creek	1.14	730	4.11
Main C	**5.94**	**3,800**	**29**

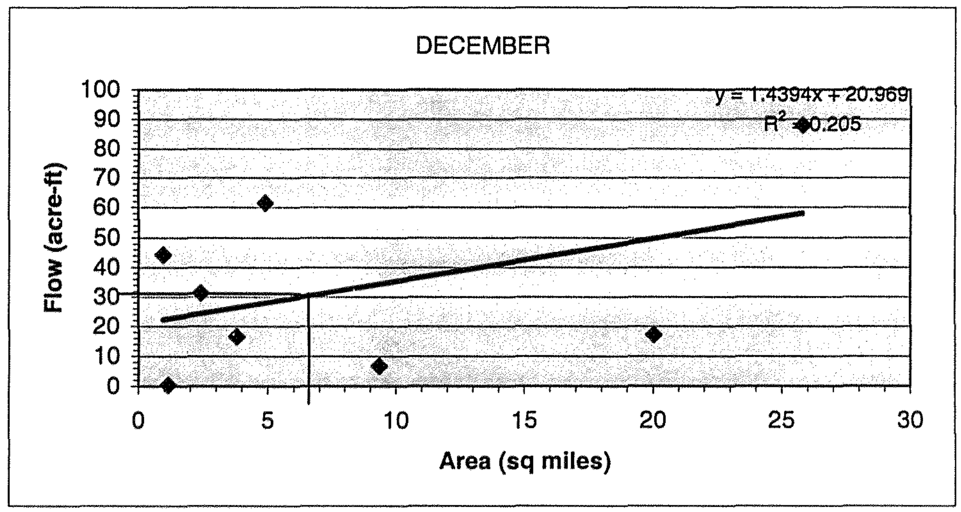
0.30	**MGD**



DECEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	17.22
Walker Creek	4.91	3,142	61.49
Braden River	25.8	16,512	87.93
Hickory Hammock	2.4	1,536	31.36
Cooper Creek	9.33	5,971	6.76
Cedar Creek	0.94	602	44.27
Rattlesnake Slough	3.78	2,419	16.60
Nonsense Creek	1.14	730	0.43
Main C	**5.94**	**3,800**	**30**

0.31	**MGD**



EXTREME DROUGHT YEAR MAIN C CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Main C

Month	Streamflow (acre-ft)	Streamflow (MGD)
January	43	0.45
February	17	0.20
March	232	2.44
April	135	1.47
May	13	0.13
June	300	3.25
July	2,873	30.20
August	981	10.31
Spetember	2,886	31.35
October	71	0.75
November	29	0.30
December	30	0.31

Statistics?

Annual Average = 6.76 MGD

Minimum (May) = 98.1% Below Average

Maximum (Sept) = 363.5% Above Average

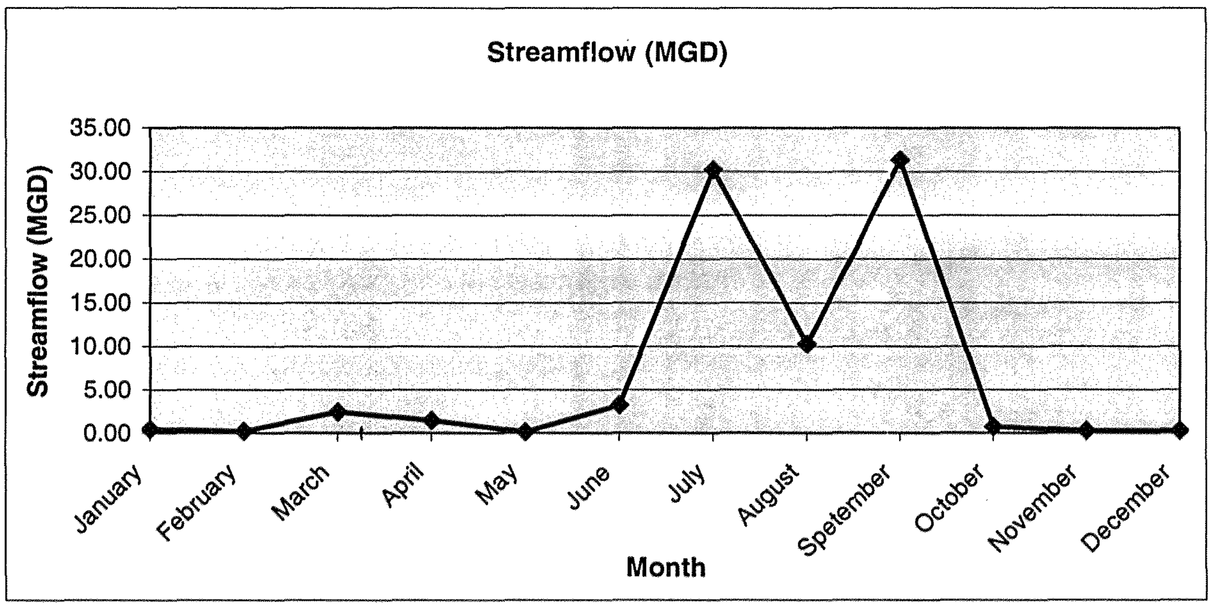


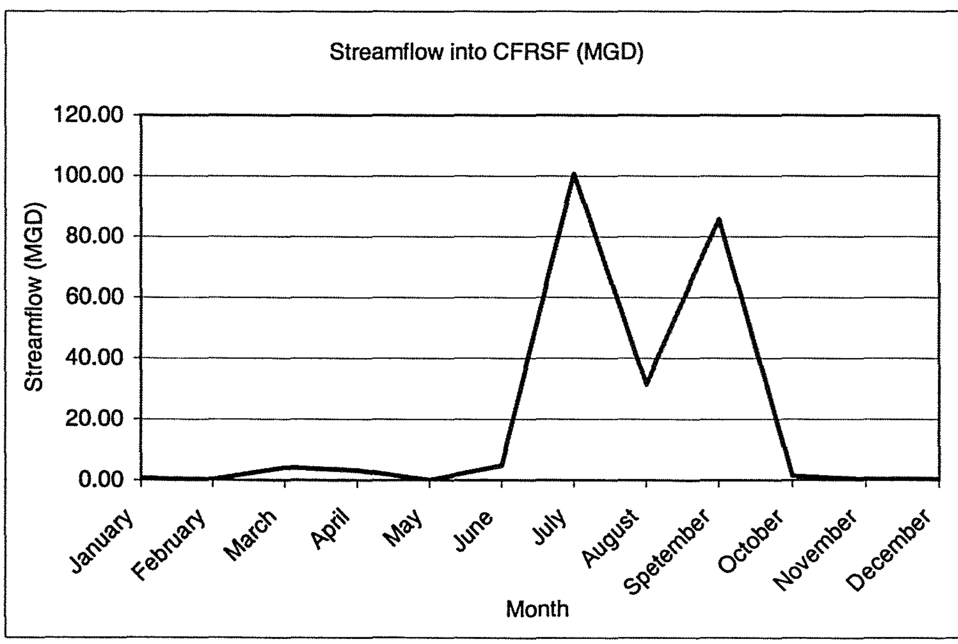
EXHIBIT 6

EXTREME DROUGHT YEAR
MAIN A CONTRIBUTING WATERSHED
STREAMFLOW DATA

EXHIBIT 6

EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Month	Streamflow	
	(acre-ft)	(MGD)
Jan	62	0.65
Feb	29	0.34
Mar	402	4.22
Apr	298	3.24
May	9	0.09
Jun	444	4.82
Jul	9,584	100.73
Aug	2,983	31.35
Sep	7,897	85.77
Oct	139	1.46
Nov	36	0.38
Dec	46	0.49
Annual Average	1,827	19.46

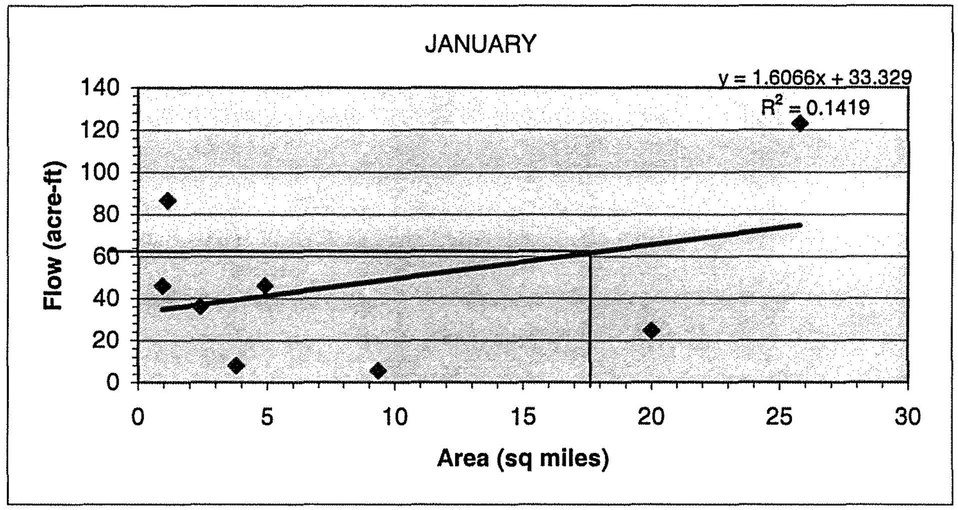


EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

JANUARY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	24.60
Walker Creek	4.91	3,142	46.12
Braden River	25.8	16,512	122.98
Hickory Hammock	2.4	1,536	36.28
Cooper Creek	9.33	5,971	5.60
Cedar Creek	0.94	602	46.12
Rattlesnake Slough	3.78	2,419	7.99
Nonsense Creek	1.14	730	86.70
Main A	**17.71**	**11,334**	**62**

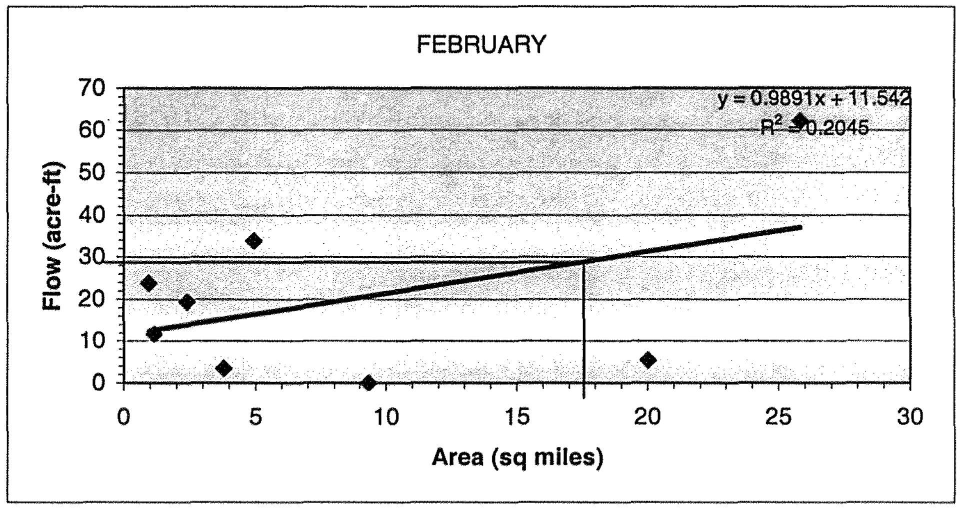
0.65 MGD



FEBRUARY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	5.39
Walker Creek	4.91	3,142	33.88
Braden River	25.8	16,512	62.20
Hickory Hammock	2.4	1,536	19.44
Cooper Creek	9.33	5,971	0.00
Cedar Creek	0.94	602	23.88
Rattlesnake Slough	3.78	2,419	3.44
Nonsense Creek	1.14	730	11.66
Main A	**17.71**	**11,334**	**29**

0.34 MGD

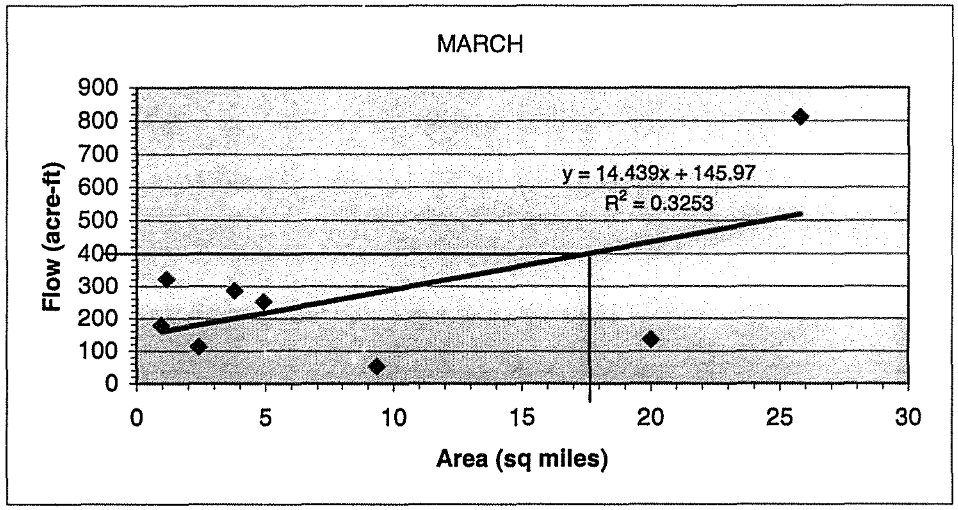


EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MARCH

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	135.89
Walker Creek	4.91	3,142	252.71
Braden River	25.8	16,512	811.64
Hickory Hammock	2.4	1,536	113.14
Cooper Creek	9.33	5,971	52.88
Cedar Creek	0.94	602	178.93
Rattlesnake Slough	3.78	2,419	286.53
Nonsense Creek	1.14	730	322.20
Main A	**17.71**	**11,334**	**402**

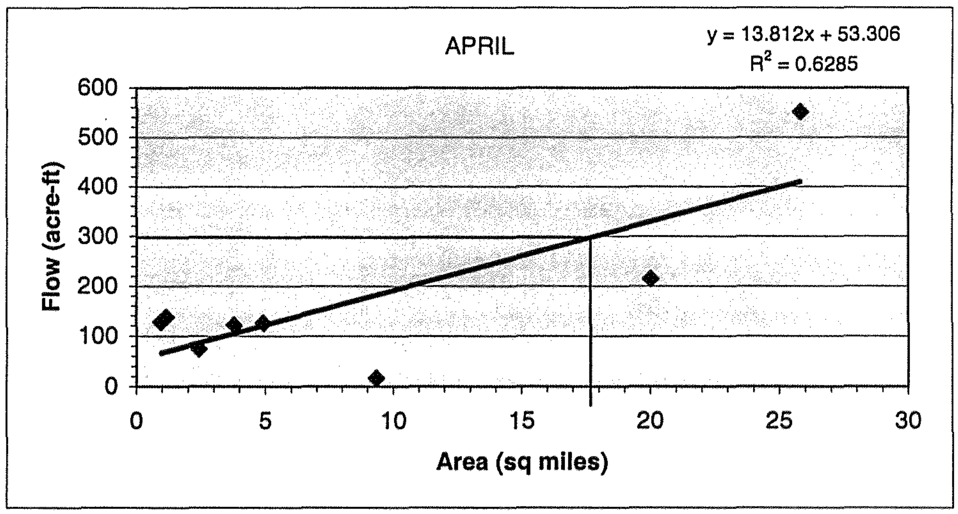
4.22 MGD



APRIL

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	214.81
Walker Creek	4.91	3,142	126.15
Braden River	25.8	16,512	551.01
Hickory Hammock	2.4	1,536	74.38
Cooper Creek	9.33	5,971	16.66
Cedar Creek	0.94	602	127.93
Rattlesnake Slough	3.78	2,419	121.39
Nonsense Creek	1.14	730	137.45
Main A	**17.71**	**11,334**	**298**

3.24 MGD

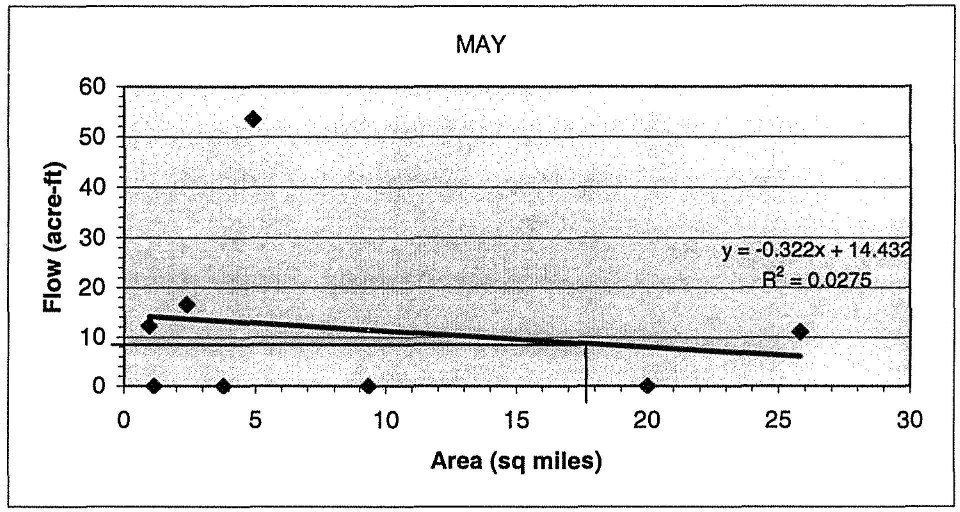


EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

MAY

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	0.00
Walker Creek	4.91	3,142	53.49
Braden River	25.8	16,512	11.07
Hickory Hammock	2.4	1,536	16.60
Cooper Creek	9.33	5,971	0.00
Cedar Creek	0.94	602	12.30
Rattlesnake Slough	3.78	2,419	0.00
Nonsense Creek	1.14	730	0.00
Main A	**17.71**	**11,334**	**9**

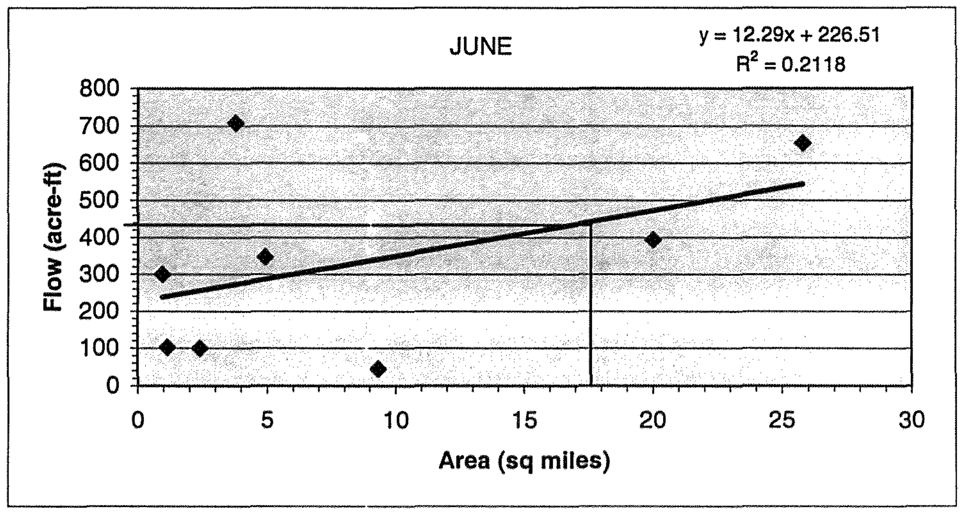
0.09 MGD



JUNE

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	393.92
Walker Creek	4.91	3,142	346.91
Braden River	25.8	16,512	654.55
Hickory Hammock	2.4	1,536	99.97
Cooper Creek	9.33	5,971	45.22
Cedar Creek	0.94	602	299.90
Rattlesnake Slough	3.78	2,419	708.10
Nonsense Creek	1.14	730	102.94
Main A	**17.71**	**11,334**	**444**

4.82 MGD

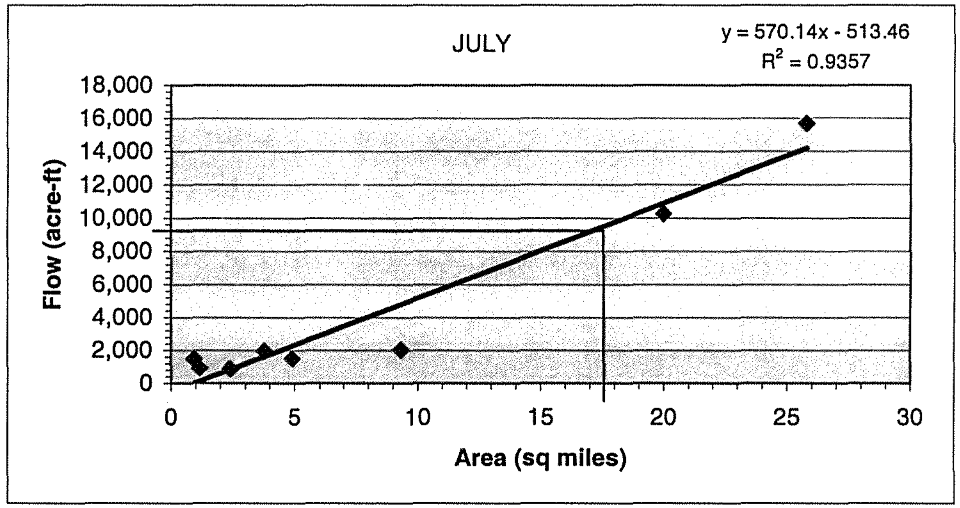


EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

JULY

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	10,268.43
Walker Creek	4.91	3,142	1,524.89
Braden River	25.8	16,512	15,679.34
Hickory Hammock	2.4	1,536	879.27
Cooper Creek	9.33	5,971	2,047.54
Cedar Creek	0.94	602	1,512.60
Rattlesnake Slough	3.78	2,419	1,967.60
Nonsense Creek	1.14	730	953.06
Main A	**17.71**	**11,334**	**9,584**

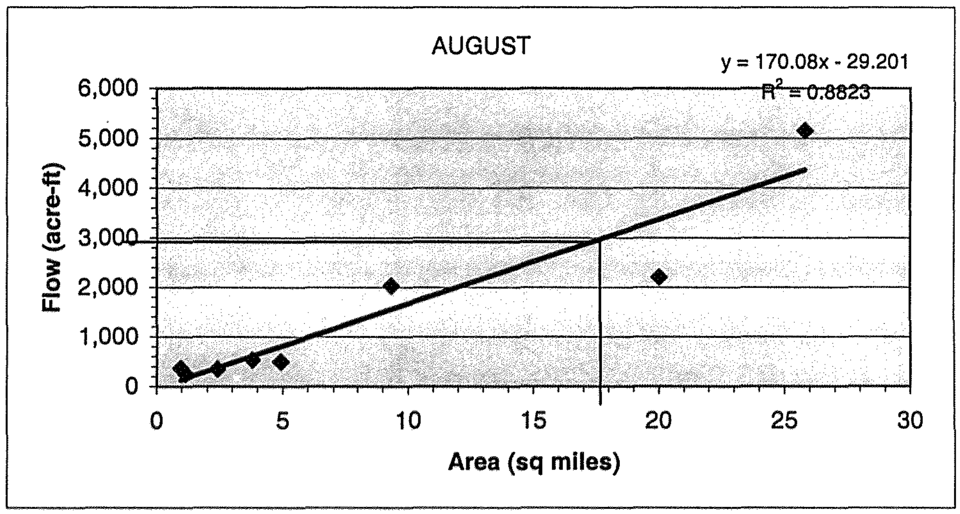
100.73 MGD



AUGUST

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	2,207.40
Walker Creek	4.91	3,142	497.43
Braden River	25.8	16,512	5,152.66
Hickory Hammock	2.4	1,536	348.02
Cooper Creek	9.33	5,971	2,029.09
Cedar Creek	0.94	602	368.93
Rattlesnake Slough	3.78	2,419	530.64
Nonsense Creek	1.14	730	248.41
Main A	**17.71**	**11,334**	**2,983**

31.35 MGD

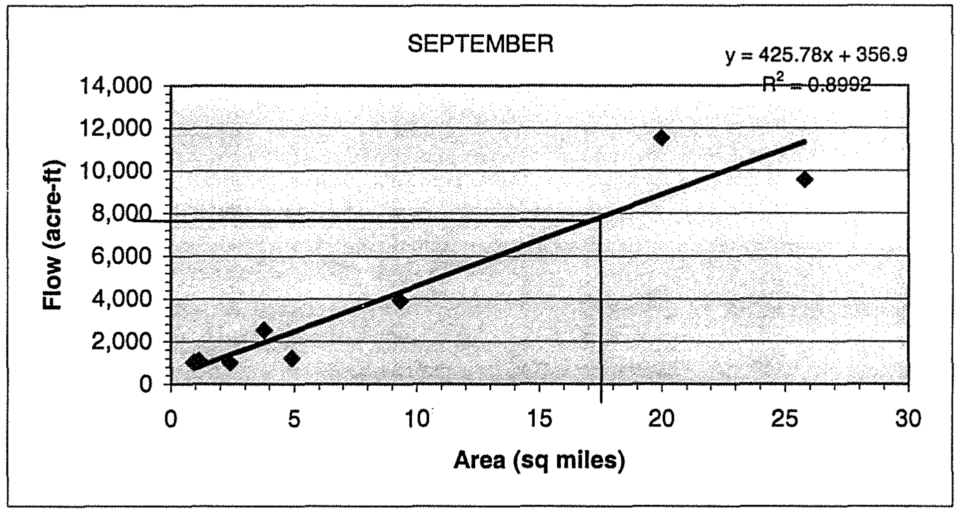


EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

SEPTEMBER

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	11,543.80
Walker Creek	4.91	3,142	1,213.88
Braden River	25.8	16,512	9,580.17
Hickory Hammock	2.4	1,536	1,017.52
Cooper Creek	9.33	5,971	3,927.27
Cedar Creek	0.94	602	1,017.52
Rattlesnake Slough	3.78	2,419	2,540.83
Nonsense Creek	1.14	730	1,094.88
Main A	**17.71**	**11,334**	**7,897**

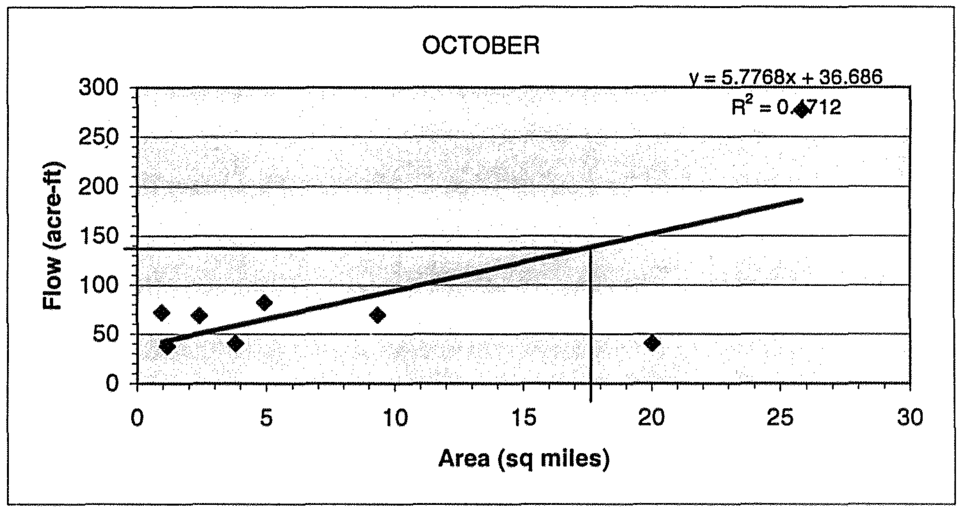
85.77 MGD



OCTOBER

	Watershed Area		Flow
	(sq miles)	(acres)	(acre-ft)
Howard Creek	20	12,800	40.58
Walker Creek	4.91	3,142	82.39
Braden River	25.8	16,512	276.69
Hickory Hammock	2.4	1,536	68.87
Cooper Creek	9.33	5,971	69.48
Cedar Creek	0.94	602	71.94
Rattlesnake Slough	3.78	2,419	40.58
Nonsense Creek	1.14	730	37.51
Main A	**17.71**	**11,334**	**139**

1.46 MGD

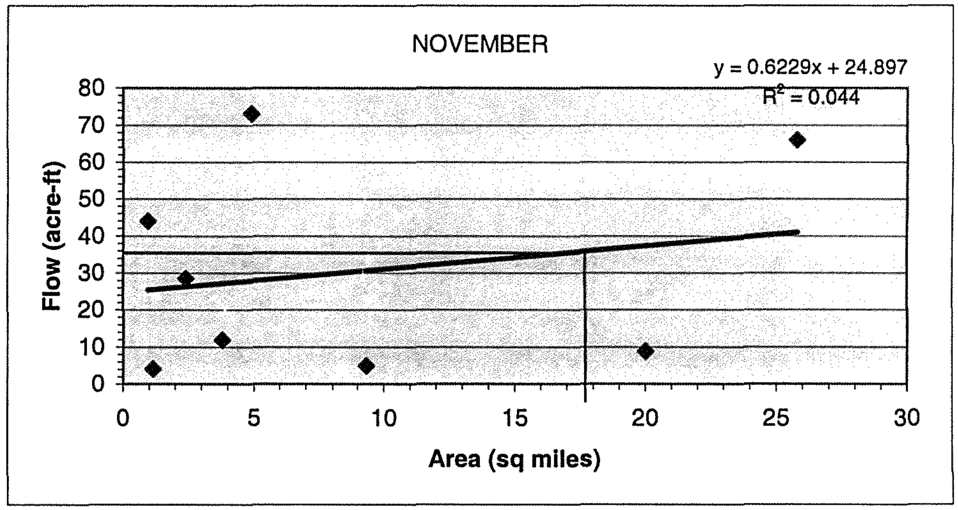


EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

NOVEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	8.89
Walker Creek	4.91	3,142	73.19
Braden River	25.8	16,512	66.05
Hickory Hammock	2.4	1,536	28.56
Cooper Creek	9.33	5,971	5.00
Cedar Creek	0.94	602	44.03
Rattlesnake Slough	3.78	2,419	11.90
Nonsense Creek	1.14	730	4.11
Main A	**17.71**	**11,334**	**36**

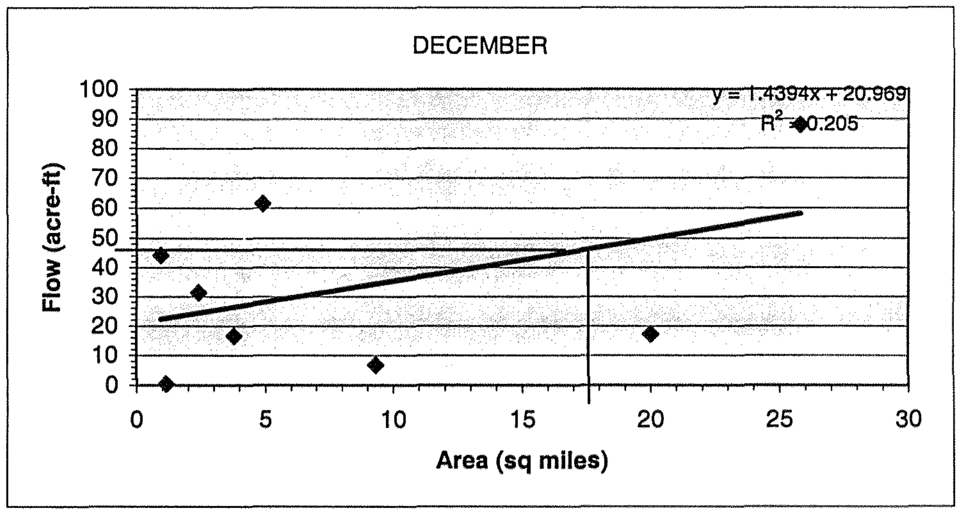
0.38 MGD



DECEMBER

	Watershed Area (sq miles)	Watershed Area (acres)	Flow (acre-ft)
Howard Creek	20	12,800	17.22
Walker Creek	4.91	3,142	61.49
Braden River	25.8	16,512	87.93
Hickory Hammock	2.4	1,536	31.36
Cooper Creek	9.33	5,971	6.76
Cedar Creek	0.94	602	44.27
Rattlesnake Slough	3.78	2,419	16.60
Nonsense Creek	1.14	730	0.43
Main A	**17.71**	**11,334**	**46**

0.49 MGD



EXTREME DROUGHT YEAR MAIN A CONTRIBUTING WATERSHED
Monthly Streamflow Analysis

Main A

Month	Streamflow (acre-ft)	Streamflow (MGD)
January	62	0.65
February	29	0.34
March	402	4.22
April	298	3.24
May	9	0.09
June	444	4.82
July	9,584	100.73
August	2,983	31.35
Spetember	7,897	85.77
October	139	1.46
November	36	0.38
December	46	0.49

Annual Average = 19.46 MGD

Minimum (May) = 99.5% Below Average

Maximum (Sept) = 340.7% Above Average

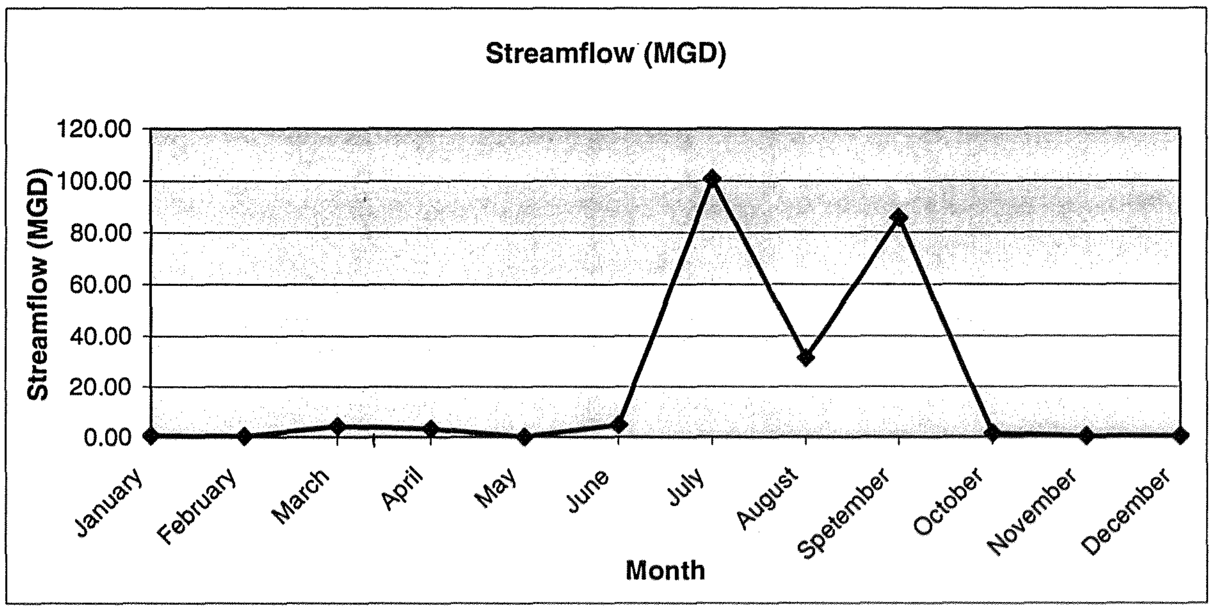


EXHIBIT 7

CFRSF CROSS SECTION

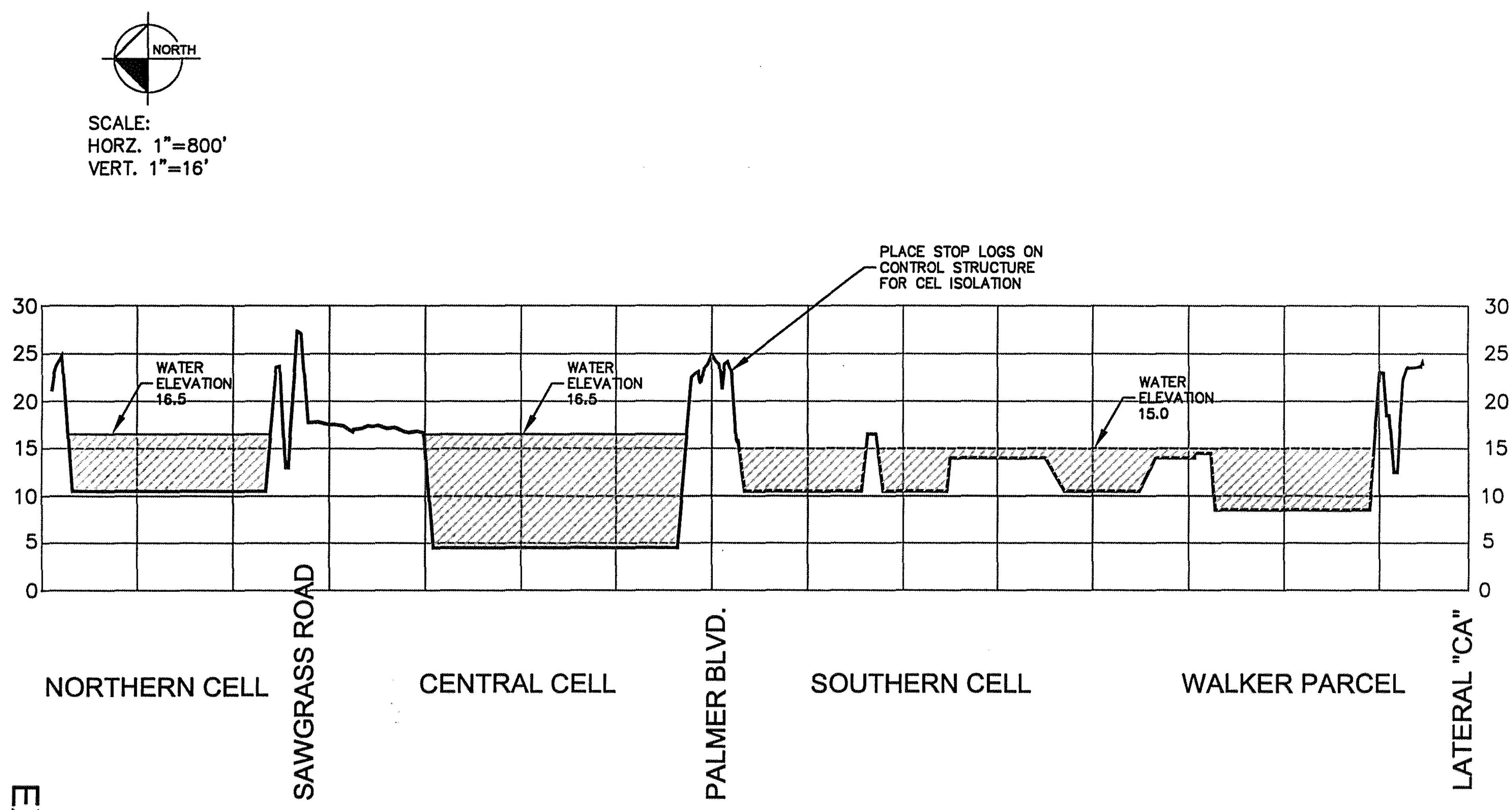


EXHIBIT 7

SCALE 1"=800' DESIGNED BY DRAWN BY MKH CHECKED BY	Kimley-Horn and Associates, Inc. © COPYWRITE 2004 2601 Cattlemen Road, Suite 500, Sarasota, FL 34232 (941) 922-8187 CA 00000696	DATE 8/17/04 PROJECT NO. 048048021	CROSS SECTION OF CFRSF FACING EAST	DESIGN ENGINEER: JEFF STREITMATTER FLORIDA REGISTRATION NUMBER: 46711	SHEET NUMBER

EXHIBIT 8

AVERAGE YEAR CFRSF WATER BUDGET & SUSTAINABLE YIELD

EXHIBIT 8-A

Average Year CFRSF Water Budget - Main C and Main A contributing watersheds

	Month	Rainfall			Surface Water Inflow from Main C and Main A			Ground Water Inflows			Potential Evapotranspiration			Total Inflows			Total Outflows			Net Difference		
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
		Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD
DRY	October	3.10	145	1.52	67.12	3,132	13.40	0.24	11	0.13	4.30	201	2.11	70.46	3,288	15.06	4.30	200.67	2.11	66.16	3,087	12.95
DRY	November	2.01	94	1.02	48.58	2,267	10.03	0.16	7	0.09	3.20	149	1.62	50.75	2,368	11.13	3.20	149.33	1.62	47.55	2,219	9.51
DRY	December	2.37	111	1.16	52.65	2,457	10.51	0.18	9	0.10	2.60	121	1.28	55.20	2,576	11.78	2.60	121.33	1.28	52.60	2,455	10.50
DRY	January	2.66	124	1.31	50.54	2,359	10.09	0.21	10	0.11	2.70	126	1.32	53.41	2,492	11.51	2.70	126.00	1.32	50.71	2,366	10.19
DRY	February	2.47	115	1.34	34.14	1,593	7.55	0.19	9	0.12	3.30	154	1.79	36.80	1,717	9.01	3.30	154.00	1.79	33.50	1,563	7.21
DRY	March	3.60	168	1.77	58.32	2,721	11.65	0.28	13	0.15	4.50	210	2.21	62.20	2,902	13.56	4.50	210.00	2.21	57.70	2,692	11.36
DRY	April	2.28	106	1.16	41.04	1,915	8.47	0.18	8	0.10	5.60	261	2.84	43.50	2,030	9.72	5.60	261.33	2.84	37.90	1,769	6.89
DRY	May	2.87	134	1.41	33.64	1,570	6.72	0.22	10	0.12	6.30	294	3.09	36.73	1,714	8.25	6.30	294.00	3.09	30.43	1,420	5.16
WET	June	7.86	367	3.98	140.65	6,564	29.03	0.61	29	0.34	5.90	275	2.99	149.13	6,959	33.35	5.90	275.33	2.99	143.23	6,684	30.36
WET	July	8.05	376	3.95	188.54	8,799	37.65	0.63	29	0.34	5.70	266	2.80	197.22	9,203	41.94	5.70	266.00	2.80	191.52	8,937	39.15
WET	August	8.62	402	4.23	259.35	12,103	51.79	0.67	31	0.37	5.30	247	2.60	268.64	12,537	56.39	5.30	247.33	2.60	263.34	12,289	53.79
WET	September	7.69	359	3.90	252.91	11,803	52.19	0.60	28	0.34	4.80	224	2.43	261.20	12,189	56.43	4.80	224.00	2.43	256.40	11,965	53.99
	Total	**53.58**	**2,500**	–	**1,227.48**	**57,282**	–	**4.17**	**195**	–	**54.20**	**2,529**	–	**1,285.23**	**59,977**	–	**54.20**	**2,529**	–	**1,231.03**	**57,448**	–
	Annual Average	**4.47**	**208**	**2.23**	**102.29**	**4,774**	**20.76**	**0.35**	**16**	**0.19**	**4.52**	**211**	**2.26**	**107.10**	**4,998**	**23.18**	**4.52**	**211**	**2.26**	**102.59**	**4,787**	**20.92**
	Dry Season																					
	Total	**21.36**	**997**	–	**386.02**	**18,014**	–	**1.66**	**78**	–	**32.50**	**1,517**	–	**409.04**	**19,089**	–	**32.50**	**1,517**	–	**376.54**	**17,572**	–
	Average	–	–	**1.33**	–	–	**9.80**	–	–	**0.12**	–	–	**2.03**	–	–	**11.25**	–	–	**2.03**	–	–	**9.22**
	Wet Season																					
	Total	**32.22**	**1,504**	–	**841.46**	**39,268**	–	**2.51**	**117**	–	**21.70**	**1,013**	–	**876.18**	**40,889**	–	**21.70**	**1,013**	–	**854.48**	**39,876**	–
	Average	–	–	**4.02**	–	–	**42.66**	–	–	**0.35**	–	–	**2.70**	–	–	**47.03**	–	–	**2.70**	–	–	**44.32**

Rainfall

A. Data obtained from SWFWMD records for Sarasota County.

B. Inflow from rainfall over the CFRSF (560 acres).

C. acre-ft = 0.3259 MG

Surface Water Inflow

D. Height contribution is assumed to vertically influence water levels over the 228 acres of open water areas.

E and F. Streamflow values are net inflows into CFRSF after evaporation and groundwater recharge in the contributing watersheds: Main C (3,800 acres) and Main A (11,334 acres). Data extrapolated from flow vs. watershed area analysis for neighbouring similar watersheds.

Ground Water Inflow

G. Height contribution is assumed to vertically influence water levels over the 228 acres of open water areas.

H and I. Inflows due to upward migration of waters from Intermediate aquifer and westward flow of Surficial aquifer. Ground water outflows assumed to be captured by CFRSF surface water outlows.

Potential Evapotranspiration

J. Data from "Potential Evapotranspiration Probabilities and Distributions in Florida" by Smajstrla, Clark, et. al.

K and L. Potential evapotranspiration over the CFRSF (560 acres). Value assumes the availability of moisture (from vegetation and/or open waters) with the potential to evaporate.

Inflows

M. Colums A+D+G

N. Colums B+E+H

O. Columns C+F+I

Outflows

P. Column J

Q. Column K

R. Column L

Net Difference

S, T and U. Net water available for capture at CFRSF. Values reprensent average year weather.

EXHIBIT 8-B

Average Year Sustainable Yield - Main C contributing watershed

	Month	Net Water Available from the CFRSF		Sustainable Yield to be Extracted		To Onsite Pond Storage		Cummulative Pond Storage*	Water Level in the CFRSF**	Water available for secondary storage method or downstream release
		MGD	MG	MGD	MG	MGD	MG	MG	ft NGVD	MG
DRY	October	-1.09	-34	0.15	5	-1.24	-38	125	15.68	0
DRY	November	-0.87	-26	0.15	5	-1.02	-31	94	15.43	0
DRY	December	-0.45	-14	0.15	5	-0.60	-19	76	15.18	0
DRY	January	-0.67	-21	0.15	5	-0.82	-25	51	14.84	0
DRY	February	-1.47	-41	0.15	4	-1.62	-45	5	14.23 ***	0
DRY	March	3.79	117	0.15	5	3.64	113	118	15.75	106
DRY	April	-1.15	-35	0.15	5	-1.30	-39	79	15.22	0
DRY	May	-2.38	-74	0.15	5	-2.53	-78	0	14.17 ***	0
WET	June	5.09	153	0.15	5	0.00	0	0	14.50	153
WET	July	34.39	1,066	0.15	5	0.00	0	0	14.50	1,066
WET	August	10.71	332	0.15	5	0.00	0	0	14.50	332
WET	September	35.71	1,071	0.15	5	0.00	0	0	14.50	1,071
	Dry Season Total	–	117	–	36	–	–	–	–	106
	Wet Season Total	–	2,622	–	18	–	–	–	–	2,622
	Annual Average	7.47	–	0.15	–	–	–	–	–	–
	Annual Total	–	2,739	–	55	–	–	–	–	–

* Maximum potential reclaimed water storage at CFRSF is approximately 125 MG.
** Control level adjusted to reflect normalization between level differences for Northern and Southern portions of CFRSF. Maximum storage occurs at the weighted level of 15.68 ft.
*** Values below 14.5 ft indicate withdrawal from the Walker Parcel storage pond.

Sustainable Yield = 0.15 MGD

EXHIBIT 9

EXTREME DROUGHT YEAR
CFRSF WATER BUDGET &
SUSTAINABLE YIELD

EXHIBIT 9-A

Extreme Drought Year CFRSF Water Budget - Main C and Main A contributing watersheds

	Month	Rainfall			Surface Water Inflow from Main C and Main A			Ground Water Inflows			Potential Evapotranspiration			Total Inflows			Total Outflows			Net Difference		
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
		Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD	Inches	Ac-Ft	MGD
DRY	October	0.29	14	0.14	11.07	210	2.21	0.24	11	0.13	4.30	201	2.11	11.60	235	2.48	4.30	201	2.11	7.30	34	0.37
	November	0.72	34	0.37	3.30	63	0.68	0.16	7	0.09	3.20	149	1.62	4.17	104	1.13	3.20	149	1.62	0.97	-46	-0.49
	December	0.85	40	0.42	4.01	76	0.80	0.18	9	0.10	2.60	121	1.28	5.04	124	1.32	2.60	121	1.28	2.44	3	0.04
	January	0.19	9	0.09	5.51	105	1.10	0.21	10	0.11	2.70	126	1.32	5.91	123	1.31	2.70	126	1.32	3.21	-3	-0.02
	February	0.01	0	0.01	2.44	46	0.54	0.19	9	0.12	3.30	154	1.79	2.64	56	0.66	3.30	154	1.79	-0.66	-98	-1.13
	March	6.93	323	3.40	33.35	634	6.66	0.28	13	0.15	4.50	210	2.21	40.56	970	10.21	4.50	210	2.21	36.06	760	8.01
	April	0.23	11	0.12	22.82	434	4.71	0.18	8	0.10	5.60	261	2.84	23.23	453	4.93	5.60	261	2.84	17.63	191	2.09
	May	0.94	44	0.46	1.10	21	0.22	0.22	10	0.12	6.30	294	3.09	2.27	75	0.80	6.30	294	3.09	-4.03	-219	-2.29
WET	June	8.85	413	4.49	39.11	743	8.07	0.61	23	0.34	5.90	275	2.99	48.57	1,179	12.90	5.90	275	2.99	42.67	904	9.91
	July	13.55	632	6.65	655.63	12,457	130.93	0.63	29	0.34	5.70	266	2.80	669.80	13,119	137.92	5.70	266	2.80	664.10	12,853	135.12
	August	5.36	250	2.63	208.61	3,964	41.66	0.67	31	0.37	5.30	247	2.60	214.64	4,245	44.66	5.30	247	2.60	209.34	3,998	42.06
	September	12.73	594	6.45	567.56	10,784	117.12	0.60	23	0.34	4.80	224	2.43	580.89	11,401	123.91	4.80	224	2.43	576.09	11,177	121.48
	Total	**50.65**	**2,364**	**–**	**1,554.50**	**29,535**	**–**	**4.17**	**185**	**–**	**54.20**	**2,529**	**–**	**1,609.32**	**32,084**	**–**	**54.20**	**2,529**	**–**	**1,559.81**	**29,920**	**–**
	Annual Average	**4.22**	**197**	**2.10**	**129.54**	**2,461**	**26.23**	**0.35**	**15**	**0.19**	**4.52**	**211**	**2.26**	**134.11**	**2,674**	**28.52**	**4.52**	**211**	**2.26**	**129.98**	**2,493**	**26.59**
	Dry Season																					
	Total	**10.16**	**474**	**–**	**83.59**	**1,588**	**–**	**1.66**	**78**	**–**	**32.50**	**1,517**	**–**	**95.42**	**2,140**	**–**	**32.50**	**1,517**	**–**	**67.61**	**989**	**–**
	Average	**–**	**–**	**0.63**	**–**	**–**	**2.12**	**–**	**–**	**0.12**	**–**	**–**	**2.03**	**–**	**–**	**2.86**	**–**	**–**	**2.03**	**–**	**–**	**1.31**
	Wet Season																					
	Total	**40.49**	**1,890**	**–**	**1,470.90**	**27,947**	**–**	**2.51**	**107**	**–**	**21.70**	**1,013**	**–**	**1,513.90**	**29,944**	**–**	**21.70**	**1,013**	**–**	**1,492.20**	**28,931**	**–**
	Average	**–**	**–**	**5.05**	**–**	**–**	**74.45**	**–**	**–**	**0.35**	**–**	**–**	**2.70**	**–**	**–**	**79.85**	**–**	**–**	**2.70**	**–**	**–**	**77.14**

Rainfall

A. Data obtained from SWFWMD records for Sarasota County.

B. Inflow from rainfall over the CFRSF (560 acres).

C. acre-ft = 0.3259 MG

Surface Water Inflow

D. Height contribution is assumed to vertically influence water levels over the 228 acres of open water areas.

E and F. Streamflow values are net inflows into CFRSF after evaporation and groundwater recharge in the contributing watersheds: Main C (3,800 acres) and Main A (11,334 acres). Data extrapolated from flow vs. watershed area analysis for neighbouring similar watersheds.

Ground Water Inflow

G. Height contribution is assumed to vertically influence water levels over the 228 acres of open water areas.

H and I. Inflows due to upward migration of waters from Intermediate aquifer and westward flow of Surficial aquifer. Ground water outflows assumed to be captured by CFRSF surface water outlows.

Potential Evapotranspiration

J. Data from "Potential Evapotranspiration Probabilities and Distributions in Florida" by Smajstrla, Clark, et. al.

K and L. Potential evapotranspiration over the CFRSF (560 acres). Value assumes the availability of moisture (from vegetation and/or open waters) with the potential to evaporate.

Inflows

M. Colums A+D+G

N. Colums B+E+H

O. Columns C+F+I

Outflows

P. Column J

Q. Column K

R. Column L

Net Difference

S, T and U. Net water available for capture at CFRSF. Values reprensent extreme drought year.

EXHIBIT 9-B

Extreme Drought Year Sustainable Yield - Main C and Main A contributing watersheds

	Month	Net Water Available from the CFRSF		Sustainable Yield to be Extracted		To Onsite Pond Storage		Cummulative Pond Storage*	Water Level in the CFRSF**	Water available for secondary storage method or downstream release
		MGD	MG	MGD	MG	MGD	MG	MG	ft NGVD	MG
DRY	October	0.37	12	0.66	20	-0.29	-9	125	15.68	0
DRY	November	-0.49	-15	0.66	20	-1.15	-34	91	15.38	0
DRY	December	0.04	1	0.66	20	-0.62	-19	71	15.12	0
DRY	January	-0.02	-1	0.66	20	-0.68	-21	50	14.84	0
DRY	February	-1.13	-32	0.66	18	-1.79	-50	0	14.17 ***	0
DRY	March	8.01	248	0.66	20	7.35	228	125	15.68	228
DRY	April	2.09	63	0.66	20	1.43	43	125	15.68	43
DRY	May	-2.29	-71	0.66	20	-2.95	-91	34	14.62	0
WET	June	9.91	297	0.66	20	0.00	0	0	14.50	297
WET	July	135.12	4,189	0.66	20	0.00	0	0	14.50	4,189
WET	August	42.06	1,304	0.66	20	0.00	0	0	14.50	1,304
WET	September	121.48	3,644	0.66	20	0.00	0	0	14.50	3,644
	Dry Season Total	–	324	–	160	–	–	–	–	271
	Wet Season Total	–	9,434	–	81	–	–	–	–	9,434
	Annual Average	26.59	–	0.66	–	–	–	–	–	–
	Annual Total	–	9,758	–	241	–	–	–	–	–

* Maximum potential reclaimed water storage at CFRSF is approximately 125 MG.
** Control level adjusted to reflect normalization between level differences for Northern and Southern portions of CFRSF. Maximum storage occurs at the weighted level of 15.68 ft.
*** Values below 14.5 ft indicate withdrawal from the Walker Parcel storage pond.

Sustainable Yield = 0.66 MGD

EXHIBIT 10

CFRSF LOG OF SOIL BORINGS

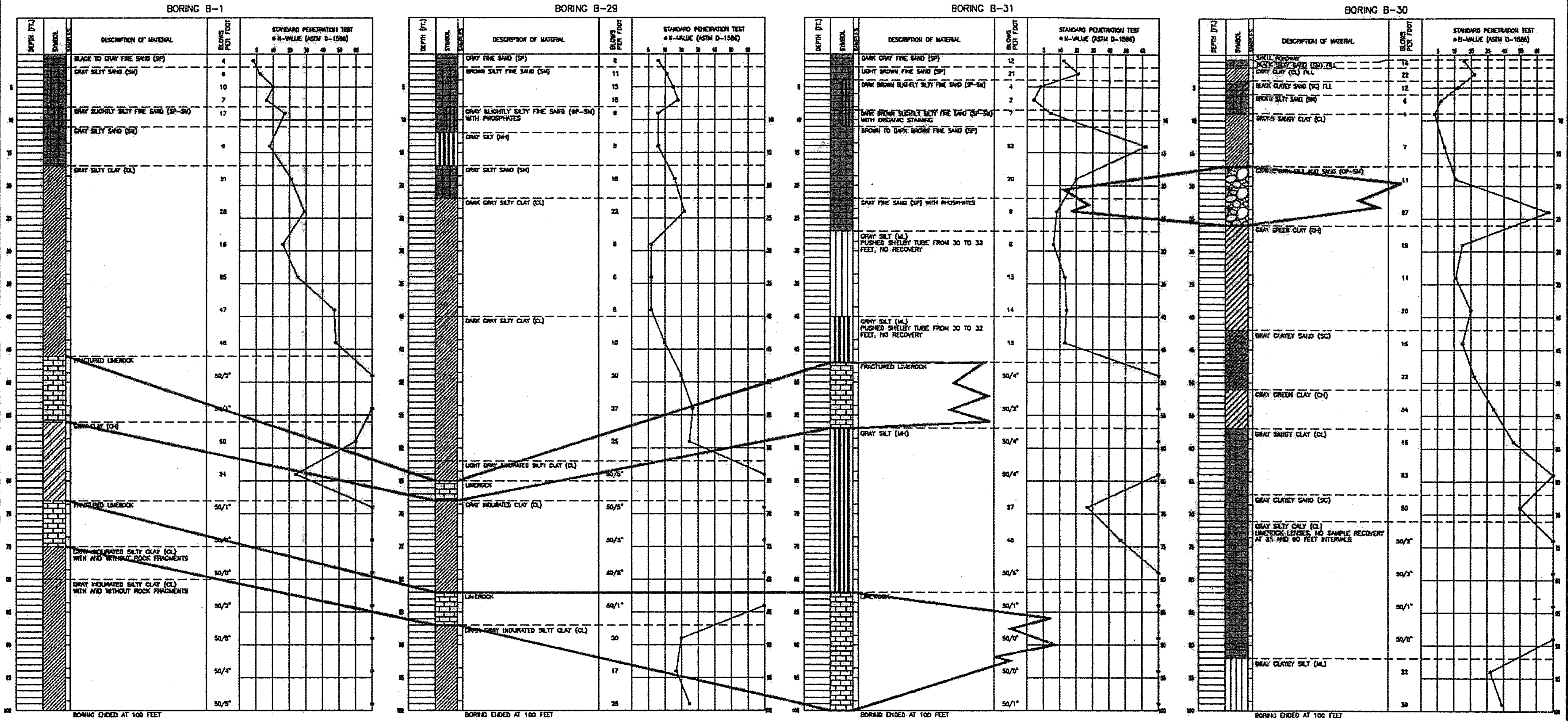


EXHIBIT 10

LOG OF SOIL BORINGS
CELERY FIELDS STORMWATER FACILITY
SARASOTA COUNTY, FLORIDA

Kimley-Horn and Associates, Inc.

P:\Bruce Cutright\Celery Fields-Borings.dwg
Oct 26, 2004 - 10:37am