POCOSIN LAKES

NATIONAL WILDLIFE REFUGE

HYDRAULIC AND HYDROLOGIC STUDY

AND

WATER MANAGEMENT STUDY

Prepared by

USDA-Soil Conservation Service

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POCOSIN LAKES NATIONAL WILDLIFE REFUGE
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1.0 INTRODUCTION

In the fall of 1992 the U.S. Fish and Wildlife Service (FWS) requested assistance from the local Soil and Water Conservation District and the Soil Conservation Service (SCS) to develop a water management plan for the Pocosin Lakes National Wildlife Refuge (NWR).

The goals, objectives, and concerns of the FWS were expressed in a proposal presented by Jim Savery, refuge manager for the Pocosin Lakes National Wildlife Refuge (refer to Appendix B). The proposal requested thirteen specific points be addressed, and established the criteria for the development of this water management plan.

2.0 SPECIFIC RESPONSES TO THE THIRTEEN GOALS, OBJECTIVES, AND CONCERNS OF THE U.S. FISH AND WILDLIFE SERVICE

Objective #1:

Prepare a map indicating all water flow routes in existing canals and approximate width of canals.

Response #1:

The existing and proposed water flow routes are indicated on Maps 1A, 1B, 2A, 2B, 2C, 3A, 3B, and 3C in Appendix A. The canals varied in width, and the average width for most canals can be found in the cross-sections located in Appendix D.

Objective #2:

Map locations of new water control structures with various sizes indicated. This should include priority locations. After installation, elevations need to be determined.

Response #2:

The proposed and existing water control structures (risers) can be found on Maps 1A, 1B, 2A, 2B, 3A, and 3C in Appendix A. The required size of each structure can be found under Section 3.2 "Watershed Management Areas And Location Of Proposed Risers".

The priority for installation of these risers should be established by the NWR managers. All risers occupying the same elevation in a watershed should be installed simultaneously. For instance, all risers controlling the green section of Watershed #2 should be installed at the same time to be effective.

Risers will be installed to maintain the water level in the ditch at the ground surface of the surrounding landscape. The approximate elevations at each riser can be found on Maps 1C, 2B, and 3A of Appendix A.

Objective #3:

Water control structure placement should hold water at normal ground surface elevation.

Response #3:

Most of the risers are designed and placed to maintain a water table staging interval of one vertical foot. This interval will allow the water levels and water tables to range approximately one vertical foot between risers. In some areas this one foot staging interval is not considered to be economically feasible at this time, and staging can be accomplished when NWR managers deem necessary.

Objective #4:

Restore large areas of landscape to sheet flow type runoff.

Response #4:

Sheet flow type runoff will only be attainable in sections of the NWR that have not been traversed by roads, or where downstream (off-site) flooding will not result in significant damage to cropland. The roads throughout the NWR serve as dikes and will inhibit overland flow, forcing water through the existing drainage system.

During manageable rainfall events, sheet flow runoff will have to be controlled to prevent off-site flooding. Thus the natural hydrology that was present during the formation of the area in and around the NWR can never be totally restored. This water management plan addresses these issues, and attempts to restore the hydrology of the NWR to the highest attainable levels given the off-site considerations.

Objective #5:

Determine how much rainfall the landscape can hold behind the individual structures; e.g., when we have water backed-up behind the structure at Clayton and Coulborne Roads (at "x" elevation), how much rainfall can occur before the water floods over the structure or road?

Response #5:

Predicting the exact amount of rainfall that can be held behind any given riser is difficult because many variables must be considered. For example, during any given amount of rainfall the following variables will exist:

A. Water table depth in the soil before rainfall.
(This factor will be controlled by the season of the year, the length of time since the last rainfall, etc.)

B. Moisture content of soil above the water table.
(This factor will be governed by the season of the year, temperature, etc.)

C. Drainage area and number of risers above the structure to be managed.
(This factor is significant because the management of drainage water above this structure will determine the amount of water that can be stored after a rainfall event.)

The above variables are constantly changing, creating many scenarios, and requiring evaluations over a period of time. Thus, computer models are used to approximate the amount of water that can be stored behind a given riser.

To predict the amount of rainfall that can be held behind any given riser, two field conditions were used to evaluate the differences in the amount of water leaving the NWR:

A. Uncontrolled drainage (open ditches - no blockages)

B. Controlled drainage (future conditions)

The ever changing environmental variables used for modelling were addressed by allowing the computer model DRAINMOD to establish the parameters based on actual weather conditions in the Plymouth area that occurred between 1966 and 1988.

Management variables, used in the computer model TR20, were set by assuming weirs on riser would be two feet below ground level at all times, allowing maximum drainage rates and preventing drainage from becoming the limiting factor in the predictions. Refer to Section 4.0 of this report for further information.

Most of the modelling information is based on the area of the refuge that is most intensively drained. This area will create most of the water management problems on-site and for the adjacent, downstream, property owners.

A quantitative analysis of the intensively drained area below Lake Phelps reveals the following:

Drainage channel surface area, including V-ditches at 300-foot spacings, make up about 3.5% of the land surface.

Drainage channel storage volume at top-of-banks is about 20 acre feet per one-half mile by one mile block of drained land. This translates into about 0.76 inches of water spread over the entire surface area; a significant amount of storage.

The following observations can be made by comparing results from the modelling and quantitative analysis:

A. The wettest periods generally occur between January and April. During this period water tables are at or near the surface under controlled drainage conditions, and average about one foot below the surface for the free-draining condition.

B. During dry periods water tables fluctuate in the soil ranging from the surface to, on rare occasions, five feet deep. Modelling revealed that during these dry periods, existing uncontrolled water tables would be approximately two to three inches lower in elevation than water tables that are controlled. The difference is small because evapotranspiration rates are greater than drainage rates and constitute the largest loss of water from the soil. However, these two to three inches of increase in water table depth translate to an increase in plant-available water supply of about two to ten days, which may be of great significance during droughty periods.

C. Using the management assumption as stated above, and the environment variables as predicted by the models, the drainage canals in the NWR will flow full with 24 hour rainfall amounts ranging from 1.0 inch during wet seasons to 5.0 inches during dry seasons.

D. Flooding on the NWR, and on adjacent off-site landowners, will occur when rainfall amounts exceed the capacity of the drainage system regardless of the management scenario used by NWR managers. The drainage system of the NWR ranges in capacity from approximately 0.5 to 1.5 inches of runoff in 24 hours. Major rainfall events can easily exceed this 24 hour capacity when 1.0 to 1.5 inches of rain occur in wet seasons, or 2.0 to 5.0 inches of rain during dry seasons.

E. Controlling drainage will result in more water leaving the NWR during large storms that overwhelm the drainage system for a short period during and possibly the day after the storm. Thereafter, controlling drainage in the NWR immediately after large storms when flows can be contained within the ditch banks will benefit adjacent, downstream, landowners by reducing the duration of flow and total volume of water leaving the NWR. Controlling drainage will result in better drainage downstream because water from the NWR will not continuously feed into downstream canals causing water levels to remain high for days and restricting drainage.

F. Intensive land clearing and shaping, and the installation of drainage systems, have caused greater peak outflows which occur faster after rainfall events. Peak flows that do not exceed the capacity of the drainage system can be managed by NWR personnel. Risers can be used during manageable rainfall events to reduce peak flow rates by storing water on the NWR; thus, reducing the potential impacts on adjacent, downstream, landowners.

   Peak flows that exceed the capacity of the drainage system will result in sheet flows that will follow the natural contour of the land. This flow will be unmanageable, and will intensify the downstream flooding.

Objective #6:

Create water storage areas to provide release of water into other canals or areas during droughts.

Response #6:

The NWR will not be able to store significant amounts of water to be released as a source of irrigation water for adjacent lands during droughts. Rainfall produces the excess water that is available throughout the NWR. As a result, during a drought there is no excess water available for irrigation. Any water released to downstream areas as a source of irrigation will come from the water table in the soil above the point of release. The water levels will drop in the areas being drained, intensifying the drought related problems. To reduce the impacts of a drought on the NWR, drainage should be prevented and water tables should be managed as high as possible during dry seasons.

Objective #7:

Establish waterfowl moist soil units south of Coulborne Road between Clayton and Evans Roads. Determine what blocks can be farmed and what blocks we could manipulate water on.

Response #7:

Waterfowl moist soil units should be located north of Coulborn Road, in the yellow water management zone (Appendix 1, Map 1B). If water is to be ponded using dikes, the moist soil units should be located several miles north of Coulborn Road to prevent the possibility of off-site damages in the event of the failure of a dike.

The area of the NWR between Clayton and Evans Roads is not desirable for farmland. Farming this area is prohibitive due to the excessive amount of logs, stumps, and organic debris, and because of the intense management required for organic soils. Refer to Section 5.3, "Soils", for more detailed soils information.

Objective #8:

Are the road elevations high enough to accomplish Objectives 1-7 and still have access to all property?

Response #8:

Managing the water level in the ditches at the surface of the ground will not have a significant impact upon the trafficability of the roads in the NWR. This appears to occur because the roads are built on organic soils which are highly unstable and the presence of a water table at the surface of the ground does not appear to intensify the instability. The degree of trafficability of the roads seems to be less dependent upon the elevation of the water table, and more dependent upon:

A. The thickness of the sandy roadbed material on top of the organic soil.

B. The height of the crown of the roadbed above the edges of the road.

C. The presence of old stumps or logs in the roadbed that have rotted and created impassable holes.

In most cases, the roads could be made more trafficable by restricting heavy trucks, and increasing the thickness of the roadbed in problem areas. Sandy material found in the bottom of the canals can be used as a source of fill. Refer to Section 3.1 for more information.

Objective #9:

Develop water table monitoring wells near agricultural lands. These should yield information about ground water levels and how we may impact our neighbors that farm.

Response #9:

Observation wells are suggested as part of the management strategies for this water management plan. Refer to Appendix D for construction and field location suggestions, and Appendix A, Maps 1A and 1B, for suggested locations in the fields of adjacent, downstream, landowners.

Objective #10:

Check elevations on east side canals such as Seagoing, Middle, Branch, Parisher, Western, and Northern.

Response #10:

Key elevations have been recorded. These elevations are shown on Maps 1C, 2B, and 3A in Appendix A. More detailed information can be found in the original survey notes in Appendix C.

Objective #11:

Establish size of culverts for Northwest Fork River and Middle Road.

Response #11:

All culverts for the area around Northwest Fork and Middle Road have been sized and can be found in Section 3.2, "WATERSHED MANAGEMENT AREAS AND LOCATION OF PROPOSED RISERS. " Further information concerning the design of these structures can be found in Appendix D, "RISER DESIGN INFORMATION."

Objective #12:

Draw up plans to correct drainage problems at J-Canal and John Williams' property.

Response #12:

Suggestions for addressing the drainage problems associated with the Williams' property have been presented. Refer to Section 3.2.

Objective #13:

Determine volume and times that the Fred Sutter pumping station operates, and what impact this activity has on the forest in that area. Determine water quality that is being pumped onto the refuge.

Response #13:

The impact of the Sutter pumping station upon the NWR property cannot be addressed in this water management study. The evaluation required is beyond the scope and charge of the Soil Conservation Service, and will require research-type evaluations that should be addressed by a consultant.

3.0 RECOMMENDATIONS (Community Actions)

Water management is the principal component required to attain the associated management goals of flood prevention, fire protection, and wildlife management on the Pocosin Lakes National Wildlife Refuge. If these goals are to be achieved, some semblance of the natural hydrology that created the pocosin must be established in harmony with the surrounding landowners.

The following recommendations should address implementing the water management goals, objectives, and concerns of the NWR in cooperation with the surrounding community:

- Establish a board of water management advisors. This board should be composed of members of the surrounding communities, FWS managers, Soil and Water Conservation District Board Members, and technical consultants.

- Develop a long range plan for the maintenance of outlet canals in cooperation with surrounding landowners. This plan should consider maintenance from NWR boundaries, through the adjacent communities, to the outlet point. As Part of this effort, a maintenance assessment should be established for each landowner per outlet canal. This assessment per landowner should be based on historic methods for distributing drainage maintenance costs between involved landowners.

- Establish long range water management goals, based on the findings of this study, and in conjunction with the board of water management advisors as suggested above.

3.1 Recommendations (Roads)

The condition and trafficability of the roads with respect to the management of canal water levels and ground water tables is a point of concern for NWR managers. Recommendations were requested for road maintenance and repair as part of the water management plan.

While surveys were being performed, the condition and trafficability of the roads was noted. Recommendations based on these observations are:

A. Use a dragline to fill low areas and stump holes, utilizing the sandy material in the bottom of the existing canals.

B. Crown all roads so that the center line is approximately 0.5 foot higher than the sides.

C. Restrict traffic during wet periods.

D. Restrict heavy trucks from all roads unless absolutely necessary.

While performing the survey and design work for this water management study, most of the surrounding landowners were contacted in an attempt to obtain their input. During these consultations with surrounding landowners, the use and maintenance of the NWR roads was discussed. From these discussions it was apparent that the roads were a point of controversy with some landowners. If a water management plan is to be implemented in harmony with the surrounding communities, the maintenance and use of the NWR road system should be considered.

The following suggestions are presented for consideration:

A. Establish a board of advisors for managing NWR roads.

   This board should be composed of members of surrounding hunting clubs, adjacent land owners that utilize the NWR roads as thoroughfares, and County Commissioners.

B. Develop road use policies in consultation with the advisory board for heavy equipment and trucks, wet and dry seasons, fire fighting, hunting, and adjacent landowner thoroughfares.

3.2 Recommendations (Watershed Management Areas And Location Of Proposed Risers)

Watershed Subdivisions

The NWR is divided into three watersheds, based on the natural drainage patterns and the location of the outlets. Water management strategies for each watershed are planned and designed based on individual needs (Water Table Management Watersheds Map and Maps 1A, 1B, 2A, 2B, 3A, 3C of Appendix A.)

Watershed #1 (Maps 1A and 1B, Appendix A)

Design Considerations (Watershed #1)

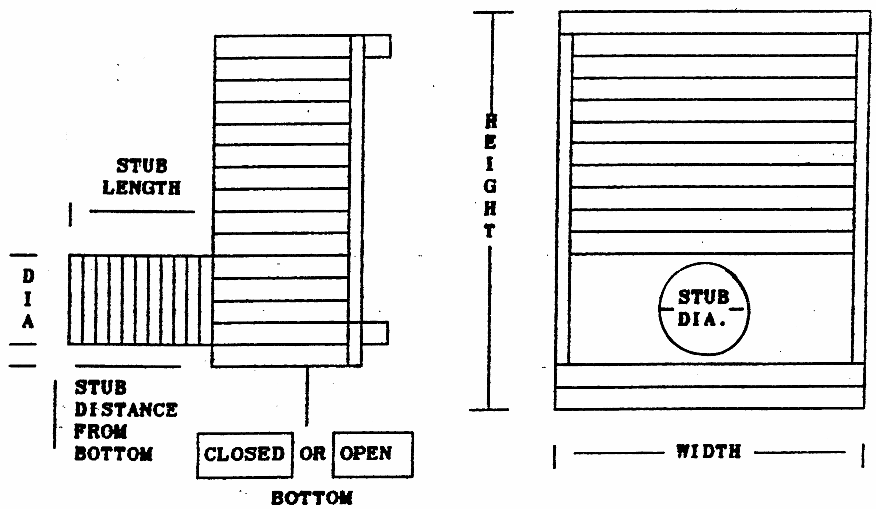
Several items of concern were addressed during the development of water management strategies for this watershed:

A. Surface water runoff flooding State Road #1183 and entering Lake Phelps.

B. The effects of managing the existing riser in Evans Canal on Watershed #2.

C. The impact of water management on adjacent, downstream landowners.

FLASHBOARD RISER
SCHEMATIC VIEW



Surface Water Runoff (Watershed #1)

Water is staged throughout most of Watershed #1 on one foot vertical intervals. During the planning process, an area between Lake Phelps and the crest of a gentle rise located several thousand feet south was a major concern. As the result of this gentle rise, surface water is driven toward Lake Phelps. The paved road creates a dike and causes the water to pond until the drainage system transports it south, back through the gentle rise toward the Pungo River. The major planning consideration is that the paved road can be flooded, which will result in water entering the lake by sheet flow.

The canals transecting the gentle rise must be blocked if the potential of flooding the paved road is to be reduced and water is to be properly staged. Drainage will be routed through Allen and Evans Canals.

Evans Canal Riser (Watershed #1)

The effects of the management of Evans Canal riser is another concern. The management of this riser is suspect in the overflows that occurred at lower elevations in Watershed #2 along the Williams/NWR property line.

To reduce the potential for overflows in this area, all canals that intersect Evans Canal and drain into Watershed #2 are to be blocked. Evans Canal will no longer drain water from Watershed #2 above the Evans riser. Thus, the total area that drains into Evans Canal has remained approximately the same, but the drainage area has shifted from Watershed #2 to Watershed #1.

Staging Water (Watershed #1)

To properly stage water throughout Watershed #1, risers will be needed in fifteen additional locations. Each location will require two risers, set side-by-side, for a total of 30 additional risers.

Additional culverts will be required to improve drainage. Two culverts (set side-by-side) will be installed.

Earthen ditch plugs will be required in three canals to redirect the flow between canals.

Materials Required For Improvements (Watershed #1)

ITEMS	UNITS
Risers (two per site)	30
Culverts (one site)	2
Earthen Ditch Plugs	3

Riser Design (Watershed #1)

All risers and connecting culverts will meet the following specifications for Watershed #1:

Riser height	----	The height of each riser should be determined on site "BEFORE" ordering.
Weir width	----	8.0 feet
Culvert diameter	----	6.0 feet
Culvert length	----	40.0 feet

Evans Road Culverts (Watershed #1)

Two culverts should be installed under Evans Road at the intersection of the Evans Road and SR #1183. These culverts should be the same size as the culverts used on the risers in this watershed and as stated above.

Watershed #2 (Maps 2A, 2B, and 2C, Appendix A)

Drainage problems with the adjacent landowners played a significant role in the water management design for this watershed. The objectives are:

A. To reduce the potential of overland flows, generated by NWR canals, from entering Williams' Canal.

B. To establish a water control system in which the natural factors of topography and rainfall patterns will govern the direction of flow.

C. To allow surface water to follow the natural contour and historic sheet flow patterns south and east.

Williams' Canal

Landowners sharing the Williams' property drainage system have concerns that overland flows from NWR land could result in flooding. Williams' Canal traverses the natural contour, falling approximately three feet in elevation from west to east. This canal has been blocked by the landowners on both ends and does not drain. As a result, any water entering this canal flows east to the intersection of J-Road (also UK2 Road). This water then ponds until it floods and crosses the J-Road on NWR property. It then enters the J-Road canal and flows south to Harvester Road.

Landowners fear that the ponding of this water will eventually result in the failure of the earthen ditch plug in J-Road canal. This earthen plug prevents water on the NWR from flowing into the adjacent drainage system which serves the Nylen tract - draining to the Scuppernong River.

During extremely wet periods, overland flows have been observed coming from the three NWR canals that end approximately 50 feet south of Williams' Canal. These flows are small. When they occur the flow is several inches deep and ranges from 20 to 50 feet wide.

To prevent all ground and surface water from entering the Williams' Canal would be almost impossible. Any ground or surface water in the vicinity of Williams' Canal is going to attempt to flow toward this canal.

The most reasonable solution for solving this potential problem would be to:

A. Reinforce the earthen plug in J-Road Canal at the NWR/Williams' property line.

B. Breach J-Road on NWR property, with or without a culvert, and drain overflows from Williams' Canal to J-Road Canal (a drop structure will be required).

These improvements would significantly reduce the probability of flooding as a result of any overland or ground water flows into Williams' Canal.

Drainage Modifications (Watershed #2)

The design of the drainage system for this particular watershed has been changed to allow drainage water to follow the natural topography and historic sheet flow patterns. Drainage water presently runs south, following the six major drainage canals, toward New Lake and Pungo River. To accommodate the natural terrain, an additional outlet will be provided by opening and controlling the drainage of the Harvester Road Canal. This will allow the drainage water to follow the topography more closely, draining down Harvester Road Canal, under Western Road, and through existing wetlands at Southwest Fork.

Staging Water (Watershed #2)

To properly stage the water all major drainways will have to be controlled. Risers and culverts will have to be installed as indicated on Map 2B.

Risers will be installed (two, side-by-side) in nine places throughout Watershed #2. Follow recommended sizes as stated below, noting that the size of Western Road risers and attached culverts vary from others in the watershed.

Culverts will have to be installed on connecting ditches to allow water to be staged and follow the natural contour. Sixteen single culverts will be required. Note that all these culverts are the same size.

Harvester Road Canal will require double culverts (side-by-side) without risers. Double culverts are to be installed at four sites.

Sixteen canals throughout the watershed, and the v-ditches east and west of Ferebee Road on the NWR/All Star Foods property line canal, should be blocked.

Materials Required For Improvements (Watershed #2)

ITEMS	UNITS
Risers (two per site)	18
Culverts:	
Single culvert in a canal	16
Double culverts (Harvester Rd.)	8
Earthen ditch plugs:	
Canals	16
V-ditches	refer to maps

Riser Design (Watershed #2)

All risers and connected culverts on major drainage canals in Watershed #2 (except those on Western Road Canal) will meet the following specifications:

Riser height	----	The height of each riser should be determined on site "BEFORE" ordering for installation.
Weir width	----	8.0 feet
Culvert diameter	----	6.0 feet
Culvert length	----	40.0 feet

Single Culvert Design (Watershed #2)

All single culverts without risers throughout Watershed #2 should meet the following specifications:

Culvert Diameter	---	6.0 feet
Culvert Length	---	40.0 feet

Double Culvert (Side-by-side) Design - Harvester Road (Watershed #2)

All double culverts, without risers, on Harvester Road Canal should meet the following specifications:

Culvert Diameter	---	6.0 feet
Culvert Length	---	40.0 feet

Riser Design ---- Western Road (Watershed #2)

All risers on Western Road Canal should meet the following specifications:

Riser height	----	The height of each riser should be determined on site "BEFORE" ordering for installation.
Weir width	----	7.0 feet
Culvert diameter	----	5.5 feet
Culvert length	----	40.0 feet

Watershed #3 (Maps 3A and 3C, Appendix A)

The management and design of this watershed is significantly influenced by the requirements of adjacent, upstream landowners that drain through NWR property. Most of the canals in Watershed #3 serve as drainage outlets for adjacent landowners. As a result, much of this watershed will remain uncontrolled.

The existing culvert at the intersection of Seagoing and Middle Roads was sized and found to restrict the flow of water. This culvert should be replaced.

The bridge at the intersection of Branch and Seagoing Roads is in need of repair and is to be replaced with culverts.

The bridge on Middle Road at the entrance to Northwest Fork will be replace. Risers should be installed. These risers will not be used at this time; however, they may be required if future land acquisitions result in the need for water control on Seagoing, Branch, and Middle Roads.

Culvert Design - Seagoing, Branch, And Middle Roads (Watershed #3)

The following specifications should be used for all culverts without risers installed on Seagoing, Branch, or Middle Roads (Watershed #3):

A total of four culverts are to be installed. Two culverts (side-by-side) are to be used at each location. Installation is required at the existing bridge on Branch Road and at the intersection of Seagoing and Branch Roads:

A. Use two culverts, side-by-side, at each location.

B. Each culvert should be 6 feet in diameter and 40 feet in length.

Bridge Replacement - Middle Road (Watershed #3)

Three risers (side-by-side) will be used to replace Middle Road Bridge.

Each riser and culvert should meet the following specifications:

Riser height	----	The height of each riser should be determined on site "BEFORE" ordering for installation.
Weir width	----	9.0 feet
Culvert diameter	----	6.0 feet
Culvert length	----	40.0 feet

Staging Water - Middle And Northern Roads (Watershed #3)

Water can be managed in the area between Middle and Northern Roads. Drainage in this area will be directed to follow the natural contour which falls from Northern Road to Northwest Fork. This will involve:

A. Blocking drainage outlets going under Nodwell Road.

B. Draining water under Parisher Road.

C. Reinforcing existing earthen ditch plugs along Northwest Fork Road.

D. Implementing drainage improvements under Middle Road.

Water will be directed from Chinkapin road, through this entire area to Northwest Fork. To accomplish this goal, the existing drainage system will be used, and a series of culverts and risers will be installed.

Increasing Surface Water Flow - Middle Road (Watershed #3)

Middle Road forms a dike, forcing all surface water flowing toward the Northwest Fork through a channel in the road. This limits the area of the swamp that can transport sheet flows. To address this problem eight culverts will be installed under Middle Road. These culverts are to be installed on the surface of the ground in the lowest points of elevation along Middle Road.

Culvert Design (Watershed #3)

The following specifications should be used for eight culverts, without risers, under Middle Road.

A. All culverts to be installed on top of ground surface in points of lowest elevation. The road bed directly over the culvert may have to be built-up to provide two feet of cover.

B. Culvert diameter required: 1.5 feet

C. Culvert length required: 40.0 feet

Staging Water - Middle To Parisher Road (Watershed #3)

To control the flow of water between Middle and Parisher Roads, one riser will be installed on the Northwest Fork. This riser should be located several hundred feet above the intersection of Northwest Fork and Middle Road.

Riser Design (Watershed #3)

The following specifications should be used for the riser and attached culvert at Northwest Fork:

Riser height	----	The height of each riser should be determined on-site "BEFORE" ordering for installation.
Weir width	----	7.0 feet
Culvert diameter	----	5.0 feet
Culvert length	----	40.0 feet

Staging Water - Parisher To Northern Road (Watershed #3)

Five risers will be installed under Parisher Road to allow the area between Parisher and Northern Roads to drain and outlet into Northwest Fork.

Riser Design (Watershed #3)

The following specifications should be used for five risers under Parisher Road:

Riser height	----	The height of each riser should be determined on site "BEFORE" ordering for installation.
Weir width	----	4.0 feet
Culvert diameter	----	3.0 feet
Culvert length	----	40.0 feet

Emergency Outlet At Nodwell Road (Watershed #3)

Presently all the water draining north of Parisher Road, flows into Parisher canal, then west under Nodwell Road. When the drainage is directed under Parisher Road, the existing riser under Nodwell Road will be used as an emergency outlet. Water will be directed through this riser only when damaging overland flows are imminent. The existing riser under Nodwell Road is in poor condition and may need to be replaced in the future.

When replacement is required, the following specifications should be used:

Riser height	----	The height of each riser should be determined on site "BEFORE" ordering for installation.
Weir width	----	3.5 feet
Culvert diameter	----	2.0 feet
Culvert length	----	40.0 feet

Staging Water - Northern And Chinkapin Roads (Watershed #3)

All drainage water between Northern and Chinkapin roads will be directed under Northern Road into the existing drainage system. Northern Road Canal will be blocked forcing water through six culverts installed under Northern Road.

Culvert Design (Watershed #3)

The following specifications will be used for six culverts, without risers, under Northern Road:

A. All culverts will be installed under Northern Road at the intersection of ditches. The ditches on the south side of Northern Road will be extended to the outlet end of the culverts at Northern Road.

B. Culvert diameter 2.0 feet

C. Culvert length 40.0 feet

Materials Required For Improvements (Watershed #3)

	Location	Improvements
1.	Branch Road Bridge	2 culverts
2.	Branch and Seagoing Roads	2 culverts
3.	Northwest Fork Bridge	3 risers
4.	Middle Road	8 culverts
5.	Northwest Fork (north of bridge)	1 riser
6.	Parisher Road	5 risers
7.	Nodwell Road	1 riser
8.	Parisher Road Canal	1 earthen plug
9.	Northern Road	6 culverts
10.	Northern Road Canal	1 earthen plug

3.3 Recommendations (Operation And Management Objectives, Concepts, and Concerns)

Management Objectives (All Watersheds)

A. Establish a line of formal communication between the NWR and downstream landowners to manage water cooperatively in a manner that will meet the long term goals of the NWR and protect the property of the adjacent landowners.

B. Restore a semblance of the natural hydrology to the pocosin.

Watershed Management Concepts (All Watersheds)

A. Water will be managed to the surface of the ground to restore the hydrologic properties of the pocosin. Water table and ditch water levels will be allowed to fluctuate naturally in accordance with rainfall and evapotranspiration. Drainage will occur if overland flows are imminent.

B. When drainage must occur, only enough water will be released to prevent overland flows. Drainage will be stopped as soon as surface water can be contained and overland flows prevented.

C. Water will be released in a manner that will encourage drainage to follow the natural contour and historic sheet flow patterns, or established artificial watershed boundaries.

Starting Drainage (All Watersheds)

When drainage is required, flashboard riser (riser) weirs will be set two feet below ground level. The drainage process should be started with the risers at the lowest elevation. This process should continue uphill until all of the risers have been lowered.

Several risers may be located at the same elevation throughout a given watershed. These risers should be released simultaneously to prevent water from draining against the contour.

Stopping Drainage (All Watersheds)

To stop all drainage, raise the riser weirs at the highest elevations first. This process should proceed downhill until the lowest riser weirs have been raised. If several risers are located at the same elevation within a given watershed, the weirs should be raised simultaneously.

Flooding Concerns (All Watersheds)

Adjacent downstream landowners are concerned that water released from NWR watersheds will cause flooding. This fear is well founded and reasonable. In certain situations downstream flooding will occur; however, it is important to realize that this flooding will occur even if the NWR canals are allowed to drain freely with no controls.

There are two scenarios in which flooding will occur downstream regardless of the status of water control on the NWR:

A. During wet periods, when the drainage systems of the adjacent farms and the NWR are overwhelmed and water must be released from the NWR in an effort to prevent sheet flows.

B. When the drainage systems of the adjacent farms and the NWR are overwhelmed and sheet flow is occurring.

Downstream Flood Prevention And Improved Drainage (All Watersheds)

Generally, flooding will be reduced downstream by managing water on the NWR:

A. When rainfall amounts are manageable, water can be stored throughout the NWR, thus reducing total annual outflows that will drain through downstream landowners. Studies conducted by Evans, Gilliam, and Skaggs, 1991, suggest that total annual outflows can be reduced by 30% or more on fields where drainage is controlled.

B. The duration of downstream flooding can be reduced by stopping the flow of water from the NWR as soon as the surface water flow can be controlled. As a result, a significant source of water can be controlled and stopped, allowing downstream water levels to drop more quickly, providing a greater rate of drainage for downstream landowners.

3.4 Recommendations (Water Management Plan)

Three watersheds have been established based on the natural contour and existing artificial watershed boundaries. Each watershed will be managed independently based on individual needs. (Appendix A, Watershed Map)

Watershed #1 (Maps 1A and 1B, and 1C, Appendix A)

The boundaries of Watershed #1 are defined by the SR 1183 to the north, Allen Road Canal to the west, Evans Road to the east, and the Pungo River to the south.

Four parallel canals running north to south direct the flow of drainage water to the Pungo River. Most of this watershed is drained intensively. In all areas of this watershed, surface and ground water enters a system of parallel field ditches that carry the water south to a collector ditch. This water flows west to one of the four main canals. All drainage water is then carried south to the Pungo River.

Management Zones (Watershed #1

Management of the water in Watershed #1 will be governed by "management zones" and wet or dry seasons of the year. The purpose of the management zone is to allow the majority of the watershed to be managed at a level that is conducive to the development of a pocosin, while providing a transition area where water levels can be reduced to be compatible with the needs of adjacent farmlands downstream. This watershed will be divided into three management zones.

Wet Season Management (Watershed #1)

During wet seasons, when drainage is required and expected on regular intervals, each zone will be staged to provide a protective buffer between the NWR and the downstream, adjacent, landowners. Using this approach, manageable rainfall amounts can be stored, and when drainage is required the following guidelines given for each zone can be used:

Pink Zone (Watershed #1)

This zone will serve as a protective buffer between the NWR and adjacent landowners.

The water level in this zone will be managed in consultation with the adjacent landowners. Usually, managing the water level in this zone at 2.5 feet below the ground surface will be adequate and will not interfere with the farming operations of adjacent landowners. Water levels may be held higher than 2.5 feet below the ground surface, provided that adjacent landowners agree; however, the water levels should never be held higher than the "Blue Zone" as stated below.

Observation wells should be installed . These wells will serve as indicators for the level that water should be managed in the NWR canal and to verify the location of the water table in the fields of adjacent landowners. Four observation wells should be installed. They should be located in the center of a field, in a row, between 100 and 150 feet from the edge of the NWR property line canal (Appendix D).

Blue Zone (Watershed #1)

This zone will serve as a safety zone providing storage and lag time during rainfall events that require drainage. Water will be managed 1.0 foot below ground level.

Part of this zone near Allen Canal may be farmed. If farmed, this entire blue zone will be managed as a "Pink Zone".

Yellow Zone (Watershed #1)

The water level in this zone will be maintained to ground level. Water will be encouraged to pond in an effort to store as much as possible without inducing overland flow that would overtop the roads.

Part of this zone (indicated by black stripes) near Allen Road may be farmed. If so, the farmed area will be managed in conjunction with the "Pink Zone".

Dry Season Management (Watershed #1)

During dry periods, when ditch water levels and water table levels are very low, the management strategy can be changed. The objective of dry season management should be to capture as much rainfall as possible during any isolated thunder showers. This is a reasonable strategy because most of the rainfall that occurs during dry seasons is short, intense, and in the form of isolated showers. Many times heavy showers will provide enough water to fill ditches, but not enough to cause significant surface water runoff. Usually, if enough rainfall occurs during the dry season to require drainage, it will occur over several days. If this happens, the management strategy can be shifted from dry season management to wet season management.

For dry season management:

A. The yellow zone will always be managed to the surface of the ground; therefore, this area will not be affected by seasonal management.

B. The blue zone can be managed to the surface during dry seasons, and if drainage becomes necessary, the wet season strategy can be implemented.

C. The pink zone should be managed in consultation with the adjacent landowners.

Watershed #2 (Maps 2A, 2B, and 2C, Appendix A)

The boundaries of Watershed #2 are defined by the Williams/NWR property line to the north, Evans Road Canal to the west, Southwest Fork to the east, and the All Star Foods property line and Alligator Lake to the south. Most of the drainage water in this watershed is transported by five canals that carry the drainage water south, through various properties, and eventually to the Pungo and Alligator Rivers. A smaller portion of this water is transported east through Northwest Fork and Southwest Fork, and eventually to the Alligator River.

Management Zones (Watershed #2)

The management of water in Watershed #2 will be governed by management zones. These zones do not apply to the staging of water as discussed in Watershed #1; rather, they apply to the area that water will be controlled. Ditch water levels will be managed to the surface of the ground in all zones.

Management of risers in Watershed #2 is critical. The riser weir levels in each zone are to be set at the same elevation. Implementation of the guidelines given for starting and stopping drainage under Section 3.2 will be very important. If these guidelines are not followed, water can be driven into adjacent watersheds by setting one riser lower than others.

Green Zone (Watershed #2)

The management of the water level in the ditches will be dictated by the ground elevation at Williams' Canal and Evans Canal. During wet periods, water should be managed to prevent the occurrence of overland flows to Williams' Canal, or the overflow of earthen ditch plugs at Evans Canal.

There are four risers that control the flow from this watershed, and all risers controlling this zone should have a permanent mark at an elevation of 14.5 feet to assist with establishing the highest allowable ditch water levels.

The elevation of 14.5 feet should be used as a guide. The maximum water level elevations should be determined by on-site investigations after the water management system has been installed.

The water levels in this zone can not be staged at one foot contour intervals because the highest point of elevation is found in the center of the green zone. Water levels can be staged on interior canals in the future, but the main canals will have to remain as designed to prevent overflows into the Williams' Canal.

Yellow Zone (Watershed #2)

The management of water levels in this zone will be dictated by the ground level elevation at Williams' Canal. The ground level at the intersection of Williams Canal and J-Road is approximately 13.2 feet. Both controlling risers should have a permanent mark at this elevation to assist with the establishment of the maximum ditch water level elevation.

An elevation of 13.5 feet should be used as a guide. The maximum water level elevations should be determined by on-site investigations after the water management system has been installed.

Pink Zone (Watershed #2)

The management of this zone will be governed by the ground level at the controlling riser. A one foot staging interval could not be justified at this time. Additional risers can be added in the future if deemed necessary.

Blue Zone (Watershed #2)

No water is staged in this zone. The only canal which controls flow and affects drainage is Harvester Road Canal.

The elevation of the land falls from west to east and drops approximately four feet. Only a small area would be benefited by staging water on Harvester Road Canal, and as a result no staging will be recommended at this time.

The existing riser at the intersection of Harvester and Western Roads is in poor condition (not shown on maps). This riser will not be used for management.

Harvester Road Canal presently drains part of Watershed #2 (Yellow and Green zones; Map 2A, Appendix 1), but the water has to flow through a series of ditches and canals to eventually get to Harvester Road. Culverts and risers will be installed in order to allow water to follow the natural contour and drain down Harvester Road Canal (Map 2B, Appendix A).

Water will be encouraged to follow the natural contour and historic sheet flow patterns by installing two risers on Western Road Canal. These risers will be installed north and south of the intersection of Harvester and Western Roads to direct runoff through wetlands east of Western Road.

The weirs on both risers in Western Road Canal will be set above ground level and at the same elevation to induce overland flow through the existing wetlands. Management will only be required if water begins overtopping Western Road.

WATERSHED #3 (Maps 3A, 3B, and 3C, Appendix A)

Drainage from Seagoing, Branch, and Middle Road Canals cannot be controlled at this time. These canals are outlets for adjacent, upstream, landowners.

The area that can be controlled ranges from Chinkapin Road to the intersection of the Northwest Fork at Middle Road Canal. Refer to Map 3A and Map 3C, Appendix 1.

Watershed #3 will be divided into two zones for water management - yellow and blue. The water will be managed at the surface of the ground in both zones. When drainage is required, the risers on Parisher Road will have to be managed in conjunction with the riser at Middle Road.

Parisher Road will present the most significant control of flow in this section of the watershed because it forms a dike that blocks the natural gradient. Risers that are to be installed under Parisher Road should significantly reduce this problem.

Middle Road also forms a dike, and funnels all the water draining through these zones to the Northwest Fork channel. The series of culverts proposed to be installed under this road should significantly increase the flood plain area and reduce the drainage bottleneck.

Water levels will not respond quickly to management in this watershed. Water will move slowly because of the flat terrain, distance between shallow ditches, and close proximity of the land elevation to the waters of the Alligator River. Most of the runoff will occur as sheet flow to the mouth of the Northwest Fork.

Blue Zone (Watershed #3)

Water will be managed to the surface of the ground in this zone. Management will be dictated by the drainage needs along Chinkapin, Northern, and Nodwell Roads. Water elevations in ditches will be set as needed for drainage in conjunction with the Yellow Zone.

Yellow Zone (Watershed #3)

The management of this zone will be governed by the drainage needs of the Blue Zone. Overland flows should not present a problem to adjacent upstream, landowners.

4.0 ALTERNATIVES INVESTIGATED, EVALUATED, AND COMPARED

The FWS requested that a total water management plan be prepared for the NWR. This effort was to include a comparison between two water management alternatives, and an evaluation of the on-site and off-site impacts associated with implementing water management practices. The information is presented in this study as Alternative #1 and Alternative #2.

Alternative #1 is the present condition, where only a few water table management structures are installed. This alternative is to be compared with Alternative #2, which is the future condition with all proposed water table management structures (risers) installed.

The description of each alternative and the effects of implementing the suggested water management practices are presented in the following sections.

4.1 Alternative #1 (Present Condition)

There are eight flashboard risers (risers) located throughout the NWR. Seven of the eight existing risers are located south of Lake Phelps in Watershed #1 (Map 1A, Appendix A). The remaining riser is located in Watershed #2 at the intersection of Western and Harvester Roads (Map 2B, Appendix A). This riser is not indicated on Map 2B because it will not be used for managing water in the proposed water management plan.

Watershed #1

Most the existing risers are located at random points throughout Watershed #1. The drainage of Watershed #1 is partially controlled. These risers provide adequate water control for the area influenced, but will provide limited benefits for managing the total volume of water entering and leaving the NWR.

Watershed #2

The water flows uncontrolled throughout all of Watershed #2 (Map 2C, Appendix A). Water flows in several different directions in an attempt to follow the natural contour, or to flow to the canal that has the best outlet. Drainage problems have occurred with adjacent landowners because of the erratic drainage patterns created when the canals were dug.

Watershed #3

The flow of water in Watershed #3 is governed by uncontrolled canals that were dug when this area was developed to service adjacent, upstream, landowners. Much of the natural contour that carried excess water by sheet flow to the Alligator River has been blocked by roads that serve as dikes.

This diking effect caused by the roads has created drainage problems for the adjacent landowners. Much of the water that would normally sheet flow along the natural contour has been forced into the drainage systems.

4.1.1 Water Quality Impacts (Alternative #1)

The development of part of the NWR for farmland in the 1970s may have contributed to some of the water quality problems experienced in the Albemarle and Pamlico Sounds.

Water management guidelines published by Evans, Gilliam, and Skaggs, 1991, indicate that agricultural operations do generate concentrations of nutrients in drainage waters that can be removed from the field through the drainage system. These guidelines suggest that a 5-10% increase in annual drainage outflows can be realized from a field that has been developed for the production of agricultural crops, and nutrients can be carried off-site to drainage outlets.

Furthermore, agricultural cropland has been implicated in a study by Craig and Kuenzler, 1983, as being the major nonpoint source of nitrogen and phosphorus contributing to the nutrient enrichment of the tributaries on the Albemarle Sound.

These and other studies indicate there is a strong possibility that the development of the NWR resulted in increased drainage outflows that may have carried any excess nutrients generated by the farming operations directly to surrounding rivers and into the sounds.

At this time, most of the farmland in the NWR has been abandoned. Studies by Gregory, et al., 1984, indicated the drainage water leaving the area south of Lake Phelps is at or near the quality of water normally found in an undeveloped pocosin. Gregory described this water as being typically low in nutrients, conductivity, and pH, and high in humic acids and color.

4.1.2 Social And Political Issues (Alternative #1)

Drainage

When First Colony Farms (FCF) owned and operated the area that is now the NWR, a line of communication with the adjacent landowners for the purpose of managing water was not needed. The drainage system was allowed to flow freely, and the outlets were maintained to the rivers by First Colony Farms.

The drainage system that was once totally controlled by FCF is now used by many individual landowners and the NWR. Currently, there is no coordination between the NWR and the adjacent landowners for the maintenance of the drainage outlets. As a result, drainage outlets are being clogged with debris, which is reducing the rate of drainage.

The reduction in the capacity of the drainage outlets has magnified the concerns of adjacent, downstream, landowners that drainage from the NWR is causing their land to flood. This has lead to conflicts over water management decisions.

Roads

The road system is also a point of concern to the NWR managers and to adjacent property owners. NWR managers are concerned about the impacts to the road system when water management practices are implemented. Adjacent landowners are concerned with current road use policies.

The road system within the NWR was constructed when the drainage system was installed. Ditch spoil, which is composed of the sandy material that underlies the organic surface of the soil, was used to create a roadbed. This sandy material was placed directly on the organic surface, and is not capable of supporting heavy trucks or equipment.

According to local residents, the condition of the roads has not changed significantly since they were constructed. The NWR is facing the same problems that were experienced by FCF. The roads oscillate from impassible to very trafficable, depending upon the weather or fires.

4.1.3 Modelling (Alternative #1)

Three computer models were used to evaluate the hydrologic conditions of Alternative #1: WSP2, DRAINMOD, and TR20.

WSP2 (channel hydraulics program) was used to evaluate the flow capacities of main and collector canals in the area below Lake Phelps. WSP2 input data for roads, culverts, risers, and cross-sections were taken from field survey data. For modelling, channel out-of-banks flow areas were assumed to be three times the top width of the channel.

DRAINMOD (field water table management program) was used to evaluate runoff and drainage from individual fields (generally 300 feet wide by 2,500 feet long) for present watershed conditions. Specific field information, such as the influence of risers, elevations, etc., along with general inputs are shown in Tables 4.2-A and 4.2-B.

TR20 (watershed hydrology program) was used to combine the runoff predicted by DRAINMOD for individual fields and determine the peak outflows after major rainfall events (1960 - 1988) for the entire watershed. Daily runoff from DRAINMOD, along with channel ratings from WSP2, were used as inputs for TR20.

TR20 was calibrated by not allowing storm flow elevations to exceed the level of the soil surface plus runoff depth in the uppermost sites of each drainage channel. This calibration was used to check the validity of the TR20 conversion of daily runoff from DRAINMOD to a runoff hydrograph. The runoff hydrograph is modified by a peak rate factor (K) which can range from 600 for steep terrain to about 50 for flat coastal areas. A (K) value of 76 was used because it closely matched TR20 stream flow elevations to DRAINMOD flood elevations in the upper reaches of the watershed.

Table 4.2-A Summary of soil property inputs to DRAINMOD for pocosin site in eastern North Carolina (Gregory, et al., 1984)

Saturated hydraulic conductivity, K	K = 70	cm/hr	for		depth	<	36 cm
	K = 0.02	cm/hr	25	<	depth	<	140 cm
	K = 0.44	cm/hr	140	<	depth	<	234 cm

Depth to restricting layer	= 234 cm
Water content at lower limit available to plants	= 0.45 cm^3/cm^3
Saturated water content in root zone	= 0.74 cm^3/cm^3

SOIL WATER CHARACTERISTIC FOR SURFACE LAYER		DRAINAGE VOLUME AND UPWARD FLUX		
Theta (cm^3/cm^3)	Head (cm)	Water Table Depth (m)	Drainage Volume (mm)	Upward Flux (mm/day)
.74	00	0	0	>20
.725	-2	0.2	3.3	0.60
.725	-10	0.4	8.3	0.30
.715	-25	0.6	17	0.23
.665	-50	0.8	27	0.17
.635	-75	1.0	38	0.12
.635	-100	1.2	50	0.08
.575	-150	1.4	63	0.06
.555	-200	1.6	76	0.03
.5	-500			
.45	-15000			

GREEN-AMPT INFILTRATION PARAMETERS

Water table depth (cm)	A (cm^2/hr)	B (cm/hr)
0	0	0
25	0.85	4.12
50	1.64	2.63
75	1.74	2.00
100	1.40	1.60
150	1.80	1.20
500	0.50	1.00

Table 4.2-B: Summary of drainage system and crop parameter inputs to DRAINMOD for pocosin site in eastern North Carolina, (Gregory, et al., 1984)

DRAINAGE SYSTEM PARAMETERS (OPEN DITCHES)

Drain depth	= 140 cm
Effective drain radius	= 19 cm
Surface depressional storage	= 2.5 cm
Drain spacing	= 100 m

CROP PARAMETERS (POCOSIN SCRUB - SHRUB)

Effective root depth	= 30 cm
Length of growing season	= 365 days

4.2 Future Condition - Water Management (Alternative #2)

The drainage system on the NWR will be controlled by a series of risers. Controlling drainage should improve water quality, enhance wildlife habitat, restore a semblance of the original pocosin hydrology, reduce the chance of wildfire, and improved drainage conditions on adjacent, downstream, farms.

The NWR is divided into three watershed management areas to contain and control the water table and ditch water levels. These areas are shown on Maps 1A, 2A, and 3C, and Appendix A, and have been discussed in detail in Sections 3.2 and 3.3 of this study.

Watershed #1 - Alternative #2 (Maps 1A, 1B, and 1C, Appendix A)

The general hydrology and flow patterns of Watershed #1 will be altered by a series of risers. These risers are designed to maximize the water storage capabilities of the drainage system. This watershed is the most intensively drained, and has the potential to produce the greatest problems with respect to downstream landowners.

Watershed #2 - Alternative #2 (Maps 2A, 2B, and 2C, Appendix A)

The drainage patterns of Watershed #2 have been altered to reduce the chance of overland flows on to the Williams' property, and to allow storm runoff to follow the natural contour and historic sheet flow patterns. As a result of the concerns for the Williams' property, it will be difficult to restore the natural pocosin type hydrology to the higher elevations of this watershed.

Watershed #3 - Alternative #2 (Maps 3A, 3B, and 3C, Appendix A)

Modifications were made in this watershed to allow storm runoff to follow the natural contours and historic sheet flow patterns. These modifications will reduce flooding on adjacent, upstream, landowners by increasing drainage capacities, and preventing runoff from the NWR from entering drainage systems that serve these landowners.

Modelling Alternative #2

The same methods described in Section 4.1.3 for WSP2, DRAINMOD, and TR20 were used in this alternative for the analysis of hydraulic and hydrologic effects for all works of improvement proposed in Alternative #2. These works of improvement would include the installation of risers, culverts, ditch plugs, etc., as discussed in Section 3.2 of this study.

The WSP2 channel hydraulic models for Alternative #1 (present condition) were modified to include all proposed works of improvement in Alternative #2. Changes in water table depths which were set by risers, were evaluated using DRAINMOD. The predicted drainage from DRAINMOD and the channel flow ratings form WSP2 were then inputted into TR20 in order to predict storm flow leaving the NWR for this alternative. For modelling, the risers were set with their weirs two feet below average ground elevation to allow passage of bank-full channel capacity. These predicted storm flows could have been altered somewhat by raising or lowering these weirs, but for comparison with Alternative #1, are being held at this design flow elevation.

4.3 Comparison of Alternatives

Comparisons were made between Alternative #1 (present conditions) and Alternative #2 (proposed conditions). The consequences of managing the water tables and ditch water levels on the NWR were evaluated. On-site and off-site impacts were investigated by comparing changes in water table fluctuations, volumes of drainage, and peak flows.

4.3.1 Water Table Fluctuations And Drainage Volumes

DRAINMOD simulations were used to determine the fluctuations of the water table between controlled and uncontrolled drainage conditions on the NWR. Simulations were made for the period 1960 - 1988, and a comparison was made between the water table elevation with and without drainage control. Figures 4.3-A through 4.3-I illustrate these comparisons for the 1980 to 1988 period.

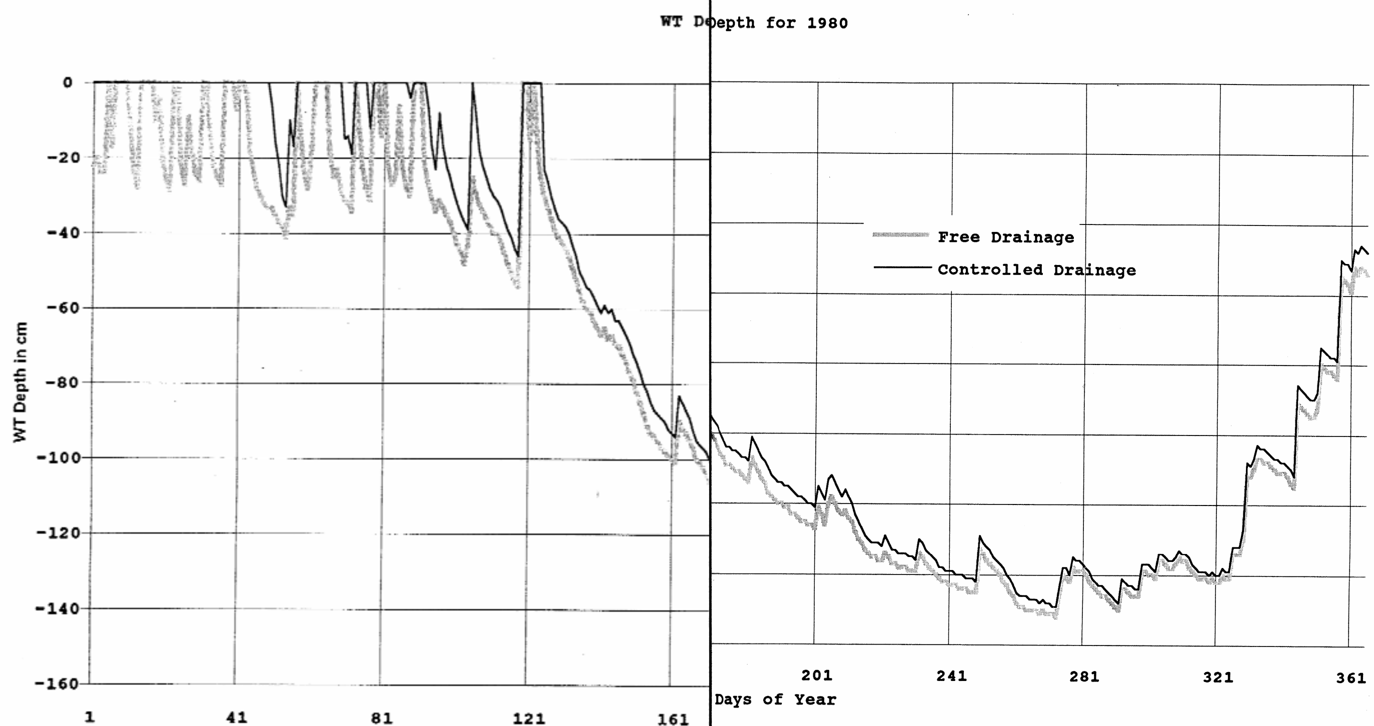


Figure 4.3A Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1980. Pocosin Lakes NWR

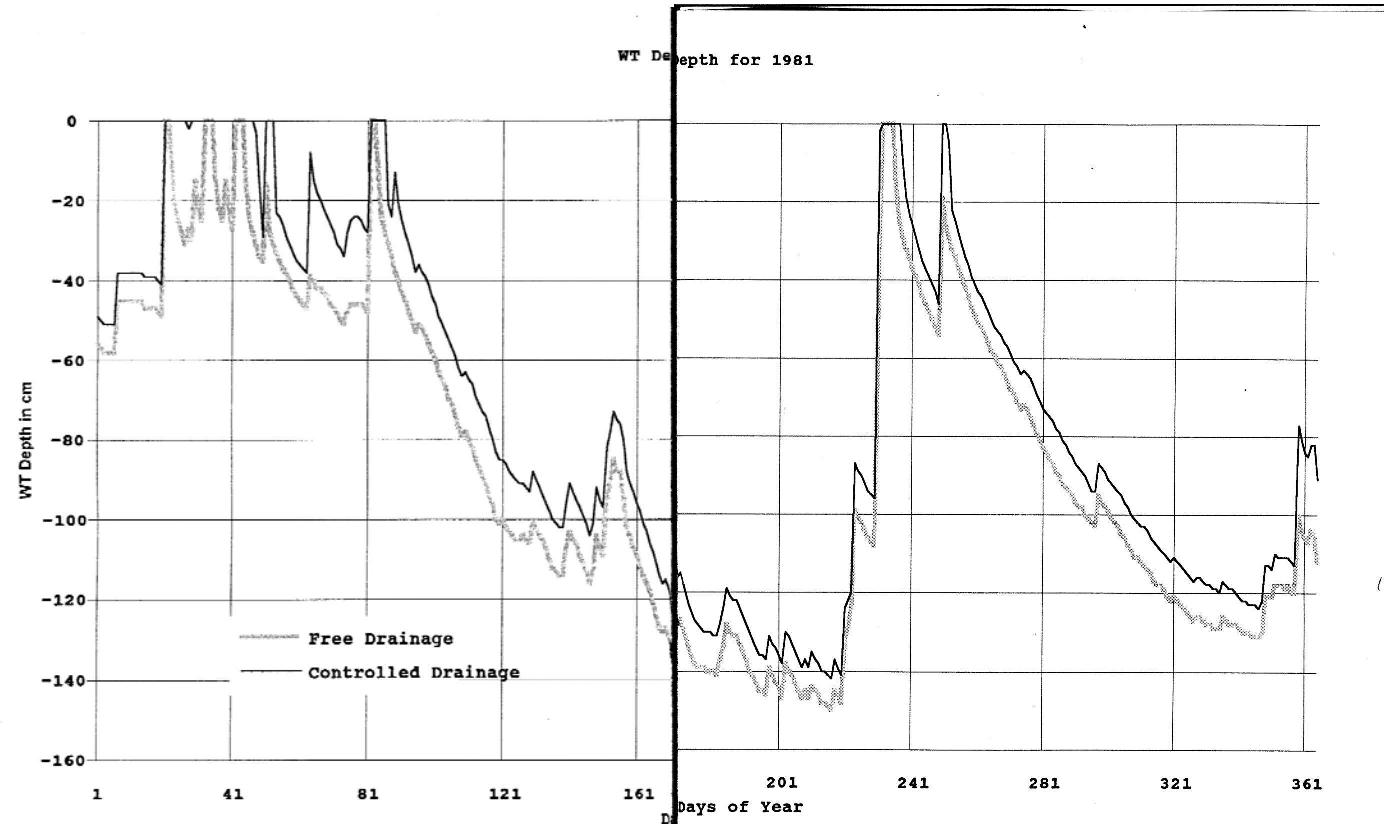


Figure 4.3B Output from Drainmod showing water table depth in cm (1 cm = 2.54 cm) versus days of the year for 1981. Pocosin Lakes NWR

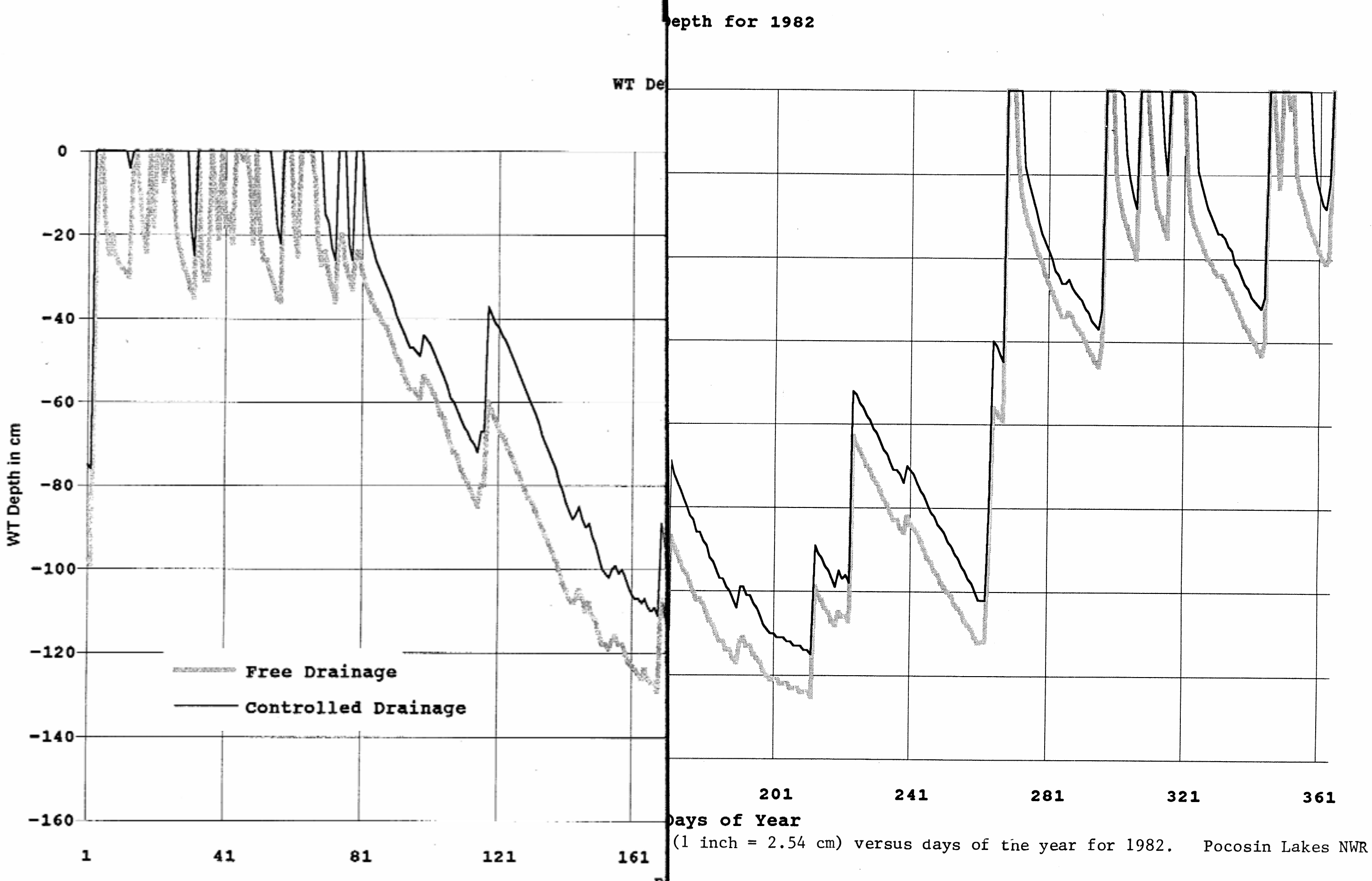


Figure 4.3C Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1982. Pocosin Lakes NWR

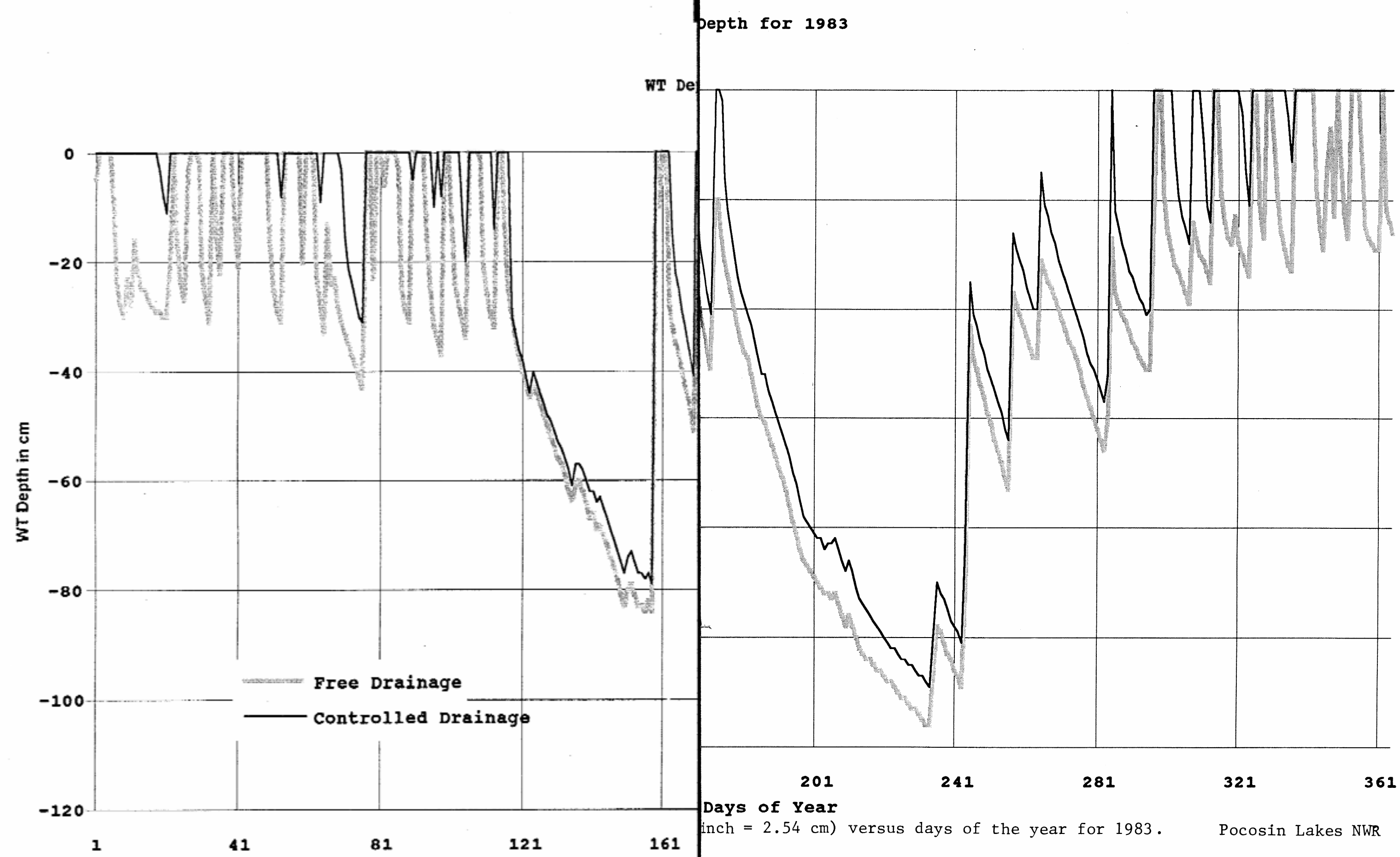


Figure 4.3D Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1983. Pocosin Lakes NWR

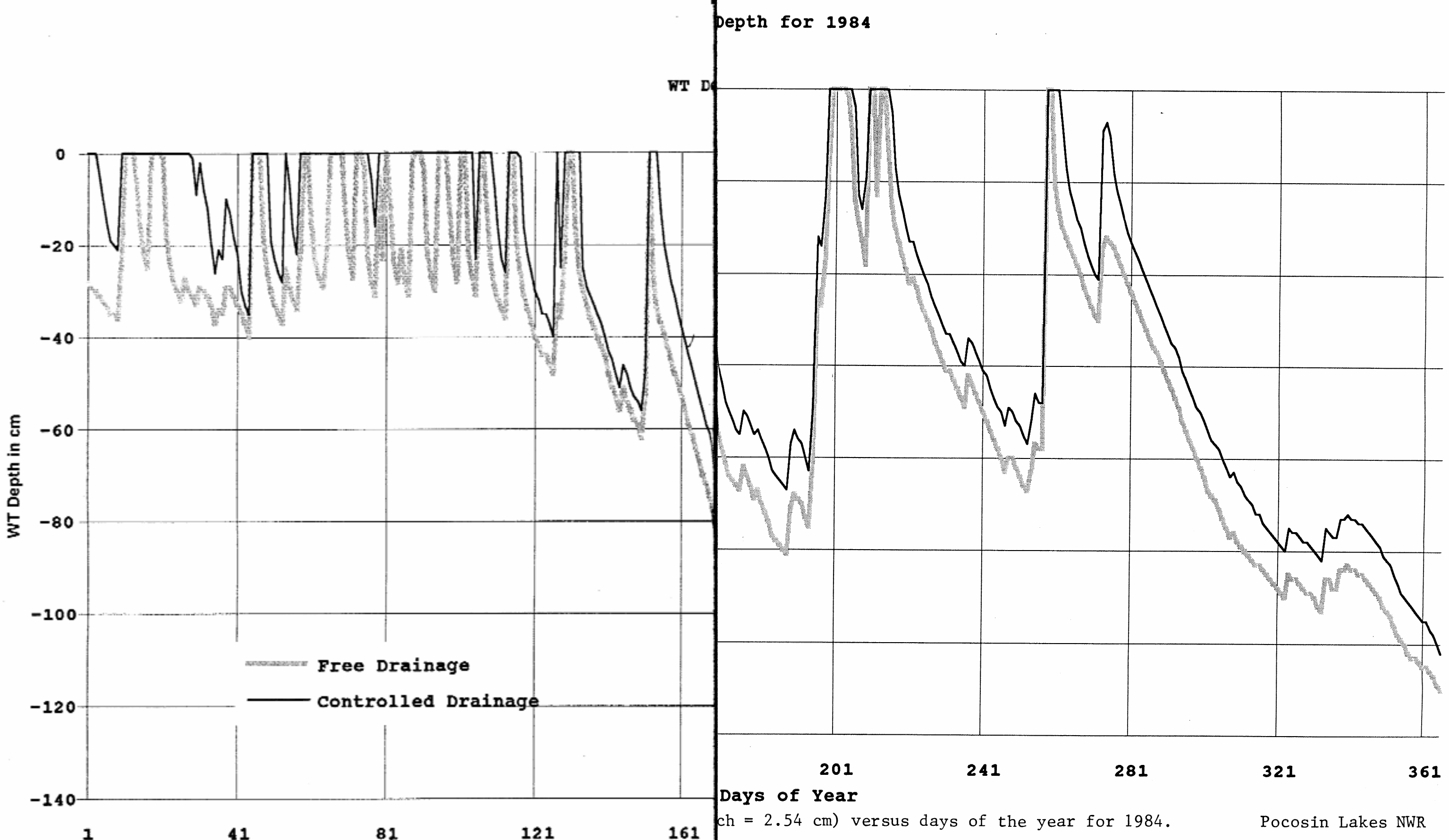


Figure 4.3E Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1984. Pocosin Lakes NWR

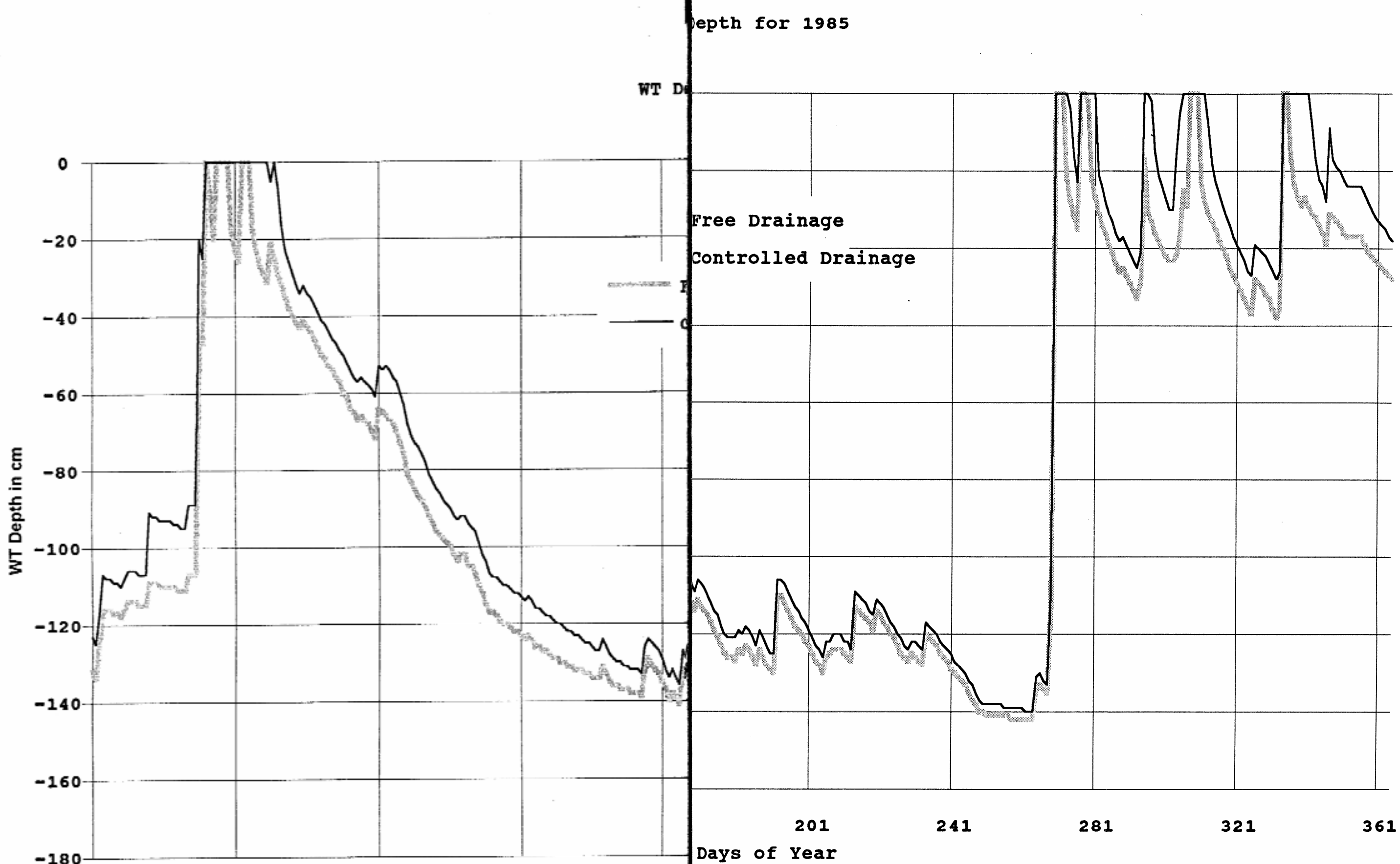


Figure 4.3 F Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1985. Pocosin Lakes NWR

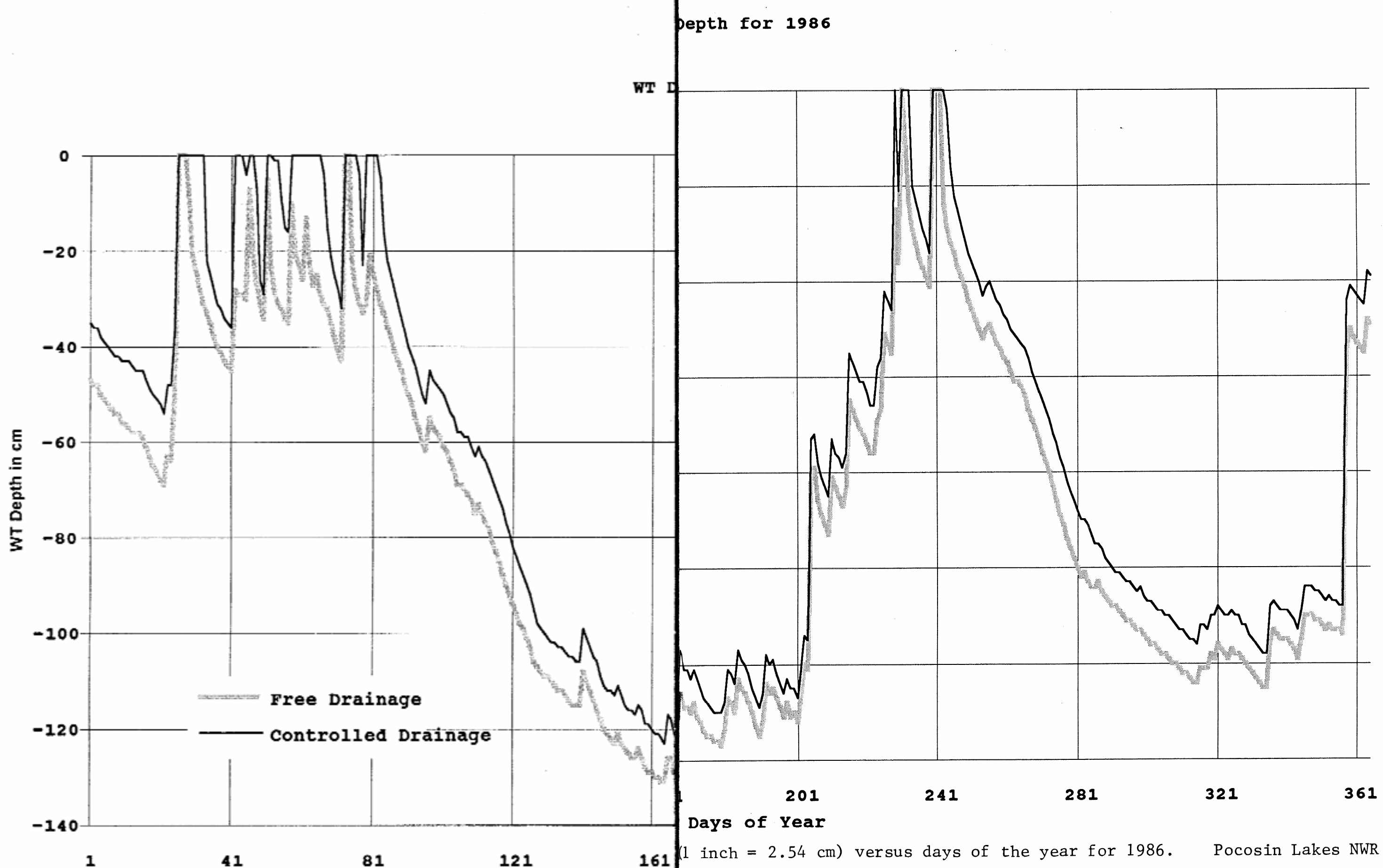


Figure 4.3G Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1986. Pocosin Lakes NWR

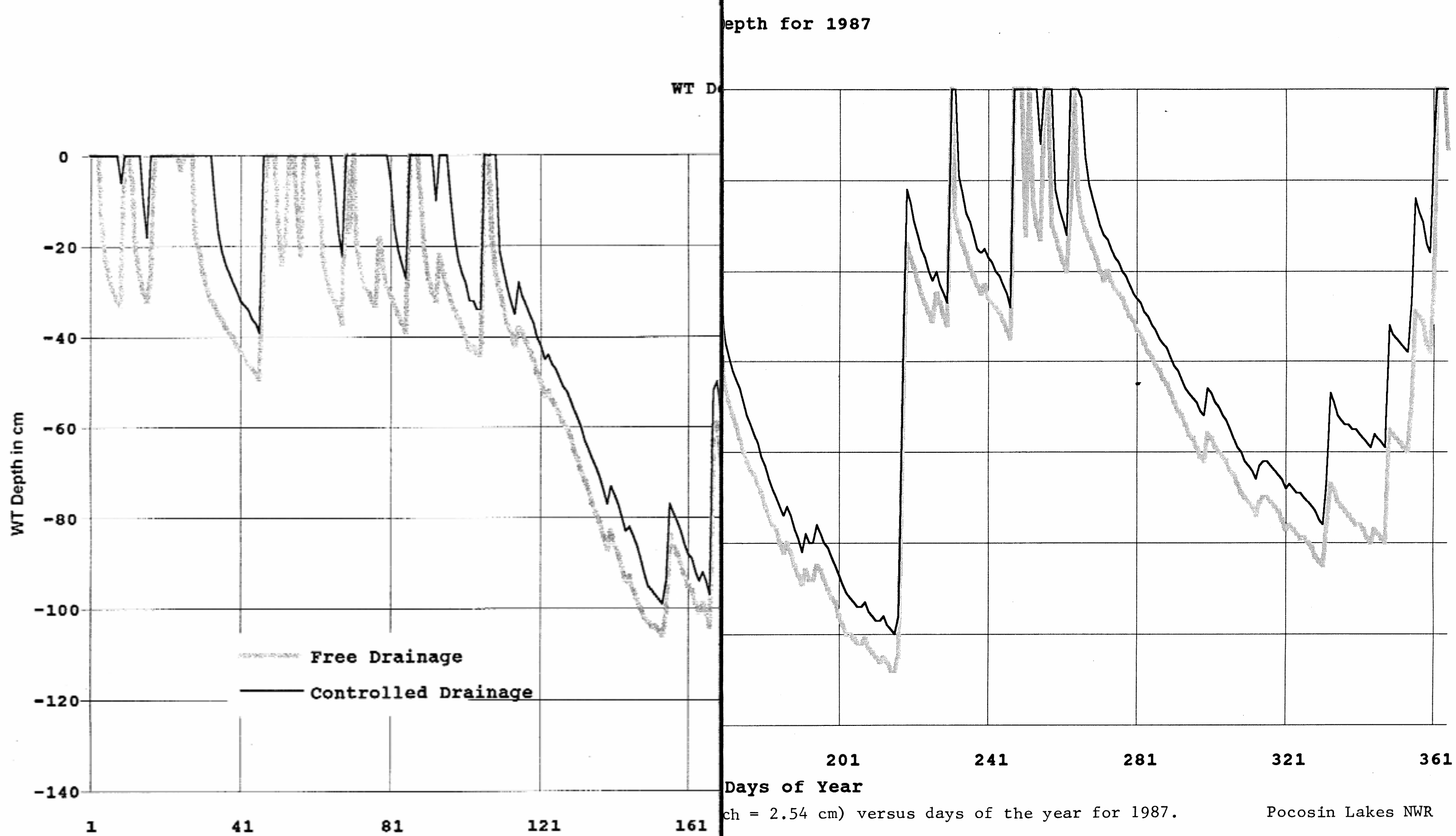


Figure 4.3H Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1987. Pocosin Lakes NWR

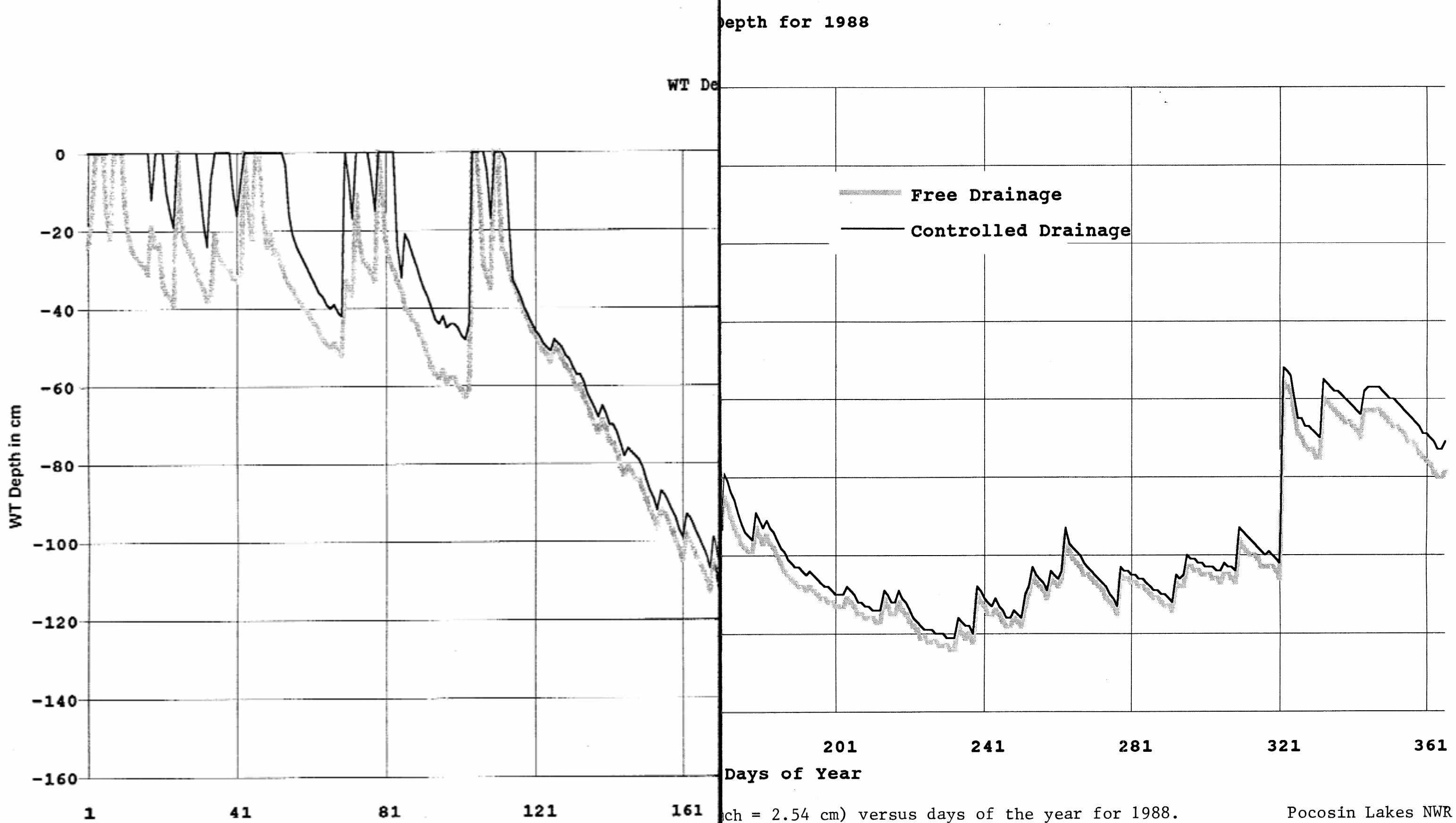


Figure 4.3I Output from Drainmod showing water table depth in cm (1 inch = 2.54 cm) versus days of the year for 1988. Pocosin Lakes NWR

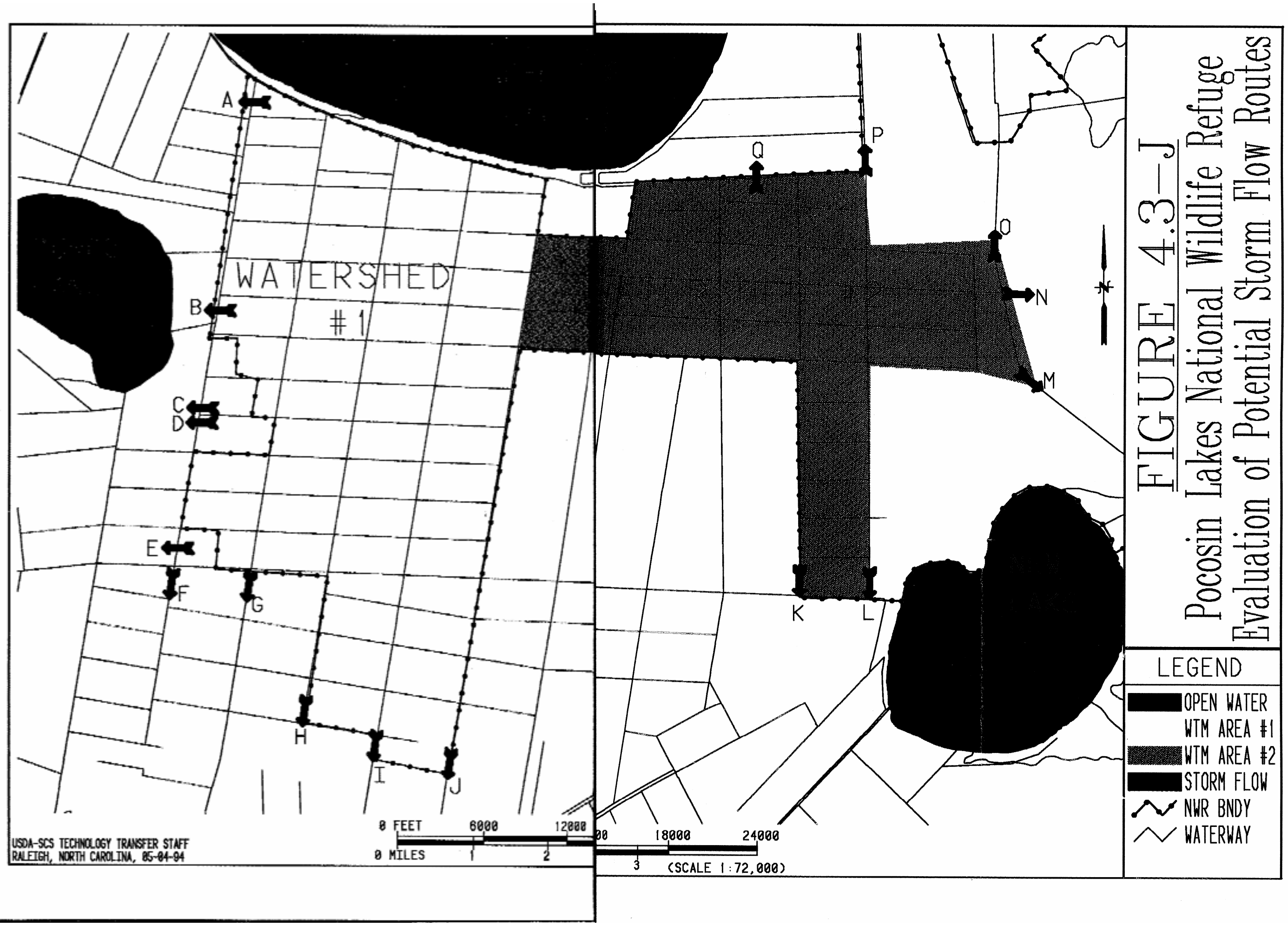


FIGURE 4.3-J
Pocosin Lakes National Wildlife Refuge
Evaluation of Potential Storm Flow Routes

In general, the water table was higher with drainage control in cool wet months. This occurs because evapotransporation rates are low during this period and the drainage system removes most of the water from the soil. Therefore, during cool wet months, the level at which water is controlled in the canals will have a bearing on the elevation of the water table in the soil.

Adjacent, downstream, landowners will receive more water after manageable rainfall events from the NWR during cool wet months when drainage is not controlled.

Without water control, ditches flow continually after manageable rainfall events. This lack of control drains the water that could be stored, and maintains water levels in downstream ditches for long periods of time. This reduces the capacity of downstream drainage systems.

During hot, dry months, evapotransporation rates usually increase, removing more water from the soil than the drainage system. During this period, controlling drainage will have less impact (about two-three inches higher) on the elevation of the water table in the soil. Water tables will rise and fall due to the stronger influence of evapotransporation, and controlled water tables will mirror the fluctuations of uncontrolled water tables. During this period, when water tables are low, water table management structures can capture most of the rainfall from small to medium storms and contain it on site.

Adjacent, downstream, landowners will benefit from controlled drainage during hot dry months. Runoff produced from most unmanageable rainfall events can be stopped as soon as water recedes into the canal banks. This will reduce the amount and duration of downstream flooding during dry months.

4.3.2 Effect on Peak Storm Flows

Three computer models were used synchronously to determine the elevation of peak storm flows for the NWR: WSP2, TR20, and DRAINMOD. Usually only WSP2 (channel hydraulics) and TR20 (hydrology) are required for making peak storm flow predictions, but the hydrology of the NWR is governed by the fluctuation of the water table. As a result, DRAINMOD (water table fluctuations) was used to predict the runoff and drainage from individual fields. This information was used as input for TR20 to predict the hydrology of the NWR.

The period between 1960 and 1988 was modelled to determine the largest storms of record. Three storms were used to evaluate the peak flows leaving the NWR watershed for the alternatives given in Sections 4.1 and 4.2 The storms occurred on the following dates:

RAINFALL

Storm No.	Date	Amount
1	9/11/1960	3.25 in. (8.26 cm)
	9/12/1960	4.37 in. (11.1 cm)
2	9/30/1971	4.53 in. (11.51 cm)
	10/1/1971	3.80 in. (9.65 cm)
	10/2/1971	0.54 in. (1.37 cm)
3	7/18/1984	3.31 in. (8.41 cm)
	7/19/1984	0.75 in. (1.90 cm)
	7/20/1984	0.54 in. (1.37 cm)

Storms 1 and 2 produced the largest amount of runoff for the period of record, and may be tropical in origin. Storm 3 is the largest summer storm runoff event and probably not of tropical origin.

Key points of low elevation were evaluated throughout the entire NWR watershed to determine the size storm that would be required to produce off-site flooding. These areas are shown on Figure 4.3-J. Points "A" through "M" were evaluated, and based on this information the following general statements can be made:

A. All points of concern, A through M on Figure 4.3-J, will experience overflows when rainfall events exceed the capacity of the drainage system. Controlling drainage will usually result in higher overflow elevations if excessive rainfall occurs during wet cool months when water tables are higher.

   For example, the models showed that the overflows would be approximately 0.3 foot higher during wet cool periods if drainage was controlled on Allen Road Canal.

B. At all key points, peak flows increased by less than 5% when drainage was controlled, but total drainage volume leaving the NWR decreased. The increase was not considered significant when compared to the flood protection benefits received.

   Peak flows returned to normal flow faster as a result of controlling the drainage.

C. When water was controlled, the models revealed that flood flows generally recede in a day or two. If drainage was uncontrolled, flood flows generally continued for two to four days.

D. In Watershed #2, points Q, P, K, and L will have less chance of overflow because drainage areas influencing these points have been reduced and redistributed. For example, as a result of allowing water to flow down Harvester Road, approximately 11% of the total drainage area is affected. This will reduce the potential for flooding at Williams' Canal. Refer to Tables 4.3.2-A and 4.3.2-B for more in depth information.

Table 4.3.2-A: Comparison of NWR drainage areas which contribute to flow leaving the NWR for Alternative #1 and Alternative #2. See Figure 4.3-J for a locational reference to this table.

LOCATION	DA FOR ALT. #1	DA FOR ALT. #2	DIFFERENCE IN DA	% OF CHANGE
@	(sq. miles)	(sq. miles)	(sq. miles)	
A	*	*		
B	*	*		
C	*	*		
D	*	*		
E	*	*		
F	7.0	7.0	0	0
G	5.0	5.0	0	0
H	6.8	6.8	0	0
I	7.3	7.3	0	0
J	4.2	2.6	-1.6	-38
K	6.6	1.4	-5.2	-79
L	0.2	3.1	2.9	1450
M	$	$	$	$
N	4.1	8.7	4.6	112
O	$	$	$	$
P	*	*		
Q	*	*		

* - This area does not have a drainage area but does have potential overland flow during large storm events.

$ - Locations M, N, and O are all fed by the same drainage area which is shown at location N.

@ - See Figure 4.3-J for the location of storm flow leaving the NWR watershed.

TABLE 4.2.3-b : Comparison of outflow peaks from the NWR for Alternatives 1 and 2.
See Figure 4.3-J for a locational index to this table.

Location	Alt. No.	PEAK FLOWS LEAVING THE NATIONAL WILDLIFE REFUGE in CFS						
		Storm #1	% Diff	Storm #2	% Diff	Storm #3	% Diff	Avg % Diff
$	&	(cfs)	@	(cfs)	@	(cfs)	@	@
---------	---------	---------	---------	---------	---------	---------	---------	---------
A	1	0		0		0		
			*		*		*	*
	2	27		28		0		
B	1	0		0		0		
			*		*		*	*
	2	0		0		0		
C	1	310		308		197		
			2.90		5.52		10.66	6.36
	2	319		325		218		
D	1	40		39		10		
			15.00		20.51		160.00	65.17
	2	46		47		26		
E	1	106		110		65		
			-30.19		-28.18		-41.54	-33.30
	2	74		79		38		
F	1	235		237		219		
			-0.85		-0.84		-0.91	-0.87
	2	233		235		217		
M	1	92		92		88		
			-95.65		-95.65		-95.45	-95.59
	2	4		4		4		
N	1	105		106		29		
			392.38		389.62		1086.21	622.74
	2	517		519		344		
O	1	49		49		48		
			-91.84		-91.84		-91.67	-91.78
	2	4		4		4		

& - There are two alternates evaluated in this study and are as follows;
1=Present conditions, 2=Future conditions w/WTM str's installed.
$ - See figure 4.3-J for the location of storm flow leaving the NWR watershed.
* - Cannot compute % differences when Alt #1 value equals zero.
@ - Percent Differences are computed as the change from alt # 1.

4.3.3 Effect on Droughts

Controlling drainage will increase the amount of plant available water retained in the soil from rainfall events during the growing season. When drainage is controlled, the water table will recede slower, and plants can utilize the available water for two to ten days longer, depending upon the weather conditions. This increase in available water can be advantageous to the NWR. A two to ten day increase in plant water supply can be very critical during summer droughty periods.

5.0 DESCRIPTION OF THE STUDY AREA

The NWR is located on the Albemarle-Pamlico Peninsula. This peninsula is surrounded by the Albemarle and Pamlico Sounds, which form the largest estuarine system in any single state on the Atlantic Coast (Street and McClees, 1981).

The NWR, which encompasses approximately 111,000 acres, is situated in Washington, Hyde, and Tyrrell Counties, North Carolina (Location Map, Appendix A). Lake Phelps and Pungo Lake lie just north and west of the site, respectively. Alligator Lake (New Lake) lies approximately three to four miles to the southeast. The Pungo River is located to the west and south of the site and empties into the Pamlico River near Pamlico Beach. The Alligator River is located east of the site and empties into the Albemarle Sound near Sandy Point and East Lake (PMA, 1983).

The surface elevation within the NWR ranges from approximately 18 feet (National Geodetic Vertical Datum), at the highest point south of Lake Phelps to approximately 2 feet or less around Northwest Fork and the Alligator River.

5.1 History

The NWR area was originally covered by pocosin-type wetlands. The major canals and some of the collector ditches were installed between the mid 1800s and the 1960s. The pocosin-type vegetation was cleared from most the NWR area in the late 1960s and early 1970s by First Colony Farms. The extensive drainage system, that still exists today, was also installed during this period. Agricultural production was attempted, but land preparation and plowing proved to be very difficult on these peat soils. Some of the farmland was converted to pasture, but most was abandoned and is reverting back to pocosin type vegetation.

In 1980, First Colony Farms (FCF) received a permit to mine peat in a 15,000-acre portion of the NWR, as shown in Figure 5.1. FCF initiated preparation for mining on a 320-acre block in the northwest corner of the permitted area in October, 1980 (see Figure 5.2). A major portion of the block (75%) was prepared for mining by incorporating the natural vegetation into the peat and shaping the surface of the mining strips to achieve a 1% slope from the center of the strip to sthe field ditch. The remainder of the block was left in natural vegetation (Gregory, et al., 1984).

On April 29, 1981, an intense wildfire moved onto FCF property from the Pungo National Wildlife Refuge (Figure 5.3). In the effort to extinguish the fire, all main canals from the permitted area were blocked and the entire area was flooded with water pumped from Lake Phelps. The fire was not completely controlled until early June 1981. In the areas burned by this fire, vegetation was destroyed and the peat was consumed to an average depth of five inches, leaving large quantities of ash on the surface (Gregory, et al., 1984)

Due to economic or regulatory restrictions no peat mining has occurred.

A fire occurred in 1985 which affected most of the NWR with many areas being completely denuded of vegetation.

In 1990, this land was donated to the U.S. Government and became the "Pocosin National Wildlife Refuge" under the stewardship of the U.S. Fish and Wildlife Service.

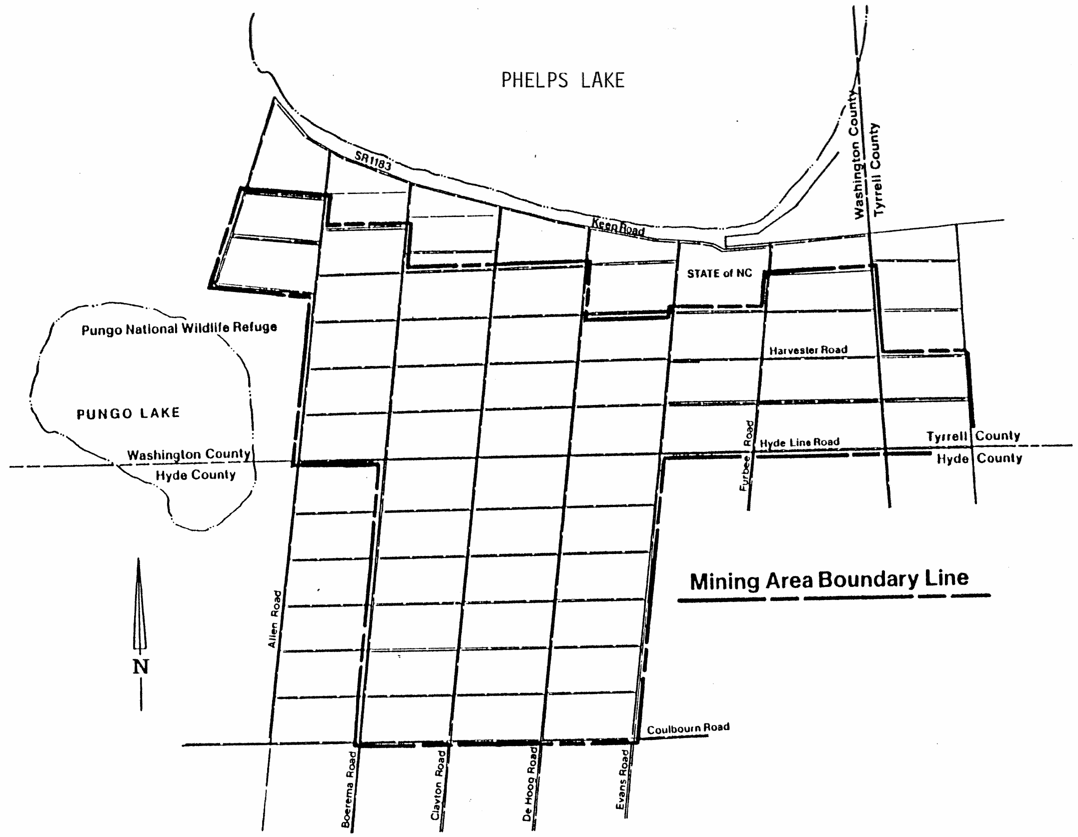


Figure 5.1 Permitted peat mining area (PMA, 1983).

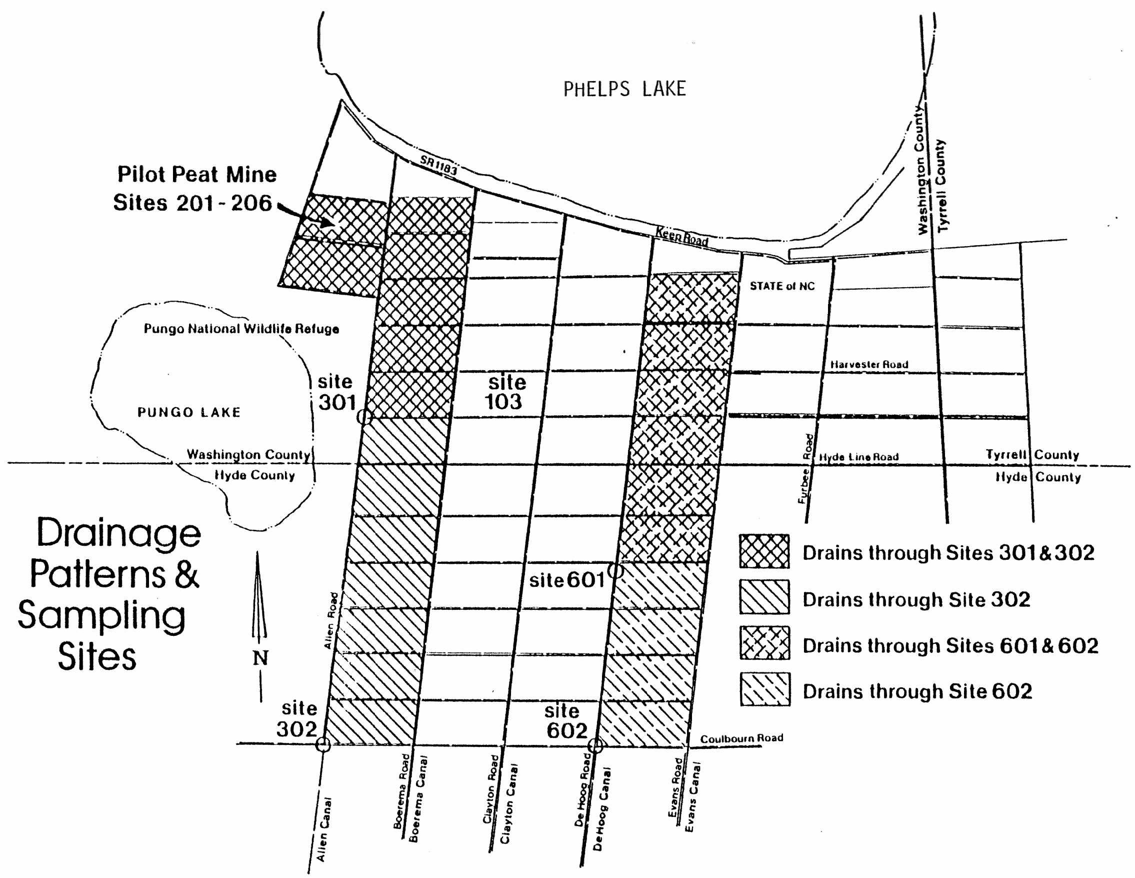


Figure 5.2 Location of pilot mining area and sampling sites (Gregory, et al., 1984).

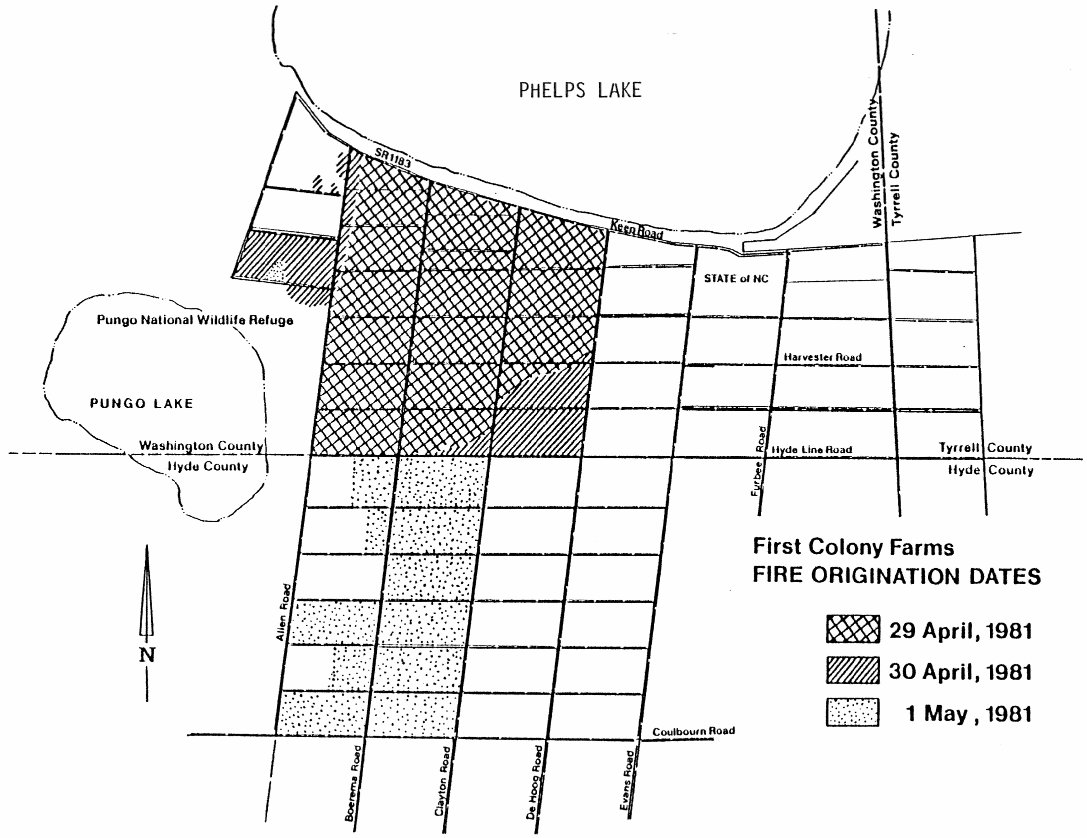


Figure 5.3 Portion of permitted mine area burned by wildfire in 1981 (Gregory, et al., 1984).

5.2 Land Use/Land Cover

The vegetation on the refuge is dominated by typical pocosin-type vegetation. The most dominant shrubs are titi, fetter-bush, bitter galberry, and Zenobia. The typical trees found are pond pine, Atlantic white cedar, bald cypress, red maple, sweet bay, and loblolly bay (Christensen, et al. 1980).

The vegetation on the refuge occurs in various stages and densities. This vegetative diversity probably reflects the land use activities that have occurred since the pocosin was first manipulated by man.

Much of the land immediately south of Lake Phelps was cleared for farmland or pasture. These areas have been abandoned and brooomstraw, sumac, wax myrtle, and an occasional pond pine and loblolly pine are now the predominate types of vegetation found.

From Evans Road east toward the Scuppernong and Alligator Rivers, the NWR is composed of typical pocosin vegetation. The density and composition of this vegetation varies significantly due to the last wildfire. Areas that were burned are characterized by low shrubs with an occasional pond pine. The remaining unburned areas have a much greater density of typical pocosin-type trees.

The vegetation on the most eastern part of the NWR near the Northwest Fork and the Alligator River begins to change from typical pocosin to bottomland hardwood. Blackgum, Carolina ash, red maple, water tupelo, loblolly pine, and bald cypress are the predominant vegetation in these areas (Pamphlet).

5.3 Soils

The soils of the NWR were believed to be created by a combination of factors that exist in the Albemarle-Pamlico Peninsula. The rainfall of this area generally exceeds the evapotranspiration and groundwater discharge rates, thus resulting in excess moisture (Heath, 1975). The NWR landscape is gently sloping with great distances between natural drainage outlets, creating significant drainage problems that result in ponding of surface water and overland flow during wet periods (Daniels, Gamble, and Wheeler, 1977). This was a significant factor in the development of the organic soils because the landscape remained saturated with water for extended periods. Consequently, this enhanced swamp developed in areas that were higher in elevation than the surrounding mineral soils, thus the term pocosin, or swamp on a hill (Lilly, 1981).

Several soil types occur on the NWR. These soils vary mostly in the thickness of the organic soil (muck) material over mineral soil, and this thickness governs the classification, land use, and land value. Generally, if the muck layer is less than 16 inches deep, the soil is "mineral" and considered valuable for farmland. If the surface organic material is more than 16 inches deep, the soil is "organic" and becomes less valuable as farmland with increasing organic layer thickness. As a general rule, soils with more than 30 inches of muck are very undesirable for farmland.

The majority of the soils on the NWR are organic and the muck (peat) ranges from 16 inches to more that 55 inches deep. The deepest muck occurs northwest of the Alligator Lake (Figure 5.4). The organic soils that occur on the NWR are Pungo, Scuppernong, Ponzer, and Belhaven (USDA-SCS, Soil Survey).

There are some mineral soils in the NWR, and these soils are located on or near the western and southern boundaries of the NWR. Most of these soils were organic (>16 inches muck) before fire and drainage of the land destroyed much of the organic surface. Conaby, Wasda, and Roper are the dominant mineral soils with organic surfaces that are found on the NWR.

Due to the size of the NWR, soil maps cannot be included in this study.
A general approximation of the location of the mineral and organic soils can be made using Figure 5.4. The organic soils would generally be found in areas that are shown on the map from the zero isopach (yellow highlight) to the maximum thickness for peat (pink highlight). Due to the difference between the definition of peat by Ingram and the definition of muck by the USDA, organic soils as defined by the USDA may be found to extend beyond the zero isopach. However, as a general rule, the zero isopach can be used to approximate the separation between mineral and organic soils on the NWR.

5.4 Wetlands

The FWS classes the NWR as a Palustrine Wetland, scrub-shrub class (Cowardin, et al., 1979).

Almost all of the NWR would be classified as a wetland using the 1985-1990 Food Security Act (Farm Bill) definition for wetlands. Wetlands as defined by the Farm Bill requires three basic items:

1. Hydric soils

2. Prevalence of hydrophytic vegetation.

3. A water table during the growing season that remains at or above the surface for 14 consecutive days.

The only areas of the NWR that will not meet the current Farm Bill definition for wetlands are:

1. Areas that are presently being farmed, and that were farmed prior to 1985.

2. Areas adjacent to canals and ditches that will not meet the hydrologic requirements of the Farm Bill wetland definition. (Usually 50-300 feet from ditch or canal).

Any wetland determination for the purposes of defining Farm Bill restrictions will require an on-site investigation, and this investigation should precede any land disturbing activity. Converting wetland as defined and regulated under the Farm Bill will result in the loss of all farm program benefits provided by the USDA.

The U.S. Army Corps of Engineers have the authority for making wetland determinations as pertain to the Federal Water Pollution Control Act, specifically Section 404. Converting wetland as defined and regulated by Section 404 would be considered a violation of law. As a result, wetland determinations made by the U.S Army Corps of Engineers will supersede any determinations made in reference to the Farm Bill with respect to this law.

5.5 Drainage/Hydrology

The entire NWR area was once a pocosin where, during large storm events, overland flows of water were common to the surrounding rivers and lakes (Heath, 1975; Figure 5.5). Drainage has affected almost every area of the NWR to some degree.

5.5.1 Existing Drainage System

Figure 5.6 shows the existing drainage canals in the NWR.

The drainage system in the NWR area just south of Lake Phelps was installed for agriculture some years prior. Most of the field and collector ditches were probably installed when a major portion of the area was cleared in the late 1960s. The major canals and some collector ditches were installed at earlier times; some date to the mid-1800s. No exact records exist on dates that specific areas were drained and/or cleared. Main canals that are about six to nine feet (2-3 m) deep are spaced one mile (1.6 km) apart and are oriented north-south.

Collector ditches are about six feet (2 m) deep and are spaced at 0.5 mile (0.8 km) intervals. These ditches are oriented east-west, and discharge to the main canals. Field ditches, which are generally oriented north-south, had been installed in some parts of the NWR at 300 feet (100 m) intervals. During the 1980's, peat mining occurred on a limited area of the NWR below Lake Phelps. The areas that were cleared for mining generally had additional collector ditches installed to reduce the spacing to 150 feet (50 m).

The remaining areas of the NWR are drained less intensively. Canals traverse these areas randomly. Most surface and ground water is removed by evapotranspiration. In some cases, these canals were dug to provide drainage outlets for agricultural lands upstream.

5.5.2 Seepage

The deep seepage rate to the Castle Hayne aquifer from the NWR area was estimated to be 0.039 cm/year (Gregory, et al., 1984). Heath, 1975, calculated groundwater seepage to be as high as 1.0 cm per year. These rates are less than 1% of the rainfall (Table 5.5.2) and are small enough to be ignored in the water budget calculations. This indicates that the NWR area can be considered a closed system isolated from deeper aquifers for modelling purposes. This closed system would have rainfall as the only input of water and the water losses would be drainage and plant evapotranspiration.

The seepage into the NWR area from Lake Phelps was estimated to be 0.193 cm/year (Gregory, et al., 1984). This is also small enough to be ignored during modelling.

Currently, lateral seepage is affecting some adjacent landowners. Trafficablility is limited on several adjacent fields for several hundred feet from property line ditches in which water is being managed by the NWR. These impacts are minimal, and will be addressed by this management plan.

5.5.3 Water Table

The water table in the NWR area is primarily dependent on rainfall. The average yearly water budget (Table 5.5.2) shows that about two-thirds of this rainfall is utilized in evapotranspiration and about one-third leaves the area as drainage.

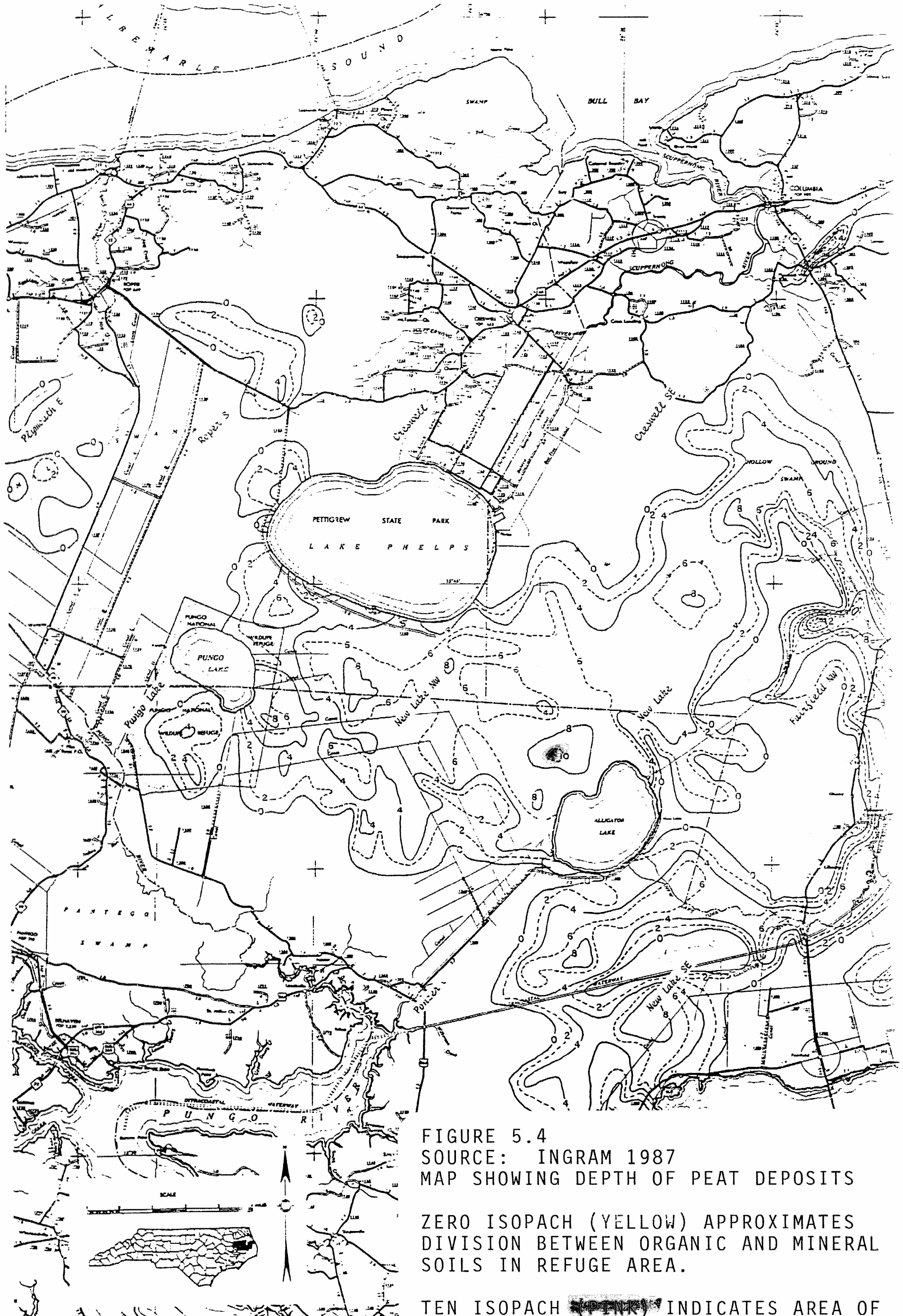


FIGURE 5.4
SOURCE: INGRAM 1987
MAP SHOWING DEPTH OF PEAT DEPOSITS

ZERO ISOPACH (YELLOW) APPROXIMATES DIVISION BETWEEN ORGANIC AND MINERAL SOILS IN REFUGE AREA.

TEN ISOPACH [redacted] INDICATES AREA OF DEEPEST PEAT DEPOSITS

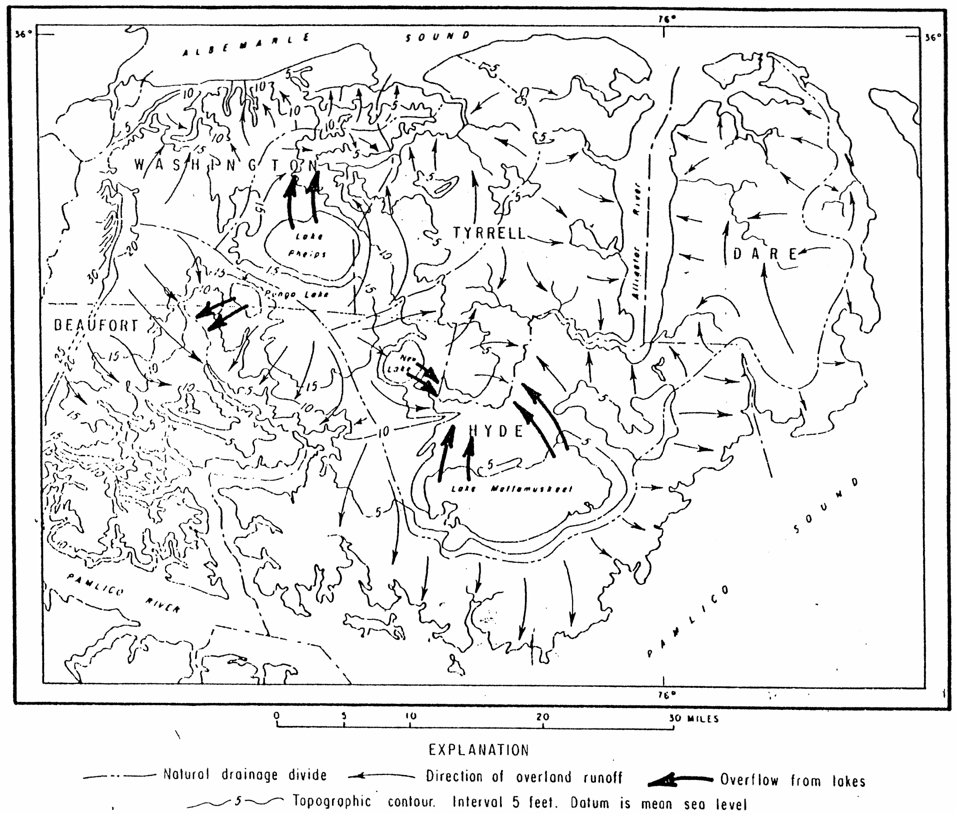
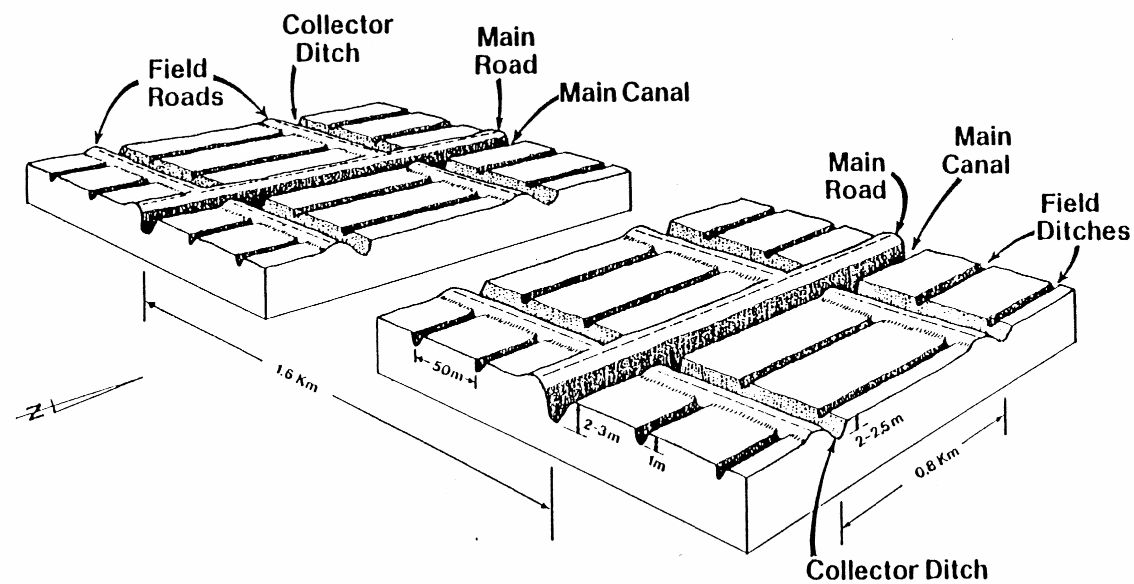


Figure 5.5 Paths taken by overland flow (Source: Heath, USGS, 1975).



Typical Artificial Drainage System for Mining
Sketch not to scale

Figure 5.6: Drainage system characteristics (Gregory, et al., 1984).

Table 5.5.2 Average Water Budget for the Albemarle-Pamlico Peninsula (Gregory, et al., 1984)		
Element	Amount (cm)	Percent of Precipitation
Precipitation	130	100
Evapotranspiration	91	70
Groundwater outflow	1	1
Runoff (by subtraction)	38	29

The "Average Water Budget" presented by Gregory, et al., 1989 represents the Albemarle-Pamlico Peninsula in general. The ratios of (evapotransporation) groundwater flow will change depending upon the intensity of drainage in a given area of the refuge. Generally, as the ditch spacing decreases, the amount of water leaving by drainage increases.

Evapotranspiration is low in the winter months and high during the hot summer months. The rainfall distribution for North Carolina is quite uniform, being close to four inches each month. Therefore, the water table is generally at or near the surface during the cooler months and can be as deep as five feet below the soil surface during the hot dry summer months.

6.0 METHODOLOGY USED AND DATA COLLECTED FOR PLANNING

This study involves four major steps:

A. Collection of field data (surveying, ditch velocities , etc.).

B. Consultation with adjacent landowners and community leaders, assuring that design and management concepts addressed their concerns.

C. Modelling, design, and compilation of the water management plan.

D. Conducting public meetings to inform NWR managers and adjacent landowners of the water management strategies, improvements, and community participation required for implementation of this water management plan.

6.1 Surveying

Elevation information along all NWR canals was needed to locate risers and to determine flood flow paths.

This work was completed during the spring of 1993. Standard surveying procedures were followed. Elevation and cross-section data was determined from tie-ins with local NCGS benchmarks. All elevations were measured to the nearest one-hundredth foot.

Surveys were performed to establish temporary bench marks (TBM) throughout the NWR. These surveys were performed by establishing base lines that connect North Carolina Geodetic Survey bench marks. All surveys were completed with a degree of precision ranging between excellent and ordinary leveling:

Excellent Leveling; allowable error = 0.05 ft. $\sqrt{M}$ (third order)

Ordinary Leveling; allowable error = 0.1 ft. $\sqrt{M}$ (fourth order)

M = distance in miles

The bench marks established throughout the NWR were adequate for the design of this water management plan. There was never an intent to establish bench marks that are of the precision required and used by the North Carolina Geodetic Survey (first and second order).

The density of the pocosin vegetation and the trafficability of the roads were the most limiting factors during the survey.

Due to the density of the pocosin vegetation, and the undulating ground surface, topographic lines were projected from road side ground elevation to road side ground elevation. This was deemed to be adequate for the design of this water management system because the general terrain slopes very gently, approximately one foot per mile.

Topographic maps that are presented were created by taking ground shots approximately 25 feet from roads. All shots taken were used for interpolating and extrapolating topographic lines between points.

6.2 Modelling

Three computer models were used to predict the hydrologic impacts of the present (uncontrolled), and future (controlled) alternatives presented in this plan: WSP2, DRAINMOD, and TR20. The method in which these models were used is presented in Section 4.1.3.

These models were used to: develop a water budget (DRAINMOD); study the hydraulic impacts of culverts, risers, and changing channel dimensions (WSP2); and to predict the response of a watershed to a rainfall event (TR20).

DRAINMOD was developed at North Carolina State University in the mid 1970s (Skaggs, 1978, 1980). It is based on a water balance in the soil profile and uses climatological records to simulate the performance of drainage and water table control systems. The model was developed specifically for shallow water table soils. Approximate methods are used to quantify the hydrologic components: subsurface drainage, subirrigation, infiltration, evapotranspiration (ET) and surface runoff.

The WSP2 model uses the Standard Step Method (Chow, 1959) to determine the backwater profile in a channel for a given flow. The Standard Step Method uses Manning's equation and the Energy (Bernoulli) equation in concert to start from a known channel position and progress up the channel, computing elevations for given flows. This method assumes sub-critical or critical flow. For this type flow, the upstream channel elevation is determined from channel characteristics, the amount of flow, and the downstream water elevation (backwater effect). Bridge structures are analyzed using a method which determines loss of conveyance coefficients which are used to estimate energy losses and flow profiles through the bridge section. Flow over roads and bridges is computed using the weir flow equation. Culvert flow is computed using either open channel flow, inlet controlled flow, or full culvert flow, whichever is appropriate for the flow profile being calculated.

The general input for WSP2 includes flood channel cross-section data, Manning's "n" values for channel reaches, bridge/road and culvert data, and starting conditions.

TR20 was developed to be used in project formulation hydrology. It is a very good tool to predict the response of a watershed to a rainfall event for several different alternatives.

TR20 could not be used independently in this case to predict runoff from the NWR. The watersheds on the NWR are unique due to the influence that the elevation of the water table has on the total amount of runoff, and time frame in which runoff occurs.

To address this problem, DRAINMOD and TR20 were used together. TR20 uses the runoff and drainage calculated by DRAINMOD for each field. The total runoff for each field is added and a cumulative total is produced for each section of the watershed in question. This process starts at the head of the watershed, taking into account the impacts of risers, culverts, and changes in channel size and grade, and proceeds to the lowest points of discharge. The end result is a prediction of the response of a watershed (time, and concentration of flow) to an individual rainfall event.

6.3 Water Control Structures and Culverts

Water control structures (risers) were designed using SCS procedures. Riser weir widths, and culverts were designed to handle the maximum flow that canals could produce.

All culverts were sized as corrugated metal "aluminum" pipe. The design head loss for each culvert was 0.2 foot to prevent a significant restriction of flow.

The equation used to size all culverts is the general culvert flow equation. This equation can be found in USDA-SCS Engineering Field Manual (EFM), Chapter 3.

The weir width of each riser was sized based on three factors:

A. The maximum flow (cfs) of each drainage canal during full flow.

B. The management required.

C. The economic feasibility of the design.

The equation for a "rectangular contracted weir" was used to determine the width of the weirs for all risers. This equation can be found in the SCS Engineering Field Manual, Chapter 3.

6.4 Soils

The soils information that was used in this study for planning and modelling came from the USDA-Soil Survey, Gregory, et al., 1984, and Peat Methanol Associates, 1983.

The soils information found in the USDA-Soil Conservation Service Soil Survey for Hyde, Tyrrell, and Washington Counties, and Peat Methanol Associates, 1983, was used for general planning. The USDA Soil Survey provided basic soils information from the surface to more than five feet, and the Peat Methanol Associates provided soils information to a depth of 100 feet.

The soil inputs for DRAINMOD came from Gregory, et al., 1984. These inputs were derived from the soils south of Lake Phelps.

6.5 Rainfall Measurements For Modelling

Rainfall data for this study was supplied in DRAINMOD format by Dr. Wayne Skaggs of North Carolina State University. This rainfall data is for Plymouth, North Carolina, and is on an hourly basis in hundredths of inches, starting in 1933 and continuing to 1988. Plymouth is located about 15 miles northwest of the NWR area.

6.6 Temperature Measurements For Modelling

Temperature data for this study was supplied in DRAINMOD format by Dr. Wayne Skaggs of North Carolina State University. This file consists of daily maximum and minimum air temperatures in degrees Fahrenheit. Temperature data is for Plymouth, North Carolina.

6.7 Water Flow Velocities Used For Design

The design for risers and culverts, and calculations for modelling require the velocity of the movement of water through the drainage system of the NWR.

The velocity of water movement through the ditches of the NWR were made by actual measurements on site. These measurements were made by timing an object as it floated down the ditch over a distance of 50 or 100 feet.

Water velocity measurements were made during the wettest period of the spring of 1993. During this period, overland flows occurred in several places within the NWR, and ditch flows were bank-full and driven by ponding water. As a result of these conditions, the velocity measurements were considered very representative of the flows that could be expected during very wet conditions.

The velocity measurements throughout the NWR ranged from 0.1 to 1.6 feet per second. The slower readings were always found on ditches that were the furthest from the outlet in the upper reaches of the watershed where the √hydraulic gradients were dependent upon the elevation of the water in the ditch downstream. The highest velocities were found in areas where the land surface began sloping, thus creating a greater hydraulic gradient. Almost all of the higher velocities occurred south of Lake Phelps in Allen through Evans Canals where the ground slope increases near the NWR property line.

A list of velocity readings for Watershed #1 can be found in Appendix C.

Based on the measurements throughout the NWR, two velocities were chosen as the design velocities for risers, culverts, and for modelling:

A. A velocity of 0.5 foot per second was used to represent the flow rate on lateral ditches and ditches that were in the upper reaches of the watershed.

B. A velocity of 1.0 foot per second was used for design on ditches that were major drainageways, or were in areas where significant elevation changes would produce higher velocities.

REFERENCES

Chow, Ven Te, PhD., "Open Channel Hydraulics", 1959, McGraw-Hill Book Company, New York.

Christensen, L.C., R.B. Burchell, A. Liggett, and E.L. Simms. 1980. The structure and development of pocosin vegetation. IN: C.J. Richardson. Proceeding of Pocosins: A Conference on Alternative Uses of Coastal Plain Freshwater Wetlands of North Carolina. 1981. Hutchinson Ross Publishing Co. 43 p.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. USFWS, Biol. Svcx. Prog. FWS/0BS-79/31.

Craig, N.J. and E.J. Kuenzler. 1983. Land use, nutrient yield and eutrophication in the Chowan River basin. Report no. 205. Water Resources Research Institute North Carolina, Raleigh, NC.

Daniels, R.B., E.E. Gamble, and W.H. Wheeler. 1977. The stratigraphy and geomorphology of the Hofmann Forest Pocosin. Soil Sci. Soc. Am. J. 41:1175-1180.

Evans, R.O., J.W. Gilliam, R.W. Skaggs. 1991. Controlled drainage management guidelines for improving drainage water quality. Publication No. AG-443, Cooperative Extension Service, North Carolina State University, Raleigh, NC.

Gregory, J.D., R.W. Skaggs, R.G. Broadhead, R.H. Culbreath, J.R. Bailey, and T.L. Foutz. 1984. Hydrologic and water quality impacts of peat mining in North Carolina. UNC-WRRI-83-214.

Green, W.H. and G. Ampt. 1911. Studies of soil physics, part I. The flow of air and water through soils. J. Agricultural Science, 4:1-24.

Heath, Ralph C., 1975. Hydrology of the Albemarle-Pamlico region, North Carolina; a preliminary report on the impact of agricultural developments. U.S. Geological Survey, Water Res. Inves. 9-75. 36 p.

Ingram, Roy L. 1987. Peat deposits of North Carolina. U.S. Geological Survey Bull. 1988. DNRCD, Div. of Land Res., Raleigh, N.C.

Lilly, J. Paul. 1981. The blackland soils of North Carolina: Their characteristics and management for agriculture. North Carolina Agricultural Research Service, Tech. Bul. No. 270.

Pamphlet. Pocosin Lakes National Wildlife NWR. nd. np. no author.

(PMA) Peat Methanol Associates, water use permit application - construction dewatering, May 9, 1983.

Skaggs, R.W. 1978. A water management model for shallow water table soils. Technical Report No. 134 of the Water Resources Research Institute of the University of North Carolina, N.C. State University, 124 Riddick Building, Raleigh, N.C. 27650.

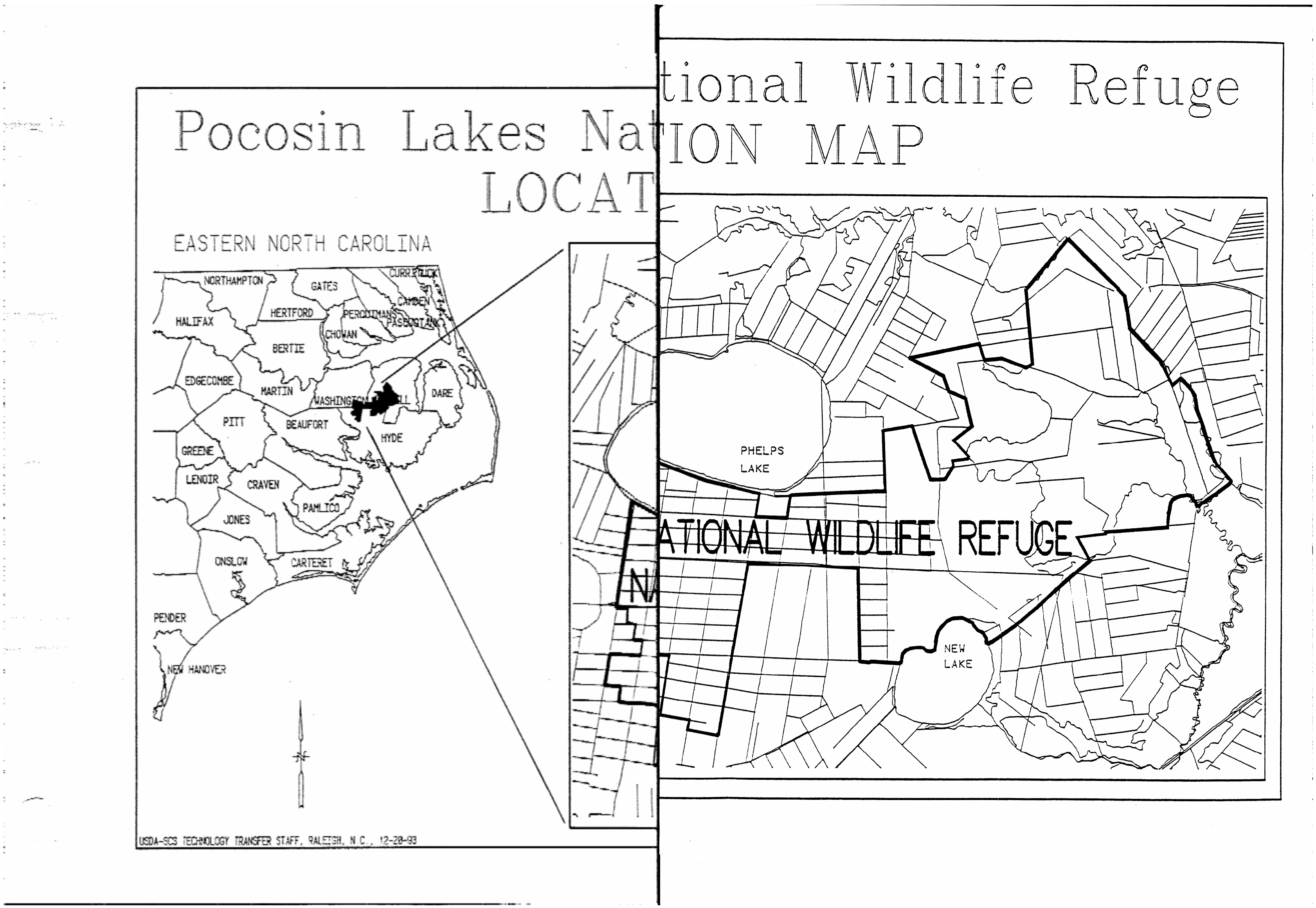
Skaggs, R.W., J.W. Gilliam, T.J. Sheets and J.S. Barnes, 1980. "Effect of agricultural land development on drainage waters in the North Carolina Tidewater Region".

Skaggs, R.W., N.R. Fausey and B.H. Nolte. 1981. Water management evaluation for North Central Ohio. Transactions of the ASAE. 24(4)922-928.

Street, M. W. and J. D. McClees. 1981. North Carolina's costal fishing industry and the influence of coastal alterations. In: C. J. Richardson (ed.) Pocosin wetlands. Hutchinson Ross Publishing Company, Stroudsburg, PA. pp.238-251.

APPENDIX A

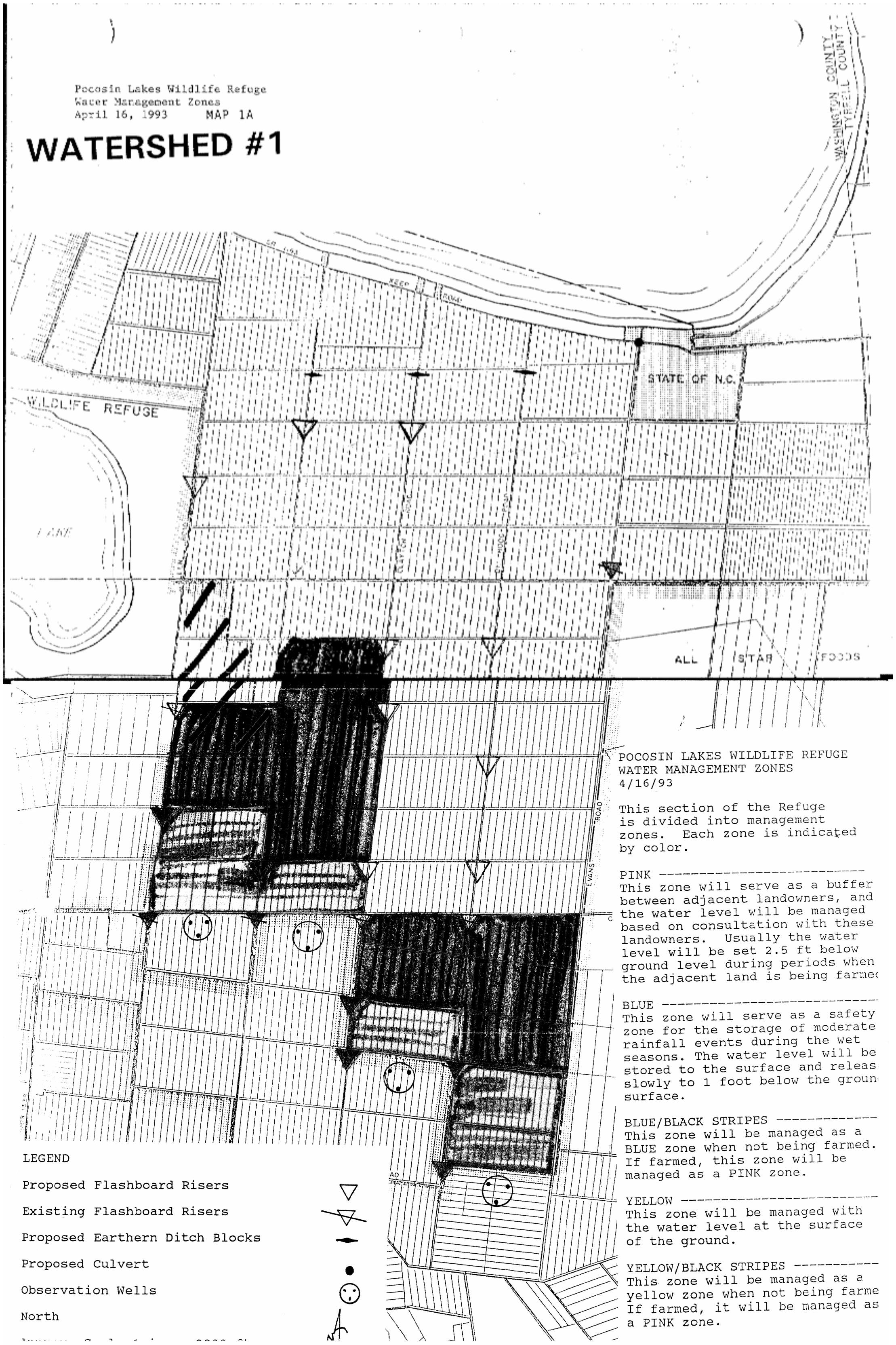
MAPS



Pocosin Lakes Na
tional Wildlife Refuge
LOCAT
ION MAP
EASTERN NORTH CAROLINA
NORTHAMPTON
GATES
CURRITUCK
CAMDEN
HALIFAX
HERTFORD
PERQUIMANS
PASQUOTANK
CHOWAN
BERTIE
EDGECOMBE
MARTIN
WASHINGTON
DARE
PITT
BEAUFORT
HYDE
GREENE
LENOIR
CRAVEN
PAMLICO
JONES
ONSLOW
CARTERET
PENDER
NEW HANOVER
N
USDA-SCS TECHNOLOGY TRANSFER STAFF, RALEIGH, N.C., 12-20-93
PHELPS
LAKE
NATIONAL WILDLIFE REFUGE
NEW
LAKE

Pocosin Lakes Wildlife Refuge
Water Management Zones
April 16, 1993 MAP 1A

WATERSHED #1



POCOSIN LAKES WILDLIFE REFUGE
WATER MANAGEMENT ZONES
4/16/93

This section of the Refuge is divided into management zones. Each zone is indicated by color.

PINK ---------------------------
This zone will serve as a buffer between adjacent landowners, and the water level will be managed based on consultation with these landowners. Usually the water level will be set 2.5 ft below ground level during periods when the adjacent land is being farmed

BLUE ----------------------------
This zone will serve as a safety zone for the storage of moderate rainfall events during the wet seasons. The water level will be stored to the surface and released slowly to 1 foot below the ground surface.

BLUE/BLACK STRIPES -------------
This zone will be managed as a BLUE zone when not being farmed. If farmed, this zone will be managed as a PINK zone.

YELLOW --------------------------
This zone will be managed with the water level at the surface of the ground.

YELLOW/BLACK STRIPES -----------
This zone will be managed as a yellow zone when not being farmed. If farmed, it will be managed as a PINK zone.

LEGEND

Proposed Flashboard Risers

Existing Flashboard Risers

Proposed Earthern Ditch Blocks

Proposed Culvert

Observation Wells

North

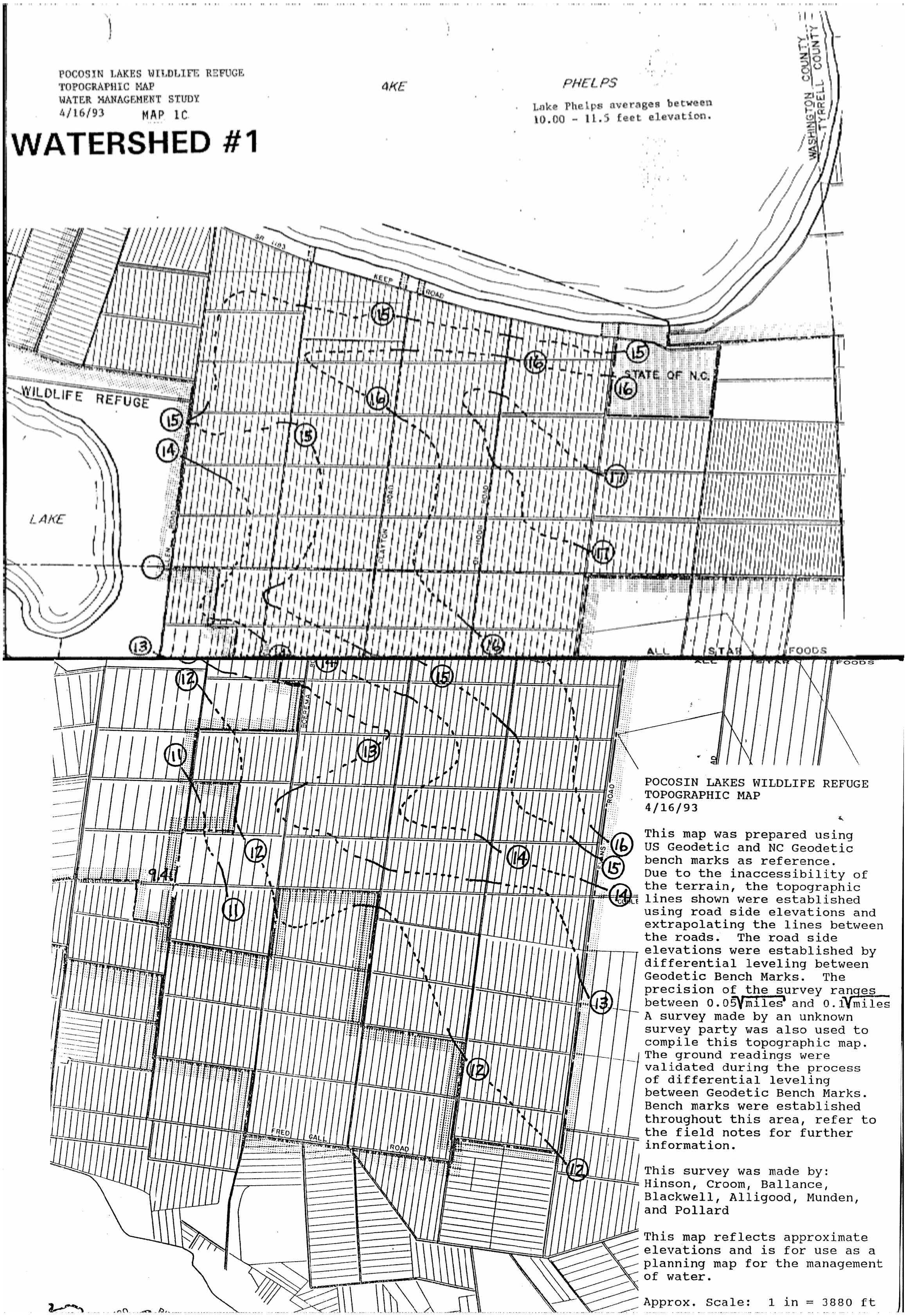
POCOSIN L WILDLIFE REFUGE
LOCATION TER CONTROL STRUCTURES
AND AFFECTED AREAS
APRIL 16, 1993

MAP IB

WATERSHED #1

POCOSIN LAKES WILDLIFE REFUGE
TOPOGRAPHIC MAP
WATER MANAGEMENT STUDY
4/16/93 MAP 1C

WATERSHED #1



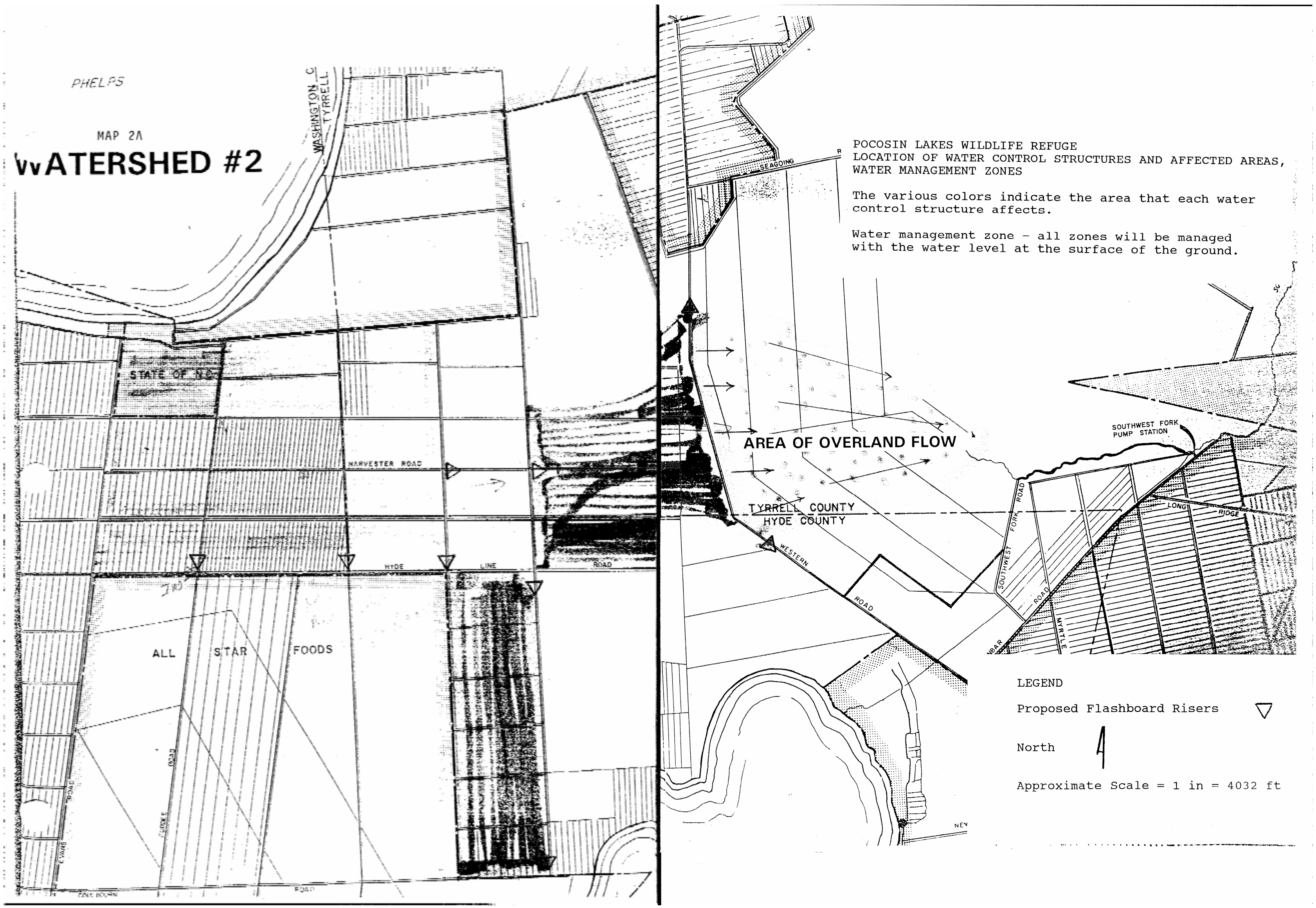
POCOSIN LAKES WILDLIFE REFUGE
TOPOGRAPHIC MAP
4/16/93

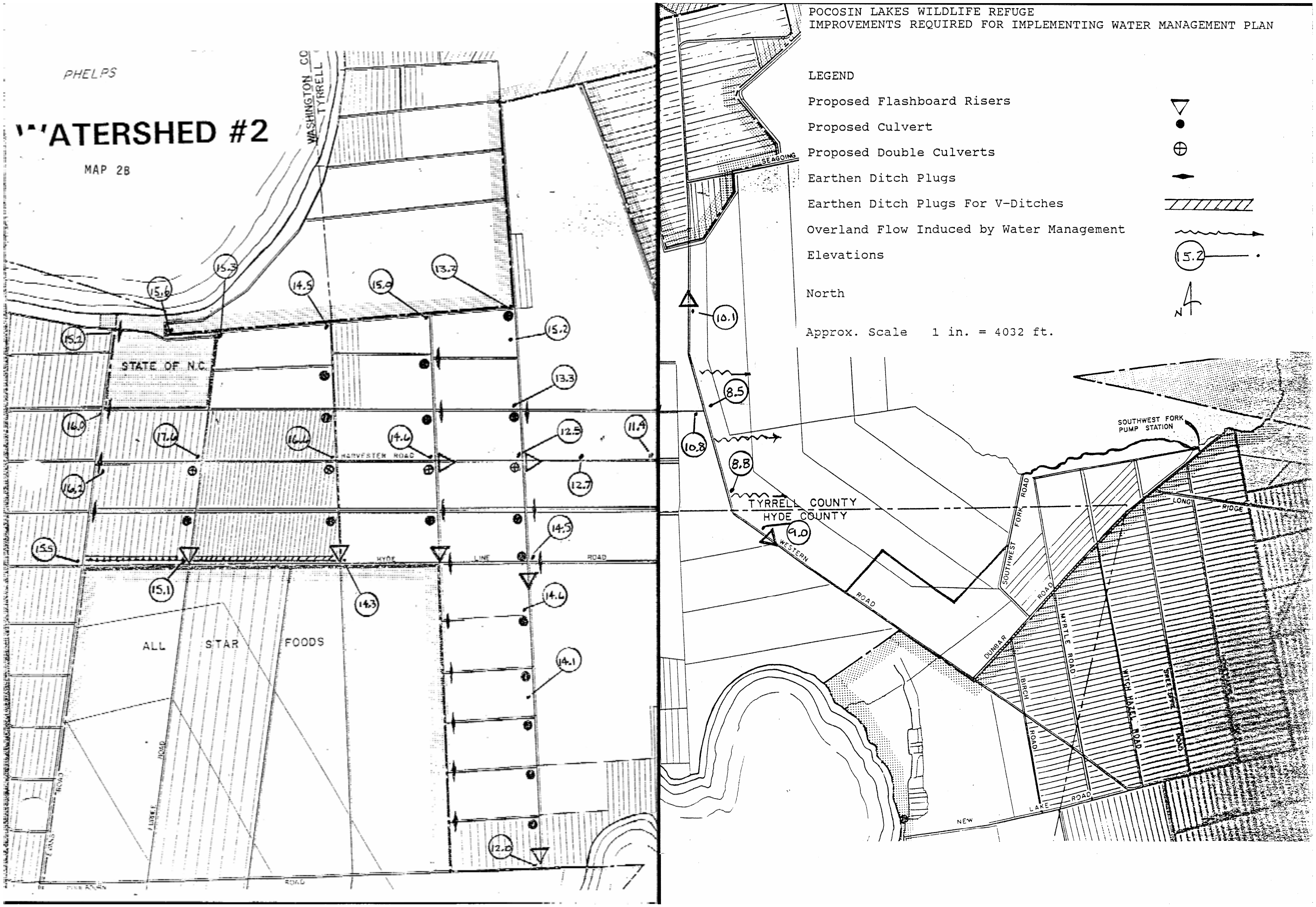
This map was prepared using US Geodetic and NC Geodetic bench marks as reference. Due to the inaccessibility of the terrain, the topographic lines shown were established using road side elevations and extrapolating the lines between the roads. The road side elevations were established by differential leveling between Geodetic Bench Marks. The precision of the survey ranges between $0.05\sqrt{miles}$ and $0.1\sqrt{miles}$ A survey made by an unknown survey party was also used to compile this topographic map. The ground readings were validated during the process of differential leveling between Geodetic Bench Marks. Bench marks were established throughout this area, refer to the field notes for further information.

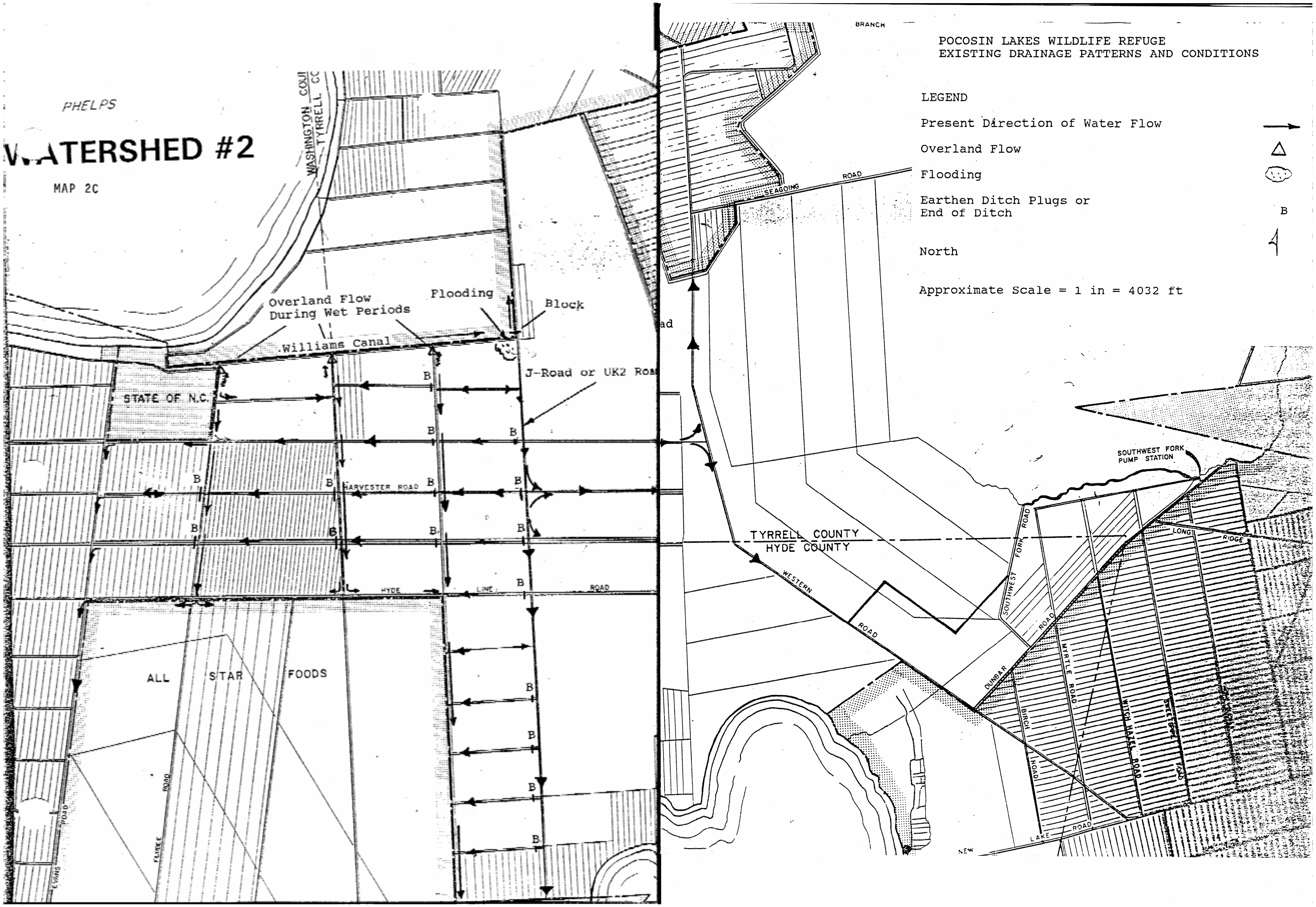
This survey was made by: Hinson, Croom, Ballance, Blackwell, Alligood, Munden, and Pollard

This map reflects approximate elevations and is for use as a planning map for the management of water.

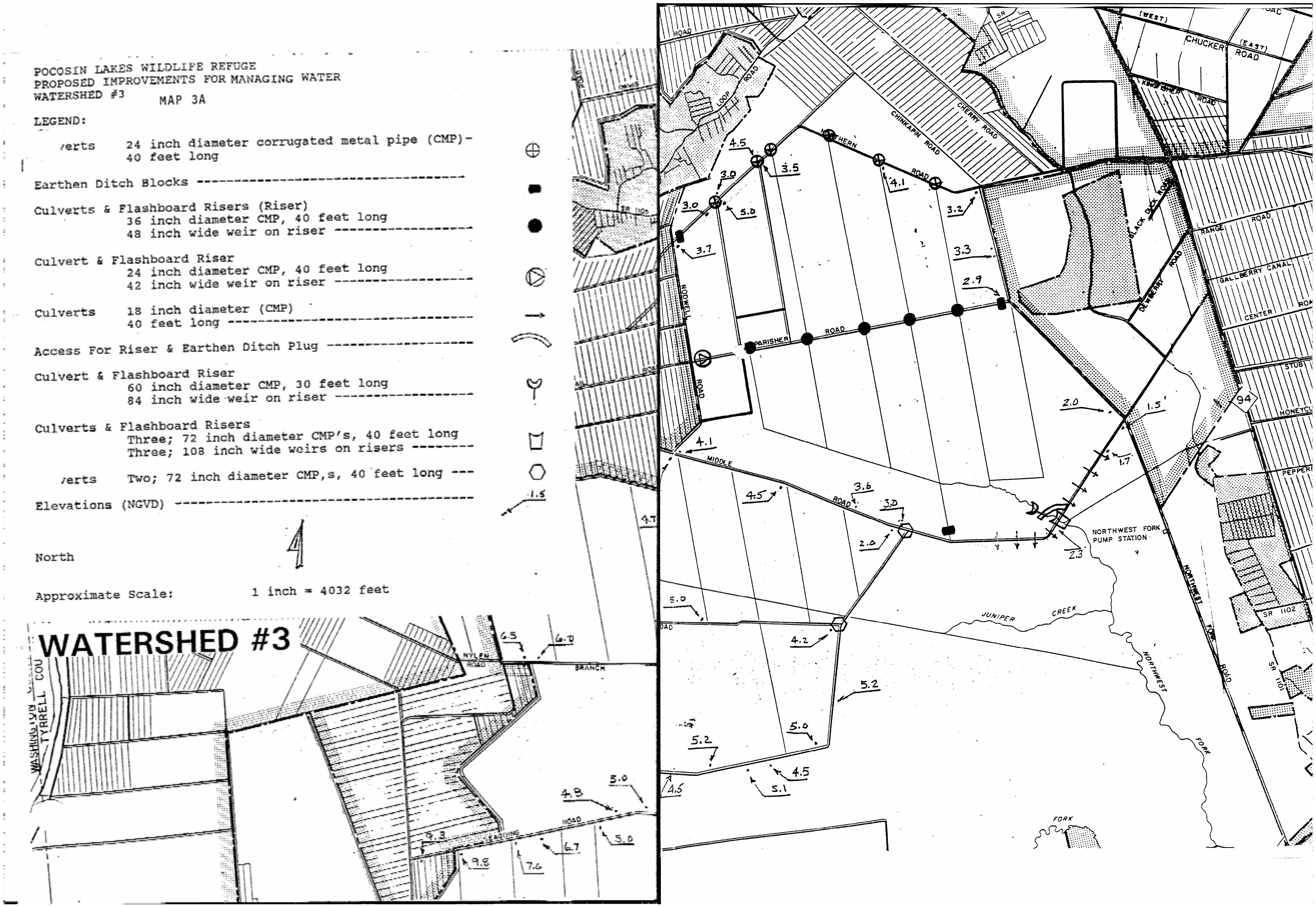
Approx. Scale: 1 in = 3880 ft


PHELPS
MAP 2A
WATERSHED #2
WASHINGTON C
TYRRELL
STATE OF N.C.
HARVESTER ROAD
HYDE
LINE
ROAD
ALL STAR FOODS
POCOSIN LAKES WILDLIFE REFUGE
LOCATION OF WATER CONTROL STRUCTURES AND AFFECTED AREAS,
WATER MANAGEMENT ZONES
The various colors indicate the area that each water control structure affects.
Water management zone - all zones will be managed with the water level at the surface of the ground.
SEAGOING
AREA OF OVERLAND FLOW
SOUTHWEST FORK PUMP STATION
TYRRELL COUNTY
HYDE COUNTY
WESTERN
ROAD
SOUTHWEST FORK ROAD
LONG RIDGE
MYRTLE
LEGEND
Proposed Flashboard Risers
North
Approximate Scale = 1 in = 4032 ft


PHELPS
WATERSHED #2
MAP 2B
WASHINGTON CO
TYRRELL
STATE OF N.C.
HARVESTER ROAD
HYDE LINE ROAD
ALL STAR FOODS
POCOSIN LAKES WILDLIFE REFUGE
IMPROVEMENTS REQUIRED FOR IMPLEMENTING WATER MANAGEMENT PLAN
LEGEND
Proposed Flashboard Risers
Proposed Culvert
Proposed Double Culverts
Earthen Ditch Plugs
Earthen Ditch Plugs For V-Ditches
Overland Flow Induced by Water Management
Elevations
15.2
North
N
Approx. Scale 1 in. = 4032 ft.
SEAGOING
SOUTHWEST FORK PUMP STATION
TYRRELL COUNTY
HYDE COUNTY
WESTERN ROAD
SOUTHWEST FORK ROAD
LONG RIDGE
DUNBAR ROAD
BIRCH ROAD
MYRTLE ROAD
WITCH HAZEL ROAD
NEW LAKE ROAD
15.6
15.3
14.5
15.0
13.7
15.2
15.2
13.3
16.0
17.6
16.6
14.6
12.5
11.4
16.2
12.7
15.5
14.5
15.1
14.3
14.6
14.1
12.0
10.1
8.5
10.8
8.8
9.0



PHELPS
WATERSHED #2
MAP 2C
WASHINGTON COU
TYRRELL CO
Overland Flow
During Wet Periods
Flooding
Block
Williams Canal
J-Road or UK2 Road
STATE OF N.C.
HARVESTER ROAD
HYDE LINE ROAD
ALL STAR FOODS
EVANS ROAD
FARMER ROAD
POCOSIN LAKES WILDLIFE REFUGE
EXISTING DRAINAGE PATTERNS AND CONDITIONS
LEGEND
Present Direction of Water Flow
Overland Flow
Flooding
Earthen Ditch Plugs or
End of Ditch
B
North
Approximate Scale = 1 in = 4032 ft
BRANCH
SEAGOING ROAD
SOUTHWEST FORK PUMP STATION
TYRRELL COUNTY
HYDE COUNTY
WESTERN ROAD
SOUTHWEST FORK ROAD
LONG RIDGE
DUNBAR ROAD
MYRTLE ROAD
BIRCH ROAD
WITCH HAZEL ROAD
NEW LAKE ROAD


POCOSIN LAKES WILDLIFE REFUGE
PROPOSED IMPROVEMENTS FOR MANAGING WATER
WATERSHED #3
MAP 3A
LEGEND:
verts 24 inch diameter corrugated metal pipe (CMP)- 40 feet long
Earthen Ditch Blocks
Culverts & Flashboard Risers (Riser) 36 inch diameter CMP, 40 feet long 48 inch wide weir on riser
Culvert & Flashboard Riser 24 inch diameter CMP, 40 feet long 42 inch wide weir on riser
Culverts 18 inch diameter (CMP) 40 feet long
Access For Riser & Earthen Ditch Plug
Culvert & Flashboard Riser 60 inch diameter CMP, 30 feet long 84 inch wide weir on riser
Culverts & Flashboard Risers Three; 72 inch diameter CMP's, 40 feet long Three; 108 inch wide weirs on risers
verts Two; 72 inch diameter CMP,s, 40 feet long
Elevations (NGVD)
1.5
North
Approximate Scale: 1 inch = 4032 feet
WATERSHED #3
TYRRELL COU
NYLEN ROAD
BRANCH
EASTING ROAD
NORTHERN ROAD
CHINKAPIN ROAD
CHERRY ROAD
LOOP ROAD
CHUCKER ROAD
(WEST)
(EAST)
BLACK DUCK ROAD
RANGE ROAD
GALLBERRY CANAL
CENTER ROAD
PARISHER ROAD
MIDDLE ROAD
NODWELL ROAD
NORTHWEST FORK PUMP STATION
NORTHWEST FORK ROAD
JUNIPER CREEK
NORTHWEST FORK
SR 1102
SR 1101
SR 1105
94
4.5
3.0
3.5
4.1
3.2
3.3
2.9
3.7
5.0
2.0
1.5
1.7
2.3
3.6
4.2
5.2
5.1
4.6
6.5
6.0
4.8
6.7
7.6
9.8
9.3


POCOSIN LAKES WILDLIFE REFUGE
EXISTING DRAINAGE PATTERNS AND CONDITIONS
MAP 3B
LEGEND:
esent Direction of Water Flow
Flooding on Farmland
Earthen Ditch Plugs
North
N
Approximate Scale: 1 in = 4032 ft
WATERSHED #3
TYRRELL COUNTY
NORTHERN ROAD
CHINKAPIN ROAD
CHERRY ROAD
LOOP ROAD
(WEST)
(EAST)
CHUCKERY ROAD
BLACK DUCK ROAD
DEWBERRY ROAD
RANGE ROAD
GALLBERRY CANAL
CENTER ROAD
STUB
HONEYCUP
PEPPERBUSH
94
PARISHER ROAD
MIDDLE ROAD
NORTHWEST FORK PUMP STATION
JUNIPER CREEK
NORTHWEST FORK
NORTHWEST FORK ROAD
SR 1102
FORK
PINTAIL ROAD
NYLEN ROAD
BRANCH ROAD
SEASONING ROAD
STATE ROAD


WATER MANAGEMENT ZONES
Colors indicate separate management zones and areas. affected by risers.
Management --
All zones will be managed with the water level at the surface of the ground.
MAP 3C
Legend:
Risers
Yellow Zone
Blue Zone
North
N
Approximate Scale:
1 inch = 4032 feet
WATERSHED #3
COW ISLAND ROAD
PINTAIL ROAD
NYLEN ROAD
BRANCH ROAD
LOOP ROAD
CHERRY ROAD
(WEST)
CHUCKER ROAD
(EAST)
KINGFISHER ROAD
RANGE ROAD
GALLBERRY CANAL
CENTER ROAD
DEWBERRY ROAD
STUB
94
MIDDLE ROAD
NORTHWEST FORK PUMP STATION
JUNIPER CREEK
NORTHWEST FORK
SR 1102
FORK

APPENDIX B

MODELLING OUTPUT DATA

FISH & WILDLIFE SERVICE OFFICIAL REQUEST

****

D R A I N M O D

VERSION: NORTH CAROLINA MICRO-UNIX 4.60a
LAST UPDATE: Sept. 1991
LANGUAGE: MS FORTRAN v 5.0 & UNIX f77

DRAINMOD IS A FIELD-SCALE HYDROLOGIC MODEL DEVELOPED FOR THE DESIGN OF SUBSURFACE DRAINAGE SYSTEMS. THE MODEL WAS DEVELOPED BY RESEARCHERS AT THE DEPT. OF BIOLOGICAL AND AGRICULTURAL ENGINEERING, NORTH CAROLINA STATE UNIVERSITY UNDER THE DIRECTION OF R. W. SKAGGS.

****

****
* D R A I N M O D -- 4.60a *
****

DATA READ FROM INPUT FILE: D:\DM46\INPUT46\ALLEN1WO.LIS
Cream selector (0=no, 1=yes) = 0

TITLE OF RUN
****

WEIR set at 183 cm below field surf.

PEAT SOIL, 100.0 M DRAIN SPACING -- POCOSIN Scrub-Shrub Vegetation, 6/24/93, SD
CONTROLLED DRAINAGE on ALLEN CANAL-A1, FOR EXISTING CONDITIONS

CLIMATE INPUTS
******* ******

DESCRIPTION	(VARIABLE)	VALUE	UNIT
FILE FOR RAINDATA .... D:\DM46\WEATHER\PLYWEN.RAI			
FILE FOR TEMPERATURE/PET DATA .. D:\DM46\WEATHER\PLYWEN.TEM			
RAINFALL STATION NUMBER........................	(RAINID)	1	
TEMPERATURE/PET STATION NUMBER..................	(TEMPID)	1	
STARTING YEAR OF SIMULATION.................	(START YEAR)	1960	YEAR
STARTING MONTH OF SIMULATION................	(START MONTH)	1	MONTH
ENDING YEAR OF SIMULATION.....................	(END YEAR)	1988	YEAR
ENDING MONTH OF SIMULATION....................	(END MONTH)	12	MONTH
TEMPERATURE STATION LATITUDE..................	(TEMP LAT)	35.52	DEG.MIN
HEAT INDEX..	(HID)	75.00	

ET MULTIPLICATION FACTOR FOR EACH MONTH
2.20 2.35 1.87 1.67 1.20 1.03 .87 .78 .89 1.18 1.51 1.94

DRAINAGE SYSTEM DESIGN
****

*** CONTROLLED DRAINAGE ***

JOB TITLE:

PEAT SOIL, 100.0 M DRAIN SPACING -- POCOSIN Scrub-Shrub V
CONTROLLED DRAINAGE on ALLEN CANAL-A1, FOR EXISTING CONDI

```
          STMAX = 2.50 CM                      SOIL SURFACE
__/)______________________________________________________________/)__
      :                                                   :
      :                                                   :
      :                                                   :
      :                                                   :
ADEPTH =234. CM                                   DDRAIN =140. CM
      :                                                   :
      :                                                   :
      :    O-------------SDRAIN =10000. CM -----------O   -
      :    *                                              :
      : EFFRAD =**** CM                                   :
      :                                           HDRAIN = 94. CM
      :                                                   :
      :                                                   :
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      :
      :
      :
      :                                       IMPERMEABLE LAYER
______________________________________________________________________
//////////////////////////////////////////////////////////////////////
```

DEPTH (CM)	SATURATED HYDRAULIC CONDUCTIVITY (CM/HR)
.0 - 30.0	70.000
30.0 - 140.0	.020
140.0 - 234.0	.440

DEPTH TO DRAIN = 140.0 CM
EFFECTIVE DEPTH FROM DRAIN TO IMPERMEABLE LAYER = 93.5 CM
DISTANCE BETWEEN DRAINS = 10000.0 CM
MAXIMUM DEPTH OF SURFACE PONDING = 2.50 CM
EFFECTIVE DEPTH TO IMPERMEABLE LAYER = 233.5 CM
DRAINAGE COEFFICIENT(AS LIMITED BY SUBSURFACE OUTLET) = 2.50 CM/DAY
ACTUAL DEPTH FROM SURFACE TO IMPERMEABLE LAYER = 234.0 CM
SURFACE STORAGE THAT MUST BE FILLED BEFORE WATER
CAN MOVE TO DRAIN = 1.00 CM
FACTOR -G- IN KIRKHAM EQ. 2-17 = 5.86

*** SEEPAGE LOSS INPUTS ***

No seepage due to field slope

No seepage due to vertical deep seepage

No seepage due to lateral deep seepage

*** end of seepage inputs ***

WIDTH OF DITCH BOTTOM = .5 CM
SIDE SLOPE OF DITCH (HORIZ:VERT) = .10 : 1.00

INITIAL WATER TABLE DEPTH = 50.0 CM

DEPTH OF WEIR FROM THE SURFACE

DATE	1/ 0	2/ 0	3/ 0	4/ 0	5/ 0	6/ 0
WEIR DEPTH	183.0	183.0	183.0	183.0	183.0	183.0

DATE	7/ 0	8/ 0	9/ 0	10/ 0	11/ 0	12/ 0
WEIR DEPTH	183.0	183.0	183.0	183.0	183.0	183.0

SOIL INPUTS
****

TABLE 1

DRAINAGE TABLE

VOID VOLUME (CM)	WATER TABLE DEPTH (CM)
.0	.0
1.0	40.2
2.0	62.4
3.0	83.8
4.0	104.7
5.0	121.1
6.0	134.2
7.0	180.0
8.0	188.8
9.0	197.6
10.0	206.5
11.0	215.3
12.0	224.1
13.0	232.9
14.0	241.7
15.0	250.5
16.0	259.4
17.0	268.2
18.0	277.0
19.0	285.8
20.0	294.6
21.0	303.4
22.0	312.3
23.0	321.1
24.0	329.9
25.0	338.7
26.0	347.5
27.0	356.3
28.0	365.2
29.0	374.0
30.0	382.8
35.0	426.9
40.0	471.0
45.0	515.1
50.0	559.1
60.0	647.3
70.0	735.5
80.0	823.7
90.0	911.8

TABLE 2

SOIL WATER CHARACTERISTIC VS VOID VOLUME VS UPFLUX

HEAD (CM)	WATER CONTENT (CM/CM)	VOID VOLUME (CM)	UPFLUX (CM/HR)
.0	.7400	.00	.0079
10.0	.7250	.14	.0046
20.0	.7183	.29	.0030
30.0	.7050	.58	.0023
40.0	.6850	.99	.0020
50.0	.6650	1.47	.0019
60.0	.6530	1.91	.0018
70.0	.6410	2.28	.0015
80.0	.6350	2.82	.0014
90.0	.6350	3.29	.0012
100.0	.6350	3.72	.0010
110.0	.6230	4.32	.0009
120.0	.6110	4.92	.0007
130.0	.5990	5.68	.0005
140.0	.5870	6.44	.0003
150.0	.5750	6.58	.0003
160.0	.5710	6.72	.0002
170.0	.5670	6.86	.0002
180.0	.5630	7.00	.0001
190.0	.5590	8.13	.0001
200.0	.5550	9.27	.0001
210.0	.5532	10.40	.0001
220.0	.5513	11.54	.0001
230.0	.5495	12.67	.0001
240.0	.5477	13.80	.0001
250.0	.5458	14.94	.0001
260.0	.5440	16.07	.0001
270.0	.5422	17.21	.0001
280.0	.5403	18.34	.0001
290.0	.5385	19.48	.0001
300.0	.5367	20.61	.0001
350.0	.5275	26.28	.0001
400.0	.5183	31.95	.0001
450.0	.5092	37.62	.0001
500.0	.5000	43.29	.0001
600.0	.4997	54.63	.0000
700.0	.4993	65.98	.0000
800.0	.4990	77.32	.0000
900.0	.4986	88.66	.0000

GREEN AMPT INFILTRATION PARAMETERS

W.T.D. (CM)	A (CM)	B (CM)
.000	.000	.000
30.000	.850	4.120
50.000	1.640	2.630
75.000	1.740	2.000
100.000	1.400	1.600
150.000	1.800	1.200
500.000	.500	1.000
1000.000	.500	1.000

TRAFFICABILITY
****

REQUIREMENTS	FIRST PERIOD	SECOND PER
-MINIMUM AIR VOLUME IN SOIL (CM):	3.20	3.
-MAXIMUM ALLOWABLE DAILY RAINFALL(CM):	1.20	1.2

```
   -MINIMUM TIME AFTER RAIN BEFORE TILLING CAN CONTINUE:  2.00        2.00

 WORKING TIMES
   -DATE TO BEGIN COUNTING WORK DAYS:                      1/ 1       12/31
   -DATE TO STOP COUNTING WORK DAYS:                      12/31       12/31
   -FIRST WORK HOUR OF THE DAY:                             6           0
   -LAST WORK HOUR OF THE DAY:                             20           0


                                  CROP
                                  ****

SOIL MOISTURE AT CROP WILTING POINT =    .45

HIGH WATER STRESS:   BEGIN STRESS PERIOD ON    1/ 1
                     END STRESS PERIOD ON     12/31
                     CROP IS IN STRESS WHEN WATER TABLE IS ABOVE  30.0 CM

DROUGHT STRESS:      BEGIN STRESS PERIOD ON    1/ 1
                     END STRESS PERIOD ON     12/31


                              MO   DAY   ROOTING DEPTH(CM)
                               1    1        30.0
                              12   31        30.0


                              WASTEWATER IRRIGATION
                              *********************

    NO WASTEWATER IRRIGATION SCHEDULED:
    -----------------------------------

  *****  Wetlands Parameter Estimation *****

             Start Day =     1          End Day =  365
             Threshold Water Table Depth (cm) =   1.0
             Threshold Consecutive Days       =     2


 ****************************** END OF INPUTS ******************************

  ----------RUN STATISTICS ----------          time:  6/24/1993  @ 14:26
 input file:   D:\DM46\INPUT46\ALLEN1WO.LIS
 parameters:       controlled drainage         and yields not calculat
               drain spacing =   10000. cm   drain depth =  140.0 cm
--------------------------------------------------------------------------



**> Computational Statistics       <**
**> Start Computations      = 866.794
**> End Computations        = 868.272
 *> Total simulation time =    88.7 seconds.
```

DRAINMOD monthly output

```
 ---------------------------------------------------
 *               DRAINMOD version 4.60a            *
 * Copyright 1990-91 North Carolina State University *
 ---------------------------------------------------
```

PEAT SOIL, 100.0 M DRAIN SPACING -- POCOSIN Scrub-Shrub Vegetation, 6/24/93, SDB
CONTROLLED DRAINAGE on ALLEN CANAL-A1, FOR EXISTING CONDITIONS
****

```
 ----------RUN STATISTICS ----------          time:  6/24/1993  @ 14:26
 input file:   D:\DM46\INPUT46\ALLEN1WO.LIS
 parameters:        controlled drainage        and yields not calculat
               drain spacing =    10000. cm   drain depth =  140.0 cm
 ------------------------------------------------------------------------
```

MONTHLY VOLUMES IN CENTIMETERS FOR YEAR 1960

MONTH	RAIN	INFIL	ET	DRAIN	RUNOFF	SEW	DRYDAY	PUMP	TWLOS
1	22.91	13.17	2.68	9.02	7.24	235.94	.0	.00	16.25
2	16.26	16.48	2.61	14.46	2.28	652.11	.0	.00	16.74
3	8.20	8.20	2.39	6.35	.00	386.40	.0	.00	6.35
4	5.31	5.31	12.19	2.34	.00	102.35	2.0	.00	2.35
5	13.06	13.06	9.13	-.09	.00	.00	7.0	.00	.10
6	8.03	8.03	13.54	.06	.00	.00	3.0	.00	.06
7	20.60	20.60	12.31	.04	.00	.00	.0	.00	.05
8	13.08	13.08	11.35	.24	.00	9.68	.0	.00	.25
9	29.13	18.44	8.47	7.63	10.42	189.25	.0	.00	18.06
10	4.45	4.71	7.21	.59	.00	32.00	.0	.00	.60
11	4.50	4.50	4.33	.13	.00	.00	.0	.00	.13
12	5.05	5.05	1.13	1.30	.00	92.35	.0	.00	1.3[illegible]
TOTALS	150.57	130.63	87.31	42.26	19.95	1700.07	12.0	.00	62.24

MONTHLY VOLUMES IN CENTIMETERS FOR YEAR 1961

MONTH	RAIN	INFIL	ET	DRAIN	RUNOFF	SEW	DRYDAY	PUMP	TWLOS
1	7.24	7.24	1.44	5.82	.00	377.11	.0	.00	5.82
2	17.27	16.95	4.21	12.91	.32	489.98	.0	.00	13.23
3	9.35	9.35	8.02	1.07	.00	70.57	.0	.00	1.08
4	11.18	11.18	8.30	5.28	.00	300.12	.0	.00	5.29
5	15.54	14.90	9.98	4.89	.65	113.29	.0	.00	5.54
6	22.30	20.25	12.67	5.72	2.05	194.24	.0	.00	7.78
7	12.85	12.85	13.68	4.11	.00	167.88	.0	.00	4.11
8	15.67	15.67	10.94	.84	.00	54.35	.0	.00	.84
9	14.48	13.98	9.65	3.28	.50	185.85	.0	.00	3.79
10	7.32	6.69	6.19	3.84	.63	119.76	.0	.00	4.47
11	6.68	6.68	5.13	.11	.00	.00	.0	.00	.12
12	8.99	8.99	2.52	4.29	.00	285.16	.0	.00	4.30
TOTALS	148.87	144.73	92.73	52.17	4.14	2358.33	.0	.00	56.36

MONTHLY VOLUMES IN CENTIMETERS FOR YEAR 1962

MONTH	RAIN	INFIL	ET	DRAIN	RUNOFF	SEW	DRYDAY	PUMP	TWLOS
1	17.09	15.83	2.74	12.53	1.27	635.16	.0	.00	13.80
2	8.18	8.18	4.99	5.23	.00	221.61	.0	.00	5.23
3	11.23	11.23	3.76	7.01	.00	418.61	.0	.00	7.01
4	8.97	8.97	9.33	2.01	.00	124.15	.0	.00	2.[illegible]
5	6.93	6.93	12.56	.12	.00	.00	3.0	.00	.[illegible]
6	33.20	24.09	12.01	2.34	8.22	57.24	.0	.00	10.[illegible]

DRAINMOD

Daily Output for 9th Month of 1960

ASA3 CONVERSION OF: allen1wo.prt

1960 9

DAY	RAIN	INFIL	ET	DRAIN	TVOL	DDZ	DTWT	STOR	RUNOFF	WLOSS
1	.20	.20	.44	.01	2.59	4.98	48.20	.00	.00	.01
2	1.50	1.50	.31	.01	1.41	.00	48.79	.00	.00	.01
3	.00	.00	.37	.01	1.79	1.13	51.00	.00	.00	.01
4	.00	.00	.34	.01	2.14	2.17	53.13	.00	.00	.01
5	.00	.00	.39	.01	2.53	3.35	55.44	.00	.00	.01
6	2.41	2.41	.28	.04	.43	.00	24.90	.00	.00	.04
7	.00	.00	.31	.04	.79	.87	29.24	.00	.00	.04
8	.00	.00	.37	.01	1.17	1.96	32.45	.00	.00	.01
9	.08	.08	.35	.01	1.45	2.71	34.68	.00	.00	.01
10	.00	.00	.42	.01	1.87	3.97	37.33	.00	.00	.01
11	8.26	3.93	.08	1.98	.00	.00	.00	2.25	2.07	4.06
12	11.10	2.50	.00	2.50	.00	.00	.00	2.50	8.35	10.85
13	.00	1.83	.30	1.54	.00	.00	.00	.67	.00	1.54
14	.00	.63	.22	.40	.00	.00	.00	.04	.00	.40
15	.00	.04	.23	.25	.44	.00	25.18	.00	.00	.25
16	.00	.00	.24	.04	.72	.61	29.18	.00	.00	.04
17	.00	.00	.29	.01	1.02	1.43	32.10	.00	.00	.02
18	.00	.00	.27	.01	1.30	2.19	34.29	.00	.00	.01
19	.00	.00	.37	.01	1.68	3.29	36.77	.00	.00	.01
20	.20	.20	.39	.01	1.87	3.76	38.64	.00	.00	.01
21	.00	.00	.39	.01	2.27	4.93	41.16	.00	.00	.01
22	.00	.00	.32	.01	2.59	5.87	43.43	.00	.00	.01
23	.00	.00	.26	.01	2.86	6.60	45.48	.00	.00	.01
24	.00	.00	.25	.01	3.12	7.30	47.47	.00	.00	.01
25	.00	.00	.23	.01	3.35	7.92	49.19	.00	.00	.01
26	.00	.00	.25	.01	3.60	8.61	50.98	.00	.00	.01
27	.05	.05	.17	.01	3.73	8.85	52.32	.00	.00	.01
28	.13	.13	.27	.01	3.87	9.18	53.75	.00	.00	.01
29	4.95	4.16	.07	.22	.00	.00	.00	.79	.00	.22
30	.25	.78	.29	.49	.00	.00	.00	.27	.00	.49

USE

WSP2

ASA3 CONVERSION OF: allen1a.out
WSP2 XEQ 07/23/93 15:42:04
REV 10/27/89

WS : PAGE
ALT: 1

----------------------- LIST OF INPUT DATA WITH LIMITED EDITING-----------------------

WSP2		ALLEN				
TITLE	POCOSIN LAKES NATIONAL WILDLIFE REFUGE, ALLEN RD CANAL WS					
TITLE	ALT 1, EXISTING CONDITIONS, USE CFS FROM TR20,7-23-93,SDB					
DISCHARGE	-7.00	0.1	0.2	0.3	0.4	0.5
DISCHARGE	-7.00	0.6	0.73	0.86	1.0	1.2
STARTS	2	0.0002	0.0002	0.0002	0.0002	0.0002
STARTS	2	0.0002	0.0002	0.0002	0.0002	0.0002
OUTPUT	R					
REACH	2	235.	10.	10.		
REACH2	4	0.0				
ROAD	STR1	2.7	50.	50.		
REACH	3	235.	1.	1.		
REACH2	4	0.0				
ROAD	STR1A	3.1	5.	5.		
REACH	4	235.	100.	100.		
REACH	6	199.	2640.	2640.		
REACH2	4	0.075				
REACH	8	215.	2640.	2640.		
REACH2	4	0.15				
REACH	10	215.	100.	100.		
REACH2	4	0.15				
REACH	12	179.	2640.	2640.		
REACH2	4	0.225				
REACH	14	143.	2640.	2640.		
REACH2	16	0.0				
ROAD	STR3	2.7	50.	50.		
REACH	15	143.	1.	1.		
ROAD	STR3A	3.1	5.	5.		
REACH	16	143.	50.	50.		
REACH	18	328.	2640.	2640.		
REACH2	16	0.5				
REACH	20	288.0	3000.	3000.		
REACH2	16	1.0				
REACH	22	252.0	2700.	2700.		
REACH2	16	1.5				
REACH	24	219.0	2640.	2640.		
REACH2	16	2.0				
REACH	26	219.0	100.	100.		
REACH2	16	2.0				
REACH	28	183.0	2640.	2640.		
REACH2	16	2.25				
REACH	30	148.0	2640.	2640.		
REACH2	16	2.5				
REACH	32	129.0	2640.	2640.		
REACH2	16	2.75				

```
--------------------------LIST OF INPUT DATA------------------------------
  CH      34      109.0    2000.    2000.
REACH2    16      3.0
REACH     35      81.0     2550.    2550.
REACH2    16      3.25
REACH     36      60.0     5350.    5350.
REACH2    16      3.5
REACH     38      17.0     4000.    4000.
REACH2    16      4.00
REACH     40      5.0      1000.    1000.
REACH2    16      4.00
SEGMENT   4       1        N        105.
NVALUE    .02
SEGMENT   4       2        C        132.
NVALUE    .03
SEGMENT   4       3        N        161.
NVALUE    .15
SECTION   4
          50.     15.0     51.      13.2     100.     13.2
          105.    13.0     109.     10.2     113.0    7.5
          117.    5.2      119.     4.9      121.     4.5
          124.    4.4      126.     5.1      128.     6.1
          130.    7.5      132.     9.1      160.     10.2
          161.    15.
ENDTABLE
SEGMENT   16      1        N        110.
NVALUE    .02
 EGMENT   16      2        C        165.
   LUE    .03
  MENT    16      3        N        181.
NVALUE    .15
SECTION   16
          50.     15.0     51.      13.8     100.     13.8
          105.    13.2     110.     11.8     113.0    10.3
          114.    9.7      119.     7.3      123.     5.7
          130.    4.7      135.     4.7      138.     5.7
          140.    6.7      145.     8.3      150.     9.7
          157.    10.3     161.     10.5     165.     10.8
          170.    11.2     180.     11.7     181.     15.0
ENDTABLE
CULV1     STR1    1        12333
CULV2     8.0              40.      4.4      4.4
SECTION   STR1
          50.     15.0     51.      13.2     160.     13.2
          161.    15.
ENDTABLE
```

```
------------------------------LIST OF INPUT DATA------------------------------
CULV1     STR1A     1         12333
CULV2     0.1                 1.        4.4       4.4
SECTION   STR1A
          50.       15.0      51.       13.2      110.      13.2
          110.1     7.4       119.1     7.4       119.2     13.2
          160.      13.2      161.      15.
ENDTABLE
CULV1     STR3      1         12333
CULV2     8.0                 40.       4.7       4.7
SECTION   STR3
          50.       15.0      51.       13.8      180.      13.8
          181.      15.
ENDTABLE
SEGMENT   15        1         N         130.
NVALUE    .02
SEGMENT   15        2         C         139.2
NVALUE    .03
SEGMENT   15        3         N         181.
NVALUE    .15
SECTION   15
          50.       15.0      51.       13.8      130.      13.8
          130.1     4.70      139.1     4.70      139.2     13.8
          180.      13.8      181.      15.
ENDTABLE
CULV1     STR3A     1         12333
CULV2     0.1                 1.        4.7       4.7
SECTION   STR3A
          50.       15.0      51.       13.8      130.      13.8
          130.1     10.0      139.1     10.0      139.2     13.8
          180.      13.8      181.      15.
ENDTABLE
COMPUTE   2         8         2
------------------------------END OF DATA LISTING------------------------------
                    COMPUTE   2         8         2

----------------------------STARTING DATA FROM GIVEN SLOPES------------------------------
```

RATING TABLE FOR SECTION 2 DA= 235.0 SQ MI EXP COEF= .00 CONT COEF= .00

NO.	ELEV FT	AREA SQ FT	Q CFS	ACRES FLOODED FLOODPLAIN DAMAGE	ACRES FLOODED CHANNEL	ACRES FLOODED TOTAL	STARTING CSM	CRIT ELEV FT	FRICTION SLOPE FT/FT	FLOW TOP WIDTH FT
0	4.4	0.0	0.0							
1	6.9	25.2	23.5	.00	.00	.00	.10	5.3	.00020	15.1
2	7.9	41.2	47.0	.00	.00	.00	.20	5.7	.00020	18.0
3	8.6	54.9	70.5	.00	.00	.00	.30	5.9	.00020	20.0
LOW GRND	9.1	65.6	90.3	.00	.00	.00				21.4
BANK FULL	9.1	65.6	90.3	.00	.00	.00				21.4
4	9.2	67.7	94.0	.00	.00	.01	.40	6.2	.00020	23.6
5	9.7	84.6	117.5	.00	.01	.01	.50	6.4	.00020	36.9
6	10.1	100.8	141.0	.00	.01	.01	.60	6.6	.00020	48.3
7	10.6	126.5	171.6	.00	.01	.01	.73	6.8	.00020	50.7
8	11.1	149.7	202.1	.00	.01	.01	.86	7.0	.00020	52.4
9	11.5	173.2	235.0	.00	.01	.01	1.00	7.2	.00020	53.1
10	12.1	204.7	282.0	.00	.01	.01	1.20	7.5	.00020	54.1

ROAD SECTION STR1

NO.	HW FT	CFS	HL FT	TW FT	STARTING CSM	BRIDGE CFS	BRIDGE AREA SQ FT	CULVERT CFS	CULVERT AREA SQ FT	WEIR CFS	WEIR AREA SQ FT	WEIR TOP WID FT
0	4.40	0.0	0.00	4.40	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.
1	6.94	23.5	.05	6.90	.10	.0	.0	23.5	13.7	.0	.0	.
2	7.98	47.0	.11	7.86	.20	.0	.0	47.0	21.7	.0	.0	.
3	8.77	70.5	.18	8.59	.30	.0	.0	70.5	28.1	.0	.0	.
4	9.42	94.0	.22	9.19	.40	.0	.0	94.0	33.2	.0	.0	.
5	9.96	117.5	.27	9.69	.50	.0	.0	117.5	37.3	.0	.0	.
6	10.53	141.0	.42	10.12	.60	.0	.0	141.0	41.3	.0	.0	.
7	11.05	171.6	.43	10.62	.73	.0	.0	171.6	44.7	.0	.0	.
8	11.59	202.1	.53	11.06	.86	.0	.0	202.1	47.6	.0	.0	.
9	12.16	235.0	.66	11.51	1.00	.0	.0	235.0	49.8	.0	.0	.
10	12.93	282.0	.83	12.10	1.20	.0	.0	282.0	50.2	.0	.0	.

MIN ROAD ELEVATION = 13.20 FT

OPENING NO.	NO. CULVERTS	CULV. CODE	HEIGHT OR DIAM	WIDTH	LENGTH	U/S INVERT	D/S INVERT	(N) COEFF
1	1	12333.	8.00		40.00	4.40	4.40	.024

RATING TABLE FOR SECTION 3 DA= 235.0 SQ MI EXP COEF= .00 CONT COEF= .00

NO.	ELEV FT	AREA SQ FT	Q CFS	------ACRES FLOODED------- FLOODPLAIN DAMAGE	CHANNEL	TOTAL	STARTING CSM	CRIT ELEV FT	FRICTION SLOPE FT/FT	FLOW TOP WIDTH FT
0	4.4	0.0	0.0							
1	6.9	26.1	23.5	.00	.02	.02	.10	5.3	.00018	15.2
2	8.0	43.4	47.0	.00	.02	.02	.20	5.7	.00017	18.3
3	8.8	58.7	70.5	.00	.02	.02	.30	5.9	.00017	20.5
LOW GRND	9.1	65.6	80.5	.00	.03	.03				21.4
BANK FULL	9.1	65.6	80.5	.00	.03	.03				21.4
4	9.4	74.9	94.0	.00	.03	.04	.40	6.2	.00016	29.9
5	10.0	95.2	117.5	.00	.03	.05	.50	6.4	.00016	44.5
6	10.5	122.7	141.0	.00	.03	.06	.60	6.6	.00014	50.4
7	11.0	149.4	171.6	.00	.03	.06	.73	6.8	.00014	52.4
8	11.6	178.1	202.1	.00	.03	.06	.86	7.0	.00014	53.3
9	12.2	209.0	235.0	.00	.03	.06	1.00	7.2	.00013	54.2
10	12.9	250.6	282.0	.00	.03	.06	1.20	7.5	.00012	55.5

ROAD SECTION STR1A

NO.	HW FT	CFS	HL FT	TW FT	STARTING CSM	BRIDGE CFS	BRIDGE AREA SQ FT	CULVERT CFS	CULVERT AREA SQ FT	WEIR CFS	WEIR AREA SQ FT	WEIR TOP WID FT
0	4.40	0.0	0.00	4.40	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.
1	8.27	23.5	1.33	6.94	.10	.0	.0	1.0	.0	22.5	7.9	9.
2	8.81	47.0	.83	7.98	.20	.0	.0	1.0	.0	46.0	12.7	9.
3	9.38	70.5	.61	8.77	.30	.0	.0	1.0	.0	69.5	17.8	9.
4	9.93	94.0	.51	9.42	.40	.0	.0	1.0	.0	93.0	22.9	9.
5	10.47	117.5	.51	9.96	.50	.0	.0	.1	.0	117.4	27.8	9.
6	11.03	141.0	.50	10.53	.60	.0	.0	.1	.0	140.9	32.9	9.
7	11.61	171.6	.56	11.05	.73	.0	.0	.1	.0	171.5	38.2	9.
8	12.20	202.1	.61	11.59	.86	.0	.0	.1	.0	202.0	43.6	9.
9	12.81	235.0	.64	12.17	1.00	.0	.0	.1	.0	234.9	49.2	9.
10	13.42	282.0	.50	12.93	1.20	.0	.0	.1	.0	281.9	77.2	109.

MIN ROAD ELEVATION = 7.40 FT

OPENING NO.	NO. CULVERTS	CULV. CODE	HEIGHT OR DIAM	WIDTH	LENGTH	U/S INVERT	D/S INVERT	(N) COEFF
1	1	12333.	.10		1.00	4.40	4.40	.024

RATING TABLE FOR SECTION 4 DA= 235.0 SQ MI EXP COEF= .00 CONT COEF= .00

NO.	ELEV FT	AREA SQ FT	Q CFS	------ACRES FLOODED------- FLOODPLAIN DAMAGE	CHANNEL	TOTAL	STARTING CSM	CRIT ELEV FT	FRICTION SLOPE FT/FT	FLOW TOP WIDTH FT
0	4.4	0.0	0.0							
1	8.3	49.1	23.5	.00	.05	.05	.10	5.3	.00003	19.1
2	8.8	59.8	47.0	.00	.05	.05	.20	5.7	.00007	20.6
LOW GRND	9.1	65.6	57.0	.00	.05	.05				21.4
BANK FULL	9.1	65.6	57.0	.00	.05	.05				21.4
3	9.4	73.6	70.5	.00	.05	.07	.30	5.9	.00009	29.0
4	9.9	94.5	94.0	.00	.05	.11	.40	6.2	.00010	44.0
5	10.5	120.1	117.5	.00	.06	.12	.50	6.4	.00010	50.1
6	11.0	148.9	141.0	.00	.06	.13	.60	6.6	.00010	52.4
7	11.6	179.6	171.6	.00	.06	.13	.73	6.8	.00010	53.3
8	12.2	211.5	202.1	.00	.06	.13	.86	7.0	.00010	54.3
9	12.8	244.4	235.0	.00	.06	.13	1.00	7.2	.00009	55.3
10	13.4	297.7	282.0	.00	.07	.19	1.20	7.5	.00009	79.2

RATING TABLE FOR SECTION 6 DA= 199.0 SQ MI EXP COEF= .00 CONT COEF= .00

NO.	ELEV FT	AREA SQ FT	Q CFS	------ACRES FLOODED------- FLOODPLAIN DAMAGE	CHANNEL	TOTAL	STARTING CSM	CRIT ELEV FT	FRICTION SLOPE FT/FT	FLOW TOP WIDTH FT
0	4.5	0.0	0.0							
1	8.3	48.9	19.9	.00	1.16	1.16	.10	5.3	.00002	19.1
2	9.0	61.0	39.8	.00	1.26	1.26	.20	5.6	.00005	20.8
LOW GRND	9.2	65.6	45.4	.00	1.30	1.30				21.4
BANK FULL	9.2	65.6	45.4	.00	1.30	1.30				21.4
3	9.6	77.4	59.7	.00	1.33	1.92	.30	5.9	.00006	31.7
4	10.1	98.9	79.6	.00	1.38	2.86	.40	6.1	.00007	47.1
5	10.7	126.2	99.5	.00	1.43	3.07	.50	6.3	.00007	50.7
6	11.2	154.8	119.4	.00	1.48	3.19	.60	6.5	.00007	52.6
7	11.8	185.6	145.3	.00	1.53	3.24	.73	6.7	.00007	53.5
8	12.4	217.4	171.1	.00	1.58	3.30	.86	6.9	.00006	54.5
9	13.0	250.1	199.0	.00	1.63	3.36	1.00	7.0	.00006	55.4
10	13.6	307.2	238.8	.00	1.64	5.12	1.20	7.3	.00006	84.4

RATING TABLE FOR SECTION 8 DA= 215.0 SQ MI EXP COEF= .00 CONT COEF= .00

NO.	ELEV FT	AREA SQ FT	Q CFS	------ACRES FLOODED------- FLOODPLAIN DAMAGE	CHANNEL	TOTAL	STARTING CSM	CRIT ELEV FT	FRICTION SLOPE FT/FT	FLOW TOP WIDTH FT
0	4.6	0.0	0.0							
1	8.4	48.8	21.5	.00	1.16	1.16	.10	5.4	.00003	19.1
2	9.1	62.4	43.0	.00	1.27	1.27	.20	5.8	.00005	20.9
LOW GRND	9.3	65.6	46.7	.00	1.30	1.30				21.4
BANK FULL	9.3	65.6	46.7	.00	1.30	1.30				21.4
3	9.7	81.3	64.5	.00	1.34	2.09	.30	6.0	.00006	34.5
4	10.3	104.4	86.0	.00	1.39	2.95	.40	6.2	.00007	48.7
5	10.9	132.5	107.5	.00	1.44	3.11	.50	6.4	.00007	51.3
6	11.4	161.0	129.0	.00	1.49	3.20	.60	6.6	.00007	52.7
7	12.0	192.0	156.9	.00	1.54	3.25	.73	6.8	.00007	53.7
8	12.6	223.6	184.9	.00	1.59	3.31	.86	7.0	.00007	54.7
9	13.2	257.4	215.0	.00	1.64	3.46	1.00	7.2	.00007	57.1
10	13.8	316.9	258.0	.00	1.64	5.44	1.20	7.5	.00006	89.8

WSP2 XEQ 07/23/93 15:42:04 POCOSIN LAKES NATIONAL WILDLIFE REFUGE, ALLEN RD CANAL WS WS : ALLEN PAGE 10
REV 10/27/89 ALT 1, EXISTING CONDITIONS, USE CFS FROM TR20,7-23-93,SDB ALT: ____

---------------------- LIST OF INPUT DATA WITH LIMITED EDITING-----------------------
ENDJOB
******************************NORMAL END OF JOB------------------------------

WSP2 XEQ 07/23/93 15:42:04 WS : ALLEN PAG 1
REV 10/27/89 ALT: ____

---------------------- LIST OF INPUT DATA WITH LIMITED EDITING-----------------------
ENDRUN
****

SCS WSP2 VERSION 10/27/89
FILE SUMMARY

INPUT = POC1A.WSP
OUTPUT = POC1A.OUT DATED 07/23/93 15:42:04

OPTIONAL FILES SAVED

OPTION R = POC1A.WRT DATED 07/23/93 15:42:04

****

STORM #1 Alt 1 TR20

```
JOB TR-20                               FULLPRINT          SUMMARY    NOPLOTS
TITLE      POCOSIN LAKES W/S,ALLEN CANAL,EXISTING COND'S,fn=ALLEN1WO.TR2
TITLE      DRAINMOD RO CONVERTED TO HOURLY RO for 9/11/60 STORM,K=76,SDB
   DIMHYD                 0.0294                                                      K=76
  8           0.0         0.5         1.0         0.96875     0.9375
  8           0.90625     0.875       0.84375     0.8125      0.78125
  8           0.75        0.71875     0.6875      0.65625     0.625
  8           0.59375     0.5625      0.53125     0.5         0.46875
  8           0.4375      0.40625     0.375       0.34375     0.3125
  8           0.28125     0.25        0.21875     0.1875      0.15625
  8           0.125       0.09375     0.0625      0.03125     0.0
  9 ENDTBL                      9/11   9/12   9/13   (see spreadsheet printout)
  5 RAINFL 4              1.0     RO = 4.06, 10.85, 1.54 cm                           9/11/60
  8           0           0.0049      0.0295      0.0393      0.0541      DRAINMOD
  8           0.9142      0.9929      0.9929      0.9929      1.0125      DAILY
  8 WL control 1.0764     1.0961      1.1305      1.1944      1.2092      RUNOFF
  8 Depth =>  1.4205      1.4795      1.4893      1.4893      1.4893      DIVIDED
  8           1.5041      1.5385      1.5483      1.5975      1.5975      BY DAILY
  8 140 cm    1.6952      1.7343      1.9787      1.9884      4.2171      RAINFALL
  8           4.2660      4.6179      4.6961      4.7156      4.7547      TIMES
  8           4.8622      4.9991      5.0284      5.0382      5.2434      HOURLY
  8           5.3412      5.3998      5.4487      5.4780      5.6344      RAINFALL
  8           5.6931      5.7224      5.7517      5.8690      5.9701      TO GET
  8           6.0711      6.1722      6.2732      6.3743      6.4753      HOURLY
  9 ENDTBL                                                                RUNOFF
  5 RAINFL 5              1.0     RO = 4.1, 10.85, 1.52 cm
  8           0           0.0050      0.0298      0.0397      0.0546      DRAINMOD
  9           0.9232      1.0027      1.0027      1.0027      1.0225      DAILY
  8 WL Cont   1.0870      1.1069      1.1416      1.2062      1.2211      RUNOFF
  8           1.4345      1.4941      1.5040      1.5040      1.5040      DIVIDED
  8  =122 cm  1.5189      1.5536      1.5636      1.6132      1.6132      BY DAILY
  8           1.7109      1.7500      1.9944      2.0042      4.2328      RAINFALL
  8           4.2817      4.6336      4.7118      4.7313      4.7704      TIMES
  8           4.8780      5.0148      5.0441      5.0539      5.2592      HOURLY
  8           5.3569      5.4156      5.4645      5.4938      5.6502      RAINFALL
  8           5.7088      5.7382      5.7675      5.8848      5.9845      TO GET
  8           6.0842      6.1840      6.2837      6.3835      6.4832      HOURLY
  9 ENDTBL                                                                RUNOFF
  5 RAINFL 6              1.0     RO = 4.13, 10.85, 1.51 cm
  8           0           0.0050      0.0300      0.0400      0.0550      DRAINMOD
  8           0.9300      1.0100      1.0100      1.0100      1.0300      DAILY
  8 WL Cont   1.0950      1.1150      1.1500      1.2150      1.2300      RUNOFF
  8           1.4450      1.5050      1.5150      1.5150      1.5150      DIVIDED
  8  =110 cm  1.5300      1.5650      1.5750      1.6250      1.6250      BY DAILY
  8           1.7227      1.7618      2.0062      2.0160      4.2446      RAINFALL
  8           4.2935      4.6454      4.7236      4.7432      4.7823      TIMES
  8           4.8898      5.0266      5.0559      5.0657      5.2710      HOURLY
  8           5.3687      5.4274      5.4763      5.5056      5.6620      RAINFALL
  8           5.7206      5.7500      5.7793      5.8966      5.9957      TO GET
  8           6.0947      6.1938      6.2929      6.3920      6.4911      HOURLY
  9 ENDTBL                                                                RUNOFF
  5 RAINFL 7              1.0     RO = 4.19, 10.85, 1.49 cm
  8           0           0.0051      0.0304      0.0406      0.0558      DRAINMOD
  8           0.9435      1.0247      1.0247      1.0247      1.0450      DAILY
  8 WL Cont   1.1109      1.1312      1.1667      1.2327      1.2479      RUNOFF
  8           1.4660      1.5269      1.5370      1.5370      1.5370      DIVIDED
  8 = 91 cm   1.5522      1.5877      1.5979      1.6486      1.6486      BY DAILY
  8           1.7464      1.7855      2.0298      2.0396      4.2682      RAINFALL
  8           4.3171      4.6690      4.7472      4.7668      4.8059      TIMES
  8           4.9134      5.0502      5.0796      5.0893      5.2946      HOURLY
  8           5.3923      5.4510      5.4999      5.5292      5.6856      RAINFALL
  8           5.7442      5.7736      5.8029      5.9202      6.0180      TO GET
              6.1157      6.2135      6.3113      6.4090      6.5068      HOURLY
  9 ENDTBL                                                                RUNOFF
  5 RAINFL 8              1.0
```

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                                              RO = 4.23, 10.85, 1.48 cm
8            0.0        0.0051      0.0307      0.0410      0.0563      DRAINMOD
8            0.9525     1.0345      1.0345      1.0345      1.0549      DAILY
8            1.1215     1.1420      1.1778      1.2444      1.2598      RUNOF
8  WL Cont   1.4800     1.5414      1.5517      1.5517      1.5517      DIVI
8            1.5670     1.6029      1.6131      1.6643      1.6643      BY D
8  = 79 cm   1.7621     1.8012      2.0456      2.0553      4.2840      RAINFALL
8            4.3329     4.6848      4.7629      4.7825      4.8216      TIMES
8            4.9291     5.0660      5.0953      5.1051      5.3103      HOURLY
8            5.4081     5.4667      5.5156      5.5449      5.7013      RAINFALL
8            5.7600     5.7893      5.8186      5.9359      6.0330      TO GET
8            6.1301     6.2273      6.3244      6.4215      6.5186      HOURLY
9 ENDTBL                                                                RUNOFF
5 RAINFL 9              1.0     RO = 4.27, 10.85, 1.45 cm
8            0.0        0.0052      0.0310      0.0414      0.0569      DRAINMOD
8            0.9615     1.0442      1.0442      1.0442      1.0649      DAILY
8  WL Cont   1.1321     1.1528      1.1890      1.2562      1.2717      RUNOFF
8            1.4940     1.5560      1.5664      1.5664      1.5664      DIVIDED
8  = 61 cm   1.5819     1.6181      1.6284      1.6801      1.6801      BY DAILY
8            1.7778     1.8169      2.0613      2.0711      4.2997      RAINFALL
8            4.3486     4.7005      4.7787      4.7982      4.8373      TIMES
8            4.9449     5.0817      5.1110      5.1208      5.3261      HOURLY
8            5.4238     5.4825      5.5313      5.5607      5.7171      RAINFALL
8            5.7757     5.8050      5.8344      5.9517      6.0468      TO GET
8            6.1420     6.2371      6.3322      6.4274      6.5225      HOURLY
9 ENDTBL                                                                RUNOFF
2 XSECTN     2                  1.00        9.10       12.09        9.10
8                               4.40        0.0         0.0         0.0 2       1
8                               6.89       23.50       25.17         .002       2
8                               7.85       47.00       41.23         .002       3
8                               8.58       70.50       54.92         .002       4
8                               9.10       90.27       65.65         .002       5
8                               9.18       94.00       67.67         .002       6
8                               9.68      117.50       84.64         .002
8                              10.11      141.00      100.80         .002
8                              10.61      171.55      126.52         .002       9
8                              11.05      202.10      149.66         .002      10
8                              11.50      235.00      173.16         .002      11
8                              12.09      282.00      204.69         .002      12
9 ENDTBL                                                                        R2
2 XSECTN     3                  1.00        9.10       12.93        9.10
8                               4.40        0.0         0.0         0.0 3       1
8                               6.94       23.50       26.08         .003       2
8                               7.98       47.00       43.38         .003       3
8                               8.77       70.50       58.74         .003       4
8                               9.10       80.54       65.65         .003       5
8                               9.42       94.00       74.90         .003       6
8                               9.96      117.50       95.23         .003       7
8                              10.53      141.00      122.67         .003       8
8                              11.05      171.55      149.43         .003       9
8                              11.59      202.10      178.08         .003      10
8                              12.16      235.00      209.01         .003      11
8                              12.93      282.00      250.64         .003      12
9 ENDTBL                                                                        R2
2 XSECTN     4                  1.00        9.10       13.43        9.10
8                               4.40        0.0         0.0         0.0 4       1
8                               8.28       23.50       49.08         .004       2
8                               8.82       47.00       59.78         .004       3
8                               9.10       56.96       65.65         .004       4
8                               9.38       70.50       73.63         .004       5
8                               9.94       94.00       94.53         .004       6
8                              10.48      117.50      120.15         .004       7
8                              11.04      141.00      148.88         .004       8
8                              11.62      171.55      179.56         .004
8                              12.21      202.10      211.47         .004
8                              12.81      235.00      244.41         .004       1
```

8			13.43	282.00	297.74	.004	12
9	ENDTBL						
2	XSECTN	6	1.00	9.18	13.60	9.18	
8			4.47	0.0	0.0	0.0 6	1
8			8.34	19.90	48.86	.006	2
8			8.95	39.80	61.01	.006	3
8			9.18	45.44	65.65	.006	4
8			9.56	59.70	77.36	.006	5
8			10.13	79.60	98.86	.006	6
8			10.68	99.50	126.23	.006	7
8			11.23	119.40	154.79	.006	8
8			11.81	145.27	185.59	.006	9
8			12.39	171.14	217.37	.006	10
8			12.99	199.00	250.11	.006	11
8			13.60	238.80	307.19	.006	12
9	ENDTBL						R2
2	XSECTN	8	1.00	9.25	13.00	9.25	
8			4.55	0.0	0.0	0.0 8	1
8			8.54	21.50	51.36	.008	2
8			9.25	37.87	65.65	.008	3
8			9.44	43.00	70.12	.008	4
8			10.11	64.50	95.33	.008	5
8			10.83	86.00	130.43	.008	6
8			11.49	107.50	164.83	.008	7
8			12.07	129.00	195.73	.008	8
8			12.65	156.95	227.08	.008	9
8			12.74	184.90	232.25	.008	10
8			12.85	215.00	237.86	.008	11
8			13.00	258.00	246.23	.008	12
9	ENDTBL						R2
2	XSECTN	10	1.00	9.25	13.01	9.25	
8			4.55	0.0	0.0	0.0 10	1
8			8.55	21.50	51.40	.0010	2
8			9.25	37.78	65.65	.0010	3
8			9.44	43.00	70.22	.0010	4
8			10.12	64.50	95.50	.0010	5
8			10.84	86.00	130.67	.0010	6
8			11.50	107.50	165.07	.0010	7
8			12.07	129.00	195.98	.0010	8
8			12.65	156.95	227.34	.0010	9
8			12.75	184.90	232.60	.0010	10
8			12.85	215.00	238.31	.0010	11
8			13.01	258.00	246.83	.0010	12
9	ENDTBL						R2
2	XSECTN	12	1.00	9.33	13.21	9.33	
8			4.63	0.0	0.0	0.0 12	1
8			8.59	17.90	50.83	.0012	2
8			9.33	31.56	65.65	.0012	3
8			9.52	35.80	70.24	.0012	4
8			10.21	53.70	96.21	.0012	5
8			10.93	71.60	131.65	.0012	6
8			11.59	89.50	165.98	.0012	7
8			12.17	107.40	196.88	.0012	8
8			12.75	130.67	228.52	.0012	9
8			12.87	153.94	235.18	.0012	10
8			13.01	179.00	242.73	.0012	11
8			13.21	214.80	253.88	.0012	12
9	ENDTBL						R2
2	XSECTN	14	1.00	10.80	13.27	10.80	
8			4.70	0.0	0.0	0.0 14	1
8			8.61	14.30	74.55	.0014	2
8			9.54	28.60	104.73	.0014	3
8			10.24	42.90	132.10	.0014	4
8			10.80	53.56	158.75	.0014	5
8			10.97	57.20	167.85	.0014	6

8			11.62	71.50	208.79	.0014	7
8			12.20	85.80	248.69	.0014	8
8			12.78	104.39	290.64	.0014	9
8			12.91	122.98	300.57	.0014	[illegible]
8			13.06	143.00	311.81	.0014	[illegible]
8			13.27	171.60	328.26	.0014	12
9	ENDTBL						R2
2	XSECTN	15	1.00	13.80	13.58	13.80	
8			4.70	0.0	0.0	0.0 15	1
8			8.62	14.30	35.47	.0015	2
8			9.56	28.60	43.96	.0015	3
8			10.26	42.90	50.38	.0015	4
8			10.98	57.20	56.99	.0015	5
8			11.64	71.50	62.95	.0015	6
8			12.21	85.80	68.23	.0015	7
8			12.86	104.39	74.16	.0015	8
8			13.10	122.98	76.39	.0015	9
8			13.33	143.00	78.48	.0015	10
8			13.58	171.60	80.74	.0015	11
9	ENDTBL						
2	XSECTN	16	1.00	10.80	13.95	10.80	
8			4.70	0.0	0.0	0.0 16	1
8			10.64	14.30	150.85	.0016	2
8			10.80	19.80	158.75	.0016	3
8			11.03	28.60	171.41	.0016	4
8			11.33	42.90	190.68	.0016	5
8			11.67	57.20	212.20	.0016	6
8			12.10	71.50	241.88	.0016	7
8			12.58	85.80	276.45	.0016	8
8			13.23	104.39	325.03	.0016	9
8			13.52	122.98	347.38	.0016	10
8			13.81	143.00	370.25	.0016	11
8			13.95	171.60	387.89	.0016	[illegible]
9	ENDTBL						
2	XSECTN	18	1.00	11.30	14.13	11.30	
8			5.20	0.0	0.0	0.0 18	1
8			11.16	32.80	152.01	.0018	2
8			11.30	36.68	158.75	.0018	3
8			12.12	65.60	208.93	.0018	4
8			13.29	98.40	291.40	.0018	5
8			13.56	131.20	311.99	.0018	6
8			13.62	164.00	316.91	.0018	7
8			13.69	196.80	322.01	.0018	8
8			13.78	239.44	329.23	.0018	9
8			13.88	282.08	336.35	.0018	10
8			13.97	328.00	343.96	.0018	11
8			14.13	393.60	355.69	.0018	12
9	ENDTBL						R2
2	XSECTN	20	1.00	11.80	14.32	11.80	
8			5.70	0.0	0.0	0.0 20	1
8			11.18	28.80	129.52	.0020	2
8			11.80	45.78	158.75	.0020	3
8			12.15	57.60	179.09	.0020	4
8			13.31	86.40	257.11	.0020	5
8			13.59	115.20	277.24	.0020	6
8			13.67	144.00	283.06	.0020	7
8			13.76	172.80	289.21	.0020	8
8			13.88	210.24	298.27	.0020	9
8			13.99	247.68	307.17	.0020	10
8			14.12	288.00	317.07	.0020	11
8			14.32	345.60	332.01	.0020	12
9	ENDTBL						R2
2	XSECTN	22	1.00	12.30	14.48	12.30	
8			6.20	0.0	0.0	0.0 22	1
8			11.19	25.20	110.64	.0022	2

8			12.18	50.40	152.83	.0022	3
8			12.30	52.53	158.75	.0022	4
8			13.34	75.60	222.85	.0022	5
			13.63	100.80	243.69	.0022	6
8			13.72	126.00	250.64	.0022	7
8			13.82	151.20	258.02	.0022	8
8			13.97	183.96	268.38	.0022	9
8			14.10	216.72	278.09	.0022	10
8			14.26	252.00	289.07	.0022	11
8			14.48	302.40	306.23	.0022	12
9	ENDTBL						R2
2	XSECTN	24	1.00	12.80	14.64	12.80	
8			6.70	0.0	0.0	0.0 24	1
8			11.21	21.90	93.50	.0024	2
8			12.21	43.80	130.75	.0024	3
8			12.80	53.72	158.75	.0024	4
8			13.36	65.70	192.59	.0024	5
8			13.66	87.60	211.55	.0024	6
8			13.78	109.50	218.68	.0024	7
8			13.89	131.40	227.06	.0024	8
8			14.06	159.87	239.00	.0024	9
8			14.21	188.34	249.92	.0024	10
8			14.39	219.00	262.37	.0024	11
8			14.64	262.80	280.51	.0024	12
9	ENDTBL						R2
2	XSECTN	26	1.00	12.80	14.64	12.80	
8			6.70	0.0	0.0	0.0 26	1
8			11.21	21.90	93.52	.0026	2
8			12.21	43.80	130.79	.0026	3
8			12.80	53.70	158.75	.0026	4
8			13.36	65.70	192.66	.0026	5
8			13.66	87.60	211.63	.0026	6
			13.78	109.50	218.80	.0026	7
			13.90	131.40	227.24	.0026	8
8			14.06	159.87	239.24	.0026	9
8			14.22	188.34	250.21	.0026	10
8			14.39	219.00	262.71	.0026	11
8			14.64	262.80	280.91	.0026	12
9	ENDTBL						R2
2	XSECTN	28	1.00	13.05	14.76	13.05	
8			6.95	0.0	0.0	0.0 28	1
8			11.22	18.30	85.71	.0028	2
8			12.23	36.60	122.02	.0028	3
8			13.05	48.54	158.75	.0028	4
8			13.39	54.90	178.31	.0028	5
8			13.70	73.20	197.81	.0028	6
8			13.82	91.50	205.80	.0028	7
8			13.95	109.80	214.23	.0028	8
8			14.14	133.59	226.59	.0028	9
8			14.31	157.38	238.76	.0028	10
8			14.49	183.00	252.07	.0028	11
8			14.76	219.60	271.57	.0028	12
9	ENDTBL						R2
2	XSECTN	30	1.00	13.30	14.86	13.30	
8			7.20	0.0	0.0	0.0 30	1
8			11.23	14.80	78.37	.0030	2
8			12.25	29.60	113.04	.0030	3
8			13.30	42.74	158.75	.0030	4
8			13.41	44.40	164.53	.0030	5
8			13.72	59.20	183.59	.0030	6
8			13.86	74.00	192.21	.0030	7
8			14.00	88.80	201.26	.0030	8
			14.19	108.04	213.60	.0030	9
			14.38	127.28	225.68	.0030	10
8			14.57	148.00	239.79	.0030	11

8			14.86	177.60	260.22	.0030	12
9	ENDTBL						R2
2	XSECTN	32	1.00	13.55	14.93	13.55	
8			7.45	0.0	0.0	0.0 32	
8			11.25	12.90	71.27	.0032	
8			12.27	25.80	103.99	.0032	3
8			13.42	38.70	152.55	.0032	4
8			13.55	43.47	158.75	.0032	5
8			13.74	51.60	169.31	.0032	6
8			13.89	64.50	178.42	.0032	7
8			14.04	77.40	188.01	.0032	8
8			14.25	94.17	200.96	.0032	9
8			14.44	110.94	212.98	.0032	10
8			14.64	129.00	226.71	.0032	11
8			14.93	154.80	247.84	.0032	12
9	ENDTBL						R2
2	XSECTN	34	1.00	13.80	14.98	13.80	
8			7.70	0.0	0.0	0.0 34	1
8			11.25	10.90	64.23	.0034	2
8			12.28	21.80	95.96	.0034	3
8			13.43	32.70	140.86	.0034	4
8			13.76	43.60	156.78	.0034	5
8			13.80	46.29	158.75	.0034	6
8			13.91	54.50	164.77	.0034	7
8			14.07	65.40	173.89	.0034	8
8			14.28	79.57	187.23	.0034	9
8			14.47	93.74	199.60	.0034	10
8			14.68	109.00	212.87	.0034	11
8			14.98	130.80	233.39	.0034	12
9	ENDTBL						R2
2	XSECTN	35	1.00	14.05	15.02	14.05	
8			7.95	0.0	0.0	0.0 35	1
8			11.26	8.10	57.81	.0035	
8			12.29	16.20	88.00	.0035	
8			13.44	24.30	130.15	.0035	4
8			13.77	32.40	145.19	.0035	5
8			13.93	40.50	152.84	.0035	6
8			14.05	46.37	158.75	.0035	7
8			14.09	48.60	161.00	.0035	8
8			14.31	59.13	173.24	.0035	9
8			14.51	69.66	185.90	.0035	10
8			14.72	81.00	199.43	.0035	11
8			15.02	97.20	218.63	.0035	12
9	ENDTBL						R2
2	XSECTN	36	1.00	14.30	15.08	14.30	
8			8.20	0.0	0.0	0.0 36	1
8			11.27	6.00	51.51	.0036	2
8			12.31	12.00	80.52	.0036	3
8			13.46	18.00	120.91	.0036	4
8			13.79	24.00	133.91	.0036	5
8			13.95	30.00	141.80	.0036	6
8			14.12	36.00	150.09	.0036	7
8			14.30	42.00	158.75	.0036	8
8			14.35	43.80	161.35	.0036	9
8			14.55	51.60	173.01	.0036	10
8			14.77	60.00	186.85	.0036	11
8			15.08	72.00	206.36	.0036	12
9	ENDTBL						R2
2	XSECTN	38	1.00	14.80	15.09	14.80	
8			8.70	0.0	0.0	0.0 38	1
8			11.28	1.70	39.62	.0038	2
8			12.31	3.40	65.68	.0038	3
8			13.46	5.10	101.78	.0038	
8			13.79	6.80	114.55	.0038	
8			13.96	8.50	120.93	.0038	6

```
8                                    14.13       10.20       127.55          .0038    7
8                                    14.35       12.41       136.84          .0038    8
8                                    14.56       14.62       146.94          .0038    9
                                     14.78       17.00       157.68          .0038   10
8                                    14.80       17.21       158.75          .0038   11
8                                    15.09       20.40       175.16          .0038   12
9 ENDTBL                                                                             R2
2 XSECTN    40                        1.00       14.80        15.09        14.80____
8                                     8.70        0.0          0.0          0.0 40    1
8                                    11.28         .50        39.62          .0040    2
8                                    12.31        1.00        65.69          .0040    3
8                                    13.46        1.50       101.78          .0040    4
8                                    13.79        2.00       114.56          .0040    5
8                                    13.96        2.50       120.94          .0040    6
8                                    14.13        3.00       127.55          .0040    7
8                                    14.35        3.65       136.85          .0040    8
8                                    14.56        4.30       146.95          .0040    9
8                                    14.78        5.00       157.69          .0040   10
8                                    14.80        5.06       158.75          .0040   11
8                                    15.09        6.00       175.18          .0040   12
9 ENDTBL                                                                             R2
2 XSECTN   106                        1.00        9.18        13.61         9.18____
8                                    12.50        0.0          0.0
8                                    13.00      300.0         50.0
8                                    13.50     1000.0        100.0
9 ENDTBL
2 XSECTN   114                        1.00       10.50        13.98        10.50____
8                                    13.00        0.0          0.0
8                                    13.50      300.0         50.0
8                                    14.00     1000.0        100.0
9 ENDTBL
2 XSECTN   116                        1.00       10.50        13.98        10.50____
8                                    13.50        0.0          0.0
8                                    14.00      300.0         50.0
8                                    14.50     1000.0        100.0
9 ENDTBL
2 XSECTN   122                        1.00       12.00        14.57        12.00____
8                                    16.00        0.0          0.0
8                                    16.50      300.0         50.0
8                                    17.00     1000.0        100.0
9 ENDTBL
2 XSECTN   135                        1.00       13.75        14.76        13.75____
8                                    15.50        0.0          0.0
8                                    16.00      300.0         20.0
8                                    17.00     1000.0        100.0
9 ENDTBL
6 RUNOFF 1   38         5 0.006         100.         0.09
6 RUNOFF 1   38         6 0.184         100.         3.4
6 ADDHYD 4   38    5 6 7                                          1       1
6 REACH  3   36    7    5 4000.
6 RUNOFF 1   36         6 0.62          100.         4.39
6 ADDHYD 4   36    5 6 7                                          1       1
6 REACH  3   35    7    5 5350.
6 RUNOFF 1   35         6 0.289         100.         3.25
6 ADDHYD 4   35    5 6 4                                          1       1
6 DIVERT 6 135     4 1 7                              35          1       1
6 REACH  3   34    7    5 2550.
6 RUNOFF 1   34         6 0.373         100.         4.00
6 ADDHYD 4   34    5 6 7                                          1       1
6 REACH  3   32    7    5 2000.
6 RUNOFF 1   32         6 0.246         100.         3.62
6 ADDHYD 4   32    5 6 7                                          1       1
6 REACH  3   30    7    5 2640.
6 RUNOFF 1   30         6 0.246         100.         3.62
6 ADDHYD 4   30    5 6 7                                          1       1
```

```
6 REACH   3   28    7    5 2640.
6 RUNOFF  1   28         6 0.492          100.         4.36
6 ADDHYD  4   28    5 6  7                                           1         1
6 REACH   3   26    7    5 2640.
6 RUNOFF  1   26         6 0.492          100.         4.36
6 ADDHYD  4   26    5 6  7                                           1         1
6 REACH   3   22    7    5 2640.
6 RUNOFF  1   22         6 0.492          100.         4.36
6 ADDHYD  4   22    5 6  4                                           1         1
6 DIVERT  6  122    4 2  7                              22           1         1
6 REACH   3   20    7    5 2700.
6 RUNOFF  1   20         6 0.492          100.         4.36
6 ADDHYD  4   20    5 6  7                                           1         1
6 REACH   3   18    7    5 3000.
6 RUNOFF  1   18         6 0.564          100.         4.58
6 ADDHYD  4   18    5 6  7                                           1         1
6 REACH   3   16    7    5 2640.
6 RUNOFF  1   16         6 0.5            100.         4.4
6 ADDHYD  4   16    5 6  4                                           1         1
6 DIVERT  6  116    4 2  7                              16           1         1
6 REACH   3   14    7    5 200.
6 DIVERT  6  114    5 2  7                              14           1         1
6 REACH   3   12    7    5 2440.
6 RUNOFF  1   12         6 0.5            100.         4.4
6 ADDHYD  4   12    5 6  7                                           1         1
6 REACH   3   10    7    5 2640.
6 RUNOFF  1   10         6 0.5            100.         4.4
6 ADDHYD  4   10    5 6  7                                           1         1
6 REACH   3    6    7    5 2640.
6 RUNOFF  1    6         6 0.5            100.         4.4
6 ADDHYD  4    6    5 6  4                                           1         1
6 DIVERT  6  106    4 3  7                               6           1         1
6 REACH   3    4    7    5 2640.
6 RUNOFF  1    4         6 0.5            100.         4.4
6 ADDHYD  4    4    5 6  7                                           1         1
6 REACH   3    2    7    5  200.
  ENDATA
7 INCREM  6                0.25
7 COMPUT  7   38     38                   1.0          1.0         4 2   01   01
7 COMPUT  7   36     26                   1.0          1.0         5 2   01   01
7 COMPUT  7   22    114                   1.0          1.0         7 2   01   01
7 COMPUT  7   12     10                   1.0          1.0         6 2   01   01
7 COMPUT  7    6      2                   1.0          1.0         8 2   01   01
  ENDCMP  1
  ENDJOB  2
```

```
TR20 ------------------------------------------------------------------ SCS -
          POCOSIN LAKES W/S,ALLEN CANAL,EXISTING COND'S,fn=ALLEN1WO.TR2  VERSION
  /09/93  DRAINMOD RO CONVERTED TO HOURLY RO for 9/11/60 STORM,K=76,SDB 2.04TEST
 :54:14                      PASS   1   JOB NO.   1                     PAGE   1


   DIMENSIONLESS HYDROGRAPH TABLE ENTERED
                    .0000       .5000     1.0000      .9688      .9375
                    .9063       .8750      .8438      .8125      .7813
                    .7500       .7188      .6875      .6563      .6250
                    .5938       .5625      .5313      .5000      .4688
                    .4375       .4063      .3750      .3438      .3125
                    .2813       .2500      .2188      .1875      .1563
                    .1250       .0938      .0625      .0313      .0000
ENDTBL

             COMPUTED TIME INCREMENT    =       .0294

             COMPUTED PEAK RATE FACTOR =     75.922
```

```
EXECUTIVE CONTROL  INCREM    MAIN TIME INCREMENT =   .250 HOURS


EXECUTIVE CONTROL  COMPUT    FROM XSECTION  38  TO XSECTION  38
    STARTING TIME =   .00       RAIN DEPTH =  1.00        RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .250 HOURS
    ALTERNATE NO. = 1           STORM NO. = 1             RAIN TABLE NO. = 4


OPERATION RUNOFF    XSECTION  38
         OUTPUT HYDROGRAPH =  5       AREA =    .01 SQ MI
         INPUT RUNOFF CURVE =100.    TIME OF CONCENTRATION =   .09 HOURS
         COMPUTED INTERNAL TIME INCREMENT =  .1080 HOURS

    PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
        5.00                            2.6                        (RUNOFF)
       29.00                            6.7                        (RUNOFF)
       31.00                            1.1                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =     .00 CFS)
                   6.47 WATERSHED INCHES;      25 CFS-HRS;       2.1 ACRE-FEET.

 *** WARNING - MAIN TIME INCREMENT (  .250) IS GREATER THAN 50% OF THE
               TIME OF CONCENTRATION (  .09) FOR SUBWATERSHED XSECTION  38.
               THIS WILL REDUCE THE COMPUTED PEAK BY ABOUT  -4.0%.


OPERATION RUNOFF    XSECTION  38
         OUTPUT HYDROGRAPH =  6       AREA =    .18 SQ MI
         INPUT RUNOFF CURVE =100.    TIME OF CONCENTRATION =  3.40 HOURS
         COMPUTED INTERNAL TIME INCREMENT =  .2400 HOURS

    PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
        7.30                            6.2                        (RUNOFF)
       16.99                            7.4                        (RUNOFF)
       32.51                           22.2                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =     .00 CFS)
                   6.48 WATERSHED INCHES;     769 CFS-HRS;      63.5 ACRE-FEET.


OPERATION ADDHYD    XSECTION  38
         INPUT HYDROGRAPHS 5,6      OUTPUT HYDROGRAPH 7
```

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
RAINFALL OF 6.48 inches AND 54.00 hr DURATION, BEGINS AT .0 hrs.								
RAINTABLE NUMBER 4, ARC 2								
MAIN TIME INCREMENT .250 HOURS								
ALTERNATE 1 STORM 1								
XSECTION	38	RUNOFF	.01	6.47	---	29.00	7	700.0
XSECTION	38	RUNOFF	.18	6.48	---	32.51	22	122.2
XSECTION	38	ADDHYD	.19	6.48	15.30	31.11	23	121.1
RAINTABLE NUMBER 5, ARC 2								
XSECTION	36	REACH	.19	6.47	13.54	40.50	20	105.3
XSECTION	36	RUNOFF	.62	6.48	---	33.15	63	101.6
XSECTION	36	ADDHYD	.81	6.48	15.29	36.94	80	98.8
XSECTION	35	REACH	.81	6.48	14.69	38.85	79	97.5
XSECTION	35	RUNOFF	.29	6.48	---	32.42	36	124.1
XSECTION	35	ADDHYD	1.10	6.48	15.28	37.24	111	100.9
XSECTION	135	DIVERT	.00	6.48	---	.00	0	********
XSECTION	35	DIVERT	1.10	6.48	15.28	37.24	111	100.9
XSECTION	34	REACH	1.10	6.48	14.70	38.00	111	100.9
XSECTION	34	RUNOFF	.37	6.48	---	32.89	41	110.8
XSECTION	34	ADDHYD	1.47	6.48	15.23	37.43	149	101.4
XSECTION	32	REACH	1.47	6.48	14.86	37.99	149	101.4
XSECTION	32	RUNOFF	.25	6.48	---	32.65	29	116.0
XSECTION	32	ADDHYD	1.72	6.48	15.16	37.53	175	101.7
XSECTION	30	REACH	1.72	6.48	14.83	38.18	175	101.7
XSECTION	30	RUNOFF	.25	6.48	---	32.65	29	116.0
XSECTION	30	ADDHYD	1.96	6.48	15.09	37.73	201	102.6
XSECTION	28	REACH	1.96	6.48	14.62	38.34	201	102.6
XSECTION	28	RUNOFF	.49	6.48	---	33.13	51	104.1
XSECTION	28	ADDHYD	2.46	6.48	14.98	37.92	249	101.2
XSECTION	26	REACH	2.46	6.48	14.56	38.49	249	101.2
XSECTION	26	RUNOFF	.49	6.48	---	33.13	51	104.1
XSECTION	26	ADDHYD	2.95	6.48	14.83	38.10	297	100.7

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
RAINTABLE NUMBER 7, ARC 2								
ALTERNATE 1 STORM 1								
XSECTION	22	REACH	2.95	6.48	14.45	38.64	297	100.7
RAINFALL OF 6.51 inches AND 54.00 hr DURATION, BEGINS AT .0 hrs.								
XSECTION	22	RUNOFF	.49	6.51	---	33.12	51	104.1
XSECTION	22	ADDHYD	3.44	6.48	14.66	38.31	345	100.3
XSECTION	122	DIVERT	.00	6.48	---	.00	0	********
XSECTION	22	DIVERT	3.44	6.48	14.66	38.31	345	100.3
XSECTION	20	REACH	3.44	6.48	14.32	38.84	344	100
XSECTION	20	RUNOFF	.49	6.51	---	33.12	51	104
XSECTION	20	ADDHYD	3.93	6.49	14.48	38.55	392	99.7
XSECTION	18	REACH	3.93	6.49	14.13	39.13	392	99.7
XSECTION	18	RUNOFF	.56	6.51	---	33.28	56	100.0
XSECTION	18	ADDHYD	4.50	6.49	14.26	38.94	446	99.1
XSECTION	16	REACH	4.50	6.49	15.29	39.55	446	99.1
XSECTION	16	RUNOFF	.50	6.51	---	33.15	51	102.0
XSECTION	16	ADDHYD	5.00	6.49	15.53	39.43	494	98.8
XSECTION	116	DIVERT	.00	6.49	14.01	39.43	310	********
XSECTION	16	DIVERT	5.00	3.38	14.01	39.43	183	36.6
XSECTION	14	REACH	5.00	3.38	13.36	39.43	183	36.6
XSECTION	114	DIVERT	.00	3.38	13.07	39.43	40	********
XSECTION	14	DIVERT	5.00	3.10	13.07	39.50F	144F	28.8
RAINTABLE NUMBER 6, ARC 2								
XSECTION	12	REACH	5.00	3.10	12.82	40.25F	144F	28.8
RAINFALL OF 6.49 inches AND 54.00 hr DURATION, BEGINS AT .0 hrs.								
XSECTION	12	RUNOFF	.50	6.49	---	33.15	51	102.0

```
?20 ------------------------------------------------------------------------ SCS -
         POCOSIN LAKES W/S,ALLEN CANAL,EXISTING COND'S,fn=ALLEN1WO.TR2  VERSION
?8/09/93 DRAINMOD RO CONVERTED TO HOURLY RO for 9/11/60 STORM,K=76,SDB 2.04TEST
15:54:14                    SUMMARY, JOB NO.   1                      PAGE  47
```

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH   T-TRUNCATED HYDROGRAPH   R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 1								
XSECTION	12	ADDHYD	5.50	3.41	13.09	37.23	193	35.1
XSECTION	10	REACH	5.50	3.41	12.78	37.78	193	35.1
XSECTION	10	RUNOFF	.50	6.49	---	33.15	51	102.0
XSECTION	10	ADDHYD	6.00	3.67	12.95	37.24	242	40.3
RAINTABLE NUMBER 8,			ARC 2					
XSECTION	6	REACH	6.00	3.67	13.64	37.88	242	40.3
RAINFALL OF 6.52 inches AND 54.00 hr DURATION, BEGINS AT .0 hrs.								
XSECTION	6	RUNOFF	.50	6.52	---	33.15	51	102.0
XSECTION	6	ADDHYD	6.50	3.89	14.40	37.30	291	44.8
XSECTION	106	DIVERT	.00	3.89	12.68	37.30	106	********
XSECTION	6	DIVERT	6.50	3.16	12.68	37.30	184	28.3
XSECTION	4	REACH	6.50	3.16	11.87	37.78	184	28.3
XSECTION	4	RUNOFF	.50	6.52	---	33.15	51	102.0
XSECTION	4	ADDHYD	7.00	3.40	12.81	33.53	235	33.6
XSECTION	2	REACH	7.00	3.40	11.50	33.53	235	33.6

```
TR20 ---------------------------------------------------------------------- S
         POCOSIN LAKES W/S,ALLEN CANAL,EXISTING COND'S,fn=ALLEN1WO.TR2  VER
08/09/93 DRAINMOD RO CONVERTED TO HOURLY RO for 9/11/60 STORM,K=76,SDB 2.04


END OF  1 JOBS IN THIS RUN




                    SCS  TR-20,  VERSION 2.04TEST
                                 FILES

     INPUT  = ALLEN1WO.TR2                          , GIVEN DATA FILE
     OUTPUT = ALLEN1WO.OUT                          , DATED 08/09/93,15:54:14

          FILES GENERATED - DATED 08/09/93,15:54:14

                         NONE!


        TOTAL NUMBER OF WARNINGS =   6,  MESSAGES =   3

                       JOB ENDED AT 15:54:36
                     *** TR-20 RUN COMPLETED ***
```

POCOSIN LAKES NATIONAL WILDLIFE REFUGE
Water Management Proposal
1992

GOAL:

a. To raise water levels to restore as much of the land between Allen Road and County Line (Washington-Tyrrell) to pocosin type wetland as possible.

b. To raise water levels to maintain pocosin type wetlands between County Line and the Gum Neck area.

OBJECTIVES:

1. Prepare a map indicating all water flow routes in existing canals and approximate width of canals.

2. Map locations of new water control structures with various sizes indicated. This should include priority locations. After installation, elevations need to be determined.

3. Water control structure placement should hold water at lands surface elevation.

4. Restore large areas of landscape to sheet flow type runoff.

5. Determine how much rainfall the landscape can hold behind the individual structures; e.g., when we have water backed-up behind structure at Clayton and Coulborne Roads (at "x" elevations), how much rainfall can occur before the water floods over the structure or road?

6. Create water storage areas to provide release of water into other canals or areas during droughts.

7. Establish waterfowl moist soil units south of Coulborne Road between Clayton and Evans Roads. Determine what blocks can be farmed and what blocks we could manipulate water on.

8. Are the road elevations high enough to accomplish items 1 - 7 above and still have access to all property.

9. Develop water table monitoring wells near agricultural lands. These should yield information about ground water levels and how we may impact our neighbors that farm.

10. Check elevations on east side canals such as Seagoing, Middle, Branch, Parisher, Western, and Northern.

11. Establish size of culverts for Northwest Fork River and Middle Road.

12. Draw up plans to correct drainage problem at I Canal and John Williams' property.

13. Determine volume and times that Fred Sutter pumping station operates, and what impact this activity has on the forest in that area. Determine water quality that is being pumped onto the Refuge.

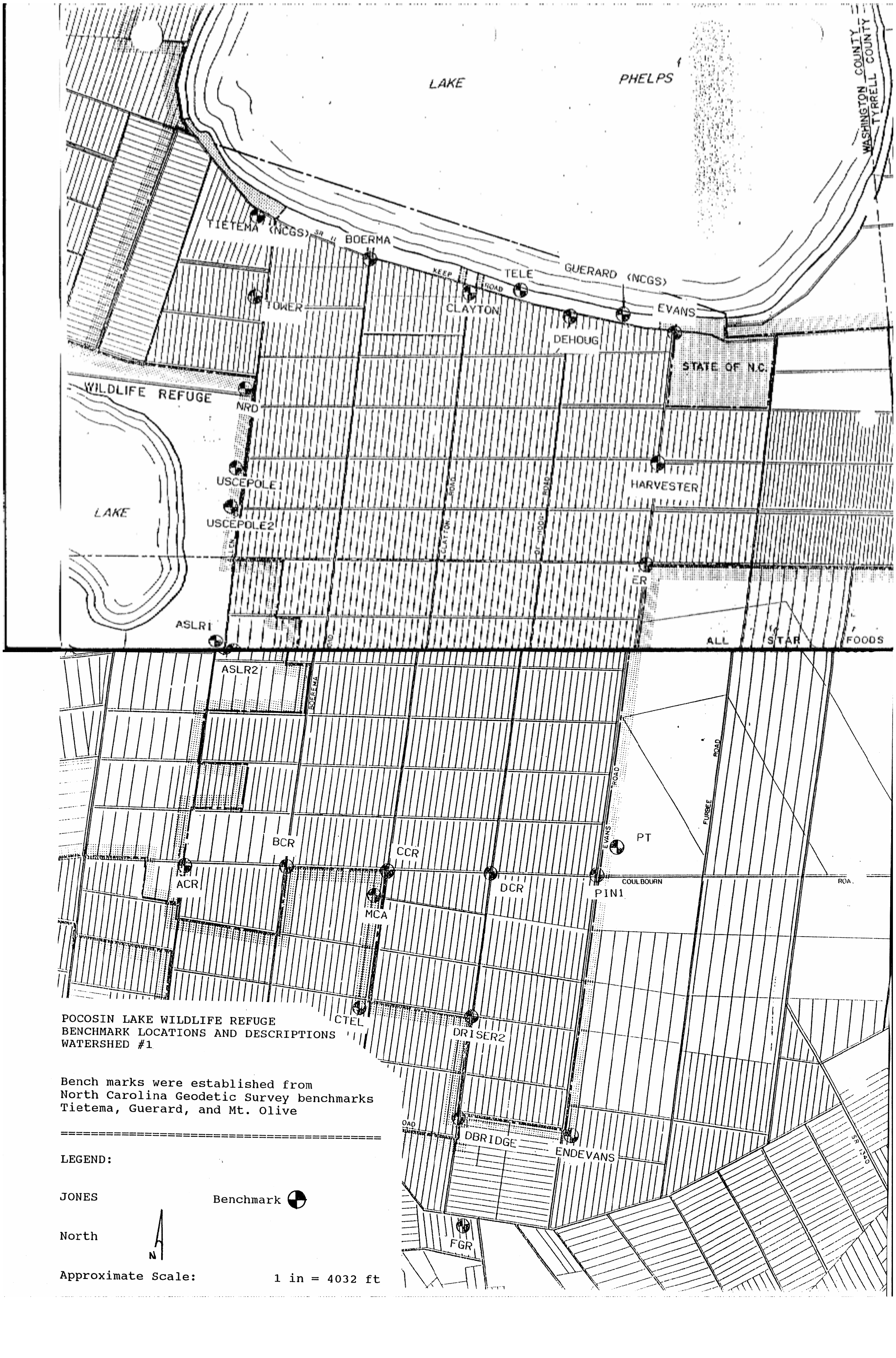
NOTE: We have found a large amount of information concerning hydrology, deep soil borings, and detailed topos of the areas between Allen and Evans Roads.

Jim Sweeney

A P P E N D I X C

SURVEYING BENCHMARK LOCATIONS AND DESCRIPTIONS

WATERSHED # 1



POCOSIN LAKE WILDLIFE REFUGE
BENCHMARK LOCATIONS AND DESCRIPTIONS
WATERSHED #1

Bench marks were established from
North Carolina Geodetic Survey benchmarks
Tietema, Guerard, and Mt. Olive

==

LEGEND:

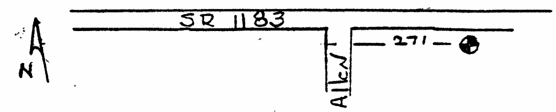
JONES Benchmark

North

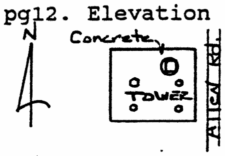
Approximate Scale: 1 in = 4032 ft

POCOSIN LAKES WILDLIFE REFUGE
LOCATION, DESCRIPTION, AND ELEVATION OF BENCH MARKS
WATERSHED #1

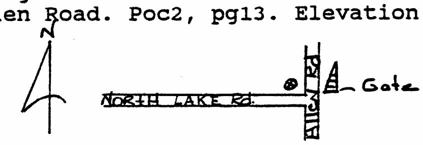
TIETEMA — NCGS monument, located approximately 270 feet east of Allen road, SR 1183 jct., approximately 25 feet south of the center line of SR 1183, and approximately 1 foot north of the edge of the canal. Elevation 15.54 feet. Poc1, pg14.



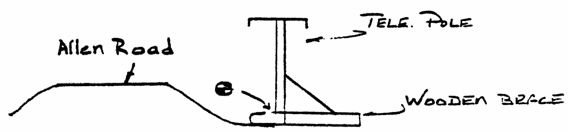
TOWER — Orange circle with 1" x 1" square in center. Located on concrete at the northeast tower support. Poc2, pg12. Elevation 16.52 feet



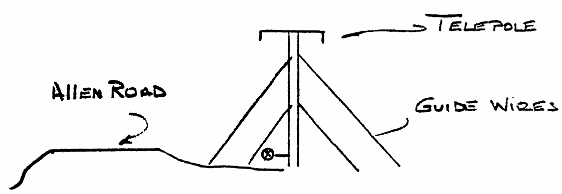
NRD — Top guard post for gate, west side, marked orange. Intersection of North Lake Rd. and Allen Road. Poc2, pg13. Elevation 20.88 feet



USCEPOLE1 — Rod set on unpainted square on horizontal brace for pole, located immediately adjacent to pole on brace. Poc2, pg13. Elevation 16.19 feet.

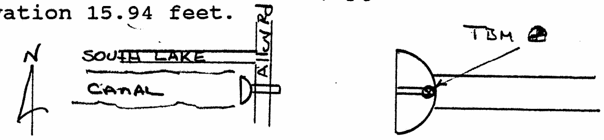


USCEPOLE2 — Nail beside NCGS aluminum triangular marker, painted orange, approximately 1 foot off ground. Poc2, pg 14, Elevation 16.44 feet.



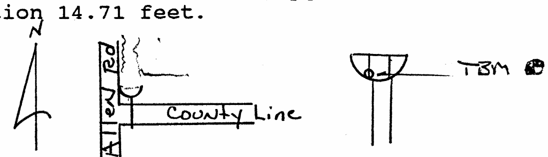
ASLR1

Top center brace against back of riser, painted orange. Riser under Allen Road at the junction with South Lake Road. Poc 4, pg 56. Elevation 15.94 feet.



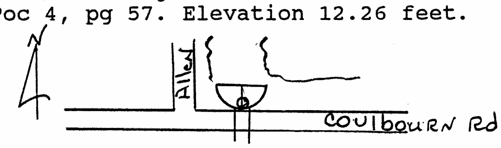
ASLR2

Top, western brace, against back of riser, painted orange. Riser under County Line Road at jct. of Allen Road. Poc 4, pg 56. Elevation 14.71 feet.



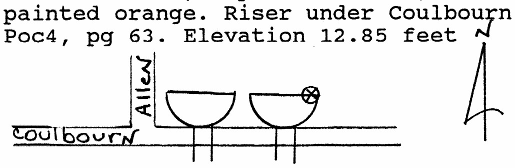
ACR

Top, center brace, against back of riser, painted orange. Riser under Coulbourn Road. Poc 4, pg 57. Elevation 12.26 feet.



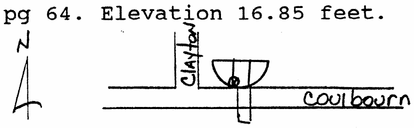
BCR

Eastern riser, top board track, east side, painted orange. Riser under Coulbourn Road. Poc4, pg 63. Elevation 12.85 feet



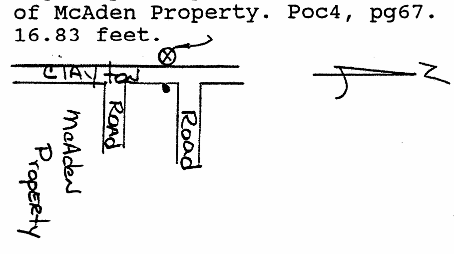
CCR

Top west brace against back of riser, painted orange. Riser under Coulbourn Road. Poc4, pg 64. Elevation 16.85 feet.



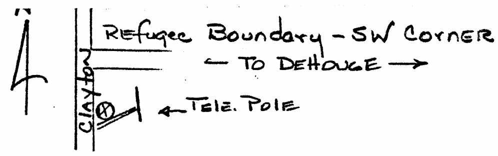
MCA

Top of east gate post, painted orange, at beginning of McAden Property. Poc4, pg67. Elevation 16.83 feet.



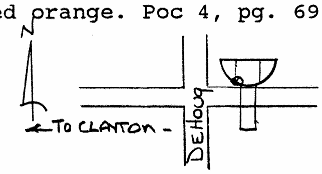
CTEL

Nail in telephone pole, approximately 100 feet south of road leading east from Clayton to Dehouge Road. Nail on north side of pole about 1 foot off ground. Poc4,pg 68. Elevation 13.00 feet.



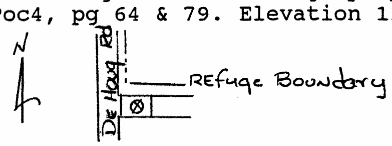
DRISER2

Top west riser center brace at back of riser, painted orange. Poc 4, pg. 69. Elevation 12.51 feet



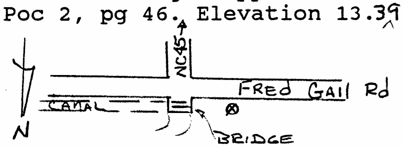
DBRIDGE

Nail, painted orange, centerline of bridge, on DeHouge Road at Refuge property line. Poc4, pg 64 & 79. Elevation 11.98 feet



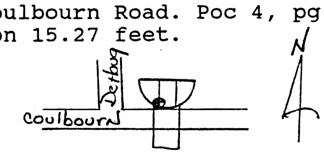
FGR

Nail in telephone pole, west side, approx. 100 feet west of bridge. Approx. 1 foot above ground. Poc 2, pg 46. Elevation 13.39 feet



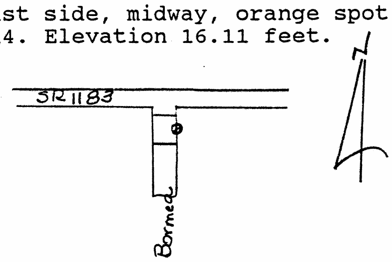
DCR

Riser, west brace at back of riser. Riser under Coulbourn Road. Poc 4, pg 65. Elevation 15.27 feet.

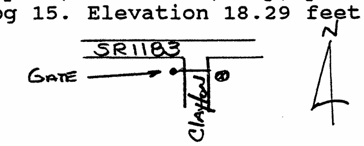


BORMEA

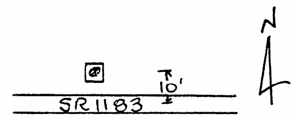
Bridge, east side, midway, orange spot. Poc1, pg 14. Elevation 16.11 feet.



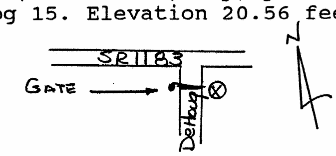
CLAYTON Wooden post, east side, top, painted orange. Poc1, pg 15. Elevation 18.29 feet



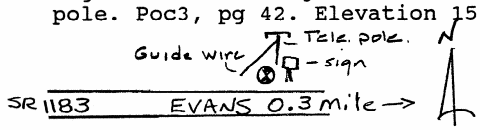
TELE Telephone canister top, #227, north side SR 1183 Poc 1, pg 15. Elevation 18.12 feet.



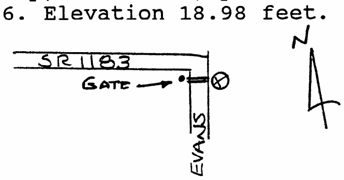
DEHOUG Gate post, east side, top, painted orange. Poc 1, pg 15. Elevation 20.56 feet



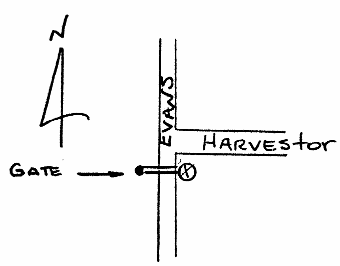
GUERARD NCGS monument. Located north of SR 1183, 0.3 mile west of Evans Road at a "no hunting sign" and beside a guide wire for a telephone pole. Poc3, pg 42. Elevation 15.50 feet



EVANS Gate post, top, east side, painted orange. Poc 1, pg 16. Elevation 18.98 feet.

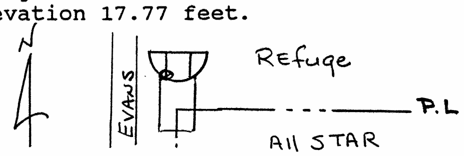


HARVESTER Gate post, top, east side, painted orange. South of Harvester Road-Evans Road jct. Poc 1, pg 25. Elevation 20.64 feet



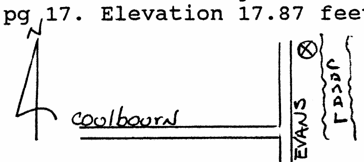
ER

Riser, west brace, against riser, painted orange. Riser beside Evans Road. Poc1, pg 28. Elevation 17.77 feet.



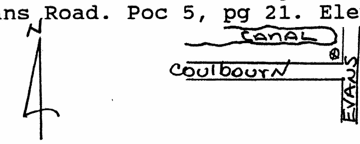
PT

Nail in 8 inch dbh pine about 1.5 feet above ground. Pine is on east side of Evans Road about 400 feet north of jct. with Coulbourn Road Poc 5, pg 17. Elevation 17.87 feet.



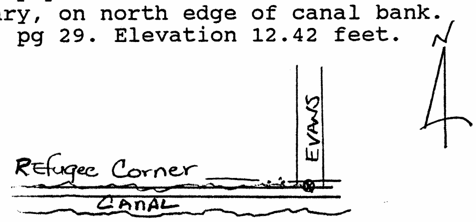
PIN1

2 inch pipe, about 1.6 feet above ground on canal bank north of jct Coulbourn Road and Evans Road. Poc 5, pg 21. Elevation 16.93 feet.



ENDEVANS

2 inch pipe centerline Evans at the Refuge boundary, on north edge of canal bank. Poc 3, pg 29. Elevation 12.42 feet.



one

JOB DESCRIPTION: BEGINNING AT TIETEMA (USGS) DOWN ALLEN TO COULBORN ACROSS COULBORN TO EVANS AT TBM MKJM (MKJM REMOVED). BACK TO TIETEMA

DATE: 3/2/93			
SURVEYORS HIN/CROM/BALL/BLACK		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.229	0.16
	0.1(M)^.5	0.458	
LENGTH OF SURVEY (		21	
DIFFERENCE IN ELEVATION BEG-END		0.16	
DIFFERENCE FS/BS		-0.16	
SUM FS		336.43	
SUM BS		336.27	
END ELEV		15.38	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV	NOTES
TIETEMA (NCGS)	6.78	22.32	0	15.54	(NOTE: ALL TURNS ON ROAD)		
p14,Poc1	5.22	20.65	6.89	15.43			
pg12,Poc2	5.38	21.49	4.54	16.11	6.2	15.29	grd
	4.94	21.84	4.59	16.9			
TOWER	4.37	20.89	5.32	16.52	TBM-----		
pg12, Poc2	4.7	20.79	4.8	16.09			
	5.75	22.62	3.92	16.87			
NRD	1.74	22.62	1.74	20.88	TBM-----		
pg 13, Poc2	4.15	21.42	5.35	17.27	6.7	14.72	grd
	4	21.77	3.65	17.77			
USCEPOLE1	4.87	21.06	5.58	16.19	TBM-----		
USCEPOLE2	4.56	21	4.62	16.44	TBM-----		
pg 14 Poc2	4.18	19.64	5.54	15.46			
pg 55 Poc4	4.66	19.22	5.08	14.56	5.9	13.32	grd
	4.69	19.15	4.76	14.46	5.8	13.35	grd
ASLR1 -----	4.84	18.83	5.16	13.99	2.89	15.94	<-ASLR1
	5.07	18.06	5.84	12.99			
pg56 Poc4	4.44	18.59	3.91	14.15			
	4.94	18.33	5.2	13.39			
	4.73	17.28	5.78	12.55			
	4.74	17.63	4.39	12.89			
ACR	7.28	19.54	5.37	12.26	TBM-----		
Outlet end of ACR	8.25	19.73	8.06	11.48	top pipe apex		
pg57,62 Poc4	5.85	17.76	7.82	11.91			
	5.68	17.29	6.15	11.61			
	5.4	17.75	4.94	12.35			
BCR	4.9	17.75	4.9	12.85	TBM-----		
DEER stand nail	4	17.79	3.96	13.79	north side		
pg60,63 Poc4	4.63	18.06	4.36	13.43			
	5.26	18.87	4.45	13.61			
CCR	2.02	18.87	2.02	16.85	TBM-----		
CG (NOT DESCRIBED)	1.03	18.3	1.6	17.27			
pg60,64 Poc4	4.95	18.5	4.75	13.55			
	3.81	18.37	3.94	14.56			
DCR	2.89	18.16	3.1	15.27	TBM----		
pg65,Poc4	4.98	18.79	4.35	13.81			
	5.27	19.33	4.73	14.06			
MKJM pipe(REMOVED)	4.12	18.65	4.8	14.53			
	5.09	19.28	4.46	14.19			
	3.89	17.87	5.3	13.98			
DCR	3.4	18.83	2.44	15.43	TBM ----		
	4.55	18.23	5.15	13.68			
	5	18.52	4.71	13.52			
CCG (NOT DESCRIBED	1.56	18.66	1.42	17.1			
SUM FS-BS	202.56		199.44		diff.	3.12	

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132) line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
	4.29	17.8	5.15	13.51		
	4.41	17.64	4.57	13.23		
DEER	5.16	18.77	4.03	13.61	(NOT DESCRIBED)	
	4.92	17.14	6.55	12.22		
	5.15	16.73	5.56	11.58		
	3.98	15.82	4.89	11.84		
ACR OUTLET	8.06	19.46	4.42	11.4	(NOT DESCRIBED)	
ACR	4.98	17.16	7.28	12.18	TBM---------	
	4.57	17.38	4.35	12.81		
	5.73	18.36	4.75	12.63		
	4.99	18.36	4.99	13.37		
	3.69	17.79	4.26	14.1		
	6.04	18.93	4.9	12.89		
	5.3	19.13	5.1	13.83		
	5.08	19.32	4.89	14.24		
	5.1	19.41	5.01	14.31		
	5.5	20.74	4.17	15.24		
USCEPOLE2	4.57	20.8	4.51	16.23	TBM----------	
USCEPOLE1	4.56	20.54	4.82	15.98	TBM----------	
	5.34	22.86	3.02	17.52		
	0.84	21.54	2.16	20.7		
	5.33	21.25	5.62	15.92		
TOWER	5.18	21.55	4.88	16.37	TBM----------	
	5.68	22.37	4.86	16.69		
	4.7	21.41	5.66	16.71		
	5.05	20.62	5.84	15.57		
	5.51	21.84	4.29	16.33		
TIETEMA NCGS	0	0	6.46	15.38	NCGS	
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
S 3S/F	336.27		336.43		diff	-0.16

/p[illegible]?pageone,pagetwo,pagethree}{cr}!lp{cr} two

JOB DESCRIPTION: BEGINNING AT TIETEMA (NCGS) TO EVANS DOWN EVANS TO FRED GALL RD TO MT OLIVE (NCGS) TO TIETEMA A

DATE: 3/2/93	(use line17-60 for math)			
SURVEYORS HIN/CROM/BLKWL/BAL/MUN/POL		ALLOWABLE		ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.278		-0.21
	0.1(M)^.5	0.557		
LENGTH OF SURVEY (		31		
DIFFERENCE IN ELEVATION BEG-END		-0.21		
DIFFERENCE FS/BS		0.21		
SUM FS		466.28		
SUM BS		466.49		
END ELEV		15.75		

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV. NOTES
TIETEMA (NCGS)	6.18	21.72	0	15.54	Allen Rd.	
Pg 14,Poc1	4.81	21.89	4.64	17.08		
	4	21.64	4.25	17.64		
All turns on road	4.21	21.8	4.05	17.59		
	4.69	22.03	4.46	17.34		
BORMEA	5.46	21.57	5.92	16.11	--TBM---	
pg 14, Poc1	4.6	20.67	5.5	16.07		
	4.33	21.41	3.59	17.08		
	6.2	21.41	6.2	15.21		
	4.39	20.33	5.47	15.94		
CLAYTON	2.08	20.37	2.04	18.29	--TBM----	
pg. 15, Poc1	5.1	21.05	4.42	15.95		
	4.78	20.86	4.97	16.08		
TELE	2.74	20.86	2.74	18.12	--TBM---	
pg 15, Poc1 TBM	5.73	21.41	5.18	15.68		
DEHOUG	0.85	21.41	0.85	20.56	--TBM---	
pg 15, Poc1 TBM	4.6	21.24	4.77	16.64		
	5.32	21.08	5.48	15.76		
	3.94	20.48	4.54	16.54		
EVANS	2.73	21.71	1.5	18.98	--TBM--	
pg 16,Poc1	4.75	21.33	5.13	16.58		
	4.27	21.39	4.21	17.12		
	4.97	21.48	4.88	16.51		
HARVESTER	1.39	22.03	0.84	20.64	--TBM--	
pg 25, Poc1	4.69	21.76	4.96	17.07		
pg 15, Poc5	4.6	21.96	4.4	17.36		
ER	4.47	22.24	4.19	17.77	--TBM---	
pg 15, Poc5	4.71	21.93	5.02	17.22		
	4.83	21.7	5.06	16.87		
wooden stake	3.88	21.95	3.63	18.07	7.6	14.35 grd.
	5.51	22.75	4.71	17.24		
pg 16-19,Poc5	4.9	22.36	5.29	17.46	6.9	15.46 grd.
	5.43	22.51	5.28	17.08		
PT	4.64	22.51	4.64	17.87	--TBM--	
MKJM (REMOVED)	4.72	19.55	7.68	14.83	--TBM--	
PIN1	2.17	19.1	2.62	16.93	--TBM--	
pg 19-21,Poc5	4.01	19.01	4.1	15		
	5.91	20.62	4.3	14.71		
	3.8	18.19	6.23	14.39		
TBM PIPE	4.4	18.63	3.96	14.23	FLUSH WITH ROAD	
TBM PIPE	2.64	18.52	2.75	15.88	(PIPE REMOVED)	
pg 22, Poc5	3.98	18.02	4.48	14.04		
	4.42	18.45	3.99	14.03		
	4.14	17.76	4.83	13.62		
SUM FS-BS	189.97		187.75		diff.	2.22

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)   line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV.
R used to set	2.67	16.89	3.54	14.22	4.47	12.42 ENDEVANS
/ANS	4.2	16.85	4.24	12.65	Poc3,pg27	
	4.41	17.17	4.09	12.76		
	4.3	16.07	5.4	11.77		
	4.58	15.66	4.99	11.08		
	7.04	18.41	4.29	11.37		
FGR	3.78	17.17	5.02	13.39	--TBM--	
	3.01	13.14	7.04	10.13		
pg 45, Poc2	3.9	11.5	5.54	7.6		
	5.72	13.13	4.09	7.41	X in south bridge rail	
	3.34	9.93	6.54	6.59	1.48	8.45
	5.86	12.72	3.07	6.86		
MT OLIVE USGS-----	6.67	13.09	6.3	6.42	---NCGS MT OLIVE--	
	3.55	10.5	6.14	6.95	ACTUAL ELEV. 6.30ft	
	6.78	13.36	3.92	6.58		
	5.77	12.44	6.69	6.67		
	5.95	13.15	5.24	7.2		
	6.52	16.18	3.49	9.66		
FGR	5.02	18.4	2.8	13.38		
	4.67	15.65	7.42	10.98		
	5.22	16.07	4.8	10.85		
	5.55	17.17	4.45	11.62		
	4.3	16.83	4.64	12.53		
	4.59	16.87	4.55	12.28		
	3.54	17.74	2.67	14.2	--REBAR	
	5.07	18.4	4.41	13.33		
	4.35	18	4.75	13.65		
	4.89	18.51	4.38	13.62		
	2.75	18.62	2.64	15.87	--PIPE TBM REMOVED	
	4.21	18.43	4.4	14.22	--PIPE IN ROAD	
	6.31	20.59	4.15	14.28		
	3.9	18.98	5.51	15.08		
	4.23	19.09	4.12	14.86		
	2.62	19.58	2.13	16.96	--PIPE 1.66FT ABOVE GRD	
	7.69	22.55	4.72	14.86	--PIPE 1IN DIA TP	
	5.25	22.41	5.39	17.16		
	5.3	22.77	4.94	17.47		
	4.71	21.99	5.49	17.28		
	3.44	21.61	3.82	18.17	--WOODEN STAKE	
	5.26	22.25	4.62	16.99		
	5.02	22.31	4.96	17.29		
	4.29	22.21	4.39	17.92	--RISER EVANS	
	4.38	21.91	4.68	17.53		
	4.89	22.14	4.66	17.25		
	0.96	21.81	1.29	20.85	--HARVESTER TBM--	
	5.2	21.75	5.26	16.55		
	4.28	21.66	4.37	17.38		
	4.8	21.58	4.88	16.78		
	1.89	21.05	2.42	19.16		
	4.69	21.38	4.36	16.69		
	4.34	21.03	4.69	16.69		
	4.92	21.05	4.9	16.13		
	2.44	21.05	2.44	18.61		
	5.33	21.16	5.22	15.83		
	5.65	21.74	5.07	16.09		
	5.64	21.76	5.62	16.12		
	4.45	21.84	4.37	17.39		
	4.24	21.94	4.14	17.7		
S BS/F	458.3		451.9		diff	6.4

/p[illegible]/pageone,pagetwo,pagethree}{cr}!lp{cr}

PAGE THREPAGE THREE DIFFERENTIAL LEVELING (A.line 70-1line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESH	ELEV.	NOTES
	4.02	21.81	4.15	17.79			
	4.17	21.41	4.57	17.24			
TIETEMA	0	0	5.66	15.75			
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
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	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
SUM BS&FS	466.49		466.28		diff	0.21	0
	BACKSIGHTS		FORESIGHT				

three

JOB DESCRIPTION: BEGINNING AT TIETEMA (NCGS) DOWN ALLEN TO COULBORN ACROSS COULBORN TO CLATYON TO DEHOUGE TO FGR TO MT OLIVE.

D 3/2/93

SU[illegible]EYORS HIN/CROM/BALL/BLACK		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.279	0.09
	0.1(M)^.5	0.558	
LENGTH OF SURVEY (		31.17	
DIFFERENCE IN ELEVATION BEG-END		0.09	
DIFFERENCE FS/BS		-0.09	
SUM FS		532.86	
SUM BS		532.77	
END ELEV		15.45	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV	NOTES
TIETEMA (---------	6.78	22.32	0	15.54	(NOTE: ALL TURNS ON ROAD)		
	5.22	20.65	6.89	15.43			
pg12,Poc2	5.38	21.49	4.54	16.11	6.2	15.29	grd
	4.94	21.84	4.59	16.9			
TOWER	4.37	20.89	5.32	16.52	TBM ----		
pg12, Poc2	4.7	20.79	4.8	16.09			
	5.75	22.62	3.92	16.87			
NRD	1.74	22.62	1.74	20.88	TBM ----		
pg 13, Poc2	4.15	21.42	5.35	17.27	6.7	14.72	grd
	4	21.77	3.65	17.77			
USCEPOLE1--	4.87	21.06	5.58	16.19	TBM ----		
USCEPOLE2	4.56	21	4.62	16.44	TBM ----		
pg 14 Poc2	4.18	19.64	5.54	15.46			
pg 55 Poc4	4.66	19.22	5.08	14.56	5.9	13.32	grd
	4.69	19.15	4.76	14.46	5.8	13.35	grd
A[illegible] -----	4.84	18.83	5.16	13.99	2.89	15.94	<-ASLR1
	5.07	18.06	5.84	12.99	3.35	14.71	<-ASLR2
p[illegible] Poc4	4.44	18.59	3.91	14.15			
	4.94	18.33	5.2	13.39			
	4.73	17.28	5.78	12.55			
	4.74	17.63	4.39	12.89			
ACR	7.28	19.54	5.37	12.26	TBM ----		
Outlet end of ACR	8.25	19.73	8.06	11.48	top pipe apex		
pg57,62 Poc4	5.85	17.76	7.82	11.91			
	5.68	17.29	6.15	11.61			
	5.4	17.75	4.94	12.35			
BCR	4.9	17.75	4.9	12.85	TBM ----		
DEER stand nail	4	17.79	3.96	13.79	(NOT DESCRIBED)		
pg60,63 Poc4	4.63	18.06	4.36	13.43			
	5.26	18.87	4.45	13.61			
CCR riser	2.02	18.87	2.02	16.85			
CG (NOT DESCRIBED)	1.42	18.69	1.6	17.27			
pg60,64 Poc4	4.63	18.2	5.12	13.57			
	4.22	17.52	4.9	13.3			
MCA	0.38	17.21	0.69	16.83	TBM-------------		
Poc4,pg67	4.53	16.6	5.14	12.07			
	4.18	16	4.78	11.82			
	4.48	16.26	4.22	11.78			
CTEL	4.54	17.54	3.26	13	TBM ----		
	5.61	18.02	5.13	12.41			
	5.49	17.47	6.04	11.98			
	6.22	18.48	5.21	12.26			
DRISER2	4.47	16.98	5.97	12.51	TBM-----		
	5.05	16.48	5.55	11.43			
S[illegible]S-BS	207.24		206.3		diff.	0.94	

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132) line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
DBRIDGE	4.5	16.48	4.5	11.98	TBM ----	
Poc4,pg65,79	5.72	16.6	5.6	10.88		
	4.41	15.04	5.97	10.63		
	6.26	16.62	4.68	10.36		
	5.34	16.09	5.87	10.75		
	5.04	16.75	4.38	11.71		
FGR	3.78	16.8	3.73	13.02	TBM-----	
Poc2,pg46	3.01	12.77	7.04	9.76		
	3.9	11.13	5.54	7.23		
	5.72	12.76	4.09	7.04		
	3.34	9.56	6.54	6.22		
	5.86	12.35	3.07	6.49		
MT OLIVE NCGS	6.67	12.72	6.3	6.05	ACTUAL ELEV. 6.30 FT	
	3.55	10.13	6.14	6.58		
	6.78	12.99	3.92	6.21		
	5.77	12.07	6.69	6.3		
	5.95	12.78	5.24	6.83		
	6.52	15.81	3.49	9.29		
FGR	3.73	16.74	2.8	13.01	TBM--------	
	4.62	16.06	5.3	11.44	6.5	9.56 GRD
	5.98	16.57	5.47	10.59	7.1	9.47 GRD
	4.79	14.99	6.37	10.2	6.3	8.69 GRD
DRISER2	5.85	16.54	4.3	10.69	TBM----	
	5.85	16.54	5.85	10.69		
	5.66	16.42	5.78	10.76		
DBRIDGE	4.5	16.42	4.5	11.92	TBM--------	
	5.54	16.94	5.02	11.4		
	6.17	18.47	4.64	12.3		
	5.43	17.44	6.46	12.01		
	6.04	17.99	5.49	11.95		
	5.05	17.51	5.53	12.46		
CTEL	3.05	16.02	4.54	12.97	TBM---------	
	4.57	16.39	4.2	11.82		
	5.34	17.21	4.52	11.87		
	4.96	17.01	5.16	12.05		
MCA	1.26	18.05	0.22	16.79	TBM ---------	
	5.07	18.27	4.85	13.2		
	4.28	17.84	4.71	13.56		
CG	1.56	18.77	0.63	17.21	NOT DESCRIBED	
	4.29	17.91	5.15	13.62		
	4.41	17.75	4.57	13.34		
DEER	5.16	18.88	4.03	13.72	NOT DESCRIBED	
	4.92	17.25	6.55	12.33		
	5.15	16.84	5.56	11.69		
	3.98	15.93	4.89	11.95		
ACR TOP PIPE	8.06	19.57	4.42	11.51	NOT DESCRIBED	
ACR	4.98	17.27	7.28	12.29	TBM--------	
	4.57	17.49	4.35	12.92		
	5.73	18.47	4.75	12.74		
	4.99	18.47	4.99	13.48		
	3.69	17.9	4.26	14.21		
	6.04	19.04	4.9	13		
	5.3	19.24	5.1	13.94		
	5.08	19.43	4.89	14.35		
	5.1	19.52	5.01	14.42		
	5.5	20.85	4.17	15.35		
USCEPOLE2	4.97	21.31	4.51	16.34	TBM -----	
USCEPOLE1	4.56	20.61	5.26	16.05	TBM------	
SUMS BS/FS	495.14		490.07		diff	5.07

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PAGE THREPAGE THREE DIFFERENTIAL LEVELING (A.line 70-1line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESH	ELEV.	NOTES
	5.34	22.93	3.02	17.59			
	0.84	21.61	2.16	20.77			
	5.33	21.32	5.62	15.99			
	5.18	21.62	4.88	16.44			
	5.68	22.44	4.86	16.76			
	4.7	21.48	5.66	16.78			
	5.05	20.69	5.84	15.64			
	5.51	21.91	4.29	16.4			
TIETEMA NCGS	0	0	6.46	15.45	NCGS--------		
	0	0	0	0			
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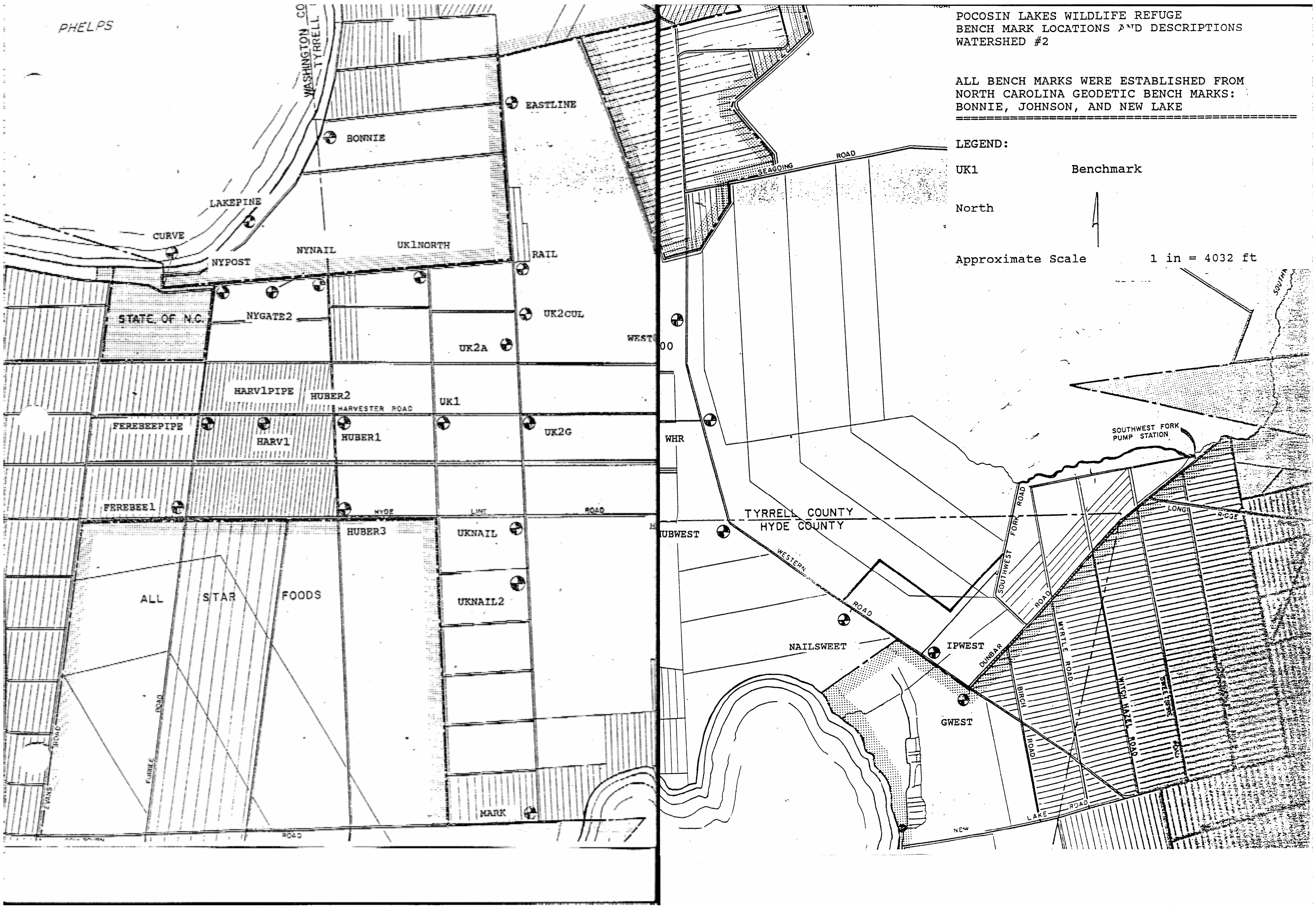
	532.77		532.86		diff	-0.09	0

SURVEYING BENCHMARK LOCATIONS AND DESCRIPTIONS

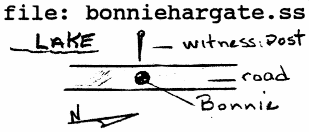
WATERSHED # 2



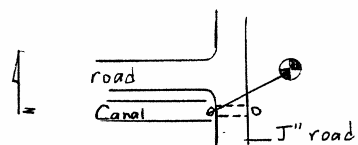
POCOSIN LAKES WILDLIFE REFUGE
BENCH MARK LOCATIONS AND DESCRIPTIONS
WATERSHED #2
ALL BENCH MARKS WERE ESTABLISHED FROM NORTH CAROLINA GEODETIC BENCH MARKS: BONNIE, JOHNSON, AND NEW LAKE
LEGEND:
UK1 Benchmark
North
Approximate Scale 1 in = 4032 ft
PHELPS
WASHINGTON CO
TYRRELL
BONNIE
EASTLINE
LAKEPINE
CURVE
NYPOST
NYNAIL
UK1NORTH
RAIL
STATE OF N.C.
NYGATE2
UK2CUL
UK2A
HARV1PIPE
HUBER2
HARVESTER ROAD
UK1
FEREBEEPIPE
HARV1
HUBER1
UK2G
WHR
FEREBEE1
HYDE LINE ROAD
HUBER3
UKNAIL
UBWEST
TYRRELL COUNTY
HYDE COUNTY
ALL STAR FOODS
UKNAIL2
WESTERN ROAD
NAILSWEET
IPWEST
GWEST
SEAGOING ROAD
SOUTHWEST FORK PUMP STATION
SOUTHWEST FORK ROAD
DUNBAR ROAD
BIRCH ROAD
MYRTLE ROAD
WITCH HAZEL ROAD
LONG RIDGE
FURBEE ROAD
EVANS ROAD
MARK
NEW LAKE ROAD

POCOSIN WILDLIFE REFUGE
LOCATION AND DESCRIPTION AND ELEVATION OF BENCH MARKS
WATERSHED #2

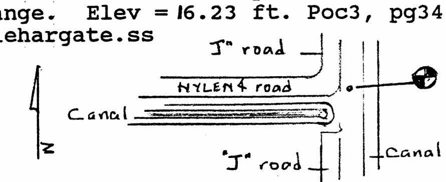
BONNIE NC Geodetic Bench Mark, located in middle of dirt road. Witness post present. Refer to official description. Elev = 14.25 ft NGVD (National Geodetic Vertical Datum)
Poc3, pg4. file: bonniehargate.ss



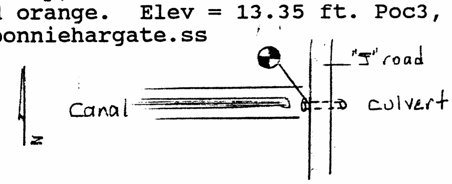
EASTLINE Culvert, top center line, east side of J" road at intersection of J" road and dirt road immediately north of Bonnie. Painted orange
Elev = 8.87 ft. Poc2, pg38, file: bonniehargate.ss



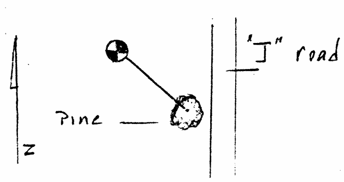
RAIL Train track rail standing "Vertical". Existing property line marker for refuge. At intersection of J' road and Nylen4 road. Painted orange. Elev = 16.23 ft. Poc3, pg34. file: bonniehargate.ss



UK2CUL Culvert top, centerline, west side UK2 road, painted orange. Elev = 13.35 ft. Poc3, pg34. file: bonniehargate.ss

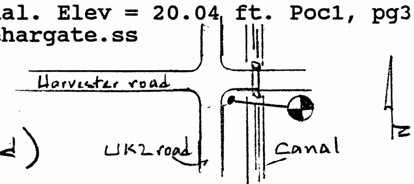


UK2A Nail, 6 in pond pine, approx. 2.5 ft off ground. West side of road, marked by orange paint and ribbons. Elev = 18.21 ft.
Poc3, pg34. file: bonniehargate.ss



UK2G

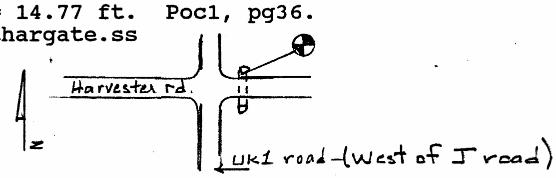
Gate, top 4" steel post, approximately 4.5 ft above ground. Painted orange. South side of Harvester road, east of UK2 road, between road and canal. Elev = 20.04 ft. Poc1, pg36.
file: bonniehargate.ss



(UK2 is J-road)

UK1

Culvert, top centerline, painted orange. North side of Harvester road, east of UK1 road. Elev = 14.77 ft. Poc1, pg36.
file: bonniehargate.ss

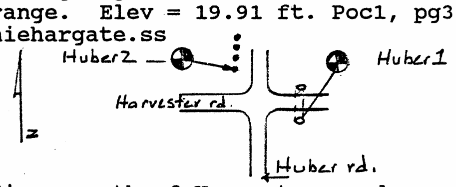


HUBER1

Culvert, top centerline, painted orange. South of Harvester road, east of Huber road. Elev = 14.82 ft. Poc1, pg33.

HUBER2

Well, top pvc pipe, first well on west side of Huber road going north from Harvester. Painted orange. Elev = 19.91 ft. Poc1, pg33
file: bonniehargate.ss

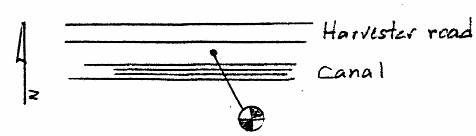


HARV1PIPE

Pipe, 2" dia., south of Harvester road between road and canal. Approx. 2.5 ft above ground. Elev = 19.49 ft. Poc1, pg33.

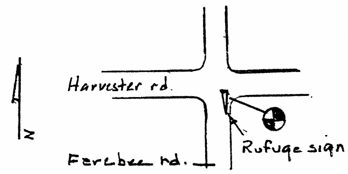
HARV1

Wooden stake beside pipe. Elev = 20.62 ft
file: bonniehargate.ss



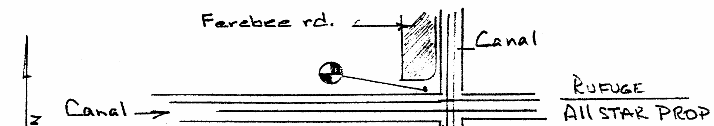
FEREBEEPIPE

Pipe, 2" dia., south of Harvester road, on east shoulder of Ferebee road, adjacent to Refuge sign. Elev = 19.17 ft. Poc1, pg32. file: harfere.ss



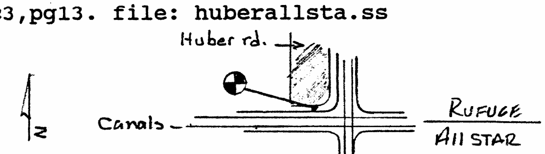
FEREBEE1

Pipe, 2" dia, painted orange, approximately 1.5 feet above ground level. Driven between canal and the southern end of Ferebee road at the All Star property boundary. Elev = 17.07 feet. Poc3,pg16. file: harfere.ss



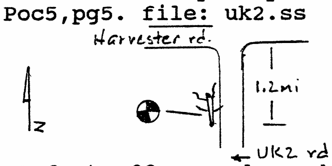
HUBER3

Pipe, 2" dia.,painted orange, approximately 1.5 feet above ground. Driven at end of Huber road between canal and road. Elev = 15.59 feet, Poc3,pg13. file: huberallsta.ss



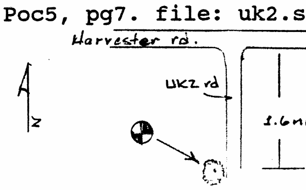
UKNAIL

Nail, approximately 2 feet off ground, marked with ribbon and orange paint. Nail in dead pine on west side of road, approximately 1.2 miles south of Harvester road. No iron post set. This bench mark will be temporary. Elev = 18.62 feet, Poc5,pg5. file: uk2.ss



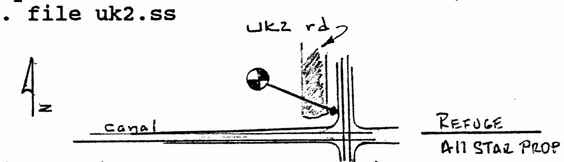
UKNAIL2

Nail, approximately 2 feet off ground, marked with ribbon and orange paint. Nail in 10" Pond pine on west side of road approximately 1.6 miles south of Harvester road. Elev = 17.88 feet, Poc5, pg7. file: uk2.ss



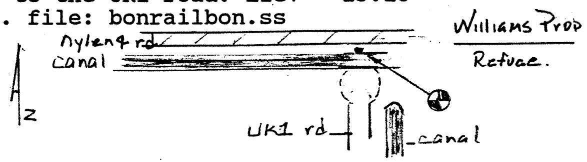
MARK

Pipe, 2" dia., approximately 1.5 feet above ground. Located on east side of UK2 road between the road and canal, and approximately 25 feet north of the intersection of the Uk2 and property line canals. Elev = 17.31 feet, Poc5, pg10. file uk2.ss



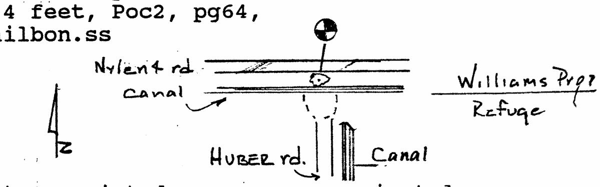
UK1NORTH

Pipe, 2" dia., painted orange, approximately 2 feet above ground. Located between the canal and Nylen4 road, approximately centerline to the UK1 road. Elev = 15.18 Poc2, pg67. file: bonrailbon.ss



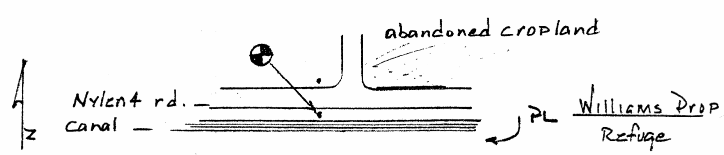
NYNAIL

Nail, in north side of 3" Bay tree facing Nylen4 road, approxiamately 2 feet off ground, marked with ribbon and orange paint. Location is between Nylen4 road and the canal, approximately in line with Huber road. Elev = 18.34 feet, Poc2, pg64, file: bonrailbon.ss



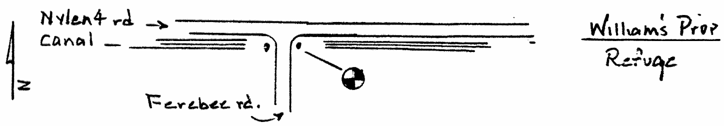
NYGATE2

Gate post, top, painted orange, approximately 2 feet above road. Located on post on south side of Nylen4 road. Gate is at the begining of cleared abandoned cropland coming from west. Elev = 19.71 feet, Poc 2, pg64, file: bonrailbon.ss



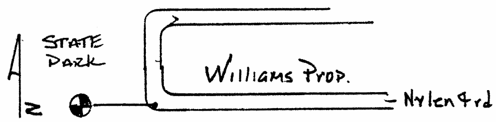
NYPOST

Gate post, top, painted orange, approximately 2.5 feet above ground. Located on east post at northern point of Ferebee road. Elev = 19.33 feet, Poc2, pg62, file: bonrailbon.ss



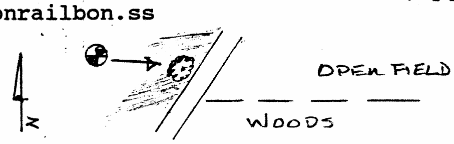
CURVE

Pipe, 2" dia., approximately 1.5 feet above ground, painted orange. Located in the south side of the curve. Elev = 19.61 feet, Poc2, pg 60, file: bonrailbon.ss



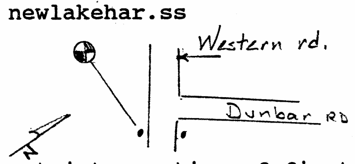
LAKEPINE

Nail, in loblolly pine 10 " , painted orange and marked with ribbon. Located west of road before entering woods going from Bonnie south. Elev = 17.45 feet. Poc2, pg57 file: bonrailbon.ss



GWEST

Gate post, top, painted orange. Located at intersection of Dunbar and Western. Gate is on Western road. South post, lake side of road. Elev = 12.14 feet. Poc1, pg46 file: newlakehar.ss

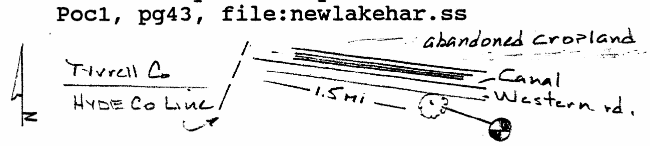


IPWEST

Rebar, at intersection of first road going north on Western from GWEST. Rebar driven beside Refuge sign. Rebar approximately 0.5 ft above ground. Elev = 7.10 feet, Poc1, pg45, file: newlakehar.ss

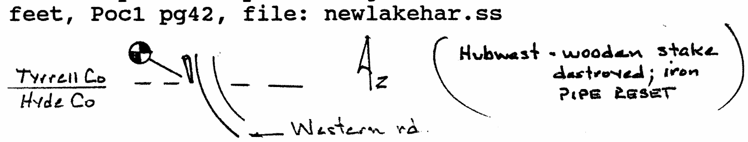
NAILSWEET

Nail, 4" sweetgum tree on west side of road approx. 0.5 ft above ground marked with ribbon and painted orange. Located on shoulder of road approximately 1.5 miles south of Hyde County line. Elev = 13.06 feet, Poc1, pg43, file:newlakehar.ss



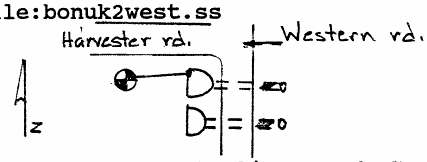
HUBWEST

Pipe, 2" dia, approximately 1 foot above ground. Located on west side of road in curve beside Hyde County line sign. Elev = 11.74 feet, Poc1 pg42, file: newlakehar.ss



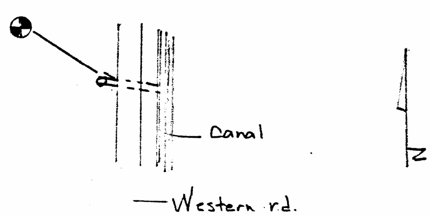
WHR

Riser brace, north edge of front riser brace at board track, painted orange. Located on riser at the intersection of Harvester and Western roads. Elev = 10.07 feet, Poc1, pg38, file:bonuk2west.ss



WEST00

Culvert, top centerline, marked with orange paint, west side of road. Location of culvert is approximately 0.9 miles north of WHR. Elev = 10.01 feet, Poc1, pg40, file: johnharrise.ss



four
JOB DESCRIPTION: BONNIE EAST TO JROAD (EASTLINE) TO TBM RAIL WEST ON NYLEN4 BACK TO BONNIE

Γ 3/3/93
S YORS HINSON,CROOM,BLACKWELL,BALLANCE ALLOWABLE ACTUAL

REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.216	0.05
	0.1(M)^.5	0.431	
LENGTH OF SURVEY (MILES)		18.6	
DIFFERENCE IN ELEVATION BEG-END		0.05	
DIFFERENCE FS/BS		-0.05	
SUM FS		479.55	
SUM BS		479.5	
END ELEV		14.2	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV.
BONNIE NCGS	6.74	20.99	0	14.25		
ALL TURNS ON ROAD	6.04	19.92	7.11	13.88	8.2	11.72 grd.
Poc3,pg4	5.74	19.76	5.9	14.02		
	6.56	19.8	6.52	13.24		
	5.54	18.3	7.04	12.76		
Rebar temporary	4.96	18.33	4.93	13.37		
Poc2,pg38	3.53	18.1	3.76	14.57		
EASTLINE	9.23	18.1	9.23	8.87	TBM------	
Poc2,pg38	5.43	18.41	5.12	12.98		
	5.31	18.5	5.22	13.19		
	4.63	18.4	4.73	13.77		
Gl at Jblock	3.61	18.41	3.6	14.8	5.7	12.71
RAIL	2.53	18.76	2.18	16.23	TBM--------	
Poc2,pg40	4.62	19.66	3.72	15.04	6	13.66
Poc2,pg68	5.67	19.88	5.45	14.21	7.1	12.78
Grd @	5	19.76	5.12	14.76	5.9	13.86
F pg68	5.34	19.88	5.22	14.54		
l RTH	4.7	19.88	4.7	15.18	TBM-----	
Grd. Lev. @ canal	4.85	19.88	4.85	15.03	4.85	15.03
Grd @ 35+00	5.93	20.47	5.34	14.54	6	14.47
Grd @ 24+00	7.84	23.69	4.62	15.85	5.3	18.39
Grd @ 12+00	5.07	22.06	6.7	16.99	6	16.06
Grd @ 2+00 NYNAIL	5.21	22.02	5.25	16.81	7.5	14.52
	4.99	21.82	5.19	16.83		
NYNAIL	3.11	21.45	3.48	18.34	TBM-----	
Grd @ Huber canal	3.14	20.05	4.54	16.91	5.6	14.45
Poc2, pg64	4.77	21.68	3.14	16.91		
NYNAIL	3.33	21.68	3.33	18.35	TBM-----	
	5.25	21.58	5.35	16.33		
NYGATE2	1.87	21.58	1.87	19.71	TBM-----	
Poc2, pg64	4.81	21.96	4.43	17.15		
	5.54	22.86	4.64	17.32		
	4.99	22.3	5.55	17.31		
	4.81	22.02	5.09	17.21		
GL @ FEREBEE	4.39	21.42	4.99	17.03	6.2	15.22
NYPOST	2.09	21.42	2.09	19.33	TBM-----	
Poc2, pg62	4.82	21.85	4.39	17.03	6.5	15.35
	4.89	21.79	4.95	16.9		
GL @ CURVE	5.08	21.87	5	16.79	6.3	15.57
CURVE	3.83	23.44	2.26	19.61	TBM-----	
Grd. @ Leo NCGS	5.31	22.58	6.17	17.27	7.2	15.38
Poc2, pg60	5.11	22.36	5.33	17.25		
	4.16	21.8	4.72	17.64	6	15.8
Grd. first curve	5.36	21.07	6.09	15.71	5.3	15.77
SUM FS-BS	215.73		208.91		diff.	6.82

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
Poc2, pg58	4.51	20.67	4.91	16.16		
LAKEPINE	3.22	20.67	3.22	17.45	5.3	15.37GRD
	4.68	20.12	5.23	15.44		
	4.47	19.41	5.18	14.94		
	5.14	19.67	4.88	14.53		
Poc2, pg58	5.05	19.56	5.16	14.51		
BONNIE NCGS----	5.43	19.56	5.43	14.13	--------	14.25 actual
	4.76	19.69	4.63	14.93		
	4.72	19.41	5	14.69		
	5.04	20.12	4.33	15.08		
Grd1000ftbeforepin	5.03	20.68	4.47	15.65	5.3	15.38
	3.22	20.68	3.22	17.46		
	4.61	21.08	4.21	16.47	5.3	15.78
Grd @ first curve	5.77	21.84	5.01	16.07	6	15.84
	4.52	22.38	3.98	17.86		
	5.01	22.59	4.8	17.58		
Grd @ plug ditch	5.92	23.47	5.04	17.55	9	14.47
CURVE	2.26	21.9	3.83	19.64	TBM-----	
Grd @ curve	6.3	21.9	6.3	15.6		
	4.88	21.8	4.98	16.92		
Grd1000ftnorth	4.68	21.84	4.64	17.16	6.5	15.34
	4.11	21.41	4.54	17.3		
Grd @ NYPOST	2.09	21.41	2.09	19.32	6.2	15.21
Poc2,pg63	4.71	22.01	4.11	17.3		
	4.7	22.26	4.45	17.56		
	5.4	22.8	4.86	17.4		
	4.51	21.91	5.4	17.4		
	4.26	21.53	4.64	17.27		
NYGATE2	1.87	21.53	1.87	19.66	TBM --------	
	5.12	21.64	5.01	16.52		
NYNAIL	3.33	21.64	3.33	18.31	TBM --------	
Grd @ Huber canal	3.43	20.01	5.06	16.58	5.6	14.41
	4.84	21.42	3.43	16.58		
NYNAIL	3.48	21.79	3.11	18.31	TBM --------	
Poc2,pg66	4.91	22	4.7	17.09	7.5	14.5
	5.08	22.07	5.01	16.99	6	16.07
Grd apexofhill	6.44	23.72	4.79	17.28	5.3	18.42
	4.28	20.49	7.51	16.21		
	5.14	19.89	5.74	14.75		
Grd UK1 canal	4.85	19.89	4.85	15.04		
UK1NORTH	4.7	19.89	4.7	15.19	TBM-----	
	5.04	19.79	5.14	14.75	5.9	13.89
	4.84	19.91	4.72	15.07	7.1	12.81
	5.1	19.68	5.33	14.58	6	13.68
Poc2, pg67	3.44	18.78	4.34	15.34		
RAIL	2.18	18.43	2.53	16.25	TBM----	
Poc2, pg40	3.77	18.62	3.58	14.85		
	4.79	18.54	4.87	13.75		
	5.22	18.46	5.3	13.24		
Poc2, pg40	5.22	18.19	5.49	12.97		
EASTLINE	9.35	18.29	9.25	8.94	TBM------	
Poc2, pg38	4.5	17.83	4.96	13.33		
Rebar (removed)	6.31	19.06	5.08	12.75		
Poc3, pg 4	6.14	19.72	5.48	13.58		
	4.65	19.44	4.93	14.79		
	6.75	20.63	5.56	13.88		
BONNIE NCGS		0	6.43	14.2	NCGS------	
				0		
SUMS BS/F	479.5		479.55		diff	-0.05

/pr{?pageone,pagetwo}{cr}!lp{cr}

five
JOB DESCRIPTION: BONNIE NCGS EAST TO EASTLINE (CUL) SOUTH TO J-BLOCK
RAIL TBM SOUTH ON UK2 ROAD TO HARVESTER UK2G TBM
WEST ON HARVESTER TO HARVESTER TBM BACK TO BONNIE

D 4/20/93
S___YORS HIN/CROM/BAL/BLAK/ALL

		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.213	-0.14
	0.1(M)^.5	0.425	
LENGTH OF SURVEY (MILES)		18.1	
DIFFERENCE IN ELEVATION BEG-END		-0.14	
DIFFERENCE FS/BS		0.14	
SUM FS		439.04	
SUM BS		439.18	
END ELEV		14.39	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV NOTES
BONNIE NCGS	6.74	20.99	0	14.25		
pg4,Poc3	6.04	19.92	7.11	13.88		
	5.74	19.76	5.9	14.02		
	6.56	19.8	6.52	13.24		
	5.54	18.3	7.04	12.76		
Rebar temporary	4.96	18.33	4.93	13.37		
pg38,Poc2	3.53	18.1	3.76	14.57		
EASTLINE	9.23	18.1	9.23	8.87	TBM-----	
pg38,Poc2	5.43	18.41	5.12	12.98		
	5.31	18.5	5.22	13.19	8.4	10.1 grd
	4.63	18.4	4.73	13.77	8.1	10.3 grd
pg40,Poc2	3.61	18.41	3.6	14.8	5.7	12.71 grd
RAIL	3.96	20.19	2.18	16.23	TBM-----	
pg34,Poc3	5.25	21.1	4.34	15.85		
	2.63	18.44	5.29	15.81		
UK2CUL	5.09	18.44	5.09	13.35	TBM-----	
	5.86	20.94	3.36	15.08	6.8	14.14 grd
L	2.73	20.94	2.73	18.21	TBM-----	
pg34, Poc3	4.17	20.34	4.77	16.17	6.1	14.24 grd
	5.71	21.11	4.94	15.4	7.2	13.91 grd
	5.58	21.27	5.42	15.69	9.1	12.17 grd
	4.28	20.55	5	16.27		
UK2G	0.38	20.42	0.51	20.04	TBM-----	
pg36,Poc1	5.17	20.67	4.92	15.5		
	4.72	20.5	4.89	15.78		
	4.71	21.35	3.86	16.64		
UK1	6.58	21.35	6.58	14.77	TBM-----	
pg36,Poc1	4.99	22.2	4.14	17.21		
	3.85	21.98	4.07	18.13		
	5.68	22.06	5.6	16.38		
HUBER1	7.81	22.63	7.24	14.82	TBM-----	
HUBER2	2.72	22.63	2.72	19.91	TBM-----	
pg33,Poc1	5.15	22.85	4.93	17.7		
	6.43	24.27	5.01	17.84		HARV1PIPE
HARV1(wooden stake	3.65	24.27	3.65	20.62	4.78	19.49
pg33,Poc1	4.9	24.52	4.65	19.62		
	3.99	23.24	5.27	19.25		FEREBEEPIPE
FEREBEEPIPE	5.97	23.24	5.97	17.27	4.07	19.17
pg32,Poc1	4.57	24.39	3.42	19.82		
	4.53	23.42	5.5	18.89		OLD FEREBEE
	5.44	22.99	5.87	17.55		
pg34,Poc1	5.15	22.74	5.4	17.59		
HARVESTER	1.06	22.71	1.09	21.65	TBM-----	
pg31,Poc1	5.53	23.12	5.12	17.59		
SUM FS-BS	215.56		206.69		diff.	8.87

six.ss

JOB DESCRIPTION: HARVESTER (UK2G) SOUTH ON UK2 TO PROPERTY LINE
AT ALLSTAR PROPERTIES
Refer to FIVE.SS for begining elevation

DATE: 3/3/93

		ALLOWABLE	ACTUAL
SURVEYORS MUNDEN/POLLARD			
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.142	-0.64
	0.1(M)^.5	0.285	Note this survey
LENGTH OF SURVEY (		8.1	is beyond tolerance,
DIFFERENCE IN ELEVATION BEG-END		-0.64	but will be used
DIFFERENCE FS/BS		0.64	because info. is
SUM FS		200.32	reliable for need
SUM BS		200.96	Elevation of Mark
END ELEV		20.68	could vary +/- 0.5ft.

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
UKG2	1.2	21.24	0	20.04	TBM-----	
ALL TURNS ON ROAD	4.44	21.63	4.05	17.19		
Poc5,pg5	4.73	21.92	4.44	17.19	5.6	16.32 GRD
	4.24	21.41	4.75	17.17		
	5.8	22.62	4.59	16.82		
UKNAIL	3.88	22.5	4	18.62	TBM-----	
Poc5, pg5	4.75	21.68	5.57	16.93		
	5.11	21.39	5.4	16.28		
	4.57	21.77	4.19	17.2		
	4.61	21.34	5.04	16.73		
UKNAIL2	3.78	21.66	3.46	17.88	TBM-------	
Poc5,pg7	5.5	20.75	6.41	15.25		
	4.55	20.14	5.16	15.59	5.5	14.64 GRD
	5.29	21.05	4.38	15.76		
	4.44	20.12	5.37	15.68		
	5.37	20.22	5.27	14.85		
woodenstake	3.46	19.88	3.8	16.42	(not described)	
Poc5, pg8	5.91	21.2	4.59	15.29	7.1	14.1 grd
	4.82	20.54	5.48	15.72		
	5.31	20.63	5.22	15.32		
	5.03	19.7	5.96	14.67	7.8	11.9 grd
MARK	2.45	19.76	2.39	17.31	TBM-----	
Poc5, pg10	5.98	20.65	5.09	14.67		
	5.13	20.48	5.3	15.35	(grdelev 12.3 at Mark TBM)	
Poc5, pg12	5.45	21.16	4.77	15.71	refer to Poc3,pg37	
	4.56	19.82	5.9	15.26		
woodstake	3.48	19.96	3.34	16.48		
	5.66	20.55	5.07	14.89		
	5.32	21.49	4.38	16.17		
	4.38	20.65	5.22	16.27		
	5.14	21.29	4.5	16.15		
	6.44	22.19	5.54	15.75		
UKNAIL2	3.57	21.97	3.79	18.4	TBM---------	
	5.08	22.22	4.83	17.14		
	4.48	22.08	4.62	17.6		
	3.66	20.41	5.33	16.75		
	6.23	22.94	3.7	16.71		
	5.2	23.05	5.09	17.85		
UKNAIL	4.23	23.41	3.87	19.18	TBM---------	
	4.65	22	6.06	17.35		
	4.73	22.48	4.25	17.75		
	4.36	22.2	4.64	17.84		
	3.99	21.87	4.32	17.88		
UK2G	0	20.68	1.19	20.68	TBM----------	
SUM FS-BS	200.96		200.32		diff.	0.64

seven.ss

JOB DESCRIPTION: BEGINNING AT HARVESTER ROAD, HUBER TBM SOUTH ON HUBER ROAD TO PROPERTY LINE AT ALL STAR FOODS
Refer to FIVE.SS for begining elevation.

D 3/3/93

S[illegible]ORS HINSON/CROOM

		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.087	0.01
	0.1(M)^.5	0.173	
LENGTH OF SURVEY (MILES)		3	
DIFFERENCE IN ELEVATION BEG-END		0.01	
DIFFERENCE FS/BS		-0.01	
SUM FS		53.52	
SUM BS		53.51	
END ELEV		14.81	

--- 2-------------

NOTES	BS	HI	FS	ELEV...	SIDESHOT	ELEV.	
HUBER1	7.94	22.76	0	14.82	10.29	12.47	WL
	5.24	23.02	4.98	17.78			
pg 33, Poc1	4.48	23.16	4.34	18.68	7.7	15.46	
All turns on road	5.06	23.42	4.8	18.36	9	14.42	
	4.38	22.85	4.95	18.47	10.27	12.58	WL
HUBER3	7.29	22.88	7.26	15.59	8.6	14.28	GRD
	5	23.47	4.41	18.47			
	4.75	23.05	5.17	18.3			
Poc3, pg13	4.35	23.01	4.39	18.66			
	5.02	22.79	5.24	17.77			
HUBER1	0	14.81	7.98	14.81	TBM		
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
	0	0	0	0			
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SU[illegible] FS-BS	53.51		53.52		diff.	-0.01	

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132) line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
	6.25	23.78	5.59	17.53		
	5.61	24.37	5.02	18.76		
	3.41	23.21	4.57	19.8		
FEREBEE sign gl	5.99	23.21	5.99	17.22		
	5.3	24.5	4.01	19.2	7.1	17.4
pg34,Poc1	4.62	24.29	4.83	19.67		
HARV1 wooden stake	3.68	24.29	3.68	20.61		
hi used twice grd	3.68	24.29	3.68	20.61	6.4	17.89
pg31,Poc1	5	22.79	6.5	17.79		
	4.67	22.67	4.79	18		
HUBER2 welltopPVC	2.72	22.67	2.72	19.95		
HUBER1 cultop	7.24	22.1	7.81	14.86		
pg35,Poc1	5.56	22.08	5.58	16.52		
	3.98	22.27	3.79	18.29		
	4.09	21.4	4.96	17.31		
UK1 cultop	6.56	21.4	6.56	14.84		
gl at UK1	6.56	21.4	6.56	14.84	5.6	15.8 grd
pg36,Poc1	3.93	20.59	4.74	16.66	5.1	15.49 grd
	4.87	20.77	4.69	15.9		
pg36,Poc3	4.92	20.53	5.16	15.61		
UK2C cultop	10.7	20.53	10.7	9.83		
for gl at tbm	10.7	20.53	10.7	9.83	7.8	12.73 grd
UK2G gatetop	0.51	20.66	0.38	20.15		
pg31,Poc3	4.74	21.39	4.01	16.65	9.1	12.29 grd
	5.2	21.25	5.34	16.05	7.2	14.05 grd
	4.61	20.48	5.38	15.87	6.1	14.38 grd
pg33,Poc3	4.58	21.06	4	16.48	6.8	14.26 grd
UK2A nail in pdpin	2.73	21.06	2.73	18.33		
	3.1	18.55	5.61	15.45		
UK2CUL cultop	5.09	18.55	5.09	13.46		
	4.97	21.19	2.33	16.22		
pg33,Poc3	4.11	20.3	5	16.19		
RAIL railroad trac	2.18	18.52	3.96	16.34		
pg40,Poc2	3.77	18.71	3.58	14.94		
	4.79	18.63	4.87	13.84		
	5.22	18.55	5.3	13.33		
pg40,Poc2	5.22	18.28	5.49	13.06		
EASTLINE cultop	9.35	18.38	9.25	9.03		
pg38,Poc2	5.06	18.48	4.96	13.42		
Rebar temporary	4.5	18.02	4.96	13.52	removed	
pg4,Poc3	6.31	19.25	5.08	12.94		
	6.14	19.91	5.48	13.77		
	4.65	19.63	4.93	14.98		
	6.75	20.82	5.56	14.07		
BONNIE NCGS	0	0	6.43	14.39		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
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SUMS BS/F	439.18		439.04		diff	0.14

/pr{?pageone,pagetwo,pagethree}{cr}!lp{cr}

eight.ss
JOB DESCRIPTION: HARVESTER SOUTH DOWN FEREBEE TO ALLSTAR

Refer to FIVE.SS for begining elevation.

I 3/3/93

		ALLOWABLE	ACTUAL
S YORS CROOM/HINSON			
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.084	0.02
	0.1(M)^.5	0.167	
LENGTH OF SURVEY (		2.8	
DIFFERENCE IN ELEVATION BEG-END		0.02	
DIFFERENCE FS/BS		-0.02	
SUM FS		45.95	
SUM BS		45.93	
END ELEV		17.25	

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
FEREBEE (OLD TBM)	5.88	23.15	0	17.27		
ALL TURNS ON ROAD	4.51	22.97	4.69	18.46		
Poc1, pg32	4.18	23.04	4.11	18.86	6.5	16.54 GRD
	4.86	22.92	4.98	18.06	7.7	15.22 GRD
	3.24	21.21	4.95	17.97		
FEREBEE1	4.15	21.22	4.14	17.07	6.1	15.12 GRD
Poc3, pg16	5.08	22.94	3.36	17.86	6.7	16.24 GRD
	4.98	22.96	4.96	17.98		
	4.15	22.85	4.26	18.7		
	4.9	23.33	4.42	18.43		
FEREBEE	0	17.25	6.08	17.25		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
NOTE: FEREBEE WAS REPLACED BY FEREBEEPIPE. FEREBEE WAS USED FOR THIS SURVEY						
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
SU FS-BS	45.93		45.95		diff.	-0.02

nine.ss

JOB DESCRIPTION: JOHNSON NCGS EAST ON NYLEN ROAD TO WESTERN WESTNYL1
SOUTH ON WESTERN TO HARVESTER ROAD AT RISER

DATE: 4/20/93 (use line17-60 for math)

		ALLOWABLE	ACTUAL
SURVEYORS HIN/CROM/BAL/BLAK/ALL			
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.211	0.04
	0.1(M)^.5	0.422	
LENGTH OF SURVEY (MILES)		17.85	
DIFFERENCE IN ELEVATION BEG-END		0.04	
DIFFERENCE FS/BS		-0.04	
SUM FS		421.43	
SUM BS		421.39	
END ELEV		11.63	

NOTES	BS	HI	FS	ELEV	SIDESHO T	ELEV.	NOTES
JOHNSON NCGS	1.72	13.39	0	11.67			
Poc1, pg 71	4.8	13.26	4.93	8.46			
	5.39	14.13	4.52	8.74	6.2	7.93 grd	
JSHOP	2.92	14.13	2.92	11.21	TBM------		
	4.66	12.73	6.06	8.07			
	5.2	13.13	4.8	7.93			
NYLEN 3	6.14	14.7	4.57	8.56	TBM------		
	4.45	13.54	5.61	9.09			
NYLEN 2	8.81	13.54	8.81	4.73	TBM------		
	4.87	13.49	4.92	8.62			
pg72	5.74	14.1	5.13	8.36			
	4.45	14.38	4.17	9.93			
WESTNYL1	8.05	13.89	8.54	5.84	TBM-------		
WESTNYL2	3.75	13.9	3.74	10.15	TBM-------		
pg56 Poc1	4.32	13.24	4.98	8.92			
	4.92	14.03	4.13	9.11			
	5.61	14.79	4.85	9.18			
	6.15	14.76	6.18	8.61			
	4.35	14.08	5.03	9.73			
	4.31	14.76	3.63	10.45			
	5	15.34	4.42	10.34			
WEST2	6.47	15.34	6.47	8.87	TBM------		
pg 57	5.75	15.48	5.61	9.73			
	3.39	14	4.87	10.61			
WEST1	9.93	14	9.93	4.07	TBM------		
pg57	4.29	14.52	3.77	10.23			
	4.84	15.43	3.93	10.59			
WESTSEA	10.25	15.72	9.96	5.47	TBM------		
pg54-40 Poc1	4.33	15.37	4.68	11.04			
	4.93	16.4	3.9	11.47			
WESTO woodenhub	4.02	16.4	4.02	12.38	TBM------		
pg41 Poc1	5.48	17.18	4.7	11.7			
	4.86	17.18	4.86	12.32			
	7.17	17.09	7.26	9.92			
	4.73	16.76	5.06	12.03			
	4.35	16.45	4.66	12.1			
pg41	4.22	15.67	5	11.45			
WHR	5.99	16.1	5.56	10.11	TBM---- use Bonnie info		
pg40	5.14	16.62	4.62	11.48		@ 10.07 f	
	4.89	17.03	4.48	12.14			
	5.35	17.43	4.95	12.08			
WESTOO	7.42	17.43	7.42	10.01	TBM-----		
	4.54	17.01	4.96	12.47			
	4.88	16.68	5.21	11.8			
SUM FS-BS	232.83		227.82		diff.	5.01	

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)   line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
WF[illegible] woodstake	4.2	16.68	4.2	12.48		
[illegible] Poc1	3.94	15.53	5.09	11.59		
	4.57	15.7	4.4	11.13		
WESTSEA	10.2	15.77	10.13	5.57		
pg 54 Poc1	3.66	14.6	4.83	10.94		
	3.77	14.05	4.32	10.28		
WEST1 cultop	9.95	14.05	9.95	4.1		
	5.16	15.77	3.44	10.61		
	5.6	15.34	6.03	9.74		
WEST2 rebar	6.46	15.34	6.46	8.88		
pg55	4.67	15	5.01	10.33		
	3.62	14.08	4.54	10.46		
	4.99	14.71	4.36	9.72		
	6.07	14.65	6.13	8.58		
	4.93	14.09	5.49	9.16		
	4.1	13.18	5.01	9.08		
pg56 Poc1	5.02	13.81	4.39	8.79		
WESTNYL1 cultop	8.05	13.81	8.05	5.76		
pg 66 Poc1	4.22	14.2	3.83	9.98		
NYLEN1 cultop	9.69	14.2	9.69	4.51		
	4.75	13.29	5.66	8.54		
	6.6	14.23	5.66	7.63		
NYLEN2 cultop	9.6	14.23	9.6	4.63		
pg67 Poc1	5.37	13.61	5.99	8.24		
	5.35	14.29	4.67	8.94		
pg68	5.59	14.58	5.3	8.99		
NYLEN3 riser	5.18	13.63	6.13	8.45		
pg70 Poc1	4.68	12.89	5.42	8.21		
	5.64	13.07	5.46	7.43		
	4.67	13.87	3.87	9.2		
	2.73	13.87	2.73	11.14		
	4.94	13.82	4.99	8.88		
	5.23	13.57	5.48	8.34		
	5.36	13.54	5.39	8.18		
JOHNSON	0	11.63	1.91	11.63		
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
BS/F	421.39		421.43		diff	-0.04

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eleven.ss
JOB DESCRIPTION: USING BONNIE INFO UK2G EAST TO WESTERN RISER

Refer to BONNIEHARGATE.SS for begining elevation

DATE: 3/3/93

SURVEYORS MUNDEN/POLLARD		ALLOWABLE	
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.066	0.07
	0.1(M)^.5	0.132	
LENGTH OF SURVEY (MILES)		1.75	
DIFFERENCE IN ELEVATION BEG-END		0.07	
DIFFERENCE FS/BS		-0.07	
SUM FS		52.47	
SUM BS		52.4	
END ELEV		19.97	

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
UKG2	0.43	20.47	0	20.04	TBM-----	
ALL TURNS ON ROAD	4.48	20.15	4.8	15.67	8.2	11.95
Poc1,pg38	5.05	19.65	5.55	14.6	7	12.65
	4.27	18.02	5.9	13.75	6.6	11.42
	3.79	17.13	4.68	13.34	6.3	10.83
	3.84	16.53	4.44	12.69		
WHR	6.25	16.32	6.46	10.07	TBM-----	
Poc1,pg38-39	4.12	16.86	3.58	12.74		
	4.54	18.74	2.66	14.2		
	5.68	20.29	4.13	14.61		
	5.16	20.81	4.64	15.65		
	4.79	20.27	5.33	15.48		
UKG2	0	19.97	0.3	19.97	TBM----	
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SUM FS-BS	52.4		52.47		diff.	-0.07

twelve.ss
JOB DESCRIPTION: NEW LAKE TBM TO GATE WESTERN/DUNBAR TO HARVESTER
WESTERN RISER .

I 12/3/92-3/10/93 (use line17-60 for math)

		ALLOWABLE	ACTUAL
S[illegible]YORS HIN/CROM/BALL/BLACK			
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.176	0
	0.1(M)^.5	0.351	
LENGTH OF SURVEY (MILES)		12.35	
DIFFERENCE IN ELEVATION BEG-END		0	
DIFFERENCE FS/BS		-5.68e-14	
SUM FS		230.95	
SUM BS		230.95	
END ELEV		10.95	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV	NOTES
NEW LAKE NCGS	5.14	16.09	0	10.95	NCGS------		
pg 53 Poc4	2.75	11.58	7.26	8.83			
	5.37	12.62	4.33	7.25			
All turns on road	5.16	12.8	4.98	7.64			
	4.81	12.75	4.86	7.94			
	4.53	12.57	4.71	8.04			
	4.96	13.81	3.72	8.85			
GWEST	2.06	14.2	1.67	12.14	TBM------		
pg 46 Poc1	4.14	13.36	4.98	9.22			~~gxd~~
	5.17	13.03	5.5	7.86			
IPWEST	5.91	13.01	5.93	7.1	TBM------		
pg 46 Poc	5.31	13.29	5.03	7.98			
	4.3	15.84	1.75	11.54			
	4.09	15.59	4.34	11.5			
	5.94	16.99	4.54	11.05			
NA[illegible]LSWEET	4	17.06	3.93	13.06	TBM------		
I Poc1	4.98	17.63	4.41	12.65			
	4.47	17.72	4.38	13.25			
	4.25	17.15	4.82	12.9			
	4.21	16.58	4.78	12.37			
*	5	16.72	4.86	11.72			HUBWEST
HUBWEST destroyed	3.34	16.72	3.34	13.38	4.98	11.74	RESET
pg 42 Poc1	4.73	16.58	4.87	11.85			Poc1pg42
	6.04	17.26	5.36	11.22			
	5.07	16.63	5.7	11.56			
WHR riser	6.03	16.52	6.14	10.49	TBM-----		
pg 41-44 Poc1	5.78	17.18	5.12	11.4			
	5.27	16.58	5.87	11.31			
	4.76	16.53	4.81	11.77			
HUBWEST destroyed	3.07	16.53	3.07	13.46	TBM----		
pg 42 Poc1	5.02	16.58	4.97	11.56			
	4.88	17.17	4.29	12.29			
	4.61	17.43	4.35	12.82			
	4.33	17.58	4.18	13.25			
SWEETNAIL	4.67	17.05	5.2	12.38	TBM-----		
pg 44, Poc1	3.94	17.02	3.97	13.08			
	3.49	15.67	4.84	12.18			
	1.6	13.11	4.16	11.51			
	5.11	13.01	5.21	7.9			
	6.02	13.01	6.02	6.99			
	5.74	13.55	5.2	7.81			
	4.89	14.2	4.24	9.31			
	5.2	14.2	5.2	9			
	1.63	13.69	2.14	12.06			
S[illegible]S-BS	201.77		199.03		diff.	2.74	

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)   line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
	3.83	12.59	4.93	8.76		
	4.58	12.6	4.57	8.02		
	4.57	12.48	4.69	7.91		
	5.14	12.71	4.91	7.57		
	4.49	11.72	5.48	7.23		
	6.57	15.37	2.92	8.8		
NEW LAKE NCGS	0	10.95	4.42	10.95	NCGS------	
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
SUMS BS/F	230.95		230.95		diff	-5.68e-14

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SURVEYING BENCHMARK LOCATIONS AND DESCRIPTIONS

WATERSHED # 3

POCOSIN LAKE WILDLIFE REFUGE
BENCHMARK LOCATIONS AND DESCRIPTIONS
WATERSHED #3

Be[illegible] marks were established from N[illegible] Carolina Geodetic Survey benchmarks TY[illegible] and Johnson.

LEGEND:

JONES Benchmark

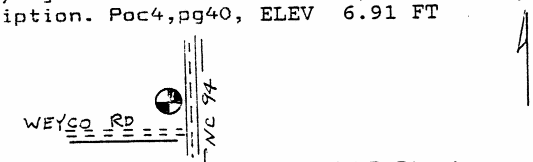
North

Approximate Scale: 1 in = 4032 ft

POCOSIN LAKES WILDLIFE REFUGE
LOCATION, DESCRIPTION AND ELEVATION OF BENCH MARKS
WATERSHED # 3

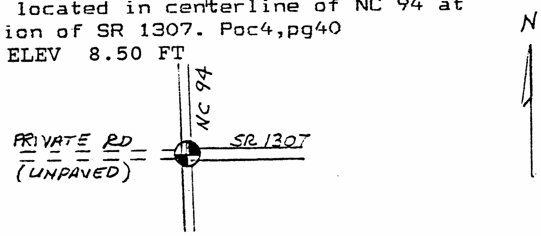
TY3

NC Geodetic Bench Mark located on highway 94, on west side, approximately 1.5 miles north of Frying Pan road. Refer to official description. Poc4,pg40, ELEV 6.91 FT



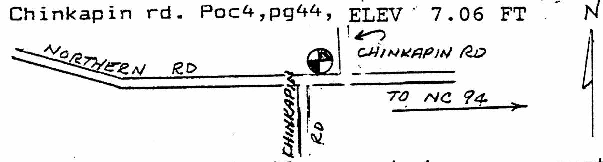
PKNAIL

Nail, located in centerline of NC 94 at junction of SR 1307. Poc4,pg40
File: ELEV 8.50 FT



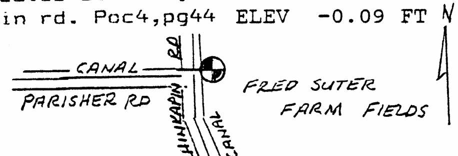
ENTRANCE

Nail, in 4 x 4 in post with Refuge sign, located on north side of Northern road at the intersection of Northern rd and Chinkapin rd. Poc4,pg44, ELEV 7.06 FT



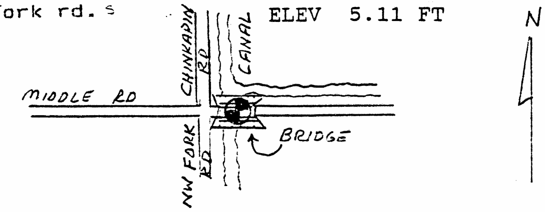
FLOODGATE

Culvert, top centerline, marked orange, east end, located at the jct. of Parisher rd. and Chinkapin rd. Poc4,pg44 ELEV -0.09 FT

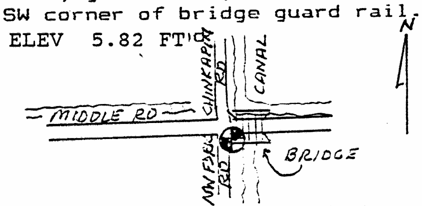


SUTER1

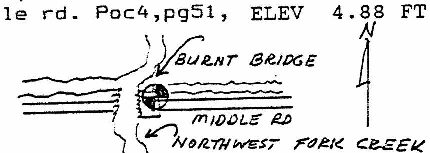
Nail, centerline of bridge, marked orange located at jct. of Middle rd. and Northwest Fork rd. ELEV 5.11 FT



SUTER2 — Bolt, galvanized, marked orange, located on SW corner of bridge guard rail. Poc4,pg49, ELEV 5.82 FT

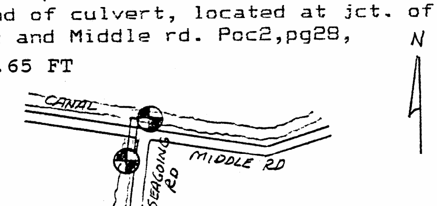


BURNT — Nail, top of bridge, marked orange, NE corner of bridge, located at jct of Northwest Fork and Middle rd. Poc4,pg51, ELEV 4.88 FT

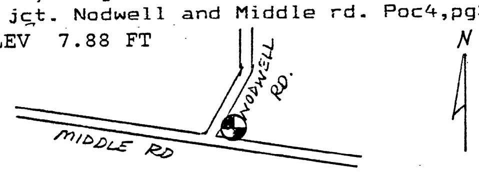


MIDSEA1 — Nail, marked orange, 4 X 4 in post with Refuge sign, approximately 1 foot off ground on east side of sign. ELEV 5.53 FT

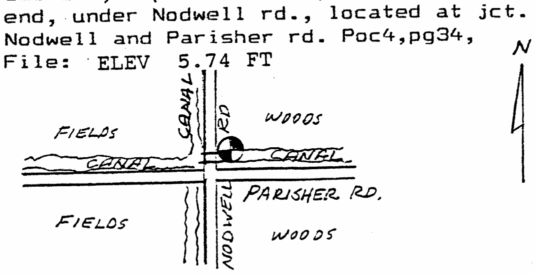
MIDSEA2 — Culvert, top centerline, marked orange, south end of culvert, located at jct. of Seagoing and Middle rd. Poc2,pg28, ELEV 3.65 FT



MIDNOD — Rebar, in ground at road sign, at NE corner of jct. Nodwell and Middle rd. Poc4,pg32, ELEV 7.88 FT

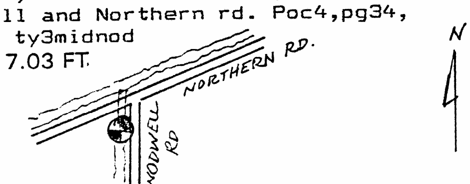


PARISHER — Culvert, top centerline, marked orange, east end, under Nodwell rd., located at jct. of Nodwell and Parisher rd. Poc4,pg34, File: ELEV 5.74 FT



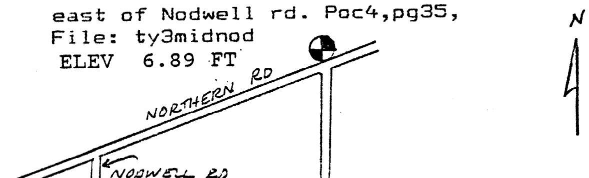
WAMPUS1 — Riser, top of board track, SW corner, painted orange, under northern rd, located at jct. Nodwell and Northern rd. Poc4,pg34, File: ty3midnod

ELEV 7.03 FT



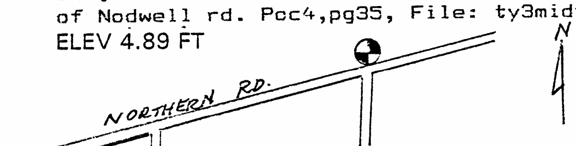
WAMPUS2 — Nail, 4in pine, north side of Northern rd, located at jct of Northern rd. and first rd. east of Nodwell rd. Poc4,pg35, File: ty3midnod

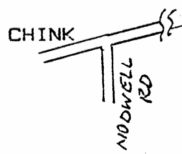
ELEV 6.89 FT



WAMPUS3 — wood hub, north of road, on shoulder, located at jct. of Northern rd. and second road east of Nodwell rd. Poc4,pg35, File: ty3midnod

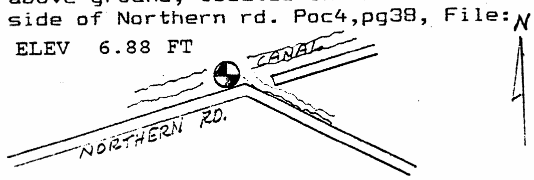
ELEV 4.89 FT



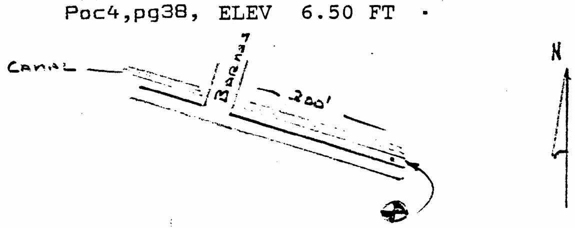


CHINK — Nail, in 6" pine, approximately 1.5 feet above ground, located in curve on north side of Northern rd. Poc4,pg38, File:

ELEV 6.88 FT

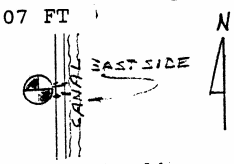


NORTH — Nail, in pine, north side of rd., approximately 300 feet east of Barns rd. Poc4,pg38, ELEV 6.50 FT



WEST1

Culvert, top centerline 15 inch dia, marked orange, under Western rd., located midway between West2 and Seagoing rd. Poc1,pg57
ELEV 4.07 FT

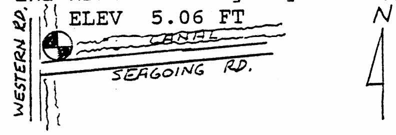


WESTSEA1

Culvert, top centerline, marked orange, north end, 48 inch dia. under Seagoing rd., located at the jct. of Seagoing and Western rd., Poc2,pg15, ELEV 5.47 FT

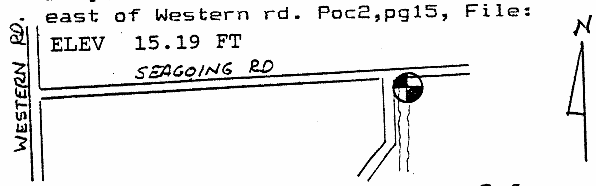
WESTSEA2

Culvert, top centerline, marked orange, west end, 60 inch dia., under farm entrance, 5.06 parallel and north of Seagoing. Poc1,pg15
ELEV 5.06 FT



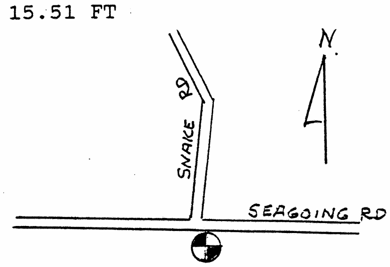
BPOST

4 X 4 post, top, marked orange, Refuge boundary sign, south side of rd., located at jct of first canal south of Seagoing rd. east of Western rd. Poc2,pg15, File:
ELEV 15.19 FT



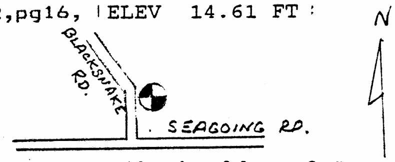
POSTSEA

4 X 4 post, top, marked orange, Refuge boundary sign, south of road, located at jct. of Snake rd. and Seagoing rd. Poc2,pg16,
ELEV 15.51 FT



SNAKE

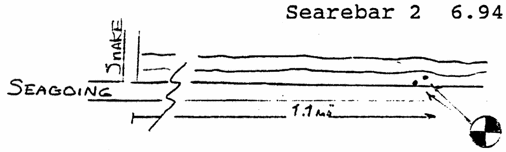
Gatepost, east post, on Snake rd., lowest cut hole cut in post, painted orange, east side of post, located at jct. of Snake rd. and Seagoing rd. , 1+50 feet north of jct. Poc2,pg16, ELEV 14.61 FT

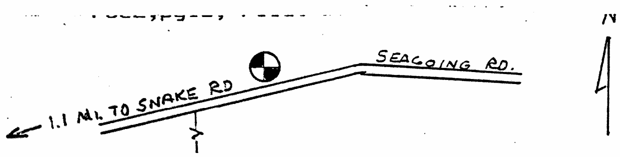


SEAREBAR 1 & 2

Rebar, on north shoulder of Seagoing Rd. Approx. 1.1 miles east of Snake Rd. Two bench marks set in muck. To insure accuracy, read both bench marks, noting there should be 0.16 ft difference in elevation. If more or less, do not use.

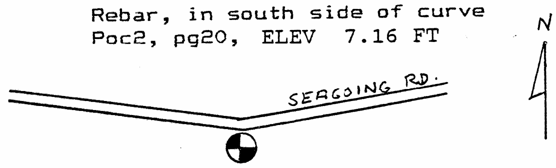
Elevation: Searebar 1 7.10 ft
Searebar 2 6.94 ft





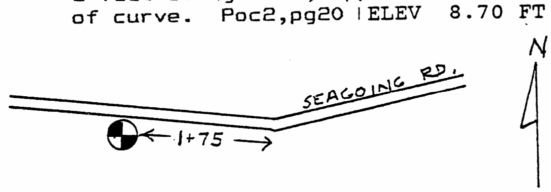
TEMPOST

Rebar, in south side of curve Poc2, pg20, ELEV 7.16 FT

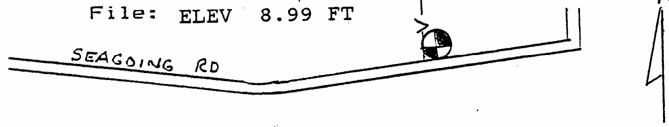


MAPLE

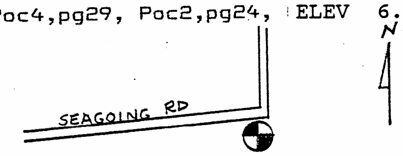
Nail, in maple tree, south side of road, 3 feet off ground, approximately 1+75 west of curve. Poc2,pg20 ELEV 8.70 FT



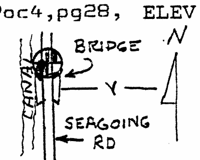
BAYSEA	nail, bay tree, 5 feet off road, 3 feet off ground, north side of road, approx. 0.65 miles east of curve at TEMPOST. Poc2,pg23, File: ELEV 8.99 FT



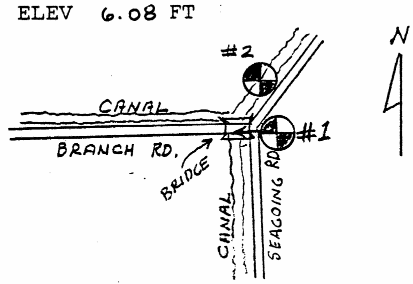
SEACURVE1	Rebar, beside Seacurve2, 4 feet off road, on south side of curve. Poc2,pg24 ELEV 6.24 FT
SEACURVE2	Iron pipe half inch dia., 4 feet off road, on south side of curve beside Seacurve1 Poc4,pg29, Poc2,pg24, ELEV 6.09 FT



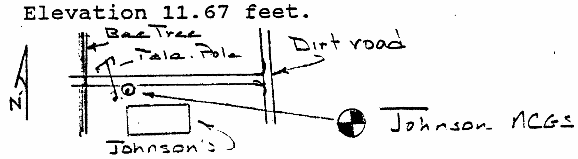
JUNIPER	20 penny nail, top of bridge, first tie, centerline, painted orange, south end. Poc2,pg24,Poc4,pg28, ELEV 6.11 FT



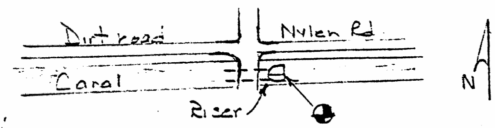
BRABRIDGE1	Bridge support, SE side, painted orange. Poc2,pg25 ELEV 4.18 FT
BRABRIDGE2	Nail, in maple tree, approx. 2ft off ground, 30 feet east of jct. Seagoing @ Branch, west side of Seagoing on shoulder between canal and road, Poc4,pg25, Poc2,pg25, ELEV 6.08 FT



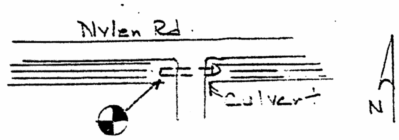
JOHNSON NCGS monument. Located in Harvey Johnson's yard, approximately 10 feet south of road toward house north of telephone pole, east of Bee Tree Canal. Refer to official description. Poc1,pg 70. Elevation 11.67 feet.



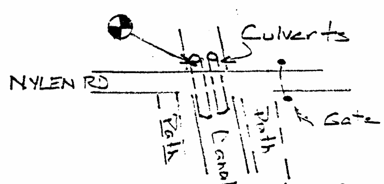
NYLEN3 Flashboard riser, center, front brace, painted orange. Poc1, pg 68. Elevation 8.56 feet.



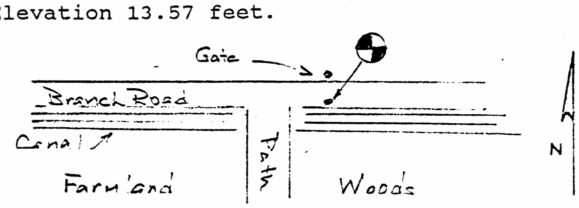
NYLEN2 Culvert, top, centerline. North side of culvert. Culvert parallels Nylen Road on south side under farm path. Poc1, pg67. Elevation 4.73 feet.



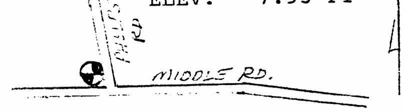
NYLEN1 Culvert, top centerline. North side of culvert. Most western 5 foot culvert. Culvert under Nylen Road at gate and intersection of farm path Poc1, pg 66. Refer to file nine.ss page two. Elevation 4.51 feet.



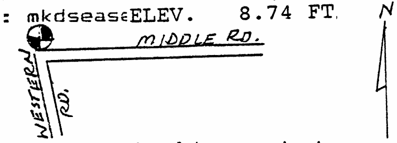
BRANCH1 Gate post. Top, painted orange, south post on Branch Road. East of farm path jct. Poc1,pg64 Elevation 13.57 feet.



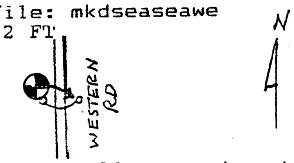
MIDPHELPS — Nail, in Refuge sign, NE of jct. of Phelps and Middle rd. Poc1,pg60, File: mkdseaseawe
ELEV. 7.93 FT



MIDWEST — Rebar, on ground, north of Middle rd., centerline of Western Rd, Poc1,pg59, File: mkdseas ELEV. 8.74 FT

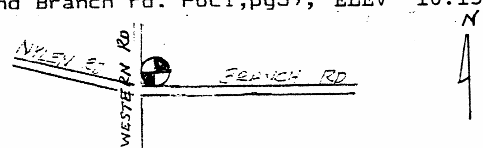


WESTGATE — Gate post, east side, marked orange, located midway between Middle and Branch rd. Poc1,pg59, File: mkdseaseawe
ELEV. 11.82 FT

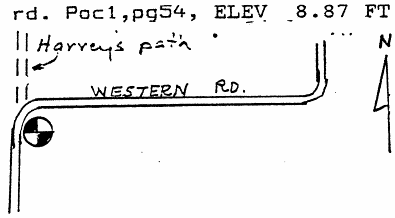


WESTNYL1 — Culvert, top centerline, east end, marked orange, under Western rd., located at jct. of Western and Branch rd. Poc1,pg 59,
ELEV 5.84 FT

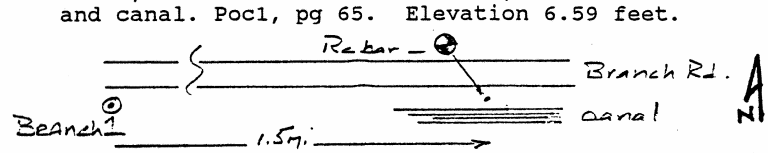
WESTNYL2 — Rebar, in ground, NE corner of jct. Western and Branch rd. Poc1,pg59, ELEV 10.15 FT



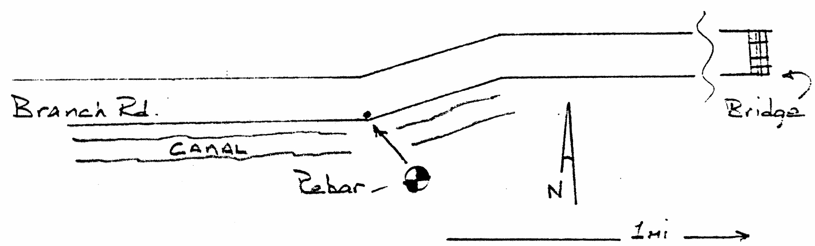
WEST2 — Rebar, on ground, east side of road, located between Western rd. and farm path going to Snake rd. Poc1,pg54, ELEV 8.87 FT



✓BRANCHPIPE1 Rebar, south side of Branch road, between road and canal. Poc1, pg 65. Elevation 6.59 feet.



✓BRANCHPIPE2 Rebar, in "S" curve on south side, between canal and road at apex of most westerly curve. Poc 2, pg 31. Elevation 6.49 feet.



nine.ss

JOB DESCRIPTION: JOHNSON NCGS EAST ON NYLEN ROAD TO WESTERN WESTNYL1
SOUTH ON WESTERN TO HARVESTER ROAD AT RISER

DATE: 4/20/93	(use line17-60 for math)		
SURVEYORS HIN/CROM/BAL/BLAK/ALL		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.211	0.04
	0.1(M)^.5	0.422	
LENGTH OF SURVEY (MILES)		17.85	
DIFFERENCE IN ELEVATION BEG-END		0.04	
DIFFERENCE FS/BS		-0.04	
SUM FS		421.43	
SUM BS		421.39	
END ELEV		11.63	

NOTES	BS	HI	FS	ELEV	SIDESHO T	ELEV.	NOTES
JOHNSON NCGS	1.72	13.39	0	11.67			
Pocl, pg 71	4.8	13.26	4.93	8.46			
	5.39	14.13	4.52	8.74	6.2	7.93 grd	
JSHOP	2.92	14.13	2.92	11.21	TBM------		
	4.66	12.73	6.06	8.07			
	5.2	13.13	4.8	7.93			
NYLEN 3	6.14	14.7	4.57	8.56	TBM------		
	4.45	13.54	5.61	9.09			
NYLEN 2	8.81	13.54	8.81	4.73	TBM------		
	4.87	13.49	4.92	8.62			
pg72	5.74	14.1	5.13	8.36			
	4.45	14.38	4.17	9.93			
WESTNYL1	8.05	13.89	8.54	5.84	TBM-------		
WESTNYL2	3.75	13.9	3.74	10.15	TBM-------		
pg56 Pocl	4.32	13.24	4.98	8.92			
	4.92	14.03	4.13	9.11			
	5.61	14.79	4.85	9.18			
	6.15	14.76	6.18	8.61			
	4.35	14.08	5.03	9.73			
	4.31	14.76	3.63	10.45			
	5	15.34	4.42	10.34			
WEST2	6.47	15.34	6.47	8.87	TBM------		
pg 57	5.75	15.48	5.61	9.73			
	3.39	14	4.87	10.61			
WEST1	9.93	14	9.93	4.07	TBM------		
pg57	4.29	14.52	3.77	10.23			
	4.84	15.43	3.93	10.59			
WESTSEA1	10.25	15.72	9.96	5.47	TBM------		
pg54-40 Pocl	4.33	15.37	4.68	11.04			
	4.93	16.4	3.9	11.47			
WEST0 woodenhub	4.02	16.4	4.02	12.38	TBM------		
pg41 Pocl	5.48	17.18	4.7	11.7			
	4.86	17.18	4.86	12.32			
	7.17	17.09	7.26	9.92			
	4.73	16.76	5.06	12.03			
	4.35	16.45	4.66	12.1			
pg41	4.22	15.67	5	11.45			
WHR	5.99	16.1	5.56	10.11	TBM---- use Bonnie info		
pg40	5.14	16.62	4.62	11.48		@ 10.07 f	
	4.89	17.03	4.48	12.14			
	5.35	17.43	4.95	12.08			
WEST00	7.42	17.43	7.42	10.01	TBM-----		
	4.54	17.01	4.96	12.47			
	4.88	16.68	5.21	11.8			
SUM FS-BS	232.83		227.82		diff.	5.01	

9

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)   line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
[illegible] woodstake	4.2	16.68	4.2	12.48		
[illegible] Pocl	3.94	15.53	5.09	11.59		
	4.57	15.7	4.4	11.13		
WESTSEA	10.2	15.77	10.13	5.57		
pg 54 Pocl	3.66	14.6	4.83	10.94		
	3.77	14.05	4.32	10.28		
WEST1 cultop	9.95	14.05	9.95	4.1		
	5.16	15.77	3.44	10.61		
	5.6	15.34	6.03	9.74		
WEST2 rebar	6.46	15.34	6.46	8.88		
pg55	4.67	15	5.01	10.33		
	3.62	14.08	4.54	10.46		
	4.99	14.71	4.36	9.72		
	6.07	14.65	6.13	8.58		
	4.93	14.09	5.49	9.16		
	4.1	13.18	5.01	9.08		
pg56 Pocl	5.02	13.81	4.39	8.79		
WESTNYL1 cultop	8.05	13.81	8.05	5.76		
pg 66 Pocl	4.22	14.2	3.83	9.98		
NYLEN1 cultop	9.69	14.2	9.69	4.51		
	4.75	13.29	5.66	8.54		
	6.6	14.23	5.66	7.63		
NYLEN2 cultop	9.6	14.23	9.6	4.63		
pg67 Pocl	5.37	13.61	5.99	8.24		
	5.35	14.29	4.67	8.94		
pg68	5.59	14.58	5.3	8.99		
NYLEN3 riser	5.18	13.63	6.13	8.45		
pg70 Pocl	4.68	12.89	5.42	8.21		
	5.64	13.07	5.46	7.43		
	4.67	13.87	3.87	9.2		
[illegible]	2.73	13.87	2.73	11.14		
	4.94	13.82	4.99	8.88		
	5.23	13.57	5.48	8.34		
	5.36	13.54	5.39	8.18		
JOHNSON	0	11.63	1.91	11.63		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
BS/F	421.39		421.43		diff	-0.04

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JOB DESCRIPTION: MIDSEA1 WEST ON MIDDLE TO WESTERN, THEN EAST ON BRANCH TO SEAGO BACK TO BRANCH

DATE: 3/2/93 (use line17-60 for math)

SURVEYORS CROOM/BALLANCE/HINSON		ALLOWABLE		ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.165		-0.16
	0.1(M)^.5	0.331		
LENGTH OF SURVEY (MILES)		10.95		
DIFFERENCE IN ELEVATION BEG-END		-0.16		
DIFFERENCE FS/BS		0.16		
SUM FS		190.87		
SUM BS		191.03		
END ELEV		5.69		

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV.	NOTES
MIDSEA1	4.19	9.72	0	5.53	TBM----		
MIDSEA2	6.07	9.72	6.07	3.65	TBM----		
Poc2,pg29	4.76	10.07	4.41	5.31			
	5.07	10.04	5.1	4.97	7	3.04	GRD
Poc2,pg69	4.69	9.58	5.15	4.89	7	2.58	GRD
MIDRUF REMOVED	5.09	9.58	5.09	4.49	REMOVED		
Poc1,pg62	5	9.66	4.92	4.66			
	4.54	9.45	4.75	4.91	5.8	3.65	GRD
	5.7	11.33	3.82	5.63	6.8	4.53	GRD
	4.58	13.41	2.5	8.83	8.7	4.71	GRD
MIDNOD	5.53	13.41	5.53	7.88	TBM---		
Poc1,pg61	4.87	13.43	4.85	8.56			
	6.66	14.73	5.36	8.07			
	4.94	14.26	5.41	9.32			
	4.66	13.63	5.29	8.97			
MIDPHELPS	5.7	13.63	5.7	7.93	TBM---		
Poc1,pg60	5.1	12.54	6.19	7.44	6.8	5.74	GRD
	3.82	13.49	2.87	9.67			
MIDWEST	4.75	13.49	4.75	8.74	TBM----		
Poc1,pg59	2.06	13.17	2.38	11.11			
	3.56	13.07	3.66	9.51			
WESTGATE	1.25	13.07	1.25	11.82	TBM----		
Poc1,pg59	4.94	13.17	4.84	8.23			
	5.14	14.99	3.32	9.85			
WESTNYL2	3.72	14.35	4.36	10.63	TBM----		
Poc1,pg56	5.84	15.04	5.15	9.2	8.6	6.44	GRD
BRANCH1	0.57	14.14	1.47	13.57	TBM----		
Poc1,pg64	3.19	11.96	5.37	8.77	6	5.96	GRD
	4.12	11.96	4.12	7.84			
	5.41	12.62	4.75	7.21			
	5.53	12.4	5.75	6.87	7.9	4.5	GRD
Poc1,pg65	4.54	11.05	5.89	6.51			
BRANCHPIPE1	4.77	11.36	4.46	6.59	TBM----		
Poc2,pg31	5.27	11.57	5.06	6.3			
BRANCHPIPE2	4.33	10.82	5.08	6.49	TBM---		
Poc2,pg31	4.19	10.61	4.4	6.42			
	4.16	9.88	4.89	5.72			
BRABRIDGE1	5.88	10.06	5.7	4.18	TBM----		
Poc2,pg31	6.8	10.06	6.8	3.26			
	4.78	9.01	5.83	4.23			
	5.26	9.54	4.73	4.28			
MIDSEA1	0		3.85	5.69	TBM----		
Poc2,pg29	0		0				
	0		0				
SUM FS-BS	191.03		190.87		diff.	0.16	

fourteen

JOB DESCRIPTION: TY3 SOUTH ON NC94, WEST ON NORTHERN RD, SOUTH ON CHINKAPIN RD, WEST ON MIDDLE RD TO NODWELL, NORTHERN T TO NC 94, TO TY3.

Γ 2/9/93

S YORS: CROOM,HINSON,BALANCE,BLACK

		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.159	0.02
	0.1(M)^.5	0.318	
LENGTH OF SURVEY (MILES)		10.13	
DIFFERENCE IN ELEVATION BEG-END		0.02	
DIFFERENCE FS/BS		-0.02	
SUM FS		396.53	
SUM BS		396.51	
END ELEV		6.89	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV.
TY3 (NCGS)	4.6	11.51	0	6.91	NCGS----	
Poc4,pg40	5.51	12.13	4.89	6.62		
	4.88	12.9	4.11	8.02		
	4.87	12.81	4.96	7.94		
	4.4	12.37	4.84	7.97		
PKNAIL	3.87	12.37	3.87	8.5	TBM----	
Poc4,pg40	4.92	11.3	5.99	6.38		
	4.93	10.93	5.3	6		
	4.17	10.78	4.32	6.61		
	4.24	9.37	5.65	5.13		
ENTRANCE	4.96	12.02	2.31	7.06	TBM---	
Poc4,pg41-44	8.8	12.02	8.8	3.22	GRD	
	4.31	12.48	3.85	8.17		
	5.9	13.73	4.65	7.83	10.5	3.23
	4.71	13.26	5.18	8.55		
	4.9	11.17	6.99	6.27		
F' 7ATE	11.92	11.83	11.26	-0.09	TBM---	
F ɔg44	9	11.83	9	2.83	GRD	
	6.48	13.21	5.1	6.73		
	4.47	12.17	5.51	7.7	7	5.17
	2.66	11.79	3.04	9.13	9.8	1.99
	1.18	9.83	3.14	8.65		
SUTER1	4.51	9.62	4.72	5.11	TBM---	
SUTER2	3.8	9.62	3.8	5.82	TBM---	
Poc4,pg49	8.1	9.62	8.1	1.52	GRD @ BRidge	
	3.49	8.6	4.51	5.11		
	4.96	8.55	5.01	3.59	6.9	1.65
	5.39	9.17	4.77	3.78		
	3.74	8.33	4.58	4.59		
BURNT	2.29	7.17	3.45	4.88	TBM----	
Poc4,pg50	4.9	7.17	4.9	2.27	GRD @ BRidge	
	5.23	8.93	3.47	3.7		
	4.98	8.63	5.28	3.65		
	4.92	9.24	4.31	4.32		
	5.12	9.64	4.72	4.52		
Poc4,pg50	5.16	9.53	5.27	4.37		
MIDSEA1	4.19	9.72	4	5.53	TBM---	
MIDSEA2	6.07	9.72	6.07	3.65	TBM---	
Poc2,pg28	4.76	10.07	4.41	5.31	7	3.07
	5.07	10.04	5.1	4.97	7.1	2.94
	4.69	9.58	5.15	4.89		
TIMRUF (removed)	5.09	9.58	5.09	4.49		
Poc1,pg62	5	9.66	4.92	4.66		
	4.54	9.45	4.75	4.91	5.8	3.65
SUM FS-BS	221.68		219.14		diff.	2.54

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
Poc1,pg62	5.7	11.33	3.82	5.63	6.8	4.53
	4.58	13.41	2.5	8.83	8.7	4.71
MIDNOD	4	11.88	5.53	7.88	TBM---	
Poc4,pg32	7.8	11.88	7.8	4.08	GRD	
	6.55	12.13	6.3	5.58		
	5.36	13.57	3.92	8.21		
	4.68	12.98	5.27	8.3		
PARISHER	7.02	12.76	7.24	5.74	TBM---	
Poc4,pg34	8.57	11.27	10.06	2.7		
	7.82	10.52	8.57	2.7		
WAMPUS1	3.75	10.78	3.49	7.03	TBM---	
Poc4,pg34	7.1	10.78	7.1	3.68		
	4.2	9.91	5.07	5.71	7	2.91
WAMPUS2	3.02	9.91	3.02	6.89	TBM---	
Poc4,pg34	4.8	9.61	5.1	4.81	6.1	3.51
WAMPUS3	4.72	9.61	4.72	4.89	TBM---	
	4.72	9.37	4.96	4.65		
CHINK	3.19	10.07	2.49	6.88	TBM--	
Poc4,pg38	5	9.49	5.58	4.49		
	5.37	10.36	4.5	4.99		
	4.56	10.84	4.08	6.28		
NORTH	4.34	10.84	4.34	6.5	TBM---	
	4.91	10.88	4.87	5.97		
	5.61	10.72	5.77	5.11		
ENTRANCE	3.48	10.59	3.61	7.11	TBM---	
	5.61	10.93	5.27	5.32		
	4.73	11.53	4.13	6.8		
	5.37	11.64	5.26	6.27		
	5.7	12.46	4.88	6.76		
PKNAIL	3.67	12.46	3.67	8.79	TBM---	
	4.77	12.97	4.26	8.2		
	4.76	12.88	4.85	8.12		
	4.32	12.42	4.78	8.1		
TY3 (NCGS)	5.05	11.64	5.83	6.59	NCGS---	
	0	0	4.75	6.89		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
			0	0		
SUMS BS/F	396.51		396.53		diff	-0.02

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fifteen.ss
JOB DESCRIPTION: MIDSEA1 WEST ON MIDDLE TO WESTERN, THEN SOUTH TO SEAGOING
THEN EAST ON SEAGOING BACK TO MIDSEA

D 3/2/93	(use line17-60 for math)			
SURVEYORS CROOM/BALLANCE/HINSON		ALLOWABLE		ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.200		-0.13
	0.1(M)^.5	0.400		
LENGTH OF SURVEY (MILES)		16		
DIFFERENCE IN ELEVATION BEG-END		-0.13		
DIFFERENCE FS/BS		0.13		
SUM FS		383.73		
SUM BS		383.86		
END ELEV		5.66		

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.	NOTES
MIDSEA1	4.19	9.72	0	5.53	TBM---		
MIDSEA2	6.07	9.72	6.07	3.65	TBM---		
Poc2,pg28	4.76	10.07	4.41	5.31			
	5.07	10.04	5.1	4.97	7	3.04	GRD
	4.69	9.58	5.15	4.89	7	2.58	GRD
MIDRUF (REMOVED)	5.09	9.58	5.09	4.49			
Poc1,pg62	5	9.66	4.92	4.66			
	4.54	9.45	4.75	4.91	5.8	3.65	GRD
	5.7	11.33	3.82	5.63	6.8	4.53	GRD
	4.58	13.41	2.5	8.83	8.7	4.71	GRD
MIDNOD	5.53	13.41	5.53	7.88	TBM---		
Poc4,pg32	4.87	13.43	4.85	8.56			
	6.66	14.73	5.36	8.07			
	4.94	14.26	5.41	9.32			
	4.66	13.63	5.29	8.97			
MIDPHELPS	5.7	13.63	5.7	7.93	TBM---		
P ?,pg61	5.1	12.54	6.19	7.44	6.8	5.74	GRD
	3.82	13.49	2.87	9.67			
MIDWEST	4.75	13.49	4.75	8.74	TBM---		
Poc1,pg59	2.06	13.17	2.38	11.11			
	3.56	13.07	3.66	9.51			
WESTGATE	1.25	13.07	1.25	11.82	TBM---		
Poc1,pg59	4.94	13.17	4.84	8.23			
	5.14	14.99	3.32	9.85			
WESTNYL2	3.74	14.37	4.36	10.63	TBM---		
WESTNYL1	8.05	14.37	8.05	6.32	TBM---		
Poc1,pg56	3.75	14.38	3.74	10.63			
	4.32	13.72	4.98	9.4			
	4.92	14.51	4.13	9.59			
	5.61	15.27	4.85	9.66			
	6.15	15.24	6.18	9.09			
	4.35	14.56	5.03	10.21			
	4.31	15.24	3.63	10.93			
	5	15.82	4.42	10.82			
WEST2	6.47	15.82	6.47	9.35	TBM---		
Poc1,pg57	5.75	15.96	5.61	10.21			
	3.39	14.48	4.87	11.09			
WEST1	9.93	14.48	9.93	4.55	TBM---		
Poc1,pg57	4.29	15	3.77	10.71			
	4.84	15.91	3.93	11.07			
WESTSEA1	9.97	15.92	9.96	5.95	TBM--- use nine.ss		
WESTSEA2	10.86	15.92	10.86	5.06	TBM---		
	6.2	16.63	5.49	10.43	7.4	9.23	GRD
	5.22	15.9	5.95	10.68			
SUM FS-BS	229.79		219.42		diff.	10.37	

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line 70-126 for math

NOTES	BS	HI	FS	ELEV	SIDESHO	ELEV.
BPOST	0.71	15.9	0.71	15.19	TBM---	
	6.81	17.49	5.22	10.68	7.7	9.79 GRD
Poc2 pg16	5.21	15.81	6.89	10.6		
POSTSEA	0.3	15.81	0.3	15.51	TBM---	
SNAKE	1.2	15.81	1.2	14.61	TBM---	
	3.46	15.19	4.08	11.73		
PINSEA temporary	4.5	14.43	5.26	9.93	temporary	
Poc2,pg16	6.8	14.43	6.8	7.63		
	3.9	13.91	4.42	10.01	7.2	6.71 GRD
	5.01	12.99	5.93	7.98	8	4.99 GRD
SEAREBAR1	5.01	12.11	5.89	7.1	TBM----	
SEAREBAR2	5.17	12.11	5.17	6.94	6.8	5.31 GRD
Poc2,pg18	4.31	12.31	4.11	8		
grd at curve	4.69	11.83	5.17	7.14	7	4.83 GRD
	5.65	12.01	5.47	6.36	7	5.01 GRD
	5.02	11.62	5.41	6.6	7.1	4.52 GRD
TEMPOST	4.69	11.85	4.46	7.16	TBM--	
MAPLE	2.82	11.52	3.15	8.7	TBM---	
Poc2,pg23	3.99	11.15	4.36	7.16	6	5.15 GRD
	4.64	11.09	4.7	6.45	6.6	4.49 GRD
BAYSEA	2.1	11.09	2.1	8.99	TBM---	
	4.85	10.57	5.37	5.72	6	4.57 GRD
SEACURVE1	4.85	11.09	4.33	6.24	TBM---	
SEACURVE2	5	11.09	5	6.09	TBM---	
JUNIPER	4.98	11.09	4.98	6.11	TBM---	
Poc2,pg24	5.04	10.09	6.04	5.05		
	4.9	10.09	4.9	5.19	GRD @ BRIDGE	
	5.19	10.39	4.89	5.2		
BRABRIDGE1	6.24	10.39	6.24	4.15	TBM---	
BRABRIDGE2	4.31	10.39	4.31	6.08	TBM---	
Poc2,pg25	5.88	10.03	6.24	4.15		
	6.8	10.03	6.8	3.23		
	4.78	8.98	5.83	4.2	5.9	3.08 GRD
	5.26	9.51	4.73	4.25		
MIDSEA1	0	0	3.85	5.66		
Poc2,pg28	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
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	0	0	0	0		
SUMS BS/F	383.86		383.73		diff	0.13

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sixteen.ss

JOB DESCRIPTION: TY3 SOUTH ON NC94, WEST ON NORTHERN RD, SOUTH ON CHINKAPIN RD, WEST ON MIDDLE RD TO WESTERN, THEN SOUTH TO NYLEN, THEN EAST TO JOHNSON, BACK TO BRANCH TO NORT

I 2/9/93

S[illegible]YORS:

		ALLOWABLE	ACTUAL
REQUIRED PRECISION OF SURVEY	.05(M)^.5	0.312	-0.18
	0.1(M)^.5	0.623	
LENGTH OF SURVEY (MILES)		38.87	
DIFFERENCE IN ELEVATION BEG-END		-0.18	
DIFFERENCE FS/BS		0.18	
SUM FS		749.88	
SUM BS		750.06	
END ELEV		7.09	

NOTES	BS	HI	FS	ELEV	SIDESHOT	ELEV.
TY3 (NCGS)	4.6	11.51	0	6.91		
Poc4,pg40	5.51	12.13	4.89	6.62		
	4.88	12.9	4.11	8.02		
	4.87	12.81	4.96	7.94		
	4.4	12.37	4.84	7.97		
PKNAIL	3.87	12.37	3.87	8.5	TBM---	
Poc4,pg40	4.92	11.3	5.99	6.38		
	4.93	10.93	5.3	6		
	4.17	10.78	4.32	6.61		
	4.24	9.37	5.65	5.13		
ENTRANCE	4.96	12.02	2.31	7.06	TBM---	
Poc4,pg41-44	8.8	12.02	8.8	3.22		
	4.31	12.48	3.85	8.17		
	5.9	13.73	4.65	7.83	10.5	3.23
	4.71	13.26	5.18	8.55		
	4.9	11.17	6.99	6.27		
F[illegible] GATE	11.92	11.83	11.26	-0.09	TBM---	
P[illegible] pg44	9	11.83	9	2.83		
	6.48	13.21	5.1	6.73		
	4.47	12.17	5.51	7.7		
	2.66	11.79	3.04	9.13	9.8	1.99
	1.18	9.83	3.14	8.65		
SUTER1	4.51	9.62	4.72	5.11	TBM---	
SUTER2	3.8	9.62	3.8	5.82	TBM---	
Poc4,pg49	8.1	9.62	8.1	1.52		
	3.49	8.6	4.51	5.11		
	4.96	8.55	5.01	3.59	6.9	1.65
	5.39	9.17	4.77	3.78		
	3.74	8.33	4.58	4.59		
BURNT	2.29	7.17	3.45	4.88	TBM---	
Poc4,pg50	4.9	7.17	4.9	2.27		
	5.23	8.93	3.47	3.7		
	4.98	8.63	5.28	3.65		
	4.92	9.24	4.31	4.32		
	5.12	9.64	4.72	4.52		
Poc4,pg50	5.16	9.53	5.27	4.37		
MIDSEA1	4.19	9.72	4	5.53	TBM---	
MIDSEA2	6.07	9.72	6.07	3.65	TBM---	
Poc2,pg28	4.76	10.07	4.41	5.31	7	3.07
	5.07	10.04	5.1	4.97	7.1	2.94
	4.69	9.58	5.15	4.89		
TIMRUF (REMOVED)	5.09	9.58	5.09	4.49		
Poc1,pg62	5	9.66	4.92	4.66		
	4.54	9.45	4.75	4.91	5.8	3.65
S[illegible]S-BS	221.68		219.14		diff.	2.54

PAGE TWO DIFFERENTIAL LEVELING (A.67-H132)

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
Poc1,pg62	5.7	11.33	3.82	5.63	6.8	4.53
	4.58	13.41	2.5	8.83	8.7	4.71
MIDNOD	5.53	13.41	5.53	7.88	TBM---	
Poc4,pg32	4.87	13.43	4.85	8.56	GRD	
--MKDSEASEAWE--	6.66	14.73	5.36	8.07		
	4.94	14.26	5.41	9.32		
	4.66	13.63	5.29	8.97		
MIDPHELPS	5.7	13.63	5.7	7.93	TBM---	
Poc1,pg61	5.1	12.54	6.19	7.44	6.8	5.74
	3.82	13.49	2.87	9.67		
MIDWEST	4.75	13.49	4.75	8.74	TBM---	
Poc1,pg59	2.06	13.17	2.38	11.11		
	3.56	13.07	3.66	9.51		
WESTGATE	1.25	13.07	1.25	11.82	TBM---	
Poc1,pg59	4.94	13.17	4.84	8.23		
--MKDSEASEAWE----	5.14	14.99	3.32	9.85		
WESTNYL2	3.74	14.37	4.36	10.63	TBM---	
WESTNYL1	8.05	14.37	8.05	6.32	TMB---	
--johnharise-----	4.22	14.76	3.83	10.54		
NYLEN1	9.69	14.76	9.69	5.07	TBM---	
Poc1,pg66	4.75	13.85	5.66	9.1	6.4	7.45
	6.6	14.79	5.66	8.19		
NYLEN2	9.6	14.79	9.6	5.19	TBM---	
Poc1,pg67	5.37	14.17	5.99	8.8		
	5.35	14.85	4.67	9.5		
	5.59	15.14	5.3	9.55		
NYLEN3	5.18	14.19	6.13	9.01	TBM---	
Poc1,pg67	4.68	13.45	5.42	8.77		
	5.64	13.63	5.46	7.99		
	4.67	14.43	3.87	9.76		
JSHOP	2.73	14.43	2.73	11.7	TBM---	
	4.94	14.38	4.99	9.44		
	5.23	14.13	5.48	8.9		
	5.36	14.1	5.39	8.74		
JOHNSON (NCGS)	1.72	13.91	1.91	12.19	--ACTUAL 11.67	
Poc1,pg70	4.8	13.78	4.93	8.98		
--johnharrise----	5.39	14.65	4.52	9.26	6.2	8.45
JSHOP.	2.92	14.65	2.92	11.73	TBM---	
Poc1,pg71	4.66	13.25	6.06	8.59		
	5.2	13.65	4.8	8.45		
NYLEN3	6.14	15.22	4.57	9.08	TBM---	
Poc1,pg71	4.45	14.06	5.61	9.61		
NYLEN2	8.81	14.06	8.81	5.25	TBM---	
Poc2,pg72	4.87	14.01	4.92	9.14		
	5.74	14.62	5.13	8.88		
	4.45	14.9	4.17	10.45		
WESTNYL1	8.05	14.41	8.54	6.36	TBM---	
WESTNYL2	3.72	14.39	3.74	10.67	TBM---	
Poc1,pg56	5.84	15.08	5.15	9.24		
BRANCH1 gatepost	0.57	14.18	1.47	13.61		
Poc1,pg64	3.19	12	5.37	8.81		
--mkdbranch------	4.12	12	4.12	7.88		
	5.41	12.66	4.75	7.25		
	5.53	12.44	5.75	6.91		
Poc1,pg65	4.54	11.09	5.89	6.55		
BRANCHPIPE1	4.77	11.4	4.46	6.63	TBM---	
Poc2,pg31	5.27	11.61	5.06	6.34		
BRANCHPIPE2	4.33	10.86	5.08	6.53	TBM---	
SUMS BS/F	510.82		506.87		diff	3.95

/pr{?pageone,pagetwo,pagethree}{cr}!lp{cr}

PAGE THREE DIFFERENTIAL LEVELING (A.67-H132)

PAGE THREE DIFFERENTIAL LEVELING (A.67-H132)

NOTES	BS	HI	FS	ELEV	ADJELE	FINAL
pg31	4.19	10.65	4.4	6.46		
	4.16	9.92	4.89	5.76		
BRABRIDGE1	5.88	10.1	5.7	4.22	TBM---	
Poc2,pg31	6.8	10.1	6.8	3.3		
	4.78	9.05	5.83	4.27		
	5.26	9.58	4.73	4.32		
MIDSEA1	4.19	9.92	3.85	5.73	TBM---	
Poc2,pg29	4.76	10.27	4.41	5.51		
--ty3midnod--	5.07	10.24	5.1	5.17		
	4.69	9.78	5.15	5.09		
TIMRUF rebar	5.09	9.78	5.09	4.69	TEMPORARY REMOVED	
Poc1,pg62	5	9.86	4.92	4.86		
	4.54	9.65	4.75	5.11		
	5.7	11.53	3.82	5.83		
	4.58	13.61	2.5	9.03		
MIDNOD	4	12.08	5.53	8.08	TBM---	
Poc4,pg32	7.8	12.08	7.8	4.28		
--ty3midnod-----	6.55	12.33	6.3	5.78		
	5.36	13.77	3.92	8.41		
	4.68	13.18	5.27	8.5		
PARISHER	7.02	12.96	7.24	5.94	TBM---	
Poc4,pg34	8.57	11.47	10.06	2.9		
	7.82	10.72	8.57	2.9		
WAMPUS1	3.75	10.98	3.49	7.23		
Poc4,pg34	7.1	10.98	7.1	3.88	TBM---	
	4.2	10.11	5.07	5.91		
WAMPUS2	3.02	10.11	3.02	7.09	TBM---	
Poc4,pg35	4.8	9.81	5.1	5.01		
[illegible]IS3, woodhub	4.72	9.81	4.72	5.09	TBM---	
	4.72	9.57	4.96	4.85		
CHINK	3.19	10.27	2.49	7.08	TBM---	
Poc4,pg38	5	9.69	5.58	4.69		
	5.37	10.56	4.5	5.19		
NORTH	4.56	11.04	4.08	6.48	TBM---	
Poc4,pg38	4.34	11.04	4.34	6.7		
	4.91	11.08	4.87	6.17		
	5.61	10.92	5.77	5.31		
ENTRANCE	3.48	10.79	3.61	7.31	TBM---	
Poc4,pg41	5.61	11.13	5.27	5.52		
	4.73	11.73	4.13	7		
	5.37	11.84	5.26	6.47		
	5.7	12.66	4.88	6.96		
PKNAIL	3.67	12.66	3.67	8.99	TBM---	
Poc4,pg40	4.77	13.17	4.26	8.4		
	4.76	13.08	4.85	8.32		
	4.32	12.62	4.78	8.3		
	5.05	11.84	5.83	6.79		
TY3 (NCGS)	0	7.09	4.75	7.09	-----	
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
	0	0	0	0		
			0	0		
BS/FS	750.06		749.88		diff	0.18

APPENDIX D

CANAL CROSS-SECTIONS

RISER DESIGN INFORMATION

OBSERVATION WELL INFORMATION

VELOCITIES RECORDED FOR POCOSIN LAKE REFUGE
WATER MANAGEMENT STUDY
1993

VEL	ELEV	DESCRIPTION
XSECTIONS AS SHOWN		
0.3 ft/s	10.3 ft (Avg gl. 13.5 ft)	X-section " A " , Allen canal. Water being held by riser 200 feet downstream. 13.4 cfs
0.55 ft/s	7.5 ft (Avg gl. 12.3 ft)	X-section "B", Allen canal at the Allen Coulborn riser. Water being held by riser. 19.25 cfs
0.16 ft/s	9.7 ft (Avg gl. 13.0 ft)	X-section "C", Boerma canal at Boerma Coulborn riser. Riser restricting flow. 17.9 cfs
0.1 ft/s	11.7 ft (Avg gl. 13.6 ft)	X-section "D", Clayton canal at Clayton Coulborn riser. Riser restricting flow. 10.8 cfs
0.11 ft/s	12.5 ft (Avg gl. 13.0 ft)	X-section "E", DeHouge canal at DeHouge Coulborn riser. Riser restricting flow. 5.4 cfs
1.0 ft/s	9.6 ft (Avg gl. 15.5 ft)	X-section "F", Evans canal at Evans Coulborn. There is no riser below to restrict flow. 41 cfs

The above measurements were made two days after the area had recieve a 1.0 - 2.0 inch rainfall. This was considered to be a wet period.

VELOCITIES FOR ALLEN -EVANS CANALS CONTINUED
POCOSING LAKES WILDLIFE REFUGE

THE FOLLOWING VELOCITIES WERE TAKEN DURING THE WETTEST PERIOD EXPERIENCED IN MANY YEARS. THESE WERE TAKEN BEFORE X-SECTIONS WERE TAKEN. ELEVATIONS WERE REFERENCED AND TAKEN AT THE TIME OF X-SECTIONS.

VEL	ELEV	DESCRIPTION
.6 ft/s	12.0 ft	Allen Coulborn, X-section B. upstream of riserrestricting water.
1.3 ft/s	unkownn	Allen Coulborn, X-section B. 100 ft below riser. Water elevation estimated at 9.0 ft
0.36 ft/s	10.0 ft	Borema Coulborn, X-section C. 100 ft above riser. Riser restricting flow.
0.56 ft/s	7.5 ft	Borema Coulborn, X-section C. 100 ft below riser
0.4 ft/s	13.0 ft	DeHouge Coulborn, X-section E. 150 ft above riser. Riser restricting water.
0.75 ft/s	11.0 ft	DeHouge Coulborn, X-section E. 150 ft below riser
0.5 ft/s	16.0	Evans above structure, no X-section. Water at ground surface, riser restricting flow.
0.75 ft/s	14.0	Evans below structure, no X-section Water flow not restricted, clear flow to outlet. This is a good representative for maximum expected flow.

CONCLUSIONS:
The canals in this area have been evaluated for velocity during the wettest period in recent history. Based on above observations and many other nonrecorded measurements, it appears that if the canals are uncontrolled and flowing full that a velocity of 1.0 to 1.3 feet per second is reasonable. If the canals are restricted by water control structures the flow at full capacity will range from 0.2 - 0.5 feet per second.

file: /eng/velocities

CANAL FLOW VELOCITY MEASUREMENTS

WATERSHED #1: DESIGN OF CULVERTS AND FLASHBOARD RISERS FOR THE WATERSHED AREA EXTENDING FROM THE SHORE OF LAKE PHELPS SOUTH TO THE REFUGE PROPERTY LINE AND EAST FROM ALLEN ROAD TO EVANS ROAD.{WATERSHED #1, FILE:CULRISE1}

The ditches are approximately the same size throughout the watershed. As a result an average area of several representative ditches will be used as design criteria.

During heavy rains, velocities of ditch water throughout the Refuge averaged from 0.1 ft/sec to 1.6 ft/sec. The average for the ditches in this watershed was approximately 0.5 ft/sec. Only in ditches with significant land slope, or on major drainage canals where drainage was induced by lowering the weir elevation on risers, was the velocity 1.0 ft - 1.5 ft/sec.

The culverts and flashboard risers will be designed to handle the capacity of the existing ditches, thus allowing the historic drainage rate to be maintained if needed. All of the canals (Allen - Evans) are primary drainage outlets. In all of these primary drainage outlets the hydraulic gradient will depend upon the management of the flashboard risers. Thus, the design velocity used will be 1 ft/sec.

The culverts and risers will be sized based on an average depth of ditch. **An on-site investigation at the specific location of the culvert or riser will be required "BEFORE" ordering culverts or risers.**

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SIZING CULVERTS AND RISERS FOR All PRINCIPAL DRAINAGE OUTLETS

Average cross-sectional area of canals at full capacity:

Allen/County Line	235 ft^2	
Allen/Coulborn	103 "	(235+103+198+108+49)/5 =
Borema/Coulborn	198 "	= 139 ft^2
Clayton/Coulborn	108 "	
DeHouge/Coulborn	49 "	
Evans (not used)		

===

DESIGN CFS ASSUMING 1.0 FT/SEC:

139 sqft x 1 ft/sec = 139 cuft/sec

===

AVERAGE DEPTH OF DITCHES (7.5+5.5+9+6+3.5)/5 = 6.3 ft

CULVERT AND RISER DESIGN FOR WATERSHED #1 CONTINUED:

FLASHBOARD RISER SIZE REQUIRED: $Q = 3.33\ H^{3/2}(L - 0.2H)$

REQUIRES:
Two risers with 8 feet of weir each at approximately 1.95 feet of head.

Thus, approximately 1.95 feet of boards will have to be removed when the water level in the canal is at the ground surface to handle the capacity of the canal.

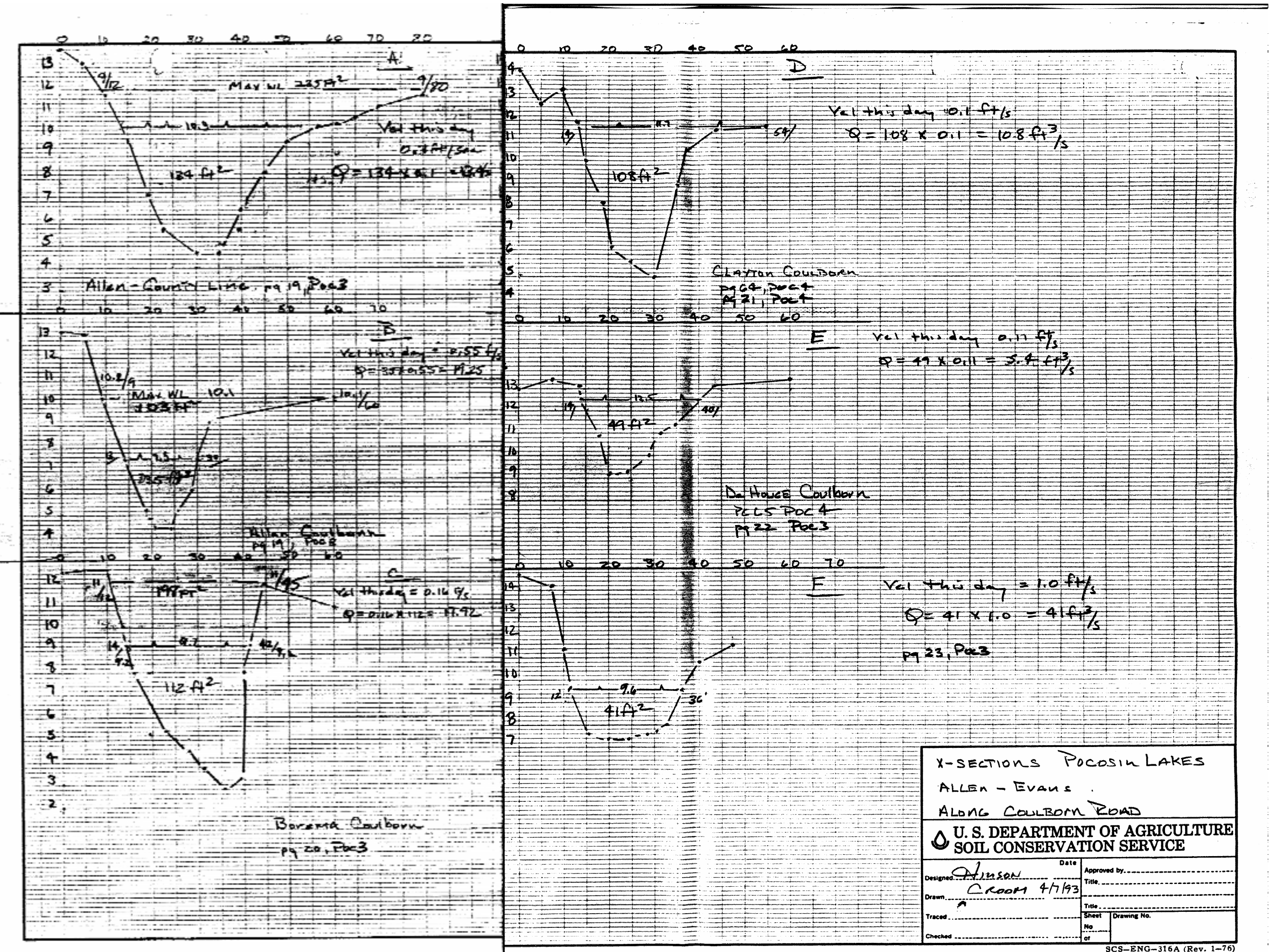
THE HEIGHT OF EACH RISER WILL BE SITE DEPENDENT.

==

Culvert size required: $Q= a\sqrt{\dfrac{2gH}{1+K_m+K_pL}}$

REQUIRES:
Two, 40 feet long x 6 ft diameter corrugated metal culverts at approximately 0.2 - 0.23 feet of head will be required.

These culverts restrict flow only slightly and should increase the water elevation approximately 0.2 ft on the upstream side of the culvert during full flow.



A
Vel this day 0.3 ft/sec
134 ft²
Allen - County Line pg 19, Doc 3
B
Vel this day = 0.55 ft/s
Max WL
Allan Coulbourn pg 19, Doc 3
C
Vel this day = 0.16 ft/s
Q = 0.16 x 112 = 17.92
112 ft²
Borema Coulborn pg 20, Doc 3
D
Vel this day 0.1 ft/s
Q = 108 x 0.1 = 10.8 ft³/s
108 ft²
Clayton Coulborn
E
Vel this day 0.11 ft/s
Q = 49 x 0.11 = 5.4 ft³/s
49 ft²
DeHouse Coulborn
F
Vel this day = 1.0 ft/s
Q = 41 x 1.0 = 41 ft³/s
pg 23, Doc 3
41 ft²
X-SECTIONS POCOSIN LAKES
ALLEN - EVANS
ALONG COULBORN ROAD
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WATERSHED #2

DESIGN OF CULVERTS AND FLASHBOARD RISERS FOR ALL MAJOR DRAINAGE CANALS (FEREBEE, HUBER, UK1 OR I-ROAD CANAL, UK2 OR J-ROAD CANAL, AND HARVESTER CANAL){Watershed#2, file:culrise2}

The entire area is relatively flat with land slopes averaging less than 2 feet per mile (0.0004 ft/ft). The ditches are approximately the same size throughout the watershed. As a result an average area of several representative ditches will be used as design criteria.

During heavy rains, velocities of ditch water throughout the Refuge averaged from 0.1 ft/sec to 1.6 ft/sec. The average for the ditches in this watershed was approximately 0.5 ft/sec. Only in ditches with significant land slope, or where drainage was induced by lowering the weir elevation on risers was the velocity 1.0 ft - 1.5 ft/sec.

The culverts and flashboard risers will be designed to handle the capacity of the existing ditches, thus allowing the historic drainage rate to be maintained if needed. The velocity of the ditches in this watershed as presently managed will range from 0.2 - 0.5 ft/sec. Thus for design the ditches that are not used as principal outlets will have an assumed maximum velocity of 0.5 ft/sec. Ditches which are used as principal outlets (Harvester, Ferebee, Huber, UK1, and UK2 canals) could have an induced hydraulic gradient as a result of the management of flashboard risers. As a result, 1 ft/sec velocity will be used for design.

The culverts and risers will be sized based on an average depth of ditch. **An on-site investigation at the specific location of the culvert or riser will be required "BEFORE" ordering culverts or risers.**

WATERSHED #2: SIZING CULVERTS AND RISERS FOR PRINCIPAL DRAINAGE OUTLETS: FEREBEE, HUBER, UK1, UK2, AND HARVESTER)
(file: culrise2)

Average cross-sectional area of canals at full capacity:

UK1 x-section	104 sqft
UK2 x-section	192 sqft
Western Rd. x-section	87 sqft

Average areas: (104 + 192 + 87)/3 = 128 sqft

==

DESIGN CFS ASSUMING 1.0 FT/SEC:
128 sqft x 1 ft/sec = 128 cuft/sec

==
==

FLASHBOARD RISER SIZE REQUIRED: $Q = 3.33\ H^{3/2}(L - 0.2H)$

REQUIRES:
Two risers with 8 feet of weir each at approximately 1.85 feet of head. Thus, approximately 1.85 feet of boards will have to be removed when the water level in the ditch is flowing at full capacity to handle the capacity of the canal.

<u>THE HEIGHT OF EACH RISER WILL BE SITE DEPENDENT.</u>

==

CULVERT SIZE REQUIRED: $Q = a\sqrt{\dfrac{2gH}{1 + k_m + K_p L}}$

REQUIRES:
Two, 40 feet long x 6 ft diameter corrugated metal culverts at approximately 0.2 - 0.23 feet of head will be required. Thus, these culverts restrict flow only slightly and should only increase the water elevation approximately 0.2 ft on the upstream side of the culvert during full flow.

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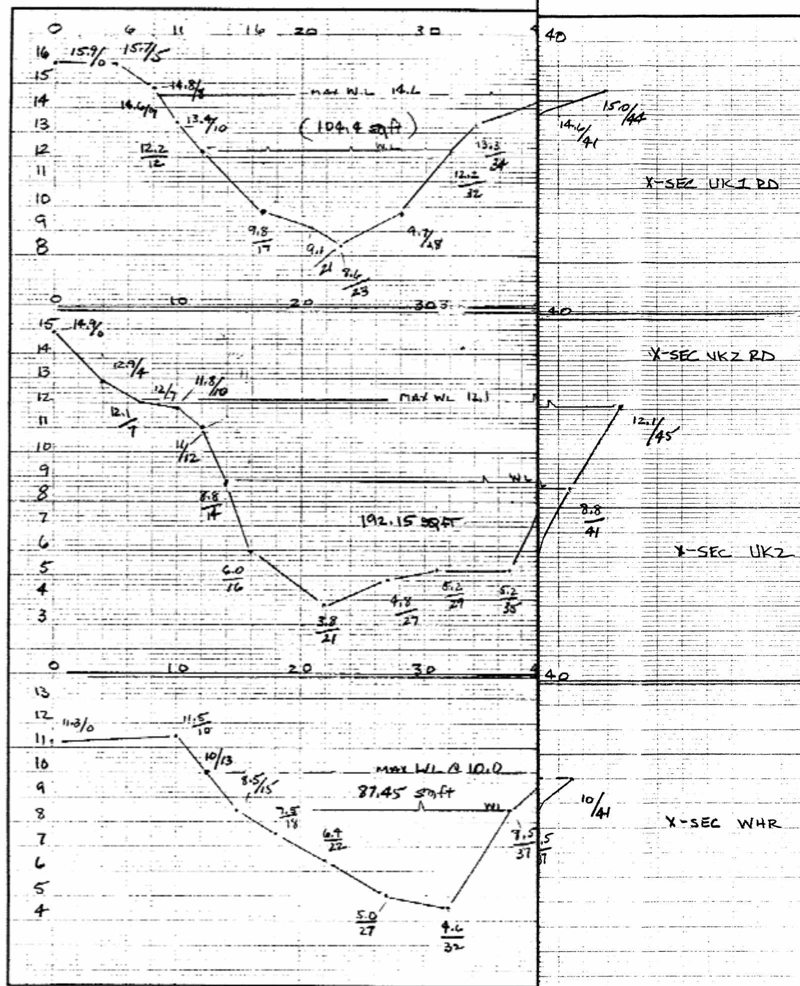
==

SIZING CULVERTS FOR ALL OTHER CANALS IN WATERSHED #2

Average x-sectional area	128 ft^3
Average velocity	0.5 ft/sec
Design CFS	64 ft^3/sec

==

REQUIRES:
One 6 foot diameter corrugated metal pipe 40 feet long



Average Ditch Area $(104 + 192 + 87)/3 = 128\,ft^2$

Average Depth $(6 + 8.3 + 5.4)/3 = 6.6\,ft$

Average velocity $= 1\,ft^3/sec$

CFS REQ $= 128\,ft^2 \times \frac{1\,ft^3}{sec} = \frac{128\,ft^3}{sec}$

PIPE SIZE REQ

Using CMP, 40 FT LONG @ 0.2 head

REQ = two - 72" CMPS

RISER SIZE REQ

REQ - Two 90" Risers @ 1.9 FT head

X-SECTIONS - HARVESTER RD CANAL

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WATERSHED #2: DESIGN OF FLASHBOARD RISERS FOR WESTERN ROAD CANAL {watershed#2, file:culrise3}

Water flowing east toward the Southwest Fork from Harvester canal will be forced to flow overland through the existing swamp to the Southwest Fork by establishing risers at areas of higher elevations north and south of the overflow area (intersection of Harvester and Western roads)

The culverts and risers will be sized based on an average depth of ditch. **AN ON-SITE INVESTIGATION AT THE SPECIFIC LOCATION OF THE CULVERT OR RISER WILL BE REQUIRED "BEFORE" ORDERING CULVERTS OR RISERS.**

===

AVERAGE AREA OF 3 CROSS-SECTIONS:

X-Sect West00	119 ft^2	
X-Sect WHR	64 "	$(119+64+145)/3 = 109\ ft^3$
X-Sect Hubwest	145 "	

Average velocity assumed at 1 ft/sec based on average measurements in areas where hydraulic gradient induced by management of risers.

DESIGN CFS $109\ ft^2 \times 1\ ft/sec = 109\ ft^3/sec$

===

===

FLASHBOARD RISER SIZE REQUIRED: $Q = 3.33\ H^{3/2}(L - 0.2H)$

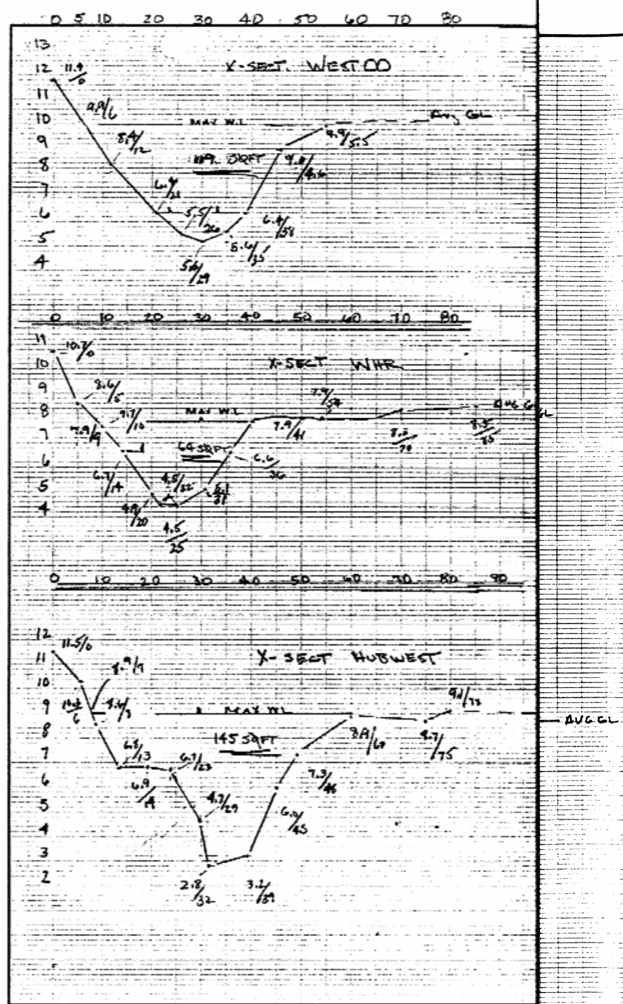
REQUIRES:
Two risers with 7 feet of weir each at approximately 1.85 feet of head. Thus, approximately 1.85 feet of boards will have to be removed when the water level in the ditch is flowing at full capacity to handle the capacity of the canal.

THE HEIGHT OF EACH RISER WILL BE SITE DEPENDENT.

===

CULVERT SIZE REQUIRED: $Q = a\sqrt{\dfrac{2gH}{1+K_m+K_pL}}$

REQUIRES:
Two, 40 feet long x 5.5 ft diameter corrugated metal culverts at approximately 0.2 - 0.23 feet of head will be required. Thus, these culverts restrict flow only slightly and should only increase the water elevation approximately 0.2 ft on the upstream side of the culvert during full flow.



The 3 areas will be averaged to obtain an average area for the ditch.

The design cfs for structures will be based on the ditch capacity @ max elevation flowing @ 1ft/sec.

Average Area $= (119 + 64 + 145)/3 = 109$ sqft

Average depth $= \left((9.9-5.4)+(7.9-4.5)+(8.9-2.8)\right)/3 = 4.7'$

DESIGN CFS $Q = A \cdot V$

$= 109 \text{ sqft} \times \frac{1 \text{ ft}}{\text{sec}}$

$= 109 \text{ ft}^3/\text{sec}$

PIPE SIZE REQ using: 0.2 head, & max of 5' pipe CMP 40 FT LENGTH.

REQUIRED TWO 5.5' DIA PIPES @ 55.4 CFS EACH

RISER SIZE REQ USING ALUMI

REQUIRED 2-84" with 1.8-1.9 FT HEAD

X-SECTIONS OF WESTERN ROAD CANAL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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WATERSHED #3: SIZING CULVERTS FOR MIDDLE, BRANCH, AND SEAGOING ROAD CANALS.
(file: culvdes1)

AREAS FOR DESIGN

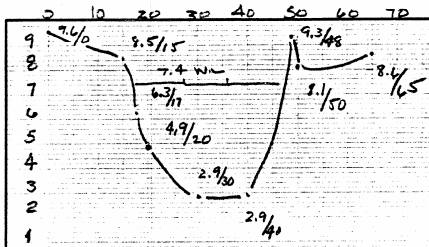
1.	Area of Seagoing Canal	130 ft^2
2.	Area of Middle Canal	<u>164 ft2</u>
	Totals	294 "

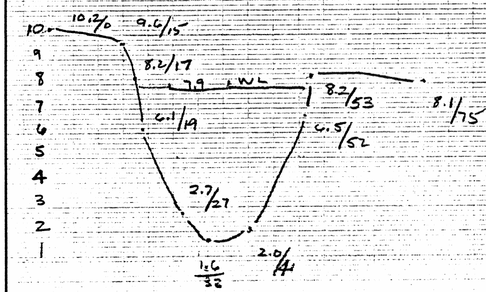
AVERAGE END AREA 147 ft^2

CFS 147

PIPES REQUIRED: Two--- 6 ft dia. x 40 ft long

X-SECT SEAGOING CANAL





X-Section SEAGOING CANAL

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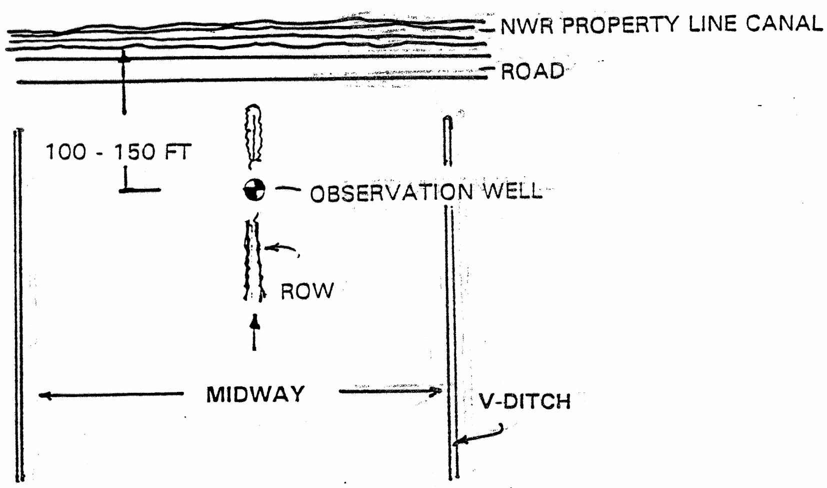
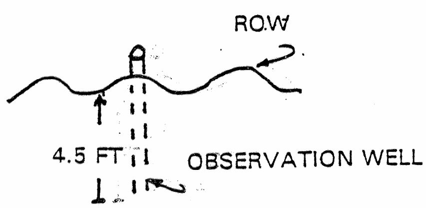
OBSERVATION WELLS

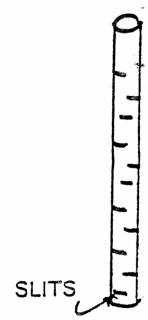
DESIGN & LOCATION



LOCATION



DESIGN



4 INCH (DIA) PVC (THIN WALLED PIPE)
5 FEET LONG
CUT SLITS WITH SAW