Bound Reports
1720

Permit Application and Drainage Computations

SOUTH HANCOCK ROAD

LAKE COUNTY, FLORIDA

Prepared For:

Lake County Public Works Department

123 N. Sinclair Avenue

Tavares, Florida 32778

Prepared By:

42-069-1357 ANG-ERP

VANASSE HANGEN BRUSTLIN, INC.

135 W. Central Boulevard, Suite 1150

Orlando, Florida 32801

October 16, 1998

Fl-Orla\projects\60581\wp\reports\Drainage Cover-Permit

TABLE OF CONTENTS

Paul W. Yeargain
10-16-98

Figures

EXECUTIVE SUMMARY

South Hancock Road is an existing rural road that extends from Hartwood Marsh Road to just north of Johns Lake Road. The roadway will be paved and widened with a typical section that will include two 12 foot lanes, two 8 foot shoulders, and a roadside swale in each direction. Only three feet of the shoulder will be paved. As a result of the proposed roadway construction, no wetlands will be impacted. The overall length of the project is approximately 2.0 miles.

In general, stormwater runoff drains away from the roadway. However, there are a few sections where offsite areas drain to the roadway. In addition, no cross drains exist along South Hancock Road, however an 18 inch diameter reinforced concrete cross drain is proposed just north of Hartwood Marsh Road.

Since the project will be permitted through the SJRWMD under 40C-42, treatment volume requirements will be met. The swales will be grassed from the right-of-way line to the edge of shoulder. It should be noted a Florida Department of Transportation (FDOT) Drainage Connection Permit will not be required.

As a result of the proposed project, a portion of the roadway will encroach into the 100-year floodplain, however the impact to the base flood elevation is minimal to none.

This project meets the requirements set forth by the SJRWMD, Lake County, and the Army Corps of Engineers.

INTRODUCTION

This report provides calculations and documentation to support the drainage design of South Hancock Road. The existing roadway is a rural road that will be paved and widened. From station 10+22 to 80+00 the roadway is a one-lane dirt road; from station 80+00 to 90+00 the roadway is paved one-lane road; from station 90+00 to 102+00 the roadway is two-lane dirt road; and from 102+00 to 107+20 the roadway is a two-lane paved road. The roadway will be paved and widened with a typical section that will include two 12 foot lanes, two 8 foot shoulders, and a roadside swale in each direction. Only three feet of the shoulder will be paved. The improvements will extend from the beginning of the project at Hartwood Marsh Road or station 10+22, to the end of the project just north of Johns Lake Road or station 107+20. The overall length of the project is approximately 2.0 miles.

This project meets the requirements set forth by the SJRWMD, Lake County, and the Army Corps of Engineers.

PROJECT LOCATION

The project is located within Sections 3, 4, 9, 10, Range 26 East, Township 23 South and Sections 33 and 34, Range 26 East, Township 22 South in Lake County, Florida. Figure 1 is a location map that shows the limits of the project. The total project area, within right-of-way, is approximately 19.5 acres.

SOILS INFORMATION

The soils within the project limits are identified in the "Soil Survey of Lake County Area, Florida" as Astatula sands. These soils are nearly level to strongly sloping, excessively drained soils. A summary of the soils information is included in Appendix A.

A subsurface exploration was performed by Nordarse and Associates, Inc., for the project. The exploration included 10 auger borings along the centerline of the roadway alignment, ranging in depth from 5 to 10 feet and 3 Falling Head Permeability tests. A copy of the report is included in Appendix A. Groundwater was not encountered at any of the borins.

FLOODPLAIN INFORMATION

Figure 3 is a copy of a portion of Panel 120421 375B of the Flood Insurance Rate Map for Lake County, Florida, dated April 1, 1982. As shown in Figure 3, the existing roadway skirts a 100-year floodplain which is designated as Zone A. The estimated 100-year elevation is approximately 177 feet. The roadway does not encroach or impact the 100-year floodplain. Therefore, there will be no impact on the estimated base flood elevation.

EXISTING DRAINAGE PATTERNS

In general, South Hancock Road is built on a ridge between adjacent drainage boundaries. Therefore, stormwater runoff drains away from the roadway to the east and west. However, from station 10+22 to 51+52 offsite stormwater runoff drains to the roadway from the east.

A drainage map showing the offsite drainage basins is included in Appendix B.

PROPOSED DRAINAGE PATTERNS AND DESIGN

The project is split into eight sub-basins. Runoff from these basins are collected in roadside swales. No new cross drains are proposed with this project.

Since the project will be permitted through the SJRWMD under 40C-42, the treatment volume requirements will be met. The treatment volume will be handled through infiltration of 80 percent of the runoff from the 3-year 1-hour storm event in the proposed swales. The ditches will be grassed from the right-of-way line to the edge of shoulder. It should be noted that according to the runoff volume computations in Appendix C, the offsite areas will not contribute runoff to the swales during a 3-year 1-hour storm event.

In general, because of limited right-of way no swales are proposed north of station 90+00. One 18 inch reinforced concrete side drain is proposed along South Hancock Road at Kingsridge Boulevard; and one 18 inch reinforced concrete cross drain is proposed just north of Hartwood Marsh Road along South Hancock Road.

DESIGN CRITERIA

Regulations which govern the stormwater management design for the South Hancock Road project include: CH. 40C-42 F.A.C., administered by the SJRWMD; NPDES, an EPA regulation administered jointly by EPA and FDEP; National Flood Insurance Program, administered by FEMA, and Lake County.

FDOT and Lake County Criteria

- Ditch and Swale Criteria
  - Design Frequency: 10-year (Lake County)
  - Design Duration: 24-hour (Lake County)
  - Channel Velocity: Table 2.4, FDOT Drainage Manual, Volume 1
V = 4 ft/s (sod) (FDOT 1997)
  - Erosion Protection: Grade ≤ 1.0 percent; Grassing and Mulch
1.0 % < Grade ≤ 3.0 %; Sodding
Grade > 3.0% Paving (except local roads which must be sodded). (Lake County)
  - Freeboard: Minimum of 1.0 feet above design storm high water elevation. (Lake County)
  - Geometry: Maximum Side Slope: 4:1 (less than 4 feet deep)
Maximum Side slopes of 3:1 with a four foot wide bottom (FDOT 1989, III-38)
  - Hydrologic Analysis: Rational Method (<600 acres) (FDOT 1997)
  - Hydraulic Analysis: Manning's Equation (FDOT 1997)
  - Manning's "n" Values: n = 0.06 for depth < 0.7 feet; n = 0.042 for depth > 0.7 feet (FDOT 1997).

- Culvert Criteria
  - Design Frequency: 25-year (Cross Drains) (Lake County)
10-year (Side Drains)
  - Design Duration: 24-hour (Lake County)
  - Hydrologic Analysis: Rational Method (<600 acres) (FDOT 1997)
  - Regional or Local Regression Equations (FDOT 1997)
  - Hydraulic Analysis: Mathematical analysis or design nomographs
FHWA Hydraulic Design Series #5 (FDOT 1997)
  - Manning's "n" Values: n = 0.012 (FDOT 1997)
  - Pipe Size: 18 inches (Cross Drain) (Lake County)
15 inches (Side Drain) (Lake County)
  - Pipe Length (Maximum): 300 feet (18 inch pipe) (Lake County)
400 feet (24 - 36 inch pipe)
500 feet (42 inch pipe)
  - Pipe Grade: Maximum: Produces a velocity of 10 ft/s. Erosion

protection shall be required to properly control entrance and outlet velocities. (Lake County)

- Tailwater: Based on the design storm frequency. (Lake County)

SJRWMD Criteria

- Treatment volume requirements: percolate 80 percent of the runoff from the 3-year 1-hour storm event.

NPDES Criteria

- Effective sediment and erosion controls be employed for construction sites which have 5 or more acres of exposed soils.

FEMA Criteria

- Since a regulatory floodway has not been established for the floodplains along South Hancock Road, encroachment in the 100-year floodplain shall cause no more than a 1.0 foot rise in the 100-year water surface elevation.

ANALYSIS

Hydrologic Analysis

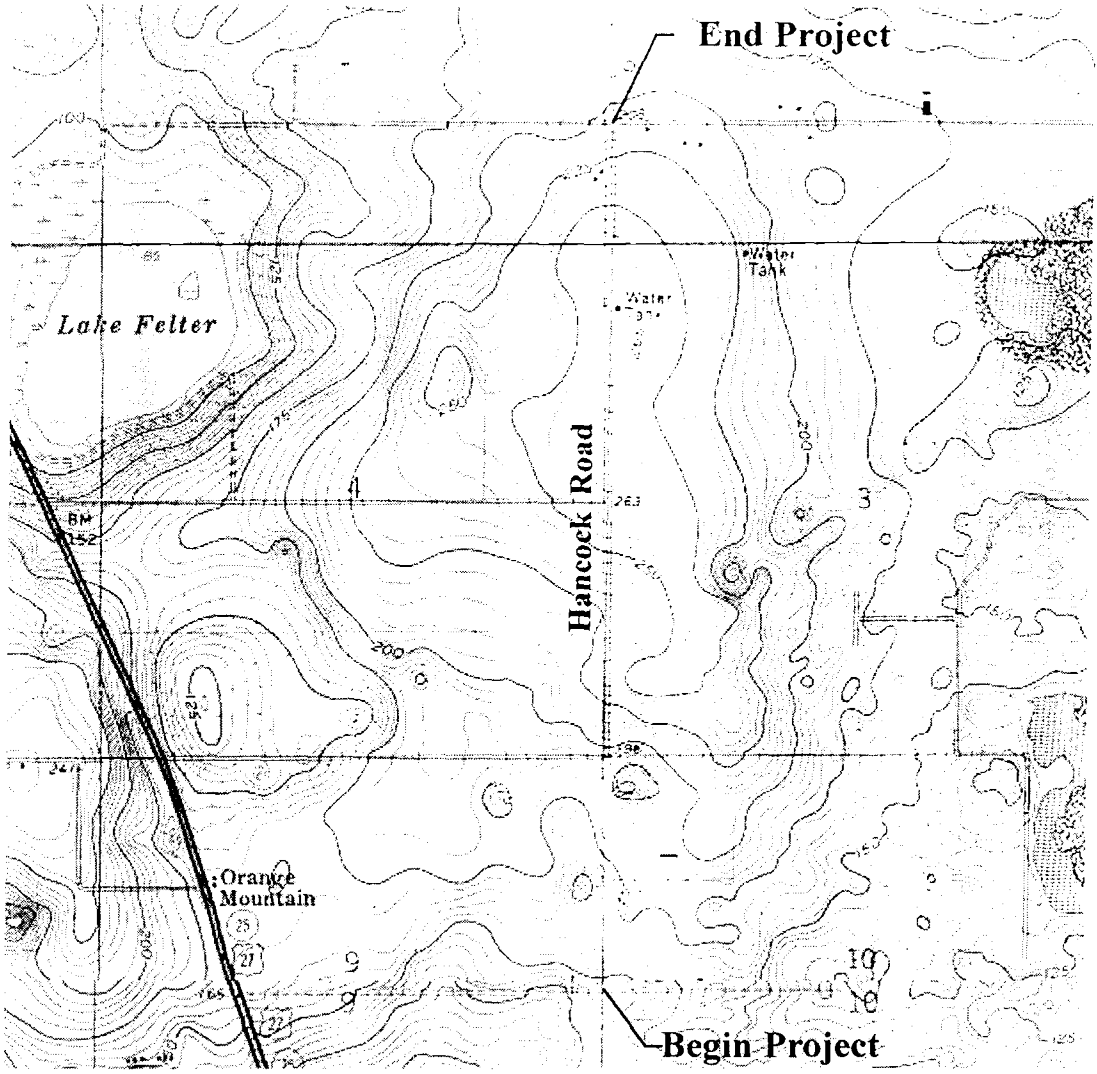
The Rational Method was used to compute peak discharges. Times of concentration and runoff volumes were computed utilizing the methodology described in TR-55. Drainage areas were computed from the roadway plans and the USGS quadrangle maps entitled, "Clermont East, FLA" and "Lake Louisa, FLA." Runoff coefficients were determined utilizing aerial photographs and Table 5-5 from the FDOT Drainage Manual, Volume 2A. Rainfall intensities were estimated from Figure 5-8 of the FDOT Drainage Manual, Volume 1. Copies of these tables and figures are included in Appendix C. Advanced Interconnected Pond Rounting was used to compute peak discharges for several of the offsite areas. Hydrologic computations are included in Appendix B.

Hydraulic Analysis

The hydraulic analysis of the cross drains was performed utilizing the hydraulic program, HY-8, and the hydraulic analysis of the ditches was performed using Manning's Equation and the hydraulic program, FlowMaster. The hydraulic analyses are included in Appendix B.

SUMMARY AND RESULTS

The cross drain was designed so that the headwater from the 25-year design storm will not encroach onto the travel lanes of South Hancock Road and the headwater from the 100-year design storm will not overtop road. Although according to the FIRM the roadway appears to encroach into the 100-year floodplain, based on the estimated 100-year floodplain elevation and the existing elevations along the roadway, no portion of the roadway will encroach into the 100-year floodplain. The roadside swales were designed to accommodate onsite stormwater runoff and offsite stormwater runoff as appropriate. A summary of the treatment volume provided is summarized in Appendix B; adequate treatment volume is provided in the roadside swales for the roadway. The depths of flow were evaluated to ensure that the ditch flow will not encroach onto the travel lanes for a 10-year design storm.



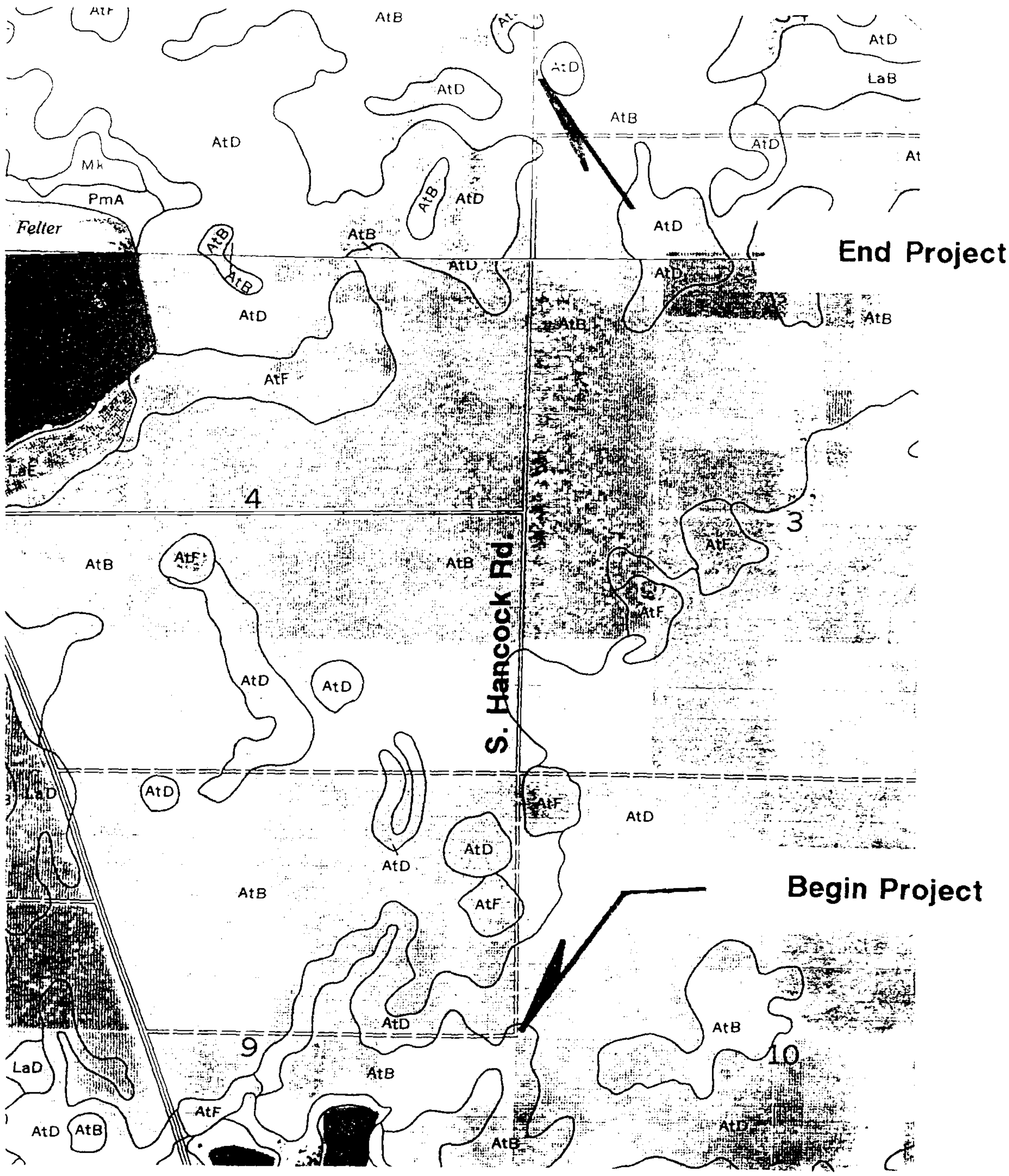
Source
USGS Quadrangle Map
Clermont East / Lake Louisa, Florida
Section 3,4,9,10, Township 23 South, Range 26 East
Section 33,34, Township 22 South, Range 26 East
Scale: 1" = 2000'

Vanasse Hangen Brustlin, Inc.

Location Map

Figure 1

Hancock Road
Lake County, FL



Source
Soil Survey of Lake County, Florida 1975
Sections 3, 4, 9, 10; Township 23 South; Range 26 East
Sections 33 and 34; Township 22 South; Range 26 East
Scale: 1:20,000

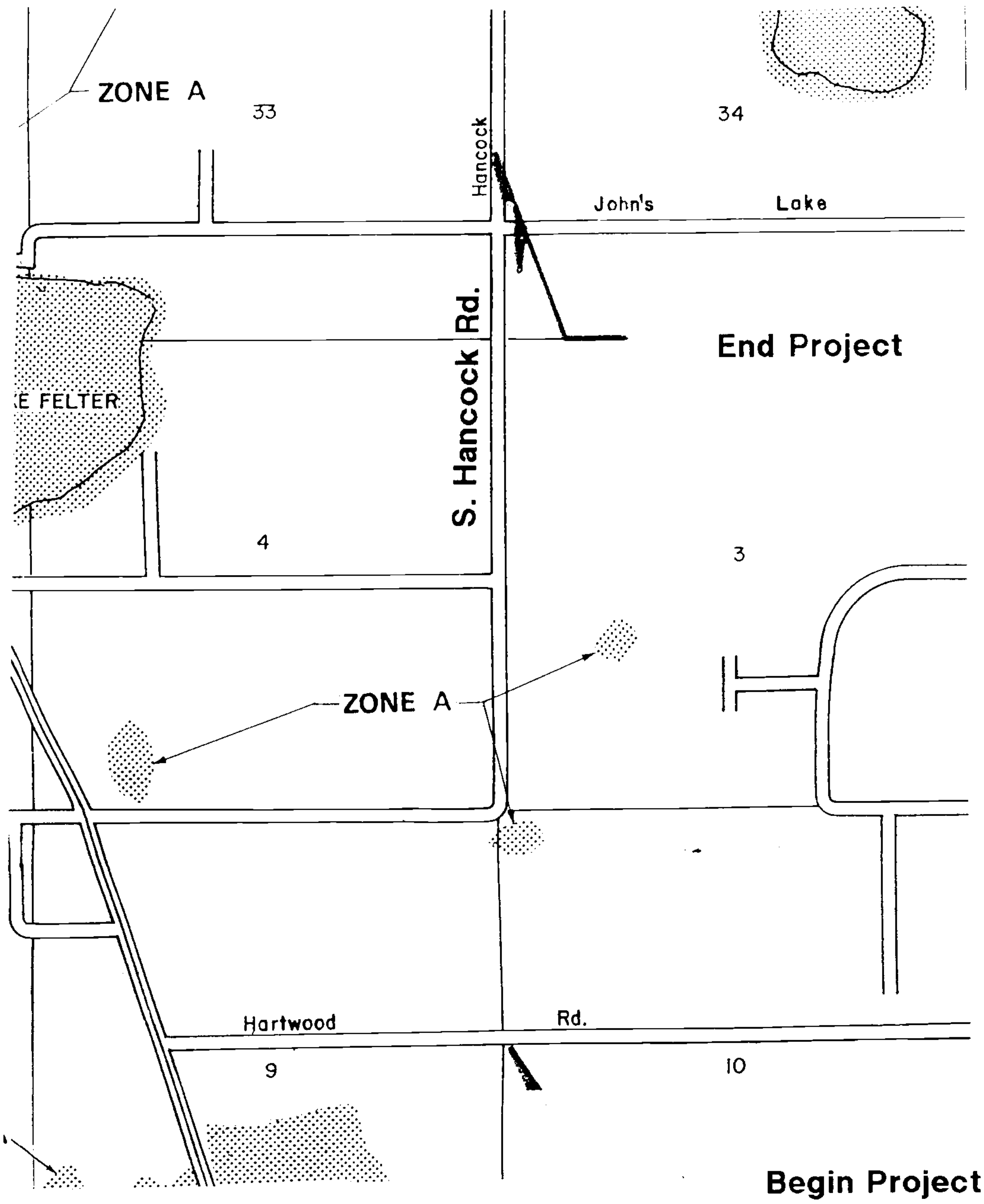
Vanasse Hangen Brustlin, Inc.

North

Soils Map

Figure 2

South Hancock Road
Lake County, FL



Source
Lake County, FL FIRM Panel # 120421 0375B
April 1, 1982
Scale: 1" = 2000'

Vanasse Hangen Brustlin, Inc.

North

Floodplain Map

Figure 3

South Hancock Road
Lake County, FL

FOR AGENCY USE ONLY

ACOE Application # ____________________ DEP/WMD Application # ________________

Date Application Received ________________ Date Application Received ________________

Proposed Project Lat. ______________ Fee Received $ ______________________

Proposed Project Long.______________ Fee Receipt # ________________________

Date Received _____ Project Use Codes ____________

Assigned Reviewers ______________ Reviewer #'s__________

SECTION A

Are any of the activities described in this application proposed to occur in, on, or over wetlands or other surface waters? ___ yes _x_ no

Is this application being filed by or on behalf of a governmental entity or drainage district? _x_ yes ___ no

A. Type of Environmental Resource Permit Requested (check at least one)

_____ Noticed General - include information requested in Section B

_____ Standard General (Single Family Dwelling) - include information requested in Sections C and D.

_____ Standard General (all other projects) - include information requested in Sections C and E.

_____ Individual (Single Family Dwelling) - include information requested in Sections C and D.

_____ Individual (all other projects) - include information requested in Sections C and E.

_____ Conceptual - include information requested in Sections C and E.

_____ Mitigation Bank Permit (construction) - include information requested in Sections C and F.

(If the proposed mitigation bank involves the construction of a surface water management system requiring another permit defined above, check the appropriate box and submit the information requested by the applicable section.)

_____ Mitigation Bank (conceptual) - include information requested in Sections C and F.

x____ Standard General Stormwater - include information requested in Sections C and H.

_____ Individual Stormwater - include information requested in Sections C and H.

B. Type of activity for which you are applying (check at least one)

_____ Construction and operation of a new system including dredging or filling in, on or over wetlands and other surface waters.

_x___ Alteration and operation of an existing system which was not previously permitted by a WMD or DEP.

_____ Modification of a system previously permitted by a WMD or DEP. Provide previous permit numbers:

____

___ Alteration and operation of a system

___ Abandonment of a system

___ Removal of a system

____ Extension of permit duration

____ Construction and operation of additional phases of a system

C. Are you requesting authorization to use State Owned Submerged Lands? ___ yes _x_ no

(If yes, include the information requested in Section G.)

D. For activities in, on, or over wetlands or other surface waters, check type of Federal dredge and fill permit requested:

___ Individual

___ General

___ Programmatic General

___ Nationwide

_x_ Not Applicable

E. Are you claiming to qualify for an exemption? ___ yes _x_ no

If yes, provide rule number if known ____.

RECEIVED
OCT 19 1998
PDS
ORLANDO
SJR WMD

OWNER(S) OF LAND	ENTITY TO RECEIVE PERMIT (IF OTHER THAN OWNER)
NAME: Lake County Board of County Commissioners	NAME: Lake County Department of Public Works
ADDRESS 315 W. Main Street	ADDRESS 123 N. Sinclair Avenue
CITY, STATE, ZIP Tavares, Florida 32778	CITY, STATE, ZIP Tavares, Florida 32778
COMPANY AND TITLE	COMPANY AND TITLE
TELEPHONE (352) 943-9655 FAX (352) 943-9495	TELEPHONE (352) 943-9655 FAX (352) 943-9596
AGENT AUTHORIZED TO SECURE PERMIT (IF AN AGENT IS USED)	**CONSULTANT (IF DIFFERENT FROM AGENT)**
NAME Jim Stivender, Jr., P.E., P.L.S.	NAME Paul W. Yeargain, P.E.
COMPANY AND TITLE Senior Director Lake County Department of Public Works	COMPANY AND TITLE VHB, Inc. Senior Stormwater Engineer
ADDRESS 123 N. Sinclair Ave.	ADDRESS 135 West Central Blvd. Suite 1150
CITY, STATE, ZIP Tavares, Florida 32778	CITY, STATE, ZIP Orlando, Florida 32801-2436
TELEPHONE (352) 943-9655 FAX (352) 943-9596	TELEPHONE (407) 839-4006 FAX (407) 839-4008

Name of project, including phase if applicable South Hancock Road

Is this application for part of a multi-phase project? ___ yes _x_ no

Total Applicant-owned area contiguous to the project ___0___ ac

Total project area for which a permit is sought ___19.5___ ac

Impervious area for which a permit is sought ___7.4___ ac

What is the total area (metric equivalent for Federally funded projects) of work in, on, or over wetlands or other surface waters? **N/A See attached letter, dated December 15, 1997, from BDA.**

0_____ acres ___0___ square feet ___0___ hectares ___0___ square meters

If a docking facility, the number of proposed new slips ___n/a___.

Project location (use additional sheets, if needed)

County(ies) Lake

Section(s) 3, 4, 9, and 10 Township(s) 23 South Range(s) 26 East

Section(s) 33 and 34 Township(s) 22 South Range(s) 26 East

and Grant name, if applicable N/A

Tax Parcel Identification Number ____________

Street address, road, or other location ____________

City, Zip code if applicable ____________

Describe, in general terms, the proposed project, system or activity.

The project involves the paving of an existing dirt road and the installation of 1 new cross drain. The roadway typical section includes one 12 foot travel lane, one 8 foot shoulder (3 feet of which will be paved), and a swale in each direction.

If there have been any pre-application meetings, including at the project site, with regulatory staff, please list the date(s), location(s), and names of key staff and project representatives.

9/15/98 Ruth Grady, SJRWMD and Paul Yeargain, VHB (Telephone call - report attached)

Please identify by number any MSSW/Wetland Resource/ERP/ACOE permits pending, issued or denied for projects at the location and any related enforcement actions.

Agency	Date	No./Type of Application	Action Taken (Pending/Issued/Denied)

Note: The following information is required for projects proposed to occur in, on, or over wetlands or other surface waters that need a Federal dredge and fill permit and/or authorization to use State owned submerged lands. Please provide the names, addresses and zip codes of property owners whose property directly adjoins the project (excluding Applicant). Please attach a plan view showing the owner's names and adjoining property lines. Attach additional sheets if necessary.

1. N/A
2.
3.
4.

By signing and submitting this application form, I am applying, or I am applying on behalf of the Applicant, for the permit and any proprietary authorizations identified above, according to the supporting data and other incidental information filed with this application. I am familiar with the information contained in this application, and represent that such information is true, complete and accurate. I understand this is an application and not a permit, and work prior to approval is a violation. I understand that this application and any permit issued or proprietary authorization issued pursuant thereto, does not relieve me of any obligation for obtaining any other required Federal, State, water management district or local permit prior to commencement of construction. I agree, or I agree on behalf of my corporation, to operate and maintain the permitted system unless the permitting agency authorizes transfer of the permit to a responsible operation entity. I understand that knowingly making any false statement or representation in this application is a violation of Section 373.430, F.S., and 18 U.S.C. Section 1001.

Jim Stivender, Jr., P.E., P.L.S.
Typed/Printed Name of Applicant (if no Agent is used) or Agent (if one is so authorized below)

10/1/98
Signature of Applicant/Agent Date

Senior Director of Lake County Department of Public Works
(Corporate Title if applicable)

AN AGENT MAY SIGN ABOVE ONLY IF THE APPLICANT COMPLETES THE FOLLOWING:

I hereby designate and authorize the agent listed above to act on my behalf, or on behalf of my corporation, as the agent in the processing of this application for the permit and/or proprietary authorization indicated above; and to furnish, on request, supplemental information in support of the application. In addition, I designate and authorize the above-listed agent to bind me, or my corporation, to perform any requirement which may be necessary to procure the permit or authorization indicated above. I understand that knowingly making any false statement or representation in this application is a violation of Section 373.430, F.S., and 18 U.S.C. Section 1001.

Lake County Department of Public Works 10/1/98
Typed/Printed Name of Applicant Signature of Applicant/Agent Date

(Corporate Title if applicable)

Please note: The Applicant's original signature (not a copy) is required above.

PERSON AUTHORIZING ACCESS TO THE PROPERTY MUST COMPLETE THE FOLLOWING:

I either own the property described in this application or I have legal authority to allow access to the property, and I consent, after receiving prior notification, to any site visit on the property by agents or personnel from the Department of Environmental Protection, the Water Management District and the U.S. Army Corps of Engineers necessary for the review and inspection of the proposed project specified in this application. I authorize these agents or personnel to enter the property as many times as may be necessary to make such review and inspection. Further, I agree to provide entry to the project site for such agents or personnel to monitor permitted work if a permit is granted.

Lake County Department of Public Works 10/1/98
Typed/Printed Name Signature Date

(Corporate Title if applicable)

BDA
ENVIRONMENTAL CONSULTANTS

December 15, 1997
File: 97077-10.1

REC'D
DEC 17 1997
VHB FLORIDA

Mr. Allen Ayash, P.E.
Senior Project Engineer
Vanasse Hangen Brustlin, Inc.
South Trust Bank Building
135 W. Central Boulevard
Orlando, Florida 32801
TEL: (407) 839-4006
FAX: (407) 839-4008

RE: Ecological Constraints Review of the Hancock Road Project Site, Lake County, Florida

Dear Allen:

Breedlove, Dennis & Associates, Inc. has completed an ecological constraints review of the proposed extension of Hancock Road south in Lake County, Florida. The Hancock Road improvements begin at the Hartwood Marsh Road north to the intersection of the currently paved portion of Hancock Road and John's Lake Road. The purpose of our ecological constraints review was to assess the proposed Hancock Road right-of-way (ROW) for the occurrence of wetlands that would be regulated by the St. Johns River Water Management District (SJRWMD), Lake County, and the Department of the Army, Corps of Engineers (ACOE), to assess for the occurrence and potential occurrence of wildlife species listed as threatened or endangered (T&E) or Species of Special Concern by the U.S. Fish and Wildlife Service (USFWS) and the Florida Game and Fresh Water Fish Commission (FGFWFC), and to assess for the occurrence of plant species listed as T&E by the USFWS. To complete our ecological constraints review, two biologists reviewed the entire Hancock Road ROW from John's Lake Road south to Hartwood Marsh Road for approximately 100 feet on either side of the proposed centerline. A Natural Resources Conservation Service soils map of the project site, U.S. Geological Survey topographic map, and aerial photograph of the project site were review to assist with the site evaluation.

Environmental Conditions

The entire area of the proposed Hancock Road ROW appears to be former *Citrus* sp. grove. A former grove access road exists along the approximate centerline of the proposed Hancock Road south extension.

Three developed areas exist along the northern portion of the proposed roadway including a water treatment plant, a high tech business, and buildings of the former *Citrus* sp. grove.

The entire road ROW is within planted pines, including sand pine (*Pinus clausa*) and an improved variety of slash pine (*Pinus elliottii*). The mid-canopy and understory contains upland annual and perennial invasive species such as bahiagrass (*Paspalum notatum*), tall redtop (*Tridens flavus*), Florida pusley (*Richardia scabra*), hairy indigo (*Indigofera hirsuta*), shrub verbena (*Lantana camara*), remnant *Citrus* sp. trees, sandspur (*Krameria lanceolata*), *Cenchurus* spp., begger-ticks (*Bidens alba*), and dog fennel (*Eupatorium capillifolium*). Soils underlain in the proposed Hancock Road south extension include Astatula sand, dark surface, of various slopes including 0% to 5%, 5% to 12%, and 12% to 40%.

Wildlife observed included upland dependent species such as mourning dove (*Zenaida macroura*), common ground dove (*Columbina passerina*), loggerhead shrike (*Lanius ludovicianus*), eastern meadowlark (*Sturnella magna*), and northern harrier (*Circus cyaneus*). None of these species are listed wildlife. All these species are endemic species that could nest within the project site with the exception of the northern harrier, which is a migrant or overwintering species. Several gopher tortoise (*Gopherus polyphemus*) burrows were observed along the outer edge of both the east and west sides of the proposed ROW. Transects revealed the presents of four active and one inactive gopher tortoise burrow, several of which appear to be utilized by juvenile gopher tortoises.

Regulatory Analysis

There are no wetland areas that would be considered jurisdictional by either the SJRWMD, Lake County, or the ACOE. All areas within the proposed Hancock Road ROW are distinctly upland in character based on vegetation and soils.

The project will need to obtain an Environmental Resource Permit (ERP) from the SJRWMD for construction of the Hancock Road extension. Wetland impacts will not need to be addressed during this permitting process. No permitting will be needed with the ACOE, as there are no wetlands on the project site.

The only listed wildlife species observed on the project site was the presence of several active and inactive gopher tortoise burrows. Each burrow was flagged during the census for subsequent survey. This survey should determine the exact distance from the centerline and the outer edge of the east and west ROWs and will subsequently determine the level of effort needed to comply with FGFWFC gopher tortoise policies. For burrows that lie within the proposed ROW or within 50 feet of the ROW, either an Incidental Take Permit (ITP) or a Gopher Tortoise Relocation Permit (GTRP) should be obtained. The ITP would allow the filling of gopher tortoise burrows without the subsequent relocation of the gopher tortoises. An ITP would require the submittal of a mitigation or management plan to the FGFWFC. This could include either preservation of an on-site area or off-site area, or a monetary donation to a mitigation bank fund. Generally, the amount needed for mitigation is 15% to 25% of the occupied habitat at a cost between $6,000 to $7,000

BDA
ENVIRONMENTAL CONSULTANTS

per acre. A GTRP can be obtained to either relocate the gopher tortoises to an on-site upland preservation area or to an off-site upland preservation area. The GTRP should be obtained 30 to 60 days prior to construction. The ERP must be issued by the SJRWMD before a GTRP can be obtained.

Due to the presence of gopher tortoises on the project site, there is a moderate to high probability that commensal species such as the eastern indigo snake (*Drymarchon corais couperi*), Florida pine snake (*Pituophis melanoleucus mugitus*), and Florida mouse (*Podomys floridanus*) could occur on the project site. There is a low probability that the Florida gopher frog (*Rana areolata aesopus*), which is also a commensal species, could occur on the project site. Any permitting for gopher tortoises such as an ITP or GTRP should also suffice to compensate for any potential impacts that may result should any of the commensal species be recorded on the project site.

No other listed wildlife species are expected to occur on the project site (Table No. 1). The FGFWFC was contacted in regard to their bald eagle (*Haliaeetus leucocephalus*) nest survey data. FGFWFC staff indicated that bald eagles were of no concern to this project as there are no nests within a mile of the project.

Summary

The proposed Hancock Road extension is located within areas of a former citrus grove. All areas are upland based on vegetation and soils. No wetland areas exist on the project site. The presence of a small gopher tortoise population along the Hancock Road proposed ROW was enumerated. An incidental take permit or relocation permit will need to be obtained by the FGFWFC. A relocation permit may be the most expedient and least expensive method for compliance with FGFWFC gopher tortoise policy. If you have any questions or need any additional information, please do not hesitate to contact either one of us.

Sincerely yours,

Mark W. Christopher, M.S., C.W.B., P.W.S.
Senior Project Manager

W. Michael Dennis, Ph.D.
President

MWC/WMD/tdm

Enclosure

Table 1. Protected Plants and Animals with Potential for Occurrence in Lake County, Florida.

Taxa	Habitat	Likelihood of Occurrence	Designated Status[1] USFWS[2]	Designated Status[1] FGFWFC[3]
AMPHIBIANS				
Rana capito Florida gopher (=crawfish) frog	Sandhills with turkey & bluejack oaks; sand pine scrub, in and around gopher tortoise burrows.	Low.		SSC
BIRDS				
Aphelocoma c. coerulescens Florida scrub jay	Oak scrub, with shrubs of live, myrtle, and Chapman's oaks, palmettos and sand pine.	Unlikely.	T	T
Aramus guarauna Limpkin	Slow moving streams and rivers, marshes, and lake shores.	Unlikely.		SSC
Dendroica kirtlandii Kirtland's warbler	Migrant in Florida in a variety of habitats.	Unlikely.	E	E
Egretta caerulea Little blue heron	Shallow freshwater, brackish, and saltwater habitats.	Unlikely.		SSC
Egretta thula Snowy egret	Ponds, stream banks, marshes, and pastures.	Unlikely.		SSC
Egretta tricolor Tricolored heron	Ponds, stream banks, marshes, and pastures.	Unlikely.		SSC

Table 1. Protected Plants and Animals with Potential for Occurrence in Lake County, Florida.

Taxa	Habitat	Likelihood of Occurrence	Designated Status[1] USFWS[2]	FGFWFC[3]
Eudocimus albus white ibis	Wetlands.	Unlikely.		SSC
Falco peregrinus tundrius Artic peregrine falcon	Winter in Florida: coastal areas provide optimum habitat where mangroves are regenerating from hurricane damage, with dead stubs standing among scattered ponds and sloughs.	Unlikely.		E
Falco sparverius paulus southeastern American kestrel	Pine flatwoods, dry prairies.	Moderate.		T
Grus canadensis pratensis Florida sandhill crane	Wet prairies, marshy lake margins, and low-lying improved cattle pastures.	Unlikely.		T
Haliaeetus l. leucocephalus Southern bald eagle	Pine flatwoods, dry prairies.	Low.	T	T
Mycteria americana Wood stork	Wetlands; nesting in cypress swamps.	Unlikely.	E	E

Table 1. Protected Plants and Animals with Potential for Occurrence in Lake County, Florida.

Taxa	Habitat	Likelihood of Occurrence	Designated Status[1] USFWS[2]	FGFWFC[3]
Rostrhamus sociabilis plumbeus snail kite	Marsh with distant horizon and low vegetative profile.	Unlikely.	E	E/CH
Speotyto cunicularia floridana Florida burrowing owl	High sandy ground with little growth, particularly prairies, sandhills, and pastures, and on prairie-like expanses of airports, industrial plants, and campuses.	Low.		SSC
Sterna antillarum least tern	Open; flat beach with coarse sand or shell. Nests seaward of vegetation.	Unlikely.		T
Vermivora bachmani Bachman's warbler	Variety of woodlands, usually in lowlands.	Unlikely.	E	E
MAMMALS				
Podomys floridanus Florida mouse	Xeric sand pine scrub in early succession, and longleaf pine-turkey oak.	Moderate.		SSC
Sciurus niger shermani Sherman's fox squirrel	Sandhills in longleaf pine-turkey oak associations, sand pine scrub.	Low.		SSC
Ursus americanus floridanus Florida black bear	Swamps, bays, and thickets. Protective status not applicable within the Apalachicola National Forest and Baker and Columbia counties.	Low.	C	T

Table 1. Protected Plants and Animals with Potential for Occurrence in Lake County, Florida.

Taxa	Habitat	Likelihood of Occurrence	Designated Status[1] USFWS[2]	FGFWFC[3]
PLANTS				
Bonamia grandiflora Florida bonamia	Sand pine scrub, white sands.	Low.	T	
Chionanthus pygmaeus pygmy fringe-tree	Sand pine scrub.	Low.	E	
Eriogonum longifolium var. gnaphalifolium scrub buckwheat	Dry pinelands & scrub	Low.	T	
Justicia cooleyi Cooley's water willow	Rocky woods; high hardwood or hardwood-pine	Low.	E	
Nolina brittoniana scrub (=Britton's) beargrass	Dry pinelands and sand pine scrub.	Low.	E	
Paronychia chartacea papery whitlow-wort	Sand pine scrub.	Low.	T	
Polygala lewtonii scrub milkwort; Lewton's polygala	Dry oak woods, sand scrub, sandhills.	Low.	E	

Table 1. Protected Plants and Animals with Potential for Occurrence in Lake County, Florida.

Taxa	Habitat	Likelihood of Occurrence	Designated Status[1] USFWS[2]	FGFWFC[3]
Polygonella myriophylla Small's jointweed; sandlace	Sand pine scrub.	Low.	E	
Prunus geniculata scrub plum	Sand pine scrub.	Low.	E	
Ribes echinellum Miccosukee gooseberry	Steeply sloping land containing stands of deciduous hardwood trees more typically found to the north.	Low.	T	
Warea amplexifolia wide-leaf warea	Sandhills; dry pinelands - north and central counties.	Low.	E	
REPTILES				
Alligator mississippiensis American alligator	Wetlands, lakes, and streams.	Unlikely.	T(S/A)	SSC
Drymarchon corais couperi eastern indigo snake	Pine flatwoods, tropical hammocks.	Moderate.	T	T
Gopherus polyphemus gopher tortoise	Xeric; sand pine, long-leaf pine, turkey oak and live oak hammocks and sand pine scrub.	Observed, burrows.		SSC
Neoseps reynoldsi sand skink	Loose sand on high elevation, central Florida ridges; sand pine scrub.	Moderate.	T	T

Table 1. Protected Plants and Animals with Potential for Occurrence in Lake County, Florida.

Taxa	Habitat	Likelihood of Occurrence	Designated Status[1] USFWS[2]	FGFWFC[3]
Pituophis melanoleucus mugitus Florida pine snake	Sandy habitats, particularly longleaf pine-turkey oak associations.	Moderate.		SSC
Stilosoma extenuatum short-tailed snake	Longleaf pine/turkey oak association, occasionally in upland hammock and sand pine scrub.	Moderate.		T

[1]E = Endangered; T = Threatened; T(S/A) = Threatened due to Similarity of Appearance; SSC = Species of Special Concern; C = Candidate for Listing, Sufficient Information Available

[2]U.S. Fish and Wildlife Service

[3]Florida Game and Fresh Water Fish Commission

[redacted]

Vanasse Hangen Brustlin, Inc.

Transportation
Land Development
Environmental Services

VHB

135 West Central Boulevard
Suite 1150
Orlando, Florida 32801-2436
407 839-4006
FAX 407 839-4008

Phone Notes

Person Contacted:	Ruth Grady	VHB Rep:	Paul Yeargain
Title:	Engineer	VHB Project No.:	60581.00
Company:	SJRWMD	Project Name:	S. Hancock Road
Telephone No.:	897-4334	Type Of Call:	Outgoing
FAX No.		Date and Time:	September 15, 1998

I told Ruth that I would like schedule a pre-application meeting for the South Hancock Road project in Lake County. She suggested that we discuss the project over the phone to serve as a 'pre-application meeting."

South Hancock Road is located south of SR 50 in Lake County. It is an existing dirt road that will be paved. The project will serve new development: Kingsridge Subdivision is currently being constructed along the west side of the project, and a Lake County Public School is being constructed along the east side of the project. Stormwater treatment will be provide in roadside swales by percolating 80% of the 3-year 1-hour storm event. It some areas swales are not proposed because of right-of-way limits. Lastly, there are no wetlands along the roadway.

Ruth said the project could be permitted under 40C-42. She suggested looking at sub-section 0.24 (C) for governmental agencies.

cc: Correspondence file
Project file

SECTION H
INFORMATION FOR ENVIRONMENTAL RESOURCE STORMWATER PERMITS

Provide the information requested below if the proposed project requires an environmental resource stormwater permit.

1. General Permit Category: Projects which meet one of the following performance criteria qualify for a general permit. If applicable, indicate the appropriate general permit category below:

a) Systems which discharge into a stormwater management system which is permitted pursuant to Paragraphs 40C-42.024(2)(b), (c), or (d), F.A.C., or Subsection 40C-42.024(3), F.A.C., or which was previously approved pursuant to a noticed exemption under Section 17-25.030, F.A.C., where the appropriate treatment criteria specified in this chapter and applied to the permitted or exempt system are not exceeded by the discharge; or,

b) Systems which meet the applicable design and performance standards of Section 40C-42.025, F.A.C., and which comply with any or more of the following:

1. dry detention systems within project areas less than 5 acres in size, and which serve a drainage area less than 5 acres in size and which meet the criteria of Subsection 40C-42.026(1), F.A.C.;

2. retention systems which meet the criteria of Subsection 40C-42.026(2), F.A.C.;

3. underdrain systems which meet the criteria of Subsection 40C-42.026(3), F.A.C.;

4. underground exfiltration trench systems which meet the criteria of Subsection 40C-42.026(4), F.A.C.;

5. wet detention systems which meet the criteria of Subsection 40C-42.026(5), F.A.C.; or

6. swale systems which meet the criteria of Subsection 40C-42.026(6), F.A.C.; or,

c) Systems that include a combination of management practices including but not limited to retention basins, swales, pervious pavement, landscape or natural retention storage that will provide for the percolation of the runoff from a three-year one-hour design storm; or,

d) Modification or reconstruction by a city, county, state agency, or special district with drainage responsibility of an existing stormwater management system which is not intended to increase the original design capacity, and which will not increase pollution loading, or change points of discharge in a manner that would adversely affect the designated uses of waters of the State; or,

e) Paving of existing public dirt roads if all of the following are met:

1. the road will not serve new development;

2. additional traffic lanes are not added to the road;

3. the traffic load is not expected to significantly increase;

4. the drainage system serving the road is not significantly altered;

5. erosion and sediment control measures are utilized to prevent turbidity during construction; and,

6. the project does not require a wetland resource management (dredge and fill) permit pursuant to Chapter 17-312, F.A.C

Individual Permit Categories: If applicable, indicate the appropriate permit category below.

a) Wetlands stormwater management systems which meet the design and performance criteria in Sections 40C-42.025 and 40C-42.0265, F.A.C.; or,

b) Systems which employ a treatment methodology or device other than those described in Subsections 40C-42.024(2) or (3), F.A.C.; or,

c) Systems which do not meet the applicable design criteria of Sections 40C-42.025, 40C-42.026, or 40C-42.0265, F.A.C.

Required Technical Information

All applicable technical information must be submitted with the completed application form. Failure to provide all required information will result in a delay in application processing and permit issuance.

A. General site conditions

1. Recent aerial photo of project site (no photocopies) - 1" to 400' scale maximum;

2. Map(s) or applicable construction plan(s) (no larger than 24" X 36") showing:

a. General location of project shown on USGS quad map(s), including points of discharge;

b. Project area boundary;

c. Pre-development (existing) topography;

d. Pre-development drainage patterns including points of discharge for existing site drainage and drainage basin boundaries;

e. Off-site drainage area and flow patterns across project site;

f. Location of existing drainage right-of-way or easements on-site;

g. Location of private and public water supply wells on-site; and

h. All wetlands on the site;

3. SCS soils map and report and/or soil boring data for treatment facility locations (borings should be a minimum 6 ft. depth below ground surface and 5 ft. below proposed treatment facility bottom);

4. Water table data

a. Date, location, and water table level of actual measurements (if collected) with the estimated depth of antecedent rainfall (nearest NOAA rainfall station or other rain gage) during the previous one month period; and

b. Estimated normal dry and wet season water table elevation (provide source or method of estimate.

B. Post-development project site conditions

1. Describe or document the legal outfall for point discharges of treated stormwater to adjacent property;

2. Identify and describe all on-site and off-site stormwater management systems which discharge into or receive discharge from the proposed project;

3. Provide the design tailwater elevation(s) at all points of discharge (include source or method of estimate);

4. Include the following on construction drawings for the project site:

a. Project land use and land cover;

b. Proposed construction, including erosion and sediment control plan for each phase (show specifications for erosion/sediment control measures on plans);

c. Vegetative cover plan for all on-site and off-site earth surfaces disturbed by construction;

d. Legal reservations for access to the treatment system for maintenance and operation by future maintenance entities for subdivided projects;

e. Provide locations for the following on construction plans:

(1) Drainage divide and area (in acres) served by each hydraulically separate stormwater treatment system;

(2) Septic tank or other proposed on-site wastewater treatment facility; and

(3) Wells and surface water withdrawals;

f. Provide plans, elevations and/or profiles, and details for the following:

(1) Roadway and parking pavements;

(2) Floor slabs, walkways and other paved surfaces;

(3) Earthwork grades for pervious landscaped areas; and

(4) All stormwater treatment and drainage facilities,

(5). Show the following details for stormwater treatment systems construction plans:

a. All treatment systems:

(1) Show the elevation of normal wet season water table, design normal water elevation, and elevations for storage of the treatment volume;

(2) Details of oil and grease control mechanism, if required;

(3) Details of the outlet and overflow control structure; and

(4) Details of treatment drawdown outlets. Show the design tailwater elevations on the outlet details; and

(5) The minimum erosion and sediment control measures to be implemented during construction and all permanent control measures in post-development conditions;

b. Retention/detention facilities (including swales designed for retention/detention treatment only):

(1) Plan contours and/or cross section details showing bottom contours and elevations, all design dimensions, side slopes, and top of bank elevations; and

(2) Grassing or planting of all treatment system earth surfaces;

c. Exfiltration trench:

(1) Trench dimensions and elevations;

(2) Pipe diameter, material, length, slope, perforation specification;

(3) Trench rock material with fillable porosity and filter fabric protection;

(4) Overflow elevation for trenches with outfall;

(5) Inlet and outlet structure details including sediment sumps; and

(6) Design and location of observation well(s);

d. Underdrain and filter systems:

(1) Pipe length, slope, diameter, and minimum and maximum inverts;

(2) Maintenance access (such as at-grade cleanouts) for the filter pipe;

(3) Permeability of filter media for filtration systems;

(4) Permeability of soils for underdrain systems;

(5) Filter media gradation (uniformity coefficient and effective grain size) for filtration systems;

(6) Underdrain or filter detail at a uniform horizontal and vertical scale no greater than 1 inch 5 feet (to scale, not typical);

(7) Permeable, protective and stable surface cover (at the surface slope) for the filter surface (such as gravel); and

(8) Filter fabric protection as applicable for perforated pipes, coarse aggregate sections, and round the filter section;

e. Wet detention systems:

(1) Littoral zone location and depths; and

(2) Elevation contours of pond bottom;

f. Wetland stormwater management systems:

(1) Delineation of wetland areas utilized for stormwater treatment;

g. Karst Sensitive Areas

(1) Geologic borings and geologic sections through the retention basin area. A geologic boring should be performed at the point of maximum excavation within the basin;

(2) Location and description of limestone outcrops and any karst features, i.e., sinkholes or solution pipes which exist at the project site; and

(3) Inventory of existing wells within a 1000 foot radius of the stormwater basin;

6. Design analysis/calculations (minimum required):

a. Provide the rational method runoff coefficient (c), drainage area, and impervious area (percentage of total drainage area) for each treatment system;

b. Calculate treatment volume required for each separate system (based on information in 5.a. above);

c. Provide stage-storage tabulations to demonstrate that required treatment storage is available in the treatment system below the overflow elevation;

d. Demonstrate 72 hour drawdown for retention, filtration, underdrain, or exfiltration trench systems based on natural soil conditions and/or specified filter media (with safety factor of 2 for filtration, underdrain, and exfiltration). Calculations must consider normal wet season water table and tailwater conditions to demonstrate recovery;

e. Demonstrate that the function of the proposed treatment systems does not adversely affect the treatment performance of all other stormwater management systems which serve or are served by the proposed project;

f. Demonstrate no more than half the treatment volume is discharged within 48 to 60 hours following a storm event for wet detention and wetland stormwater management systems;

g. Design analysis for sizing wet detention permanent pool volume;

h. Describe any additional management practices such as pretreatment, which will be used to enhance the water quality of the stormwater discharge; and

i. Peak discharge and conveyance calculations (if appropriate) for pre-development and post-development conditions as follows:

(1) Runoff characteristics, including area, runoff curve number or runoff coefficient, SCS hydrologic soil group, and time of concentration for each drainage hydrologic unit;

(2) Design storms used including duration, frequency, and time distribution;

(3) Runoff hydrograph(s) for each drainage basin for all required design storm events;

(4) State-storage computations for any storage area, such as a detention area or channel storage, used in storage routing;

(5) Stage-discharge computations for any storage areas at a selected control point, such as structure control or natural restriction;

(6) Flood routings through on-site conveyance and storage areas;

(7) Water surface profiles and elevations in the primary surface water management system for the required design storm event(s); and

(8) Runoff peak rates and volumes discharged from the system for the design storm event(s);

7. Operation and maintenance

a. Describe the overall maintenance and operation schedule for the proposed stormwater treatment system;

b. If the proposed operation and maintenance entity is not a property owners association, provide proof of the existence of an entity or the future acceptance of the system by an entity, pursuant to Paragraphs 40C-42.027, (1)(a)-(d), F.A.C.. which will operate and maintain the system;

c. If a property owners association is the proposed operation and maintenance entity, provide articles of incorporation for this association and the declaration, restrictive covenants, deed restrictions or other operational documents that assign responsibility for the operation and maintenance of the system, pursuant to 40C-42.027(4), F.A.C.; and

d. Provide information to ensure the continued adequate access to stormwater treatment systems for maintenance purposes;

8. Alternative stormwater treatment (individual permit)

If equivalent treatment is to be provided, it is the applicant's responsibility to demonstrate that the stormwater management system, as designed, will meet or exceed the requirements set forth in the rule. Describe the subject stormwater discharge system. Discuss how the design is intended to achieve a treatment level equivalent to the design and performance criteria in Subparagraph 40C-42.024(2)(b)2. or Subsection 40C-42.024(4), F.A.C. Provide design analysis and calculations necessary to demonstrate that equivalent treatment will be achieved.

9. Wekiva River Basin (if applicable)

Submit the Local Government Notification form when any part of the system/project is within the Wekiva River Protection Area.

Note: If professional engineering, geology, or landscape architecture is required by Florida Statute for the design of the proposed stormwater management system, construction plans and calculations must be signed and sealed by an appropriate professional registered in the State of Florida.

Section H

A. General site conditions
   1. Recent aerial photo of project site. *Figure H.1 is an aerial photograph of the project site.*
   2. Map(s) or applicable construction plan(s) showing:
      a. General location of project shown on USGS quad map(s), including points of discharge. *Figure 1 of the report is a general location map.*
      b. Project area boundary. *Figure 1 of the report shows the limits of the project.*
      c. Pre-development (existing) topography. *The existing profile of South Hancock Road is included in the attached plans.*
      d. Pre-development drainage patterns including points of discharge for existing site drainage and drainage basin boundaries. *A copy of the pre-development and offsite drainage map is included in Appendix C.*
      e. Off-site drainage area and flow patterns across project site. *A copy of the pre-development and offsite drainage map is included in Appendix C.*
      f. Location of existing drainage right-of-way easements on-site. *The rights of way for South Hancock Road are shown on the attached plans.*
      g. Location of private and public water supply wells on-site. *There are no private and public water supply wells on-site.*
      h. All wetlands on the site. *There are no wetlands within or adjacent to the project limits.*
   3. SCS soils map and report and/or soil boring date for treatment facility locations. *Figure 2 of the report is a copy of the SCS soils map for the project area. Soils information is included in Appendix B.*
   4. Water table data
      a. Date, location, and water table level of actual measurements (if collected) with estimated depth of antecedent rainfall during the previous one month period. *Water table elevations were collected and are included in the Soils Report in Appendix B. No groundwater was encountered in any of the soil borings.*
      b. Estimated normal dry and wet season water table elevation. *No groundwater was encountered in any of the soil borings. However, estimated wet season water table elevations are estimated to be deeper than 6 feet beneath the existing ground surface.*

B. Post-development Project Site Conditions
   1. Describe or document the legal outfall for point discharges of treated stormwater to adjacent property. *Roadside swales are proposed along both sides of the roadway. In general, stormwater will infiltrate into the ground.*
   2. Identify and describe all on-site and off-site stormwater management systems which discharge into or receive discharge from the proposed project. *Roadside swales are proposed along both sides of the roadway. In general, stormwater will infiltrate into the ground.*

Remove Bold

3. Provide the design tailwater elevation at all points of discharge. *Not applicable (discharge is through infiltration).*
4. **Include the following on construction drawings for the project site:**
   a. Project land use and land cover.
   b. Proposed construction, including erosion and sediment control plan for each phase. *Please see the attached construction plans. Please note this is not a phased construction.*
   c. Vegetative cover plan for all on-site and off-site earth surfaces disturbed by construction. *All disturbed surfaces will either be sodded or seeded and mulched. Please see the attached construction plans.*
   d. Legal reservations for access to the treatment system for maintenance and operation by future maintenance entities for subdivided projects. *Stormwater treatment will be provided in the proposed roadside swales which are within the Lake County right-of-way. Access to the swales will from the South Hancock Road.*
   e. Provide locations for the following on construction plans:
      (1) Drainage divide and area served by each hydraulically separate stormwater treatment system. *A drainage map for the project is included in the attached report.*
      (2) Septic tank or other proposed on-site wastewater treatment facility. *Not applicable.*
      (3) Wells and surface water withdrawals. *Not applicable.*
   f. Provide plans, elevations and/or profiles, and details for the following:
      (1) Roadway and parking pavements. *Please see the attached construction plans.*
      (2) Floor slabs, walkways and other paved surfaces. *All proposed sidewalks are shown on the attached construction plans.*
      (3) Earthwork grades for pervious landscaped areas. *Please see the attached construction plans.*
      (4) All stormwater treatment and drainage facilities. *Please see the attached construction plans.*
      (5) Show the following details for stormwater treatment systems construction plans.
         a) All treatment systems:
            (1) Show the elevations of normal wet season water table, design normal water elevation, and elevations for storage of the treatment volume. *Stormwater treatment will be provided in roadside swales that percolate 80% of the 3-year 1-hour storm. According to the geotechnical report, included in Appendix A, the seasonal high water table is at least 6 feet below the existing ground surface. No groundwater was encountered in the soil borings.*
            (2) Details of oil and grease control mechanism, if required. *Not applicable.*
            (3) Details of the outlet and overflow control structure. *Not applicable.*

(4) Details of treatment drawdown outlets. Show the design tailwater elevations on the outlet details. *Not applicable.*

(5) The minimum erosion and sediment control measures to be implemented during construction and all permanent control measures in post-development conditions. *Please see the attached construction plans.*

b) Retention/detention facilities:

c) Exfiltration trench. *Not applicable.*

d) Underdrain and filter systems. *Not applicable.*

e) Wet detention systems. *Not applicable.*

f) Wetland stormwater management systems. *Not applicable.*

g) Karst Sensitive Areas. *Not applicable.*

6. **Design analysis/calculations**
   a. Provide the rational method runoff coefficient, drainage area, and impervious area for each treatment system. *The runoff coefficient, drainage area, and impervious area calculations are included in Appendix C.*
   b. Calculate treatment volume required for each separate system. *Treatment volume calculations are included in Appendix C.*
   c. Provide stage-storage tabulations… *Not applicable.*
   d. Demonstrate 72-hour drawdown… *Not applicable.*
   e. Demonstrate that the function of the proposed treatment systems does not aversely affect the treatment performance of all other stormwater management systems which serve or are served by the proposed project. *Not applicable.*
   f. Demonstrate no more than half the treatment volume is discharge within 48 to 60 hours… *Not applicable.*
   g. Design analysis for sizing wet detention permanent pool volume. *Not applicable.*
   h. Describe any additional management practices such as pretreatment, which will be used to enhance the water quality of the stormwater discharge. *Not applicable.*
   i. Peak discharge and conveyance calculations for pre-development and post-development conditions as follows:
      (1) Runoff characteristics, including area, runoff curve number or runoff coefficient, SCS hydrologic soil group, and time of concentration for each drainage hydrologic unit. *Runoff coefficients and times of concentrations are included in Appendix C.*
      (2) through (8). *Not applicable*
7. **Operation and maintenance** *South Hancock Road will be owned and operated by Lake County. Therefore, the roadside swales will be operated and maintained by Lake County.*
8. **Alternative stormwater treatment** *Not applicable*
9. **Wekiva River Basin** *Not applicable*

Nodarse
& Associates

Report of Subsurface Exploration and
Geotechnical Engineering Evaluation
Proposed Paving and
Drainage Improvements
South Hancock Road
Lake County, Florida

Geotechnical, Environmental Geotechnics & Material Engineers

Nodarse
& Associates, Inc.

August 31, 1998
Project No. W97-G-139-E

TO: **VANASSE HANGEN BRUSTLIN, INC.**
135 West Central Boulevard, Suite 1150
Orlando, Florida 32801-2436

ATTN: Mr. S. Alan Ayash, P.E.

RE: **Report of Subsurface Exploration and**
Geotechnical Engineering Evaluation
Proposed Paving and Drainage Improvements
South Hancock Road
Lake County, Florida

Dear Mr. Ayash:

Nodarse & Associates, Inc. (N&A) is pleased to submit the following report of subsurface exploration and geotechnical engineering evaluation for the above-referenced project. This exploration was performed in general accordance with the scope in our contract dated October 10, 1997 to provide geotechnical services for engineering design of five Lake County Roadway Projects. The purpose of this exploration was to obtain geotechnical engineering data to aid in paving and drainage design at the above-referenced site.

SITE AND PROJECT DESCRIPTION

The section of South Hancock Road to be improved is approximately 1.8 miles long. The project begins at Station 10+00 at the intersection of Hartwood Marsh Road and extends north to Station 107+19.40 just past the intersection of John's Lake Road. The subject roadway is located on the boundary of Sections 33 and 34, Township 22 South and Sections 3, 4, 9 and 10, Township 23 South, Range 26 East in Lake County, Florida. A vicinity map showing the project location is included as **Figure 1** in the **Appendix**. We understand the central portion of the existing roadway is an old poorly paved grove road, the southern portion has just been cleared and the northern portion is an unpaved clay road. A Preliminary Contamination Assessment (PCA) was also performed for a specific location along this project and was previously submitted under separate cover.

Geotechnical, Environmental Geotechnics & Material Engineers
1030 North Orlando Avenue ◆ Suite A ◆ Winter Park, Florida 32789 ◆ Telephone 407.740.6110 ◆ Facsimile 407.740.6112
e-mail nodarse@nodarse.com

For this project, the USDA Soil Conservation Service soil survey report for Lake County was reviewed. The soils on the project are shown below. Also included is the depth of the estimated seasonal high groundwater level for the site in its natural condition.

SCS Map Symbol	Conversion Symbol	Map Unit Name	Lake County Soil Survey Estimated Seasonal High Groundwater Level
AtB	13	Candler sand, 0 to 5 percent slopes	Greater Than 6.0'
AtD	15	Candler sand, 5 to 12 percent slopes	Greater Than 6.0'
AtF	17	Candler sand, 12 to 25 percent slopes	Greater Than 6.0'

A soils map showing the project limits is included as **Figure 2** in the **Appendix**.

SUBSURFACE EXPLORATION

Our field exploration consisted of performing a series of ten (10) hand auger borings along the centerline of the proposed roadway alignment ranging from in depth from 5 to 10 feet below the existing road surface. These depths were chosen based on the plan/profile sheets supplied by your firm. The approximate station and offset for each of the borings is shown on **Figure 3** in the **Appendix**.

The hand auger boring procedure consisted of manually turning a 3 inch diameter, 6 inch long sampler into the soil until it is full. The sampler was then retrieved and the soils in the sampler were visually examined and classified. The procedure was repeated until the desired termination depth was achieved. Samples of representative strata were obtained for further visual examination and classification in our laboratory. The borings were then backfilled with soil cuttings.

GENERAL SUBSURFACE CONDITIONS

The soil and groundwater conditions encountered in the auger borings are shown on **Figure 3** in the **Appendix**. Descriptions of the soils encountered in the borings are accompanied by the American Association of State Highway and Transportation Officials (AASHTO) symbol.

Generally, the borings encountered light brown to brown fine sand, trace roots (A-3) (Stratum 1). Next, the borings generally encountered a light brown to orangish-brown fine sand (A-3) (Stratum 2). Two exceptions were noted to this generalized boring profile. The first exception observed was in the form of orangish-brown silty fine sand (A-2-4) (Stratum 3). This exception was found in Boring AB-3 from 9 feet to the boring termination depth of 10 feet below the existing ground surface. The second exception found was an orangish-brown clayey fine sand (A-2-6) (Stratum 4). This exception was found only in Boring AB-9 from a depth of 3 inches to 1 foot below the existing ground surface. This stratum appears to be imported roadway material.

Groundwater was not encountered during our field exploration to depths of 5 to 10 feet beneath the existing ground surface. Where not encountered, groundwater should not be a concern for roadway design unless substantial cuts are planned.

LABORATORY TESTING

Laboratory testing for this project included two (2) single sieve grain size analyses, one (1) Atterberg Limits test and one (1) natural moisture content test. All tests results are shown on **Table 1** in the **Appendix**. The tests are performed in accordance with the appropriate American Society for Testing Materials (ASTM) procedures.

LABORATORY PERMEABILITY TESTING

Three (3) falling head permeability tests were performed on boring samples obtained from the proposed swale areas. The resulting vertical permeability rates were measured to be from 68 to 126 feet per day. Although a vertical permeability rate in excess of 68 feet per day was recorded, we recommend limiting using vertical and horizontal permeability rates for design to 30 and 40 feet per day, respectively. Compaction effects of construction and mowing equipment, and siltation of the swale bottom, can reduce the effective permeability rate. Results for each location are shown on **Table 2** in the **Appendix.**

CONCLUSIONS AND RECOMMENDATIONS

General: The following conclusions and recommendations are based on the project characteristics previously described, the data obtained in our field exploration and our experience with similar subsurface conditions and construction types. If subsurface conditions different from those disclosed by the borings are encountered during construction, we should be notified immediately so that we might review the following recommendations in light of such changes.

Roadway Construction: Based on the results of this exploration, the soil and groundwater conditions appear suitable for conventional construction according to the applicable Lake County requirements and the Florida Department of Transportation (FDOT) Roadway and Traffic Design Standards. Strata 1, 2 and 3 encountered for this study can be treated as select (S) material and should generally be suitable for use as fill soils. The silty fine sand (A-2-4) material included in Stratum 3 may be sensitive to moisture content changes. Stratum 4 should be considered a plastic (P) material and is most likely part of the old clay grove road. This material can be very difficult

Nodarse & Associates, Inc.

to handle if it becomes wet. However, if moisture content is carefully controlled and the material is thoroughly pulverized and mixed with subgrade soils, it can be used as a stabilizing material. The old asphalt should be disposed of as directed by the owner.

During our subsurface exploration, no near surface muck material was encountered. However, if muck is encountered within the roadway embankment area during construction, it should be removed in accordance with Index 500 of the FDOT Roadway and Traffic Design Standards.

The Lake County soil survey estimates seasonal high groundwater depth for the site in its natural state to be deeper than 6 feet beneath the existing ground surface. Therefore, based on our field exploration and the soil survey, groundwater does not appear to be a concern in roadway design. Pavement construction should be according to any Lake County requirements.

For pavement design, an estimated Limerock Bearing Ratio (LBR) value of 20 should be used for soils encountered at the site.

CLOSURE

N&A appreciates the opportunity to be of service to you on this project. If you should have any questions concerning the contents of this report, or if we may be of further assistance, please do not hesitate to contact us.

Sincerely,

NODARSE & ASSOCIATES, INC.

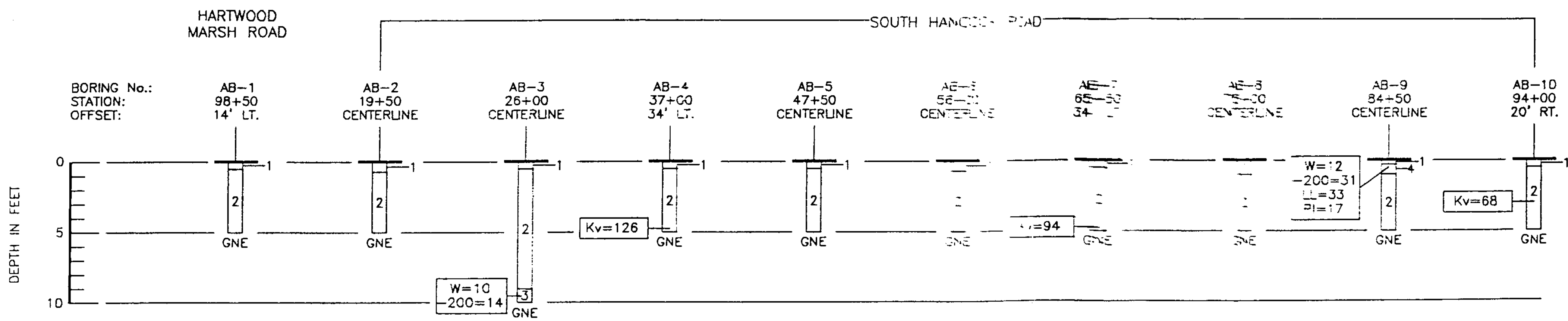
8-31-98
Michael J. Horst, P.E.
Project Engineer
FL Registration No. 52668

8-31-98
Jay W. Casper, P.E.
Manager, Geotechnical Services
FL Registration No. 36330

W97-139E.REP:MJH24/sc

APPENDIX

FED. ROAD DIV. NO.	STATE	PROJECT NO.	FISCAL YEAR	SHEET NO.
	FLA.			



LEGEND

1 LIGHT BROWN TO BROWN FINE SAND, TRACE ROOTS (A-3)

2 LIGHT BROWN TO ORANGISH-BROWN FINE SAND (A-3)

3 REDDISH-BROWN TO ORANGISH-BROWN SILTY FINE SAND (A-2-4)

4 ORANGISH-BROWN CLAYEY FINE SAND (A-6)

(A-3) A.A.S.H.T.O. SOIL CLASSIFICATION GROUP SYMBOL AS DETERMINED BY VISUAL EXAMINATION

GNE GROUNDWATER NOT ENCOUNTERED TO DEPTH OF BORING

W NATURAL MOISTURE CONTENT (%)

-200 FINES PASSING No. 200 SIEVE (%)

LL LIQUID LIMIT

PI PLASTICITY INDEX

APPROVED BY: ______________________

JAY W. CASPER

P.E. NO.: 36330 DATE:

REPORT OF AUGER BORINGS

PAVING AND DRAINAGE IMPROVEMENTS
SOUTH HANCOCK ROAD
LAKE COUNTY, FLORIDA

REVISIONS								
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

	NAME	DATE		NAME	DATE
DESIGNED BY			DRAWN BY	MG	8-31-98
CHECKED BY			CHECKED BY	MJH	8-31-98
SUPERVISED BY: JWC					

Nodarse & Associates, Inc. Geotechnical, Environmental & Materials Engineers

APPROVED BY:

DATE:

NODARSE No. W97-G-139F FIGURE: 3

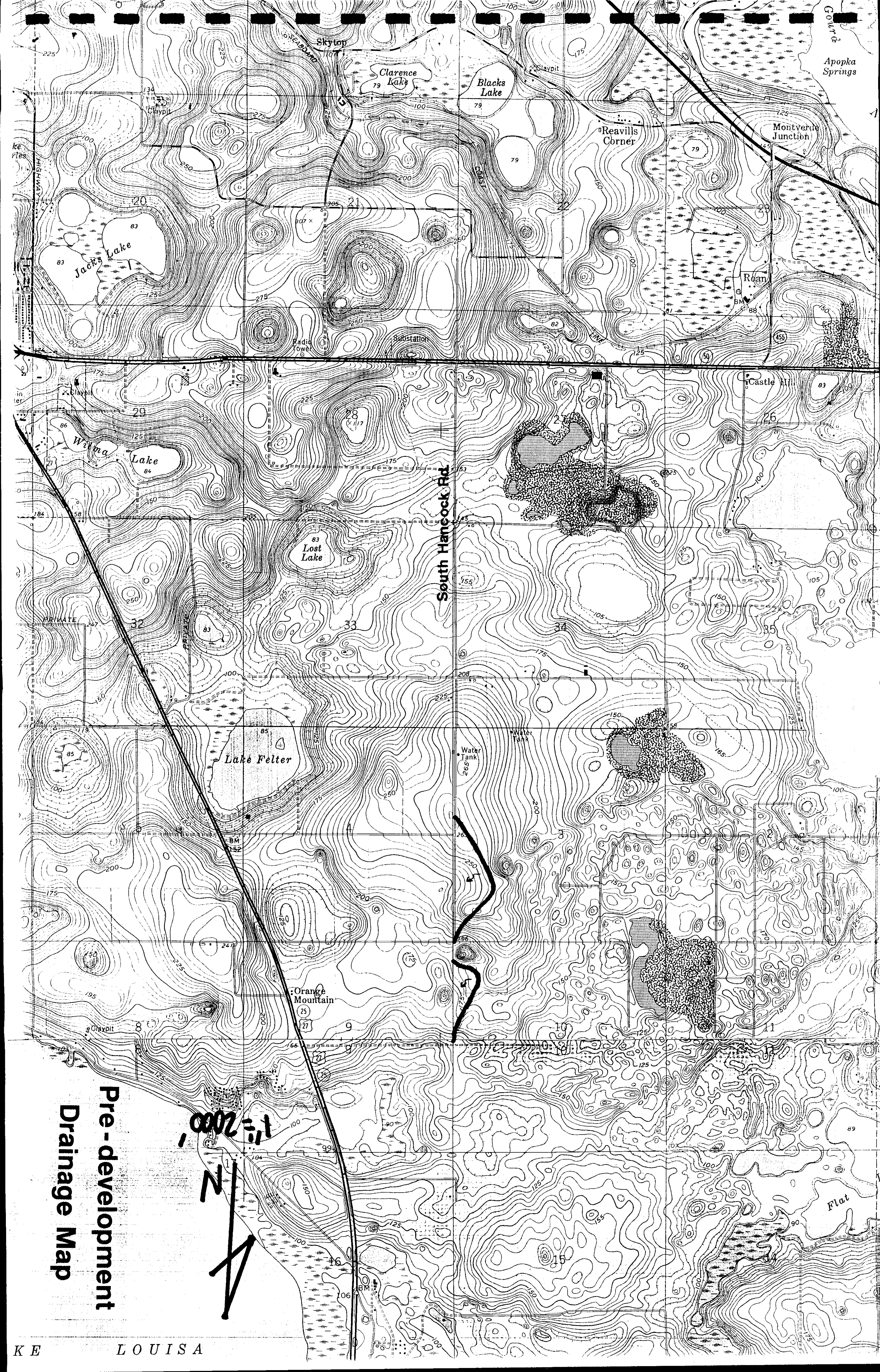
TABLE 1
SUMMARY OF LABORATORY TESTING
SOUTH HANCOCK ROAD
LAKE COUNTY, FLORIDA
N&A PROJECT NO. W97-G-139-E

Stratum No.	Station	Offset (feet)	Sample Depth (feet)	Percent Passing Sieve No. 200	Moisture Content (%)	Atterberg Limits		AASHTO Classification
						LL	PI	
3	26+00	Centerline	9.0	14	10	---	---	A-2-4
4	84+50	Centerline	0.25	31	12	33	17	A-6

TABLE 2
LABORATORY PERMEABILITY TESTING RESULTS
SOUTH HANCOCK ROAD
LAKE COUNTY, FLORIDA
N&A PROJECT NO. W97-G-139-E

Boring No.	Station	Offset from Baseline (feet)	Sample Depth (feet)	Stabilized Infiltration Rate (feet/day)
AB-4	37+00	34 LT	4 to 4.5	126*
AB-7	65+50	34 LT	4 to 4.5	94*
AB-10	94+00	20 RT	3 to 3.5	68*

*We recommend limiting the vertical and horizontal permeability rate used for design to maximum rates of 30 and 40 feet/day, respectively.



Pre-development Drainage Map
1"=2000'
N
Skytop
Clarence Lake
Blacks Lake
Claypit
Apopka Springs
Reavills Corner
Montverde Junction
Jacks Lake
Roan
Radio Tower
Substation
Castle Hill
Wilma Lake
Lost Lake
South Hancock Rd.
PRIVATE
Lake Felter
Water Tank
Orange Mountain
Flat
KE LOUISA

Ditch Calculations

Hydraulic Worksheet for Roadside Ditches
Basin A

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 9/23/98

Checked by: JK
Date: 9/23/98

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
10+22 to 18+78	West	4.30	0.79	0.48	16.4	6.2	2.34	3	0	3	0.060	0.59	2.21	Sod	Basin A

10+22 to 18+78	East	4.30	4.23	0.17	38.6	4.2	3.02	3	0	3	0.060	0.67	2.35	Sod	Basin A

10+22 to 18+78
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	10+22 to 18+78 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.043000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.34	cfs

Results		
Depth	0.59	ft
Flow Area	1.06	ft^2
Wetted Perimeter	3.76	ft
Top Width	3.57	ft
Critical Depth	0.52	ft
Critical Slope	0.088208	ft/ft
Velocity	2.21	ft/s
Velocity Head	0.08	ft
Specific Energy	0.67	ft
Froude Number	0.71	
Flow is subcritical.		

10+22 to 18+78
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	10+22 to 18+78 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.043000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	3.02	cfs

Results		
Depth	0.65	ft
Flow Area	1.28	ft^2
Wetted Perimeter	4.14	ft
Top Width	3.92	ft
Critical Depth	0.58	ft
Critical Slope	0.085257	ft/ft
Velocity	2.35	ft/s
Velocity Head	0.09	ft
Specific Energy	0.74	ft
Froude Number	0.73	
Flow is subcritical.		

Time of Concentration (TR-55)

Project:	S. Hancock Road	**Computed by:**	PWY
Location:	Basin A	**Date:**	8/17/98
Condition:	Post-development	**Checked by:**	GK
		Date:	9/23/98

Sheet Flow

	Segment ID		
	1		
1. Surface Description (Table 3-1)	Woods		
2. Manning's roughness coeff., n (Table 3-1)	0.4		
3. Flow Length, L (total <= 300 ft) (feet)	300		
4. 2-year 24-hour rainfall, P_2 (inches)	4.7		
5. Land slope, s (ft/ft)	0.03		Sub-total
6. Tt =(0.007 * (nL)^0.8)/((P_2^0.5)*(s^0.4)) (hr)	0.60		0.60

Shallow Concentrated Flow

	Segment ID		
	2		
7. Surface description (paved or unpaved)	unpaved		
8. Flow length, L (feet)	400		
9. Watercourse slope, s (ft/ft)	0.031		
10. Average velocity, V (figure 3-1) (ft/s)	2.85		Sub-total
11. Tt = (L/(3600*V) (hr)	0.04		0.04

Channel Flow

	Segment ID		
12. Cross section flow area, a (ft^2)			
13. Wetted perimeter, Pw (ft)			
14. Hydraulic radius, r = a/Pw (ft)			
15. Channel slope, s (ft/ft)			
16. Manning/s roughness coeff., n			
17. $V = (1.49*(r^{2/3})*(s^{1/2}))/n$ (ft/s)			
18. Flow length, L (ft)			Sub-total
19. Tt = (L/3600*V) (hr)	0.00		0.00

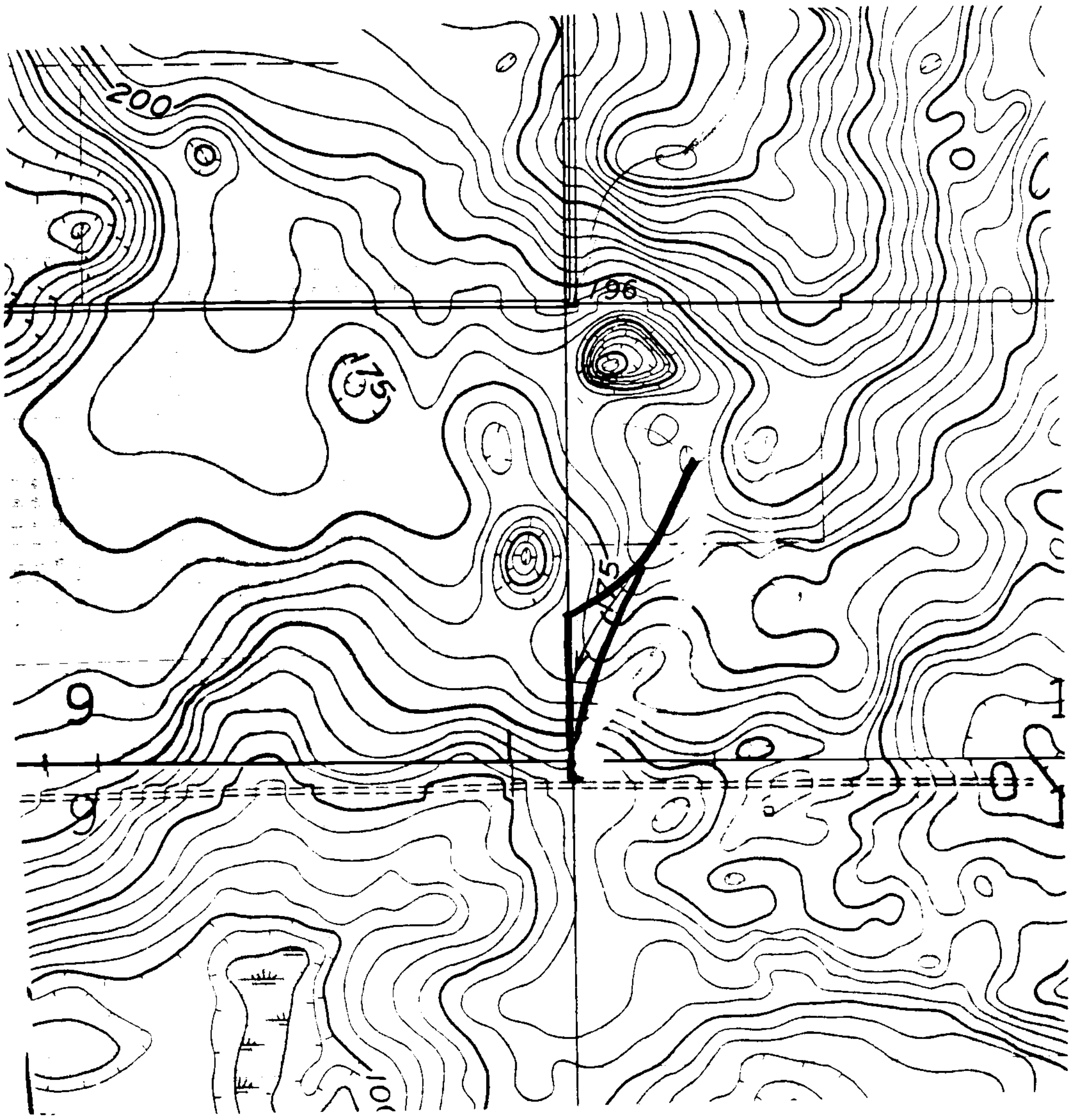
Total

	Total
20. Total Tc (hr)	0.64
21. Total Tc (min)	38.6 ✓

Notes:
Offsite Area to Ditch

VHB **Computations**

Project S. Hancock Rd — Project # 60581
Location Lake Co. — Sheet 1 of
Calculated by PWY — Date 8/17/98
Checked by — Date
Title Drainage Area/Tc Flowpath Basin A



Scale: 1" = 1000'

Hydraulic Worksheet for Roadside Ditches
Basin B

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 9/23/98

Checked by: JK
Date: 9/23/98

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
18+78 to 22+92	West	2.82	0.38	0.48	13.2	6.7	1.23	3	0	3	0.060	0.44	1.60	Sod	Basin B
18+78 to 22+92	East	2.82	10.38	0.11	41.5	4.0	4.75	3	0	3	0.042	0.73	2.94	Sod	Basin B

18+78 to 22+92
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	18+78 to 22+92 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.028200	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	4.75	cfs

Results		
Depth	0.73	ft
Flow Area	1.62	ft^2
Wetted Perimeter	4.64	ft
Top Width	4.40	ft
Critical Depth	0.69	ft
Critical Slope	0.039326	ft/ft
Velocity	2.94	ft/s
Velocity Head	0.13	ft
Specific Energy	0.87	ft
Froude Number	0.86	
Flow is subcritical.		

18+78 to 22+92
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	18+78 to 22+92 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.028200	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.23	cfs

Results		
Depth	0.51	ft
Flow Area	0.77	ft^2
Wetted Perimeter	3.20	ft
Top Width	3.03	ft
Critical Depth	0.40	ft
Critical Slope	0.096096	ft/ft
Velocity	1.60	ft/s
Velocity Head	0.04	ft
Specific Energy	0.55	ft
Froude Number	0.56	
Flow is subcritical.		

Time of Concentration (TR-55)

Project:	S. Hancock Road	**Computed by:**	PWY
Location:	Basin B	**Date:**	8/17/98
Condition:	Post-development	**Checked by:**	
		Date:	

Sheet Flow

	Segment ID		
	1		
1. Surface Description (Table 3-1)	Grass		
2. Manning's roughness coeff., n (Table 3-1)	0.4		
3. Flow Length, L (total <= 300 ft) (feet)	300		
4. 2-year 24-hour rainfall, P_2 (inches)	4.7		
5. Land slope, s (ft/ft)	0.03		**Sub-total**
6. Tt =(0.007 * (nL)^0.8)/((P_2^0.5)*(s^0.4)) (hr)	0.65		0.65

Shallow Concentrated Flow

	Segment ID		
	2		
7. Surface description (paved or unpaved)	unpaved		
8. Flow length, L (feet)	520		
9. Watercourse slope, s (ft/ft)	0.048		
10. Average velocity, V (figure 3-1) (ft/s)	3.53		**Sub-total**
11. Tt = (L/(3600*V) (hr)	0.04		0.04

Channel Flow

	Segment ID		
12. Cross section flow area, a (ft^2)			
13. Wetted perimeter, Pw (ft)			
14. Hydraulic radius, r = a/Pw (ft)			
15. Channel slope, s (ft/ft)			
16. Manning/s roughness coeff., n			
17. $V = (1.49*(r^{2/3})*(s^{1/2}))/n$ (ft/s)			
18. Flow length, L (ft)			**Sub-total**
19. Tt = (L/3600*V) (hr)	0.00		0.00

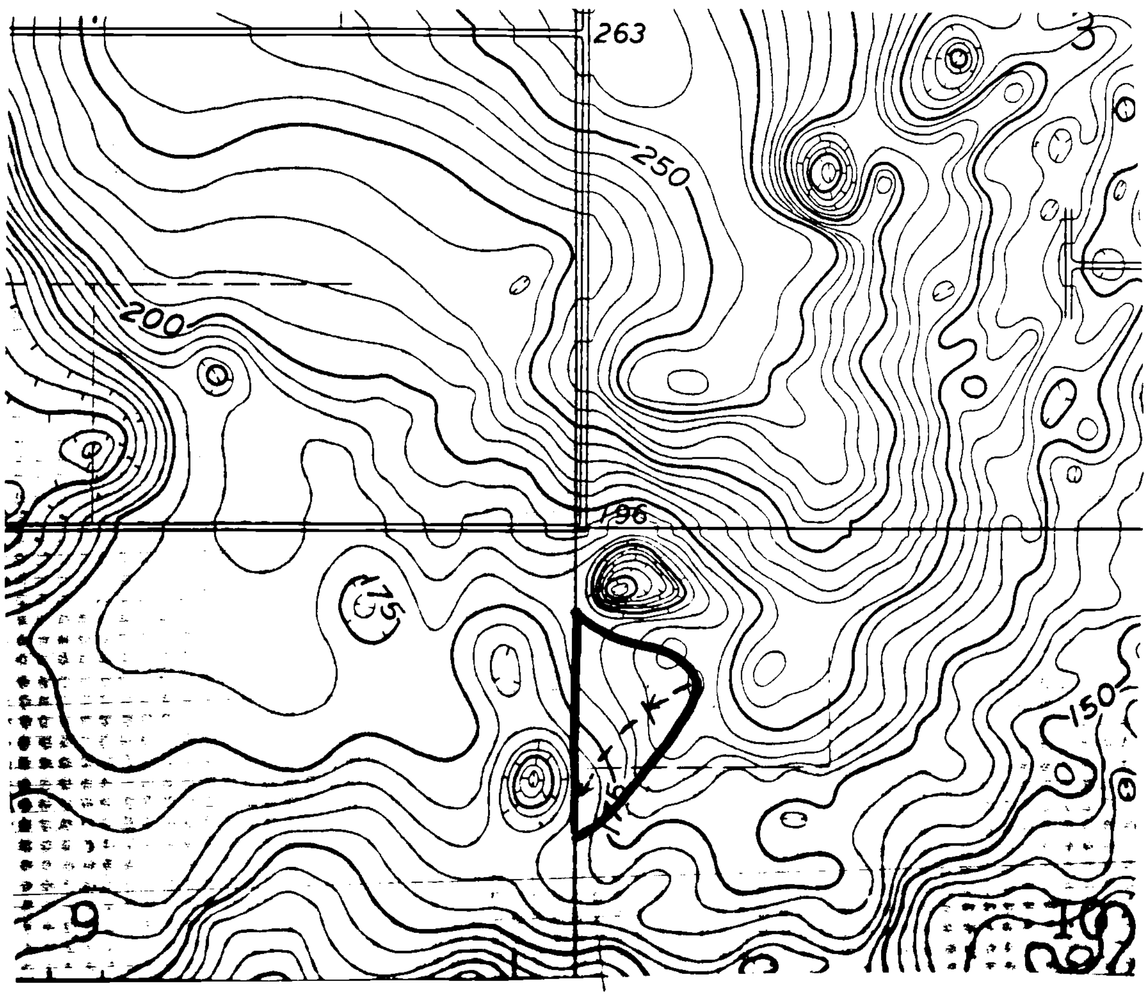
Total

	Total
20. Total Tc (hr)	0.69
21. Total Tc (min)	41.5

Notes:
Offsite Area to Ditch

VHB Computations

Project S. Hancock Rd. Project # 60581
Location Lake Co. Sheet 1 of
Calculated by PWY Date 8/17/98
Checked by JK Date 9/23/98
Title Drainage Area / TC flow path Basin B



Hydraulic Worksheet for Roadside Ditches
Basin C

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 9/2/98

Checked by: JC
Date: 9/23/98

Station to Station	Side	Slope	Drainage Area	C	Tc	I_{10}	Q	Ditch Section			n	d (ft)	V	Ditch Lining	Remarks
				2.07				F.S.	B.W.	B.S.		0.66	(ft/s)		
		(%)	(acres)			(in/hr)	(ft^3/s)	(Z:1)	(ft)	(Z:1)					
23+50 to 28+25	West	5.26	2.12	0.48	28.8	4.8	4.94	3	0	3	0.042	0.68	3.75	Sod	Basin C
28+25 to 36+26	West	1.38	1.63	0.48	20.9	5.6	4.39	3	0	3	0.042	0.79	2.35	Sod	Basin C
37+25 to 45+99	West	7.05	0.80	0.48	15.2	6.4	2.46	3	0	2	0.060	0.59	2.79	Sod	Basin C
22+92 to 28+25	East	5.26	33.55	0.12	43.0	3.9	2.53[1]	3	0	3	0.060	0.59	2.43	Sod	Basin C
28+25 to 37+25	East	1.38	12.76	0.15	43.0	3.9	0.96[1]	3	0	3	0.060	0.53	1.15	Sod	Basin C
37+25 to 45+99	East	7.05	1.26	0.34	15.2	6.4	2.76	3	0	3	0.060	0.58	2.77	Sod	Basin C

Notes:
1. Discharges computed using AdICPR for the 10-Year 24-hour storm event.

23+50 to 28+25
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	22+92 to 45+99 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.052600	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	4.94	cfs

Results		
Depth	0.66	ft
Flow Area	1.32	ft^2
Wetted Perimeter	4.19	ft
Top Width	3.98	ft
Critical Depth	0.70	ft
Critical Slope	0.039121	ft/ft
Velocity	3.75	ft/s
Velocity Head	0.22	ft
Specific Energy	0.88	ft
Froude Number	1.15	
Flow is supercritical.		

28+25 to 37+25

Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	22+92 to 45+99 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.016300	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	4.39	cfs

Results		
Depth	0.79	ft
Flow Area	1.87	ft^2
Wetted Perimeter	4.99	ft
Top Width	4.74	ft
Critical Depth	0.67	ft
Critical Slope	0.039741	ft/ft
Velocity	2.35	ft/s
Velocity Head	0.09	ft
Specific Energy	0.88	ft
Froude Number	0.66	
Flow is subcritical.		

37+25 to 45+99
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	22+92 to 45+99 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.070500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	2.46	cfs

Results		
Depth	0.59	ft
Flow Area	0.88	ft^2
Wetted Perimeter	3.21	ft
Top Width	2.97	ft
Critical Depth	0.57	ft
Critical Slope	0.088283	ft/ft
Velocity	2.78	ft/s
Velocity Head	0.12	ft
Specific Energy	0.71	ft
Froude Number	0.90	
Flow is subcritical.		

22+92 to 28+25
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	22+92 to 45+99 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.052600	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.53	cfs

Results		
Depth	0.59	ft
Flow Area	1.04	ft^2
Wetted Perimeter	3.73	ft
Top Width	3.54	ft
Critical Depth	0.54	ft
Critical Slope	0.087286	ft/ft
Velocity	2.43	ft/s
Velocity Head	0.09	ft
Specific Energy	0.68	ft
Froude Number	0.79	
Flow is subcritical.		

28+25 to 37+25
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	22+92 to 45+99 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.013800	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	0.96	cfs

Results		
Depth	0.53	ft
Flow Area	0.83	ft^2
Wetted Perimeter	3.33	ft
Top Width	3.16	ft
Critical Depth	0.36	ft
Critical Slope	0.099329	ft/ft
Velocity	1.15	ft/s
Velocity Head	0.02	ft
Specific Energy	0.55	ft
Froude Number	0.40	
Flow is subcritical.		

37+25 to 45+99
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	22+92 to 45+99 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.070500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.76	cfs

Results		
Depth	0.58	ft
Flow Area	1.00	ft^2
Wetted Perimeter	3.65	ft
Top Width	3.46	ft
Critical Depth	0.55	ft
Critical Slope	0.086279	ft/ft
Velocity	2.77	ft/s
Velocity Head	0.12	ft
Specific Energy	0.70	ft
Froude Number	0.91	
Flow is subcritical.		

Time of Concentration (TR-55)

Project:	S. Hancock Road	**Computed by:**	PWY
Location:	Basin C	**Date:**	8/17/98
Condition:	Post-development	**Checked by:**	
		Date:	

Sheet Flow

	Segment ID		
	1		
1. Surface Description (Table 3-1)	Grass		
2. Manning's roughness coeff., n (Table 3-1)	0.4		
3. Flow Length, L (total <= 300 ft) (feet)	300		
4. 2-year 24-hour rainfall, P_2 (inches)	4.7		
5. Land slope, s (ft/ft)	0.03		**Sub-total**
6. Tt =(0.007 * (nL)^0.8)/((P_2^0.5)*(s^0.4)) (hr)	0.65		0.65

Shallow Concentrated Flow

	Segment ID		
	2		
7. Surface description (paved or unpaved)	unpaved		
8. Flow length, L (feet)	700		
9. Watercourse slope, s (ft/ft)	0.033		
10. Average velocity, V (figure 3-1) (ft/s)	2.93		**Sub-total**
11. Tt = (L/(3600*V) (hr)	0.07		0.07

Channel Flow

	Segment ID		
12. Cross section flow area, a (ft^2)			
13. Wetted perimeter, Pw (ft)			
14. Hydraulic radius, r = a/Pw (ft)			
15. Channel slope, s (ft/ft)			
16. Manning/s roughness coeff., n			
17. V = (1.49*($r^{2/3}$)*($s^{1/2}$))/n (ft/s)			
18. Flow length, L (ft)			**Sub-total**
19. Tt = (L/3600*V) (hr)	0.00		0.00

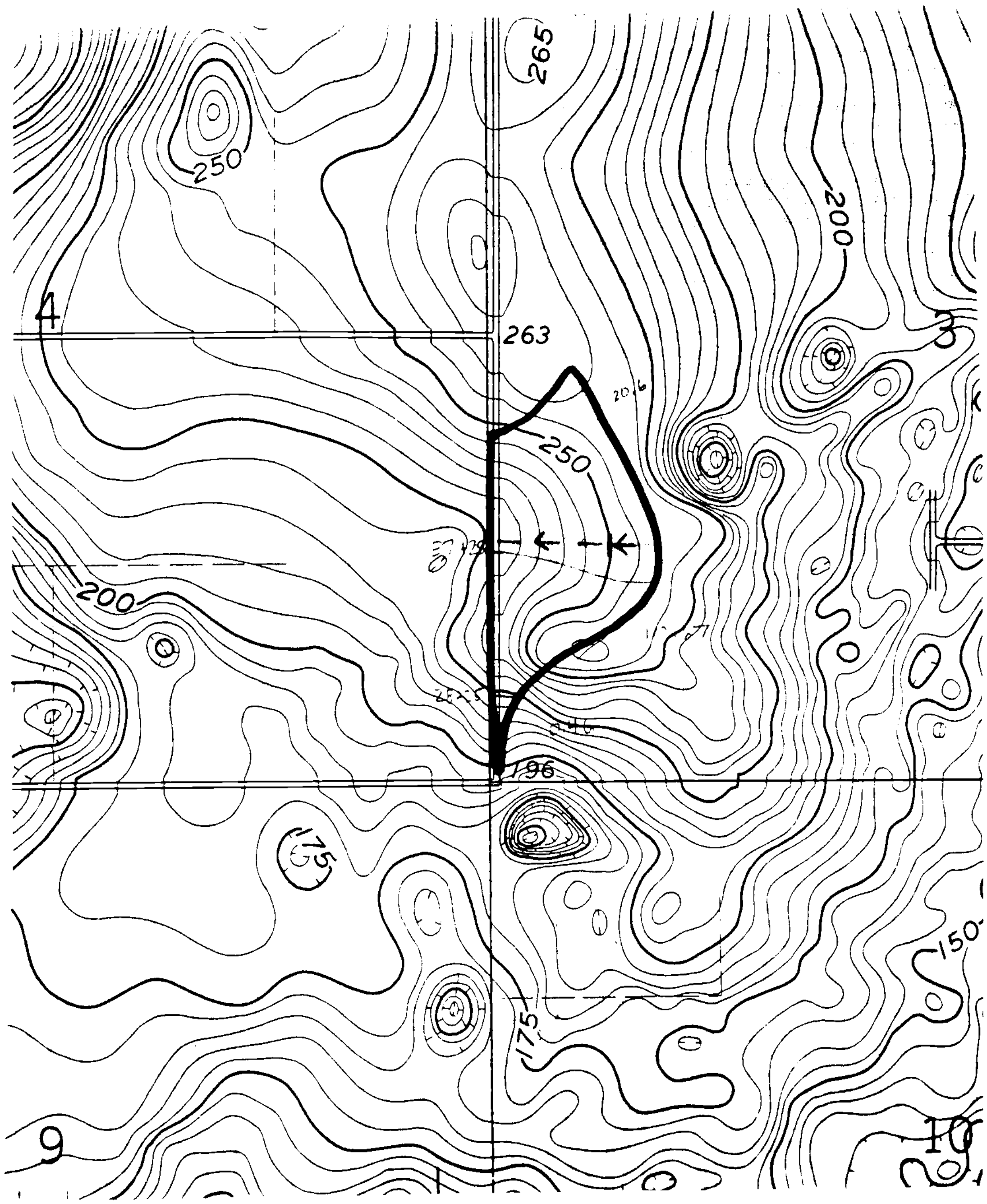
Total

	Total
20. Total Tc (hr)	0.72
21. Total Tc (min)	43.0

Notes:
Offsite Area to Ditch

VHB Computations

Project S. Hancock Rd   Project # 60581
Location Lake Co.   Sheet 1 of
Calculated by PWY   Date 8/17/98
Checked by   Date
Title Tc flowpath / Basin Area   Basin C



Hydraulic Worksheet for Roadside Ditches
Basin D

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 9/23/98

Checked by: JK
Date: 9/23/98

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
45+99 to 51+52	West	3.05	0.51	0.48	15.3	6.4	1.55	2	0	2	0.060	0.64	1.88	Sod	Basin D
45+99 to 51+52	East	3.05	2.91	0.17	46.3	3.8	1.83	3	0	3	0.060	0.58	1.83	Sod	Basin D

45+99 to 51+52
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	45+99 to 51+52 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.030500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.83	cfs

Results		
Depth	0.58	ft
Flow Area	1.00	ft^2
Wetted Perimeter	3.66	ft
Top Width	3.47	ft
Critical Depth	0.47	ft
Critical Slope	0.091137	ft/ft
Velocity	1.83	ft/s
Velocity Head	0.05	ft
Specific Energy	0.63	ft
Froude Number	0.60	
Flow is subcritical.		

45+99 to 51+52
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	45+99 to 51+52 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.030500	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.56	cfs

Results		
Depth	0.64	ft
Flow Area	0.83	ft^2
Wetted Perimeter	2.88	ft
Top Width	2.57	ft
Critical Depth	0.52	ft
Critical Slope	0.095403	ft/ft
Velocity	1.88	ft/s
Velocity Head	0.06	ft
Specific Energy	0.70	ft
Froude Number	0.59	
Flow is subcritical.		

Time of Concentration (TR-55)

Project:	S. Hancock Road	**Computed by:**	PWY
Location:	Basin D	**Date:**	8/17/98
Condition:	Post-development	**Checked by:**	GK
		Date:	9/23/98

Sheet Flow

	Segment ID		
	1		
1. Surface Description (Table 3-1)	Grass		
2. Manning's roughness coeff., n (Table 3-1)	0.24		
3. Flow Length, L (total <= 300 ft) (feet)	300		
4. 2-year 24-hour rainfall, P_2 (inches)	4.7		
5. Land slope, s (ft/ft)	0.01		**Sub-total**
6. Tt =(0.007 * (nL)^0.8)/((P_2^0.5)*(s^0.4)) (hr)	0.73		0.73 ✓

Shallow Concentrated Flow

	Segment ID		
	2		
7. Surface description (paved or unpaved)	unpaved		
8. Flow length, L (feet)	400		
9. Watercourse slope, s (ft/ft)	0.030		
10. Average velocity, V (figure 3-1) (ft/s)	2.79		**Sub-total**
11. Tt = (L/(3600*V) (hr)	0.04		0.04 ✓

Channel Flow

	Segment ID		
12. Cross section flow area, a (ft^2)			
13. Wetted perimeter, Pw (ft)			
14. Hydraulic radius, r = a/Pw (ft)			
15. Channel slope, s (ft/ft)			
16. Manning/s roughness coeff., n			
17. V = (1.49*($r^{2/3}$)*($s^{1/2}$))/n (ft/s)			
18. Flow length, L (ft)			**Sub-total**
19. Tt = (L/3600*V) (hr)	0.00		0.00

Total

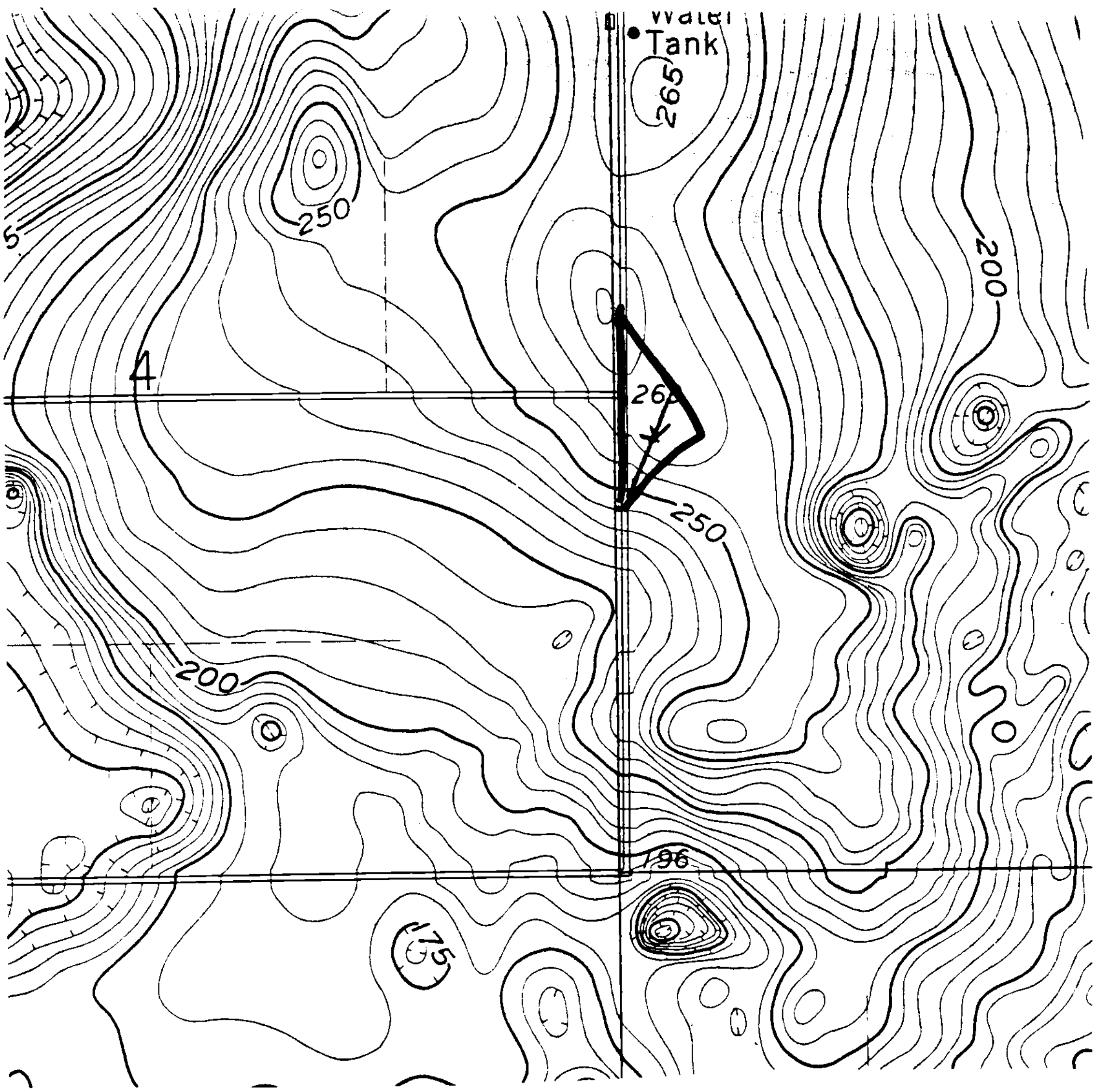
	Total
20. Total Tc (hr)	0.77 ✓
21. Total Tc (min)	46.3

Notes:

Offsite Area to Ditch

VHB **Computations**

Project S. Hancock Rd. Project # 60581
Location Lake Co Sheet 1 of
Calculated by PWY Date 8/17/98
Checked by Date
Title



Vanasse Hangen Brustlin, Inc.

Printed on Recycled Paper

Hydraulic Worksheet for Roadside Ditches
Basin E

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 8/26/98

Checked by: JK
Date: 9/23/98

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
51+52 to 59+00	West	6.00	0.69	0.48	14.9	6.4	2.12	3	0	3	0.060	0.54	2.44	Sod	Basin E
59+00 to 67+75	West	1.26	1.49	0.48	21.8	5.5	3.94	3	0	2	0.060	0.86	2.14	Sod	Basin E

51+52 to 57+75	East	6.00	0.57	0.48	14.5	6.5	1.79	3	0	3	0.060	0.50	2.34	Sod	Basin E

59+00 to 67+75
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	51+52 to 67+75 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.012600	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	3.94	cfs

Results		
Depth	0.86	ft
Flow Area	1.84	ft^2
Wetted Perimeter	4.63	ft
Top Width	4.29	ft
Critical Depth	0.69	ft
Critical Slope	0.040629	ft/ft
Velocity	2.14	ft/s
Velocity Head	0.07	ft
Specific Energy	0.93	ft
Froude Number	0.58	
Flow is subcritical.		

51+52 to 57+75
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	51+52 to 57+75 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.79	cfs

Results		
Depth	0.50	ft
Flow Area	0.77	ft^2
Wetted Perimeter	3.19	ft
Top Width	3.03	ft
Critical Depth	0.47	ft
Critical Slope	0.091411	ft/ft
Velocity	2.34	ft/s
Velocity Head	0.09	ft
Specific Energy	0.59	ft
Froude Number	0.82	
Flow is subcritical.		

Hydraulic Worksheet for Roadside Ditches
Basin F

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 8/17/98

Checked by: JK
Date: 9/23/98

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
67+75 to 75+39	West	3.30	0.70	0.48	16.5	6.2	2.08	3	0	3	0.060	0.60	1.94	Sod	Basin F

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
67+75 to 75+39	East	3.30	0.70	0.48	16.5	6.2	2.08	3	0	3	0.060	0.60	1.94	Sod	Basin F

67+75 to 75+39
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	67+75 to 75+39 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.033000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.08	cfs

Results		
Depth	0.60	ft
Flow Area	1.07	ft^2
Wetted Perimeter	3.78	ft
Top Width	3.59	ft
Critical Depth	0.50	ft
Critical Slope	0.089604	ft/ft
Velocity	1.94	ft/s
Velocity Head	0.06	ft
Specific Energy	0.66	ft
Froude Number	0.63	
Flow is subcritical.		

67+75 to 75+39
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	67+75 to 75+39 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.033000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.08	cfs

Results		
Depth	0.60	ft
Flow Area	1.07	ft²
Wetted Perimeter	3.78	ft
Top Width	3.59	ft
Critical Depth	0.50	ft
Critical Slope	0.089604	ft/ft
Velocity	1.94	ft/s
Velocity Head	0.06	ft
Specific Energy	0.66	ft
Froude Number	0.63	
Flow is subcritical.		

Hydraulic Worksheet for Roadside Ditches
Basin G

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 8/17/98

Checked by: JK
Date: 9/20/98

Station to Station	Side	Slope (%)	Drainage Area (acres)	C	Tc	I_{10} (in/hr)	Q (ft^3/s)	Ditch Section F.S. (Z:1)	Ditch Section B.W. (ft)	Ditch Section B.S. (Z:1)	n	d (ft)	V (ft/s)	Ditch Lining	Remarks
75+39 to 82+38	West	1.99	0.64	0.48	17.3	6.1	1.87	3	0	3	0.060	0.63	1.56	Sod	Basin G
75+39 to 82+38	East	1.99	0.64	0.48	17.3	6.1	1.87	3	0	3	0.060	0.63	1.56	Sod	Basin G

p:\projects\60581\drainage\ditches.xls

75+39 to 82+38
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	75+39 to 82+38 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.019900	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.87	cfs

Results		
Depth	0.63	ft
Flow Area	1.20	ft^2
Wetted Perimeter	3.99	ft
Top Width	3.79	ft
Critical Depth	0.47	ft
Critical Slope	0.090883	ft/ft
Velocity	1.56	ft/s
Velocity Head	0.04	ft
Specific Energy	0.67	ft
Froude Number	0.49	
Flow is subcritical.		

75+39 to 82+38
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	75+39 to 82+38 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.019900	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.87	cfs

Results		
Depth	0.63	ft
Flow Area	1.20	ft^2
Wetted Perimeter	3.99	ft
Top Width	3.79	ft
Critical Depth	0.47	ft
Critical Slope	0.090883	ft/ft
Velocity	1.56	ft/s
Velocity Head	0.04	ft
Specific Energy	0.67	ft
Froude Number	0.49	
Flow is subcritical.		

Hydraulic Worksheet for Roadside Ditches
Basin H

Project: Lake County
Basin: S. Hancock Road
Computed by: PWY
Date: 9/24/98

Checked by:
Date:

Station to Station	Side	Slope	Drainage Area	C	Tc	I_{10}	Q	Ditch Section			n	d (ft)	V	Ditch Lining	Remarks
								F.S.	B.W.	B.S.			(ft/s)		
		(%)	(acres)			(in/hr)	(ft^3/s)	(Z:1)	(ft)	(Z:1)					
82+38 to 89+50	West	0.30	0.65	0.48	21.5	5.5	1.74	3	0	3	0.042	0.77	0.99	Sod	Basin H
92+00 to 95+00	West	5.00	1.16	0.48	25.2	5.2	2.87	3	0	3	0.600	0.62	2.46	Sod	Basin H

82+38 to 91+60	East	0.30	0.85	0.48	25.3	5.1	2.10	3	0	3	0.042	0.82	1.03	Sod	Basin H
91+60 to 103+80	East	5.00	1.97	0.48	31.0	4.7	4.42	3	0	3	0.042	0.64	3.58	Sod	Basin H
103+80 to 107+00	East	3.00	2.26	0.48	32.8	4.5	4.94	3	0	3	0.042	0.74	3.04	Sod	Basin H

82+38 to 91+60
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	82+38 to 91+60 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.003000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.10	cfs

Results		
Depth	0.82	ft
Flow Area	2.03	ft^2
Wetted Perimeter	5.20	ft
Top Width	4.94	ft
Critical Depth	0.50	ft
Critical Slope	0.043845	ft/ft
Velocity	1.03	ft/s
Velocity Head	0.02	ft
Specific Energy	0.84	ft
Froude Number	0.28	
Flow is subcritical.		

91+60 to 103+80
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	91+60 to 103+80 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.050000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	4.42	cfs

Results		
Depth	0.64	ft
Flow Area	1.23	ft^2
Wetted Perimeter	4.06	ft
Top Width	3.85	ft
Critical Depth	0.67	ft
Critical Slope	0.039707	ft/ft
Velocity	3.58	ft/s
Velocity Head	0.20	ft
Specific Energy	0.84	ft
Froude Number	1.11	
Flow is supercritical.		

103+80 to 107+00
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	103+80 to 107+00 (West)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.030000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	4.94	cfs

Results		
Depth	0.74	ft
Flow Area	1.63	ft^2
Wetted Perimeter	4.66	ft
Top Width	4.42	ft
Critical Depth	0.70	ft
Critical Slope	0.039123	ft/ft
Velocity	3.04	ft/s
Velocity Head	0.14	ft
Specific Energy	0.88	ft
Froude Number	0.88	
Flow is subcritical.		

82+38 to 89+50
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	82+38 to 89+50 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.042	
Channel Slope	0.003000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	1.74	cfs

Results		
Depth	0.77	ft
Flow Area	1.76	ft^2
Wetted Perimeter	4.85	ft
Top Width	4.60	ft
Critical Depth	0.46	ft
Critical Slope	0.044962	ft/ft
Velocity	0.99	ft/s
Velocity Head	0.02	ft
Specific Energy	0.78	ft
Froude Number	0.28	
Flow is subcritical.		

92+00 to 95+00
Worksheet for Triangular Channel

Project Description	
Project File	p:\60581\drainage\hancock-.fm2
Worksheet	92+00 to 95+00 (East)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.050000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	2.87	cfs

Results		
Depth	0.62	ft
Flow Area	1.17	ft^2
Wetted Perimeter	3.94	ft
Top Width	3.74	ft
Critical Depth	0.56	ft
Critical Slope	0.085835	ft/ft
Velocity	2.46	ft/s
Velocity Head	0.09	ft
Specific Energy	0.72	ft
Froude Number	0.78	
Flow is subcritical.		

Culvert Calculations

VHB **Computations**

Project S Hancock Rd. Project # 60581
Location Lake CO Sheet 1 of
Calculated by PWY Date 9/2/98
Checked by JK Date 9/23/98
Title

Analysis of Culvert at Hartwood Marsh Rd:

1. Drainage Area:

$A_T = 22.4$ Ac ✓

$A_{imp} = (12 ft)(1100 ft)\left(\frac{1 ac}{43560 ft^2}\right) = 0.30$ Ac (Hartwood Marsh)

$= 0.29$ Ac (Hancock Rd)

$A_{imp} = 0.59$ Ac ✓

$A_{grass} = (28 ft)(1100 ft)\left(\frac{1 ac}{43560 ft^2}\right) + 0.49 Ac = 1.20$ Ac ✓

$A_{woods} = 20.61$ ac ✓

2. Runoff Coefficient:

$$C_T = \frac{(0.59 Ac)(0.95) + (1.20 Ac)(0.15) + (20.61)(0.10)}{22.4 Ac}$$

$C_T = 0.13$ ✓

3. $T_c = 69.9$ minutes (see attached sheet) ✓

4. CN: $CN_T = \frac{(0.59)(98) + (1.20)(39) + (20.61)(30)}{22.4}$

$CN_T = 32.3$ ✓

Vanasse Hangen Brustlin, Inc. Printed on Recycled Paper

PWY 9/2/98

CURRENT DATE: 09-02-1998
CURRENT TIME: 14:59:49

FILE DATE: 09-02-1998
FILE NAME: HANCOCK2
60581

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULV NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	132.99	131.88	100.01	1 RCP	1.50	1.50	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: HANCOCK2 DATE: 09-02-1998

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
134.01	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.00	1
134.10	4.1	4.2	0.0	0.0	0.0	0.0	0.0	0.00	1
134.19	4.7	4.7	0.0	0.0	0.0	0.0	0.0	0.00	1
134.27	5.3	5.3	0.0	0.0	0.0	0.0	0.0	0.00	1
134.35	5.9	5.9	0.0	0.0	0.0	0.0	0.0	0.00	1
134.44	6.5	6.5	0.0	0.0	0.0	0.0	0.0	0.00	1
134.48	6.8	6.8	0.0	0.0	0.0	0.0	0.0	0.00	1
134.60	7.6	7.6	0.0	0.0	0.0	0.0	0.0	0.00	1
134.69	8.2	8.2	0.0	0.0	0.0	0.0	0.0	0.00	1
134.78	8.8	8.8	0.0	0.0	0.0	0.0	0.0	0.00	1
134.88	9.4	9.4	0.0	0.0	0.0	0.0	0.0	0.00	1
135.99	14.8	14.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: HANCOCK2 DATE: 09-02-1998

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
134.01	0.000	3.57	0.00	0.00
134.10	0.000	4.15	0.00	0.00
134.19	0.000	4.73	0.00	0.00
134.27	0.000	5.31	0.00	0.00
134.35	0.000	5.89	0.00	0.00
134.44	0.000	6.47	0.00	0.00
134.48	0.000	6.75	0.00	0.00
134.60	0.000	7.62	0.00	0.00
134.69	0.000	8.20	0.00	0.00
134.78	0.000	8.78	0.00	0.00
134.88	0.000	9.36	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

Pwy
60581

CURRENT DATE: 09-02-1998
RRENT TIME: 14:59:49

FILE DATE: 09-02-1998
FILE NAME: HANCOCK2

PERFORMANCE CURVE FOR CULVERT 1 - 1(1.50 (ft) BY 1.50 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
3.57	134.01	1.02	1.02	1-S1f	0.56	0.72	0.90	1.50	3.22	0.00
4.15	134.10	1.11	1.11	1-S1f	0.61	0.78	0.90	1.50	3.75	0.00
4.73	134.19	1.20	1.20	1-S1f	0.65	0.83	1.00	1.50	3.78	0.00
5.31	134.27	1.28	1.28	1-S1f	0.70	0.89	1.00	1.50	4.25	0.00
5.89	134.35	1.36	1.36	1-S1f	0.74	0.93	1.10	1.50	4.23	0.00
6.47	134.44	1.45	1.45	1-S1f	0.78	0.98	1.10	1.50	4.64	0.00
6.75	134.48	1.49	1.49	1-S1f	0.80	1.00	1.20	1.50	4.45	0.00
7.62	134.60	1.61	1.61	1-S1f	0.87	1.07	1.20	1.50	5.03	0.00
8.20	134.69	1.70	1.70	1-S1f	0.91	1.11	1.30	1.50	5.06	0.00
8.78	134.78	1.79	1.79	1-S1f	0.95	1.14	1.30	1.50	5.41	0.00
9.36	134.88	1.89	1.59	4-FFt	1.00	1.18	1.00	1.50	7.51	0.00

El. inlet face invert 132.99 ft El. outlet invert 131.88 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION	0.00 ft
INLET ELEVATION	132.99 ft
OUTLET STATION	100.00 ft
OUTLET ELEVATION	131.88 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0111
CULVERT LENGTH ALONG SLOPE	100.01 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	1.50 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	BEVELED EDGE (1.5:1)
INLET DEPRESSION	NONE

PWY

CURRENT DATE: 09-02-1998
RRENT TIME: 14:59:49

FILE DATE: 09-02-1998
FILE NAME: HANCOCK2
60581

TAILWATER

CONSTANT WATER SURFACE ELEVATION
133.38

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	60.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	135.99 ft

fl Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.11) [1]

S. Hanock Road
100-year 24-hour
PWY 9/2/98

********** Basin Summary - 10YR24HR **

***

Basin Name:	HARMARSH
Group Name:	BASE
Node Name:	HARMARSH
Hydrograph Type:	UH
Unit Hydrograph:	UH484
Peaking Factor:	484.00
Spec Time Inc (min):	9.32
Comp Time Inc (min):	9.32
Rainfall File:	FLMOD
Rainfall Amount (in):	7.40
Storm Duration (hr):	24.00
Status:	ONSITE
Time of Conc. (min):	69.90
Lag Time (hr):	0.00
Area (acres):	22.40
Vol of Unit Hyd (in):	1.00
Curve Number:	32.00
DCIA (%):	0.00
Time Max (hrs):	13.20
Flow Max (cfs):	1.40
Runoff Volume (in):	0.40
Runoff Volume (cf):	32907

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.11) [1]

S. Hanock Road
100-year 24-hour
PWY 9/2/98

********** Basin Summary - 25YR24HR **

***

Basin Name:	HARMARSH
Group Name:	BASE
Node Name:	HARMARSH
Hydrograph Type:	UH
Unit Hydrograph:	UH484
Peaking Factor:	484.00
Spec Time Inc (min):	9.32
Comp Time Inc (min):	9.32
Rainfall File:	FLMOD
Rainfall Amount (in):	8.60
Storm Duration (hr):	24.00
Status:	ONSITE
Time of Conc. (min):	69.90
Lag Time (hr):	0.00
Area (acres):	22.40
Vol of Unit Hyd (in):	1.00
Curve Number:	32.00
DCIA (%):	0.00
Time Max (hrs):	13.05
Flow Max (cfs):	3.57
Runoff Volume (in):	0.74
Runoff Volume (cf):	59851

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.11) [1]

S. Hanock Road
100-year 24-hour
PWY 9/2/98

********** Basin Summary - 50YR24HR **

***

Basin Name:	HARMARSH
Group Name:	BASE
Node Name:	HARMARSH
Hydrograph Type:	UH
Unit Hydrograph:	UH484
Peaking Factor:	484.00
Spec Time Inc (min):	9.32
Comp Time Inc (min):	9.32
Rainfall File:	FLMOD
Rainfall Amount (in):	9.80
Storm Duration (hr):	24.00
Status:	ONSITE
Time of Conc. (min):	69.90
Lag Time (hr):	0.00
Area (acres):	22.40
Vol of Unit Hyd (in):	1.00
Curve Number:	32.00
DCIA (%):	0.00
Time Max (hrs):	12.89
Flow Max (cfs):	6.75
Runoff Volume (in):	1.14
Runoff Volume (cf):	93097

S. Hanock Road
100-year 24-hour
PWY 9/2/98

********** Basin Summary - 100YR24H ***

***

Basin Name:	HARMARSH
Group Name:	BASE
Node Name:	HARMARSH
Hydrograph Type:	UH
Unit Hydrograph:	UH484
Peaking Factor:	484.00
Spec Time Inc (min):	9.32
Comp Time Inc (min):	9.32
Rainfall File:	FLMOD
Rainfall Amount (in):	10.60
Storm Duration (hr):	24.00
Status:	ONSITE
Time of Conc. (min):	69.90
Lag Time (hr):	0.00
Area (acres):	22.40
Vol of Unit Hyd (in):	1.00
Curve Number:	32.00
DCIA (%):	0.00
Time Max (hrs):	12.89
Flow Max (cfs):	9.36
Runoff Volume (in):	1.46
Runoff Volume (cf):	118358

Time of Concentration (TR-55)

Project:	S. Hancock Road	**Computed by:**	PWY
Location:	Hartwood Marsh	**Date:**	9/2/98
Condition:	Post-development	**Checked by:**	JK
		Date:	9/23/98

Sheet Flow

	Segment ID		
	1		
1. Surface Description (Table 3-1)	Woods		
2. Manning's roughness coeff., n (Table 3-1)	0.4		
3. Flow Length, L (total <= 300 ft) (feet)	300		
4. 2-year 24-hour rainfall, P_2 (inches)	4.7		
5. Land slope, s (ft/ft)	0.008		**Sub-total**
6. Tt =(0.007 * (nL)^0.8)/((P_2^0.5)*(s^0.4)) (hr)	1.01		1.01

Shallow Concentrated Flow

	Segment ID		
	2	3	
7. Surface description (paved or unpaved)	unpaved	unpaved	
8. Flow length, L (feet)	1300	400	
9. Watercourse slope, s (ft/ft)	0.031	0.056	
10. Average velocity, V (figure 3-1) (ft/s)	2.85	3.82	**Sub-total**
11. Tt = (L/(3600*V) (hr)	0.13	0.03	0.16

Channel Flow

	Segment ID		
12. Cross section flow area, a (ft^2)			
13. Wetted perimeter, Pw (ft)			
14. Hydraulic radius, r = a/Pw (ft)			
15. Channel slope, s (ft/ft)			
16. Manning/s roughness coeff., n			
17. $V = (1.49*(r^{2/3})*(s^{1/2}))/n$ (ft/s)			
18. Flow length, L (ft)			**Sub-total**
19. Tt = (L/3600*V) (hr)	0.00		0.00

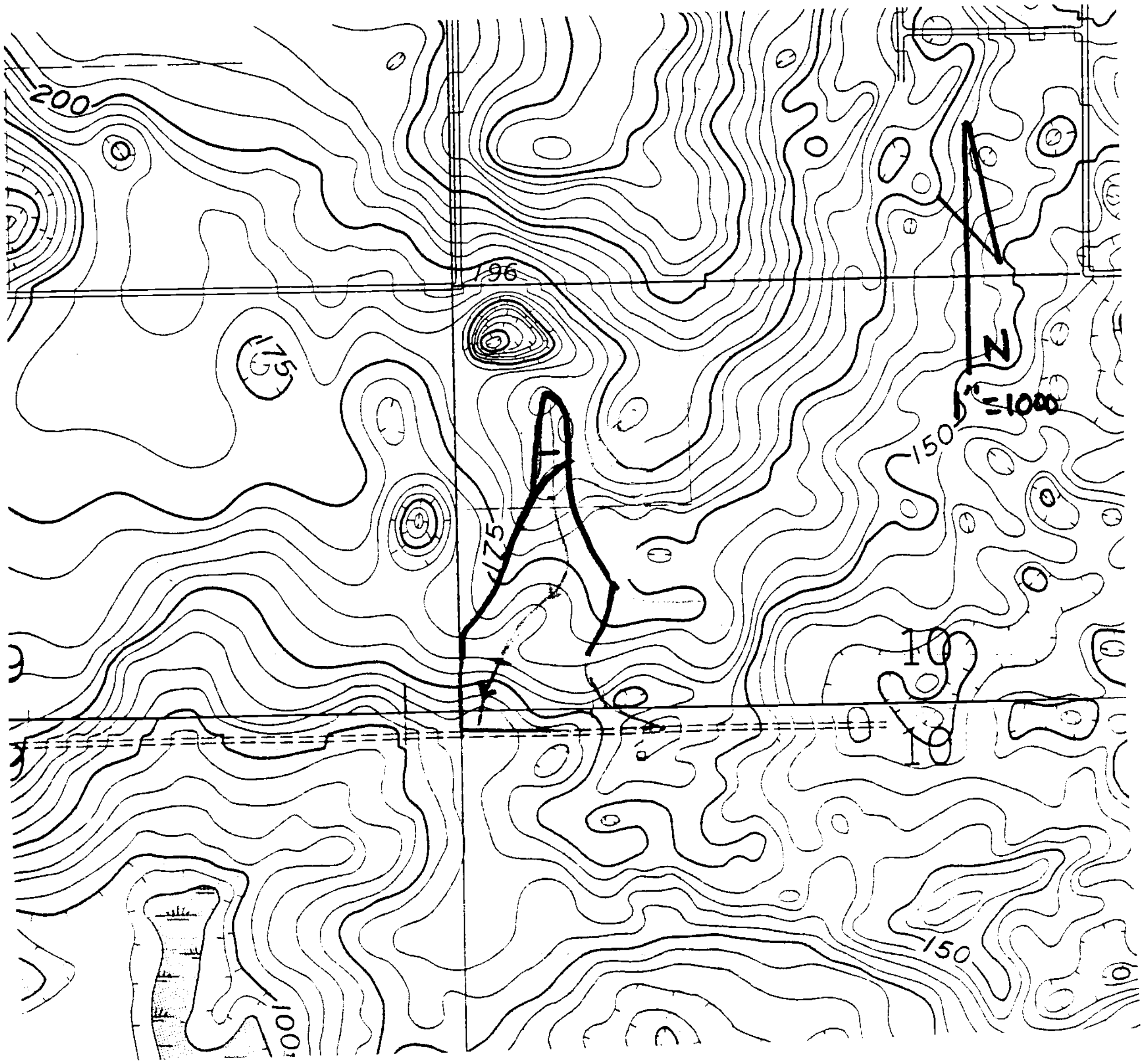
Total

	Total
20. Total Tc (hr)	1.17
21. Total Tc (min)	69.9

Notes:
Offsite Area to Ditch along Hartwood Marsh

VHB Computations

Project S. Hancock Rd Project # 60581
Location Lake Co. Sheet 1 of
Calculated by PWY Date 9/2/98
Checked by JK Date 9/22/98
Title Tc Flow Path / Drainage Area



A_T = 22.4 Ac

VHB **Computations**

Project S Hancock Rd. Project # 60581
Location Lake Co. Sheet 1 of
Calculated by PWY Date 9/23/98
Checked by Date
Title Side drain analysis/design Kingsridge Blvd.

1. Drainage Area:

$A_T = 1.63$ Acres (See ditch calculation)

2. Runoff Coefficient:

$C = 0.48$ (See ditch calculation)

3 Time of Concentration:

$T_c = 20.9$ minutes (See ditch calculations)

4 Intensity:

$I_{10} = 5.6$ in/hr

5 Discharge: $Q = 4.39\ ft^3/s$

CURRENT DATE: 09-24-1998
CURRENT TIME: 11:30:43

FILE DATE: 09-24-1998
FILE NAME: HANCOCK1

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.0

CULV NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	195.28	190.93	150.06	1 RCPE	1.92	1.17	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: HANCOCK1 DATE: 09-24-1998

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
195.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
195.56	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.00	1
195.69	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.00	1
195.79	1.6	1.6	0.0	0.0	0.0	0.0	0.0	0.00	1
195.88	2.1	2.1	0.0	0.0	0.0	0.0	0.0	0.00	1
195.97	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.00	1
196.05	3.2	3.2	0.0	0.0	0.0	0.0	0.0	0.00	1
196.13	3.7	3.7	0.0	0.0	0.0	0.0	0.0	0.00	1
196.21	4.2	4.2	0.0	0.0	0.0	0.0	0.0	0.00	1
196.24	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.00	1
196.30	5.3	4.9	0.0	0.0	0.0	0.0	0.0	0.00	30
196.34	5.1	5.1	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: HANCOCK1 DATE: 09-24-1998

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
195.28	0.000	0.00	0.00	0.00
195.56	0.000	0.53	0.00	0.00
195.69	0.000	1.06	0.00	0.00
195.79	0.000	1.59	0.00	0.00
195.88	0.000	2.12	0.00	0.00
195.97	0.000	2.65	0.00	0.00
196.05	0.000	3.18	0.00	0.00
196.13	0.000	3.71	0.00	0.00
196.21	0.000	4.24	0.00	0.00
196.24	0.000	4.40	0.00	0.00
196.30	-0.002	5.30	0.44	8.30

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-24-1998
RRENT TIME: 11:30:43

FILE DATE: 09-24-1998
FILE NAME: HANCOCK1

PERFORMANCE CURVE FOR CULVERT 1 - 1(1.92 (ft) BY 1.17 (ft)) RCPE

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	195.28	0.00	-3.56	0-NF	0.00	0.00	0.00	0.79	0.00	0.00
0.53	195.56	0.28	-3.55	1-S2n	0.13	0.21	0.01	0.79	32.76	0.00
1.06	195.69	0.41	-3.54	1-S2n	0.18	0.30	0.10	0.79	11.26	0.00
1.59	195.79	0.51	-3.51	1-S2n	0.23	0.38	0.22	0.79	6.52	0.00
2.12	195.88	0.60	-3.46	1-S2n	0.26	0.44	0.14	0.79	22.86	0.00
2.65	195.97	0.69	-3.39	1-S2n	0.29	0.49	0.19	0.79	12.51	0.00
3.18	196.05	0.77	-3.31	1-S2n	0.32	0.54	0.24	0.79	11.03	0.00
3.71	196.13	0.85	-3.21	1-S2n	0.35	0.59	0.33	0.79	8.29	0.00
4.24	196.21	0.93	-3.11	1-S2n	0.37	0.64	0.24	0.79	14.96	0.00
4.40	196.24	0.96	-3.08	1-S2n	0.38	0.66	0.26	0.79	14.44	0.00
4.86	196.30	1.02	-2.98	1-S2n	0.39	0.70	0.30	0.79	12.75	0.00

El. inlet face invert 195.28 ft El. outlet invert 190.93 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION	3750.00 ft
INLET ELEVATION	195.28 ft
OUTLET STATION	3600.00 ft
OUTLET ELEVATION	190.93 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0290
CULVERT LENGTH ALONG SLOPE	150.06 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	ELLIPTICAL
BARREL SPAN	1.92 ft
BARREL RISE	1.17 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQ. EDGE WITH HEADWALL
INLET DEPRESSION	NONE

CURRENT DATE: 09-24-1998 FILE DATE: 09-24-1998
RRENT TIME: 11:30:43 FILE NAME: HANCOCK1

TAILWATER

CONSTANT WATER SURFACE ELEVATION
191.72

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	100.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	196.34 ft

Swale Treatment Volume Calculations (Infiltration)

VHB **Computations**

Project S. Hancock Rd Project # 60581
Location Lake Co Sheet ____ of ____
Calculated by PWY Date 8/26/98
Checked by JK Date 9/23/98
Title Runoff - Offsite Areas

Calculate Runoff Volume for 3-Year 1-Hour and 10-Year 24-hour storm events

P (3-YR 1-HR) = 2.7 in
P (10-YR 24-HR) = 7.4 in

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$$S = \frac{1000}{CN} - 10$$

$$I_a = 0.2S$$

Basin	Area (acres)	CN	S	I_a	Runoff (Q) (in)		Runoff (R) ac-ft	
					3 YR 1 HR	10 YR 24 HR	3 Yr 1 Hr	10 Yr 24 Hr
A - East	3.40	30	23.33	4.67	0	0.29	0	0.08
B - East	10.0	30	23.33	4.67	0	0.29	0	0.24
C - East	20.3	30	23.33	4.67	0	0.29	0	0.49
D - East	2.4	30	23.33	4.67	0	0.29	0	0.06

Note: 1 For a 3 Year 1 Hour storm event P (2.7 in) < I_a (4.67 in)
∴ Q (Runoff) = 0.

Runoff Curve Number

Project: S. Hancock Road
Location: Lake County
Basin: C-East
Condition: Post-development

Computed by: PWY
Date: 8/26/98
Checked:
Date:

Soil Name and Hydrologic Group	Cover Description	CN			Area (acres)	Product of CN x Area
		Table 2-2	Fig. 2-3	Fig. 2-4		
A	Open Space (good condition)	39			1.33	51.9
A	Open Space (good condition)	30			31.43	942.9
Impervious	Roadway Pavement	98			0.79	77.4
				Totals =	33.55	1072.2

CN (Weighted) = (total product)/(total area) = 31.96 **Use CN =** **32**

Directly Connected Impervious Area (%)= 2.4

CN (NDCIA) = 30.37 **Use CN =** **30**

Vanasse Hangen Brustlin, Inc.
Reference: SCS TR-55

Swale Design for Infiltration
Summary

Project: Hancock Rd (South)
Computed by: PWY
Date: 10/16/98

Basin	Ditch Segment	Volume (ft^3) V_{req}	V_i	Comment
F	95+75 to 100+00 (North)	1905.90	2455.28	Meets criteria
	95+75 to 100+00 (South)	1427.67	1250.73	Vreq > Vi
	100+00 to 106+20 (North)	2062.20	2556.48	Meets criteria
	100+00 to 106+20 (South)	2062.20	2556.48	Meets criteria
A	10+22 to 18+78 (West)	2948.66	2983.09	Meets criteria
	10+22 to 18+78 (East)	2982.25	3224.56	Meets criteria
B	18+78 to 22+92 (West)	1418.34	1448.72	Meets criteria
	18+78 to 22+92 (East)	1418.34	1448.46	Meets criteria
C	22+92 to 28+25 (West)	597.20	822.45	Meets criteria
	22+92 to 28+25 (East)	671.85	965.76	Meets criteria
	28+25 to 37+25 (West)	1157.07	1885.19	Meets criteria
	28+25 to 37+25 (East)	1157.07	1884.92	Meets criteria
	37+25 to 45+99 (West)	1119.74	1733.31	Meets criteria
	37+25 to 45+99 (East)	1119.74	1588.59	Meets criteria
D	45+99 to 51+52 (West)	1903.56	1946.36	Meets criteria
	45+99 to 51+52 (East)	1903.56	2091.63	Meets criteria
E	51+52 to 59+00 (West)	1418.34	1823.11	Meets criteria
	51+52 to 57+75 (East)	2127.51	2139.69	Meets criteria
	59+00 to 67+75 (West)	2985.98	3793.27	Meets criteria
F	67+75 to 75+39 (West)	2612.74	2782.71	Meets criteria
	67+75 to 75+39 (West)	2612.74	2782.71	Meets criteria
G	75+39 to 82+38 (West)	2388.79	2674.89	Meets criteria
	75+39 to 82+38 (East)	2388.79	2536.31	Meets criteria
H	82+38 to 89+50 (West)	2426.11	3188.22	Meets criteria
	82+38 to 91+60 (East)	3172.61	4336.01	Meets criteria
	89+50 to 95+00 (West)	2276.81	3062.70	Meets criteria
	91+60 to 103+80 (East)	3172.61	3814.29	Meets criteria
	103+80 to 107+00 (West)	4105.73	1240.54	Vreq > Vi
	103+80 to 107+00 (East)	1082.42	1002.71	Vreq > Vi
	Total	**58627**	**66019**	**Meets criteria**

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin A
Basin:	10+22 to 18+78 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:

Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.3	**Long Slope (S):**	0.0605
Drainage Area (A):	0.79	**Manning's n:**	0.06
Begin Station:	1022	**Length (ft):**	856
End Station:	1878	**K_{vu} (in/hr):**	30.5

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 1.02 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 3685.82 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **2948.66 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.41 ft

   Wetted perimeter (P) = 2.59 ft

   Velocity (V) = 2.04 ft/s

   Area of bottom (A_b) = 2214 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 6641.15 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15.25 in/hr

   Q_{ip} = 46.89 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 2983.09

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin A
Basin:	10+22 to 18+78 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/26/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	0.51	**Side Slopes (Z):**	3
Time of Conc (T_c):	37.8	**Long Slope (S):**	0.0605
Drainage Area (A):	4.23	**Manning's n:**	0.06
Begin Station:	1022	**Length (ft):**	856
End Station:	1878	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 1.04 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 3727.81 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 2982.25 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.41 ft

   Wetted perimeter (P) = 2.60 ft

   Velocity (V) = 2.05 ft/s

   Area of bottom (A_b) = 2223 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 6669.42248 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 46.32 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 3224.56

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin B
Basin:	18+78 to 22+92 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.3	**Long Slope (S):**	0.0282
Drainage Area (A):	0.38	**Manning's n:**	0.06
Begin Station:	1878	**Length (ft):**	414
End Station:	2292	**K_{vu} (in/hr):**	35

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_P = 0.49 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 1772.93 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = **1418.34 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.36 ft

   Wetted perimeter (P) = 2.27 ft

   Velocity (V) = 1.28 ft/s

   Area of bottom (A_b) = 939 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 2816.67 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 17.5 in/hr

   Q_{ip} = 22.82 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\,[D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 1448.72

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin B
Basin:	18+78 to 22+92 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/26/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.3	**Long Slope (S):**	0.0282
Drainage Area (A):	0.38	**Manning's n:**	0.042
Begin Station:	1878	**Length (ft):**	414
End Station:	2292	**K_{vu} (in/hr):**	40

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.49 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 1772.93 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 1418.34 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.31 ft

   Wetted perimeter (P) = 1.98 ft

   Velocity (V) = 1.67 ft/s

   Area of bottom (A_b) = 821 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 2464.04 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 20 in/hr

   Q_{ip} = 22.82 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1448.46

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin C
Basin:	22+92 to 28+25 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	14.1	**Long Slope (S):**	0.0526
Drainage Area (A):	0.16	**Manning's n:**	0.042
Begin Station:	2292	**Length (ft):**	533
End Station:	2825	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$
   Q_p = 0.21 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$
   V_R = 746.50 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$
   V_{req} = **597.20 ft^3**

4. Swale Parameters:
   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.20 ft
   Wetted perimeter (P) = 1.28 ft
   Velocity (V) = 1.70 ft/s
   Area of bottom (A_b) = 680 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$
   Fillable porosity (f) = 0.3
   Height of swale above
   Groundwater Table (h_b) = 10 ft
   V_U = 2040.505 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$
   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 14.17 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$
   V_I = 822.45

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin C
Basin:	22+92 to 28+25 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/26/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	14.1	**Long Slope (S):**	0.0526
Drainage Area (A):	0.18	**Manning's n:**	0.06
Begin Station:	2292	**Length (ft):**	533
End Station:	2825	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.23 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 839.81 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 671.85 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.24 ft
   Wetted perimeter (P) = 1.52 ft
   Velocity (V) = 1.34 ft/s
   Area of bottom (A_b) = 813 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3
   Height of swale above Groundwater Table (h_b) = 10 ft
   V_U = 2437.856 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 16.93 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 965.76

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin C
Basin:	28+25 to 37+25 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	20.9	**Long Slope (S):**	0.0138
Drainage Area (A):	0.31	**Manning's n:**	0.042
Begin Station:	2825	**Length (ft):**	1100
End Station:	3925	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.40 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 1446.34 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **1157.07 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.33 ft
   Wetted perimeter (P) = 2.10 ft
   Velocity (V) = 1.21 ft/s
   Area of bottom (A_b) = 2312 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3
   Height of swale above Groundwater Table (h_b) = 10 ft
   V_U = 6935.477 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 48.16 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1885.19

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin C
Basin:	28+25 to 37+25 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/26/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	20.9	**Long Slope (S):**	0.0138
Drainage Area (A):	0.31	**Manning's n:**	0.06
Begin Station:	2825	**Length (ft):**	900
End Station:	3725	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.40 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 1446.34 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 1157.07 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.38 ft

   Wetted perimeter (P) = 2.40 ft

   Velocity (V) = 0.93 ft/s

   Area of bottom (A_b) = 2162 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 6486.559 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 45.05 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1884.92

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin C
Basin:	37+25 to 45+99 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:

Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.2	**Long Slope (S):**	0.0705
Drainage Area (A):	0.3	**Manning's n:**	0.06
Begin Station:	3725	**Length (ft):**	874
End Station:	4599	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.39 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 1399.68 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **1119.74 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.28 ft

   Wetted perimeter (P) = 1.75 ft

   Velocity (V) = 1.70 ft/s

   Area of bottom (A_b) = 1528 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 4582.843 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 31.83 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1733.31

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin C
Basin:	37+25 to 45+99 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/26/98	**Date:**	

Required Input:

Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.2	**Long Slope (S):**	0.0705
Drainage Area (A):	0.3	**Manning's n:**	0.042
Begin Station:	3725	**Length (ft):**	874
End Station:	4599	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.39 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 1399.68 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 1119.74 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.24 ft

   Wetted perimeter (P) = 1.53 ft

   Velocity (V) = 2.22 ft/s

   Area of bottom (A_b) = 1336 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 4009.099 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 27.84 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1588.59

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin D
Basin:	45+99 to 51+52 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.3	**Long Slope (S):**	0.0305
Drainage Area (A):	0.51	**Manning's n:**	0.06
Begin Station:	4599	**Length (ft):**	553
End Station:	5152	**K_{vu} (in/hr):**	32

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_P = 0.66 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 2379.46 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = **1903.56 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.39 ft
   Wetted perimeter (P) = 2.50 ft
   Velocity (V) = 1.42 ft/s
   Area of bottom (A_b) = 1380 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3
   Height of swale above Groundwater Table (h_b) = 10 ft
   V_U = 4139.961 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 16 in/hr
   Q_{ip} = 30.67 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\,[D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 1946.36

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin D
Basin:	45+99 to 51+52 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/26/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15.3	**Long Slope (S):**	0.0305
Drainage Area (A):	0.51	**Manning's n:**	0.06
Begin Station:	4599	**Length (ft):**	553
End Station:	5152	**K_{vu} (in/hr):**	35

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.66 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 2379.46 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 1903.56 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.39 ft

   Wetted perimeter (P) = 2.50 ft

   Velocity (V) = 1.42 ft/s

   Area of bottom (A_b) = 1380 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 4139.961 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 17.5 in/hr

   Q_{ip} = 33.54 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 2091.63

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin E
Basin:	51+52 to 59+00 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	14.9	**Long Slope (S):**	0.06
Drainage Area (A):	0.38	**Manning's n:**	0.06
Begin Station:	5152	**Length (ft):**	748
End Station:	5900	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_P = 0.49 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 1772.93 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = **1418.34 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.31 ft

   Wetted perimeter (P) = 1.97 ft

   Velocity (V) = 1.69 ft/s

   Area of bottom (A_b) = 1472 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 4417.287 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 30.68 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\, [D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 1823.11

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin E
Basin:	51+52 to 57+75 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:

Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	14.5	**Long Slope (S):**	0.06
Drainage Area (A):	0.57	**Manning's n:**	0.06
Begin Station:	5152	**Length (ft):**	623
End Station:	5775	**K_{vu} (in/hr):**	34

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$
   Q_P = 0.74 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$
   V_R = 2659.39 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$
   V_{req} = 2127.51 ft^3

4. Swale Parameters:
   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.36 ft
   Wetted perimeter (P) = 2.29 ft
   Velocity (V) = 1.88 ft/s
   Area of bottom (A_b) = 1428 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$
   Fillable porosity (f) = 0.3
   Height of swale above
   Groundwater Table (h_b) = 10 ft
   V_U = 4283.278 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$
   Infiltration rate (I_d) = 17 in/hr
   Q_{ip} = 33.71 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\, [D + T_c - (T_c\, Q_{ip})/Q_p]$
   V_I = 2139.69

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin E
Basin:	59+00 to 67+75 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	14.9	**Long Slope (S):**	0.0126
Drainage Area (A):	0.8	**Manning's n:**	0.06
Begin Station:	5900	**Length (ft):**	875
End Station:	6775	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_P = 1.04 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 3732.48 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = **2985.98 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.55 ft
   Wetted perimeter (P) = 3.49 ft
   Velocity (V) = 1.14 ft/s
   Area of bottom (A_b) = 3051 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3
   Height of swale above Groundwater Table (h_b) = 10 ft
   V_U = 9153.472 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 63.57 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\, [D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 3793.27

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin F
Basin:	67+75 to 75+39 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	16.5	**Long Slope (S):**	0.033
Drainage Area (A):	0.70	**Manning's n:**	0.06
Begin Station:	6775	**Length (ft):**	764
End Station:	7539	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_p = 0.91 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 3265.92 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = 2612.74 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.44 ft

   Wetted perimeter (P) = 2.77 ft

   Velocity (V) = 1.58 ft/s

   Area of bottom (A_b) = 2115 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 6346.325 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 44.07 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\,[D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 2782.71

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin F
Basin:	67+75 to 75+39 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	16.5	**Long Slope (S):**	0.033
Drainage Area (A):	0.70	**Manning's n:**	0.06
Begin Station:	6775	**Length (ft):**	764
End Station:	7539	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_P = 0.91 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 3265.92 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = 2612.74 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.44 ft
   Wetted perimeter (P) = 2.77 ft
   Velocity (V) = 1.58 ft/s
   Area of bottom (A_b) = 2115 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3
   Height of swale above
   Groundwater Table (h_b) = 10 ft
   V_U = 6346.325 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 44.07 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\, [D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 2782.71

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin G
Basin:	75+39 to 82+38 (West)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	17.3	**Long Slope (S):**	0.0199
Drainage Area (A):	0.64	**Manning's n:**	0.06
Begin Station:	7539	**Length (ft):**	699
End Station:	8238	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.83 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 2985.98 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **2388.79 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.47 ft

   Wetted perimeter (P) = 2.94 ft

   Velocity (V) = 1.28 ft/s

   Area of bottom (A_b) = 2058 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 6173.028 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 42.87 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 2674.89

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin G
Basin:	75+39 to 82+38 (East)		
Computed by:	PWY	**Checked by:**	
Date:	8/18/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	17.3	**Long Slope (S):**	0.0199
Drainage Area (A):	0.64	**Manning's n:**	0.06
Begin Station:	7539	**Length (ft):**	699
End Station:	8238	**K_{vu} (in/hr):**	28

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$
   Q_P = 0.83 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$
   V_R = 2985.98 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$
   V_{req} = 2388.79 ft^3

4. Swale Parameters:
   - Hydraulic radius (R) = 0.47 * d
   - Depth (d) = 0.47 ft
   - Wetted perimeter (P) = 2.94 ft
   - Velocity (V) = 1.28 ft/s
   - **Area of bottom (A_b) = 2058 ft^2**

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$
   - Fillable porosity (f) = 0.3
   - Height of swale above Groundwater Table (h_b) = 10 ft
   - **V_U = 6173.028 ft^3**

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$
   - Infiltration rate (I_d) = 14 in/hr
   - **Q_{ip} = 40.01 ft^3/min**

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$
   V_I = 2536.31

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin H
Basin:	82+38 to 89+50 (West)		
Computed by:	PWY	**Checked by:**	
Date:	9/25/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	21.5	**Long Slope (S):**	0.003
Drainage Area (A):	0.65	**Manning's n:**	0.042
Begin Station:	8238	**Length (ft):**	712
End Station:	8950	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.84 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 3032.64 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **2426.11 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.58 ft
   Wetted perimeter (P) = 3.69 ft
   Velocity (V) = 0.82 ft/s
   Area of bottom (A_b) = 2630 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3
   Height of swale above Groundwater Table (h_b) = 10 ft
   V_U = 7888.83 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 54.78 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 3188.22

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin H
Basin:	82+38 to 91+60 (East)		
Computed by:	PWY	**Checked by:**	
Date:	9/25/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	25.3	**Long Slope (S):**	0.003
Drainage Area (A):	0.85	**Manning's n:**	0.042
Begin Station:	8238	**Length (ft):**	922
End Station:	9160	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 1.10 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 3965.76 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 3172.61 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.65 ft

   Wetted perimeter (P) = 4.08 ft

   Velocity (V) = 0.88 ft/s

   Area of bottom (A_b) = 3766 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 11296.74 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 78.45 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 4336.01

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin H
Basin:	89+50 to 95+00 (West)		
Computed by:	PWY	**Checked by:**	
Date:	9/25/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	21.5	**Long Slope (S):**	0.003
Drainage Area (A):	0.61	**Manning's n:**	0.042
Begin Station:	8238	**Length (ft):**	712
End Station:	8950	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$
   Q_P = 0.79 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$
   V_R = 2846.02 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$
   V_{req} = **2276.81 ft^3**

4. Swale Parameters:
   - Hydraulic radius (R) = 0.47 * d
   - Depth (d) = 0.57 ft
   - Wetted perimeter (P) = 3.61 ft
   - Velocity (V) = 0.81 ft/s
   - **Area of bottom (A_b) = 2568 ft^2**

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$
   - Fillable porosity (f) = 0.3
   - Height of swale above Groundwater Table (h_b) = 10 ft
   - **V_U = 7703.157 ft^3**

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$
   - Infiltration rate (I_d) = 15 in/hr
   - **Q_{ip} = 53.49 ft^3/min**

7. Infiltration Volume: $V_I = Q_{ip}\,[D + T_c - (T_c\, Q_{ip})/Q_p]$
   V_I = 3062.70

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin H
Basin:	91+60 to 103+80 (East)		
Computed by:	PWY	**Checked by:**	
Date:	9/25/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	31	**Long Slope (S):**	0.05
Drainage Area (A):	0.85	**Manning's n:**	0.042
Begin Station:	9160	**Length (ft):**	1220
End Station:	10380	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 1.10 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 3965.76 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 3172.61 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.38 ft

   Wetted perimeter (P) = 2.41 ft

   Velocity (V) = 2.53 ft/s

   Area of bottom (A_b) = 2940 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 8820.341 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 61.25 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 3814.29

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin H
Basin:	103+80 to 107+00 (West)		
Computed by:	PWY	**Checked by:**	
Date:	9/25/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	32.8	**Long Slope (S):**	0.03
Drainage Area (A):	1.1	**Manning's n:**	0.042
Begin Station:	10500	**Length (ft):**	200
End Station:	10700	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 1.43 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 5132.16 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 4105.73 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.46 ft

   Wetted perimeter (P) = 2.92 ft

   Velocity (V) = 2.23 ft/s

   Area of bottom (A_b) = 584 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 1752.84 ft^3

   V_U < V_R

   Vertical saturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 12.17 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1072.79

   V_I < V_{req}

Swale Design for Infiltration

Project:	Hancock Rd (South)		Basin H
Basin:	103+80 to 107+00 (East)		
Computed by:	PWY	**Checked by:**	
Date:	9/25/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.48	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	32.8	**Long Slope (S):**	0.03
Drainage Area (A):	0.29	**Manning's n:**	0.042
Begin Station:	10380	**Length (ft):**	320
End Station:	10700	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\, I_D\, A$

   Q_P = 0.38 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\, D$

   V_R = 1353.02 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\, V_R$

   V_{req} = 1082.42 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.28 ft
   Wetted perimeter (P) = 1.77 ft
   Velocity (V) = 1.60 ft/s
   Area of bottom (A_b) = 567 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\, f\, h_b$

   Fillable porosity (f) = 0.3
   Height of swale above
   Groundwater Table (h_b) = 10 ft
   V_U = 1701.137 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\, L\, P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 11.81 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\,[D + T_c - (T_c\, Q_{ip})/Q_p]$

   V_I = 893.30

   V_I < V_{req}

Swale Design for Infiltration

Project:	Hartwood Marsh		Hartwood
Basin:	95+75 to 100+00 (North)		
Computed by:	PWY	**Checked by:**	
Date:	10/16/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.43	**Ditch Section:**	Trapezoid
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15	**Long Slope (S):**	0.0369
Drainage Area (A):	0.57	**Manning's n:**	0.06
Begin Station:	9575	**Length (ft):**	425
End Station:	10000	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.66 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 2382.37 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **1905.90 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.10
   Depth (d) = 0.11 ft
   Wetted perimeter (P) = 4.67 ft
   Velocity (V) = 1.44 ft/s
   Area of bottom (A_b) = 1985 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3
   Height of swale above
   Groundwater Table (h_b) = 10 ft
   V_U = 5954.25 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 41.35 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 2455.28

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hartwood Marsh		Hartwood
Basin:	95+75 to 100+00 (South)		
Computed by:	PWY	**Checked by:**	
Date:	10/16/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.68	**Ditch Section:**	Trapezoid
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15	**Long Slope (S):**	0.0369
Drainage Area (A):	0.27	**Manning's n:**	0.06
Begin Station:	9575	**Length (ft):**	425
End Station:	10000	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.50 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 1784.59 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 1427.67 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.34 ft

   Wetted perimeter (P) = 2.16 ft

   Velocity (V) = 1.41 ft/s

   Area of bottom (A_b) = 919 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 2756.1118 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 19.14 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 1250.73

   V_I < V_{req}

Swale Design for Infiltration

Project:	Hartwood Marsh		Hartwood
Basin:	100+00 to 106+20 (North)		
Computed by:	PWY	**Checked by:**	
Date:	10/16/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.68	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15	**Long Slope (S):**	0.0082
Drainage Area (A):	0.39	**Manning's n:**	0.06
Begin Station:	10000	**Length (ft):**	620
End Station:	10620	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.72 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 2577.74 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = **2062.20 ft^3**

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d

   Depth (d) = 0.52 ft

   Wetted perimeter (P) = 3.29 ft

   Velocity (V) = 0.88 ft/s

   Area of bottom (A_b) = 2040 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3

   Height of swale above Groundwater Table (h_b) = 10 ft

   V_U = 6118.78 ft^3

   V_U > V_R

   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr

   Q_{ip} = 42.49 ft^3/min

7. Infiltration Volume: $V_i = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 2556.48

   V_I > V_{req}

Swale Design for Infiltration

Project:	Hartwood Marsh		Hartwood
Basin:	100+00 to 106+20 (South)		
Computed by:	PWY	**Checked by:**	
Date:	10/16/98	**Date:**	

Required Input:			
Runoff Coefficient (C):	0.68	**Ditch Section:**	Triangle
Intensity (I_D):	2.7	**Side Slopes (Z):**	3
Time of Conc (T_c):	15	**Long Slope (S):**	0.0082
Drainage Area (A):	0.39	**Manning's n:**	0.06
Begin Station:	10000	**Length (ft):**	620
End Station:	10620	**K_{vu} (in/hr):**	30

1. Peak Runoff (A_p): $Q_p = C\ I_D\ A$

   Q_P = 0.72 ft^3/s

2. Volume of Runoff (V_R): $V_R = Q_p\ D$

   V_R = 2577.74 ft^3

3. Required Volume (V_{req}): $V_{req} = 0.8\ V_R$

   V_{req} = 2062.20 ft^3

4. Swale Parameters:

   Hydraulic radius (R) = 0.47 * d
   Depth (d) = 0.52 ft
   Wetted perimeter (P) = 3.29 ft
   Velocity (V) = 0.88 ft/s
   Area of bottom (A_b) = 2040 ft^2

5. Lateral Saturated Infiltration: $V_U = A_b\ f\ h_b$

   Fillable porosity (f) = 0.3
   Height of swale above Groundwater Table (h_b) = 10 ft
   V_U = 6118.7788 ft^3

   V_U > V_R
   Vertical unsaturated flow

6. Peak infiltration rate: $Q_{ip} = I_d\ L\ P$

   Infiltration rate (I_d) = 15 in/hr
   Q_{ip} = 42.49 ft^3/min

7. Infiltration Volume: $V_I = Q_{ip}\ [D + T_c - (T_c\ Q_{ip})/Q_p]$

   V_I = 2556.48

   V_I > V_{req}

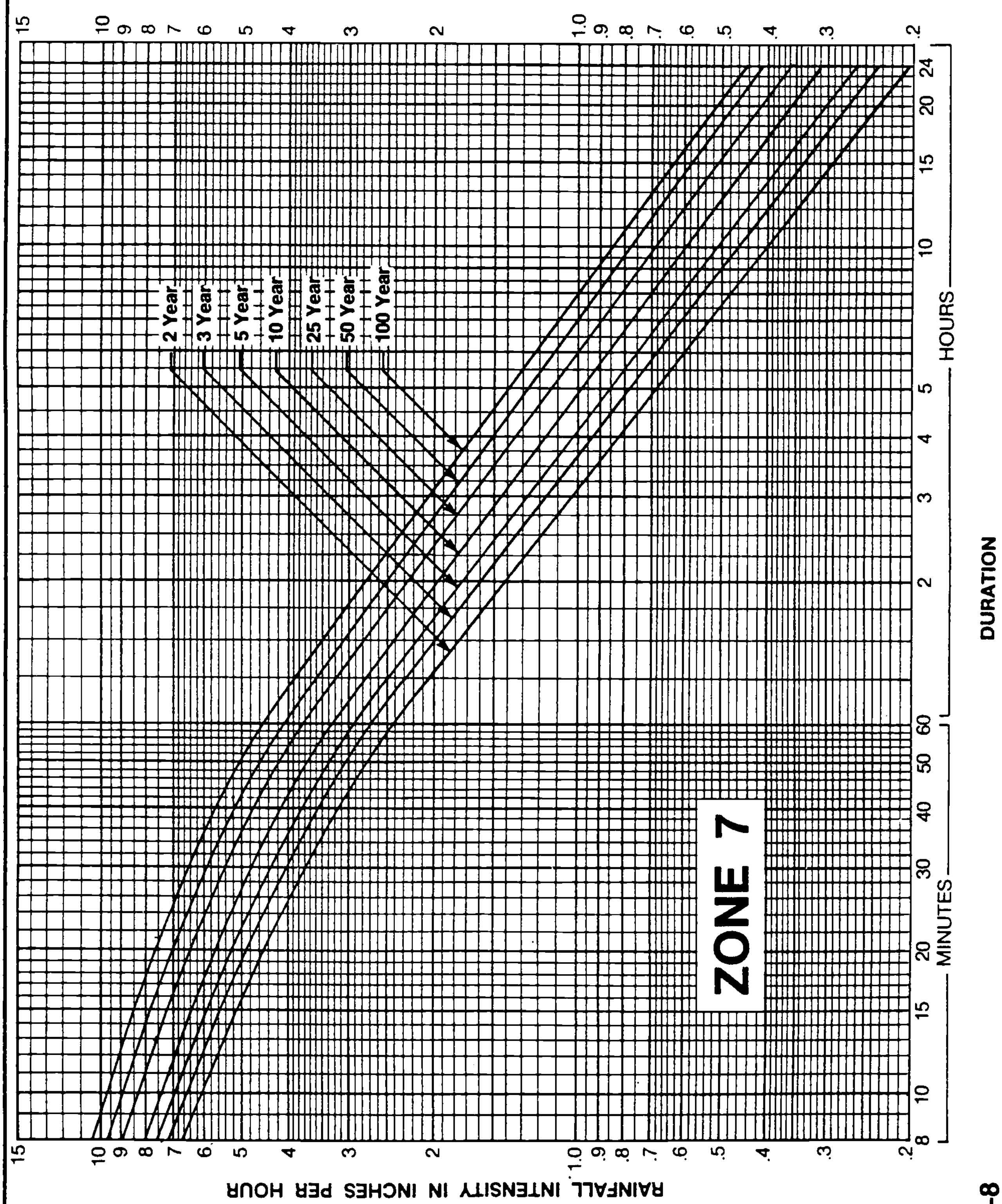


FIGURE 5-8
Rainfall Intensity-Duration-Frequency Curves for Zone 7

Table 5-6
DESIGN STORM FREQUENCY FACTORS
FOR PERVIOUS AREA RUNOFF COEFFICIENTS *

Return Period (years)	Design Storm Frequency Factor, X_T
2 to 10	1.0
25	1.1
50	1.2
100	1.25

Reference: Wright-McLaughlin Engineers (1969).

* DUE TO THE INCREASE IN THE DURATION TIME THAT THE PEAK OR NEAR PEAK DISCHARGE RATE IS RELEASED FROM STORMWATER MANAGEMENT SYSTEMS, THE USE OF THESE SHORT DURATION PEAK RATE DISCHARGE ADJUSTMENT FACTORS ARE NOT APPROPRIATE FOR FLOOD ROUTING COMPUTATIONS.

Table 5-5
RUNOFF COEFFICIENTS[a] FOR A DESIGN STORM RETURN PERIOD OF 10 YEARS OR LESS

Slope	Land Use	Sandy Soils Min.	Sandy Soils Max.	Clay Soils Min.	Clay Soils Max.
Flat (0-2%)	Woodlands	0.10	0.15	0.15	0.20
	Pasture, grass, and farmland[b]	0.15	0.20	0.20	0.25
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[c]	0.75	0.95	0.90	0.95
	SFR: ½-acre lots and larger	0.30	0.35	0.35	0.45
	Smaller lots	0.35	0.45	0.40	0.50
	Duplexes	0.35	0.45	0.40	0.50
	MFR: Apartments, townhouses, and condominiums	0.45	0.60	0.50	0.70
	Commercial and Industrial	0.50	0.95	0.50	0.95
Rolling (2-7%)	Woodlands	0.15	0.20	0.20	0.25
	Pasture, grass, and farmland[b]	0.20	0.25	0.25	0.30
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[c]	0.80	0.95	0.90	0.95
	SFR: ½-acre lots and larger	0.35	0.50	0.40	0.55
	Smaller lots	0.40	0.55	0.45	0.60
	Duplexes	0.40	0.55	0.45	0.60
	MFR: Apartments, townhouses, and condominiums	0.50	0.70	0.60	0.80
	Commercial and Industrial	0.50	0.95	0.60	0.95
Steep (7%+)	Woodlands	0.20	0.25	0.25	0.30
	Pasture, grass, and farmland[b]	0.25	0.35	0.30	0.40
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[c]	0.85	0.95	0.90	0.95
	SFR: ½-acre lots and larger	0.40	0.55	0.50	0.65
	Smaller lots	0.45	0.60	0.55	0.70
	Duplexes	0.45	0.60	0.55	0.70
	MFR: Apartments, townhouses, and condominiums	0.60	0.75	0.65	0.85
	Commercial and Industrial	0.60	0.95	0.65	0.95

[a] Weighted coefficient based on percentage of impervious surfaces and green areas must be selected for each site.

[b] Coefficients assume good ground cover and conservation treatment.

[c] Depends on depth and degree of permeability of underlying strata.

Note: SFR = Single Family Residential
MFR = Multi-Family Residential

Table 5-8
SCS RUNOFF CURVE NUMBERS FOR SELECTED AGRICULTURAL, SUBURBAN, AND URBAN LAND USE

Land Use Description		Hydrologic Soil Group A	B	C	D
Cultivated Land[a]:					
Without conservation treatment		72	81	88	91
With conservation treatment		62	71	78	81
Pasture or range land:					
Poor condition		68	79	86	89
Good condition		39	61	74	80
Meadow: good condition		30	58	71	78
Wood or Forest Land:					
Thin stand, poor cover, no mulch		45	66	77	83
Good cover[b]		25	55	70	77
Open Spaces, Lawns, Parks, Golf Courses, Cemeteries:					
Good condition: grass cover on 75% or more of the area		39	61	74	80
Fair condition: grass cover on 50% to 75% of the area		49	69	79	84
Poor condition: grass cover on 50% or less of the area		68	79	86	89
Commercial and Business Areas (85% impervious)		89	92	94	95
Industrial Districts (72% impervious)		81	88	91	93
Residential[c]:					
Average lot size	Average % Impervious[d]				
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
Paved Parking Lots, Roofs, Driveways[e]:		98	98	98	98
Streets and Roads:					
Paved with curbs and storm sewers[e]		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89
Paved with open ditches		83	89	92	93
Newly graded area (no vegetation established)[f]		77	86	91	94

[a]For a more detailed description of agricultural land use curve numbers, refer to Table 5-9.

[b]Good cover is protected from grazing and litter and brush cover soil.

[c]Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street with a minimum of roof water directed to lawns where additional infiltration could occur.

[d]The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

[e]In some warmer climates of the country, a curve number of 96 may be used.

[f]Use for temporary conditions during grading and construction.

Note: These values are for Antecedent Moisture Condition II, and $I_a = 0.2S$.

Reference: USDA, SCS, TR-55 (1984).