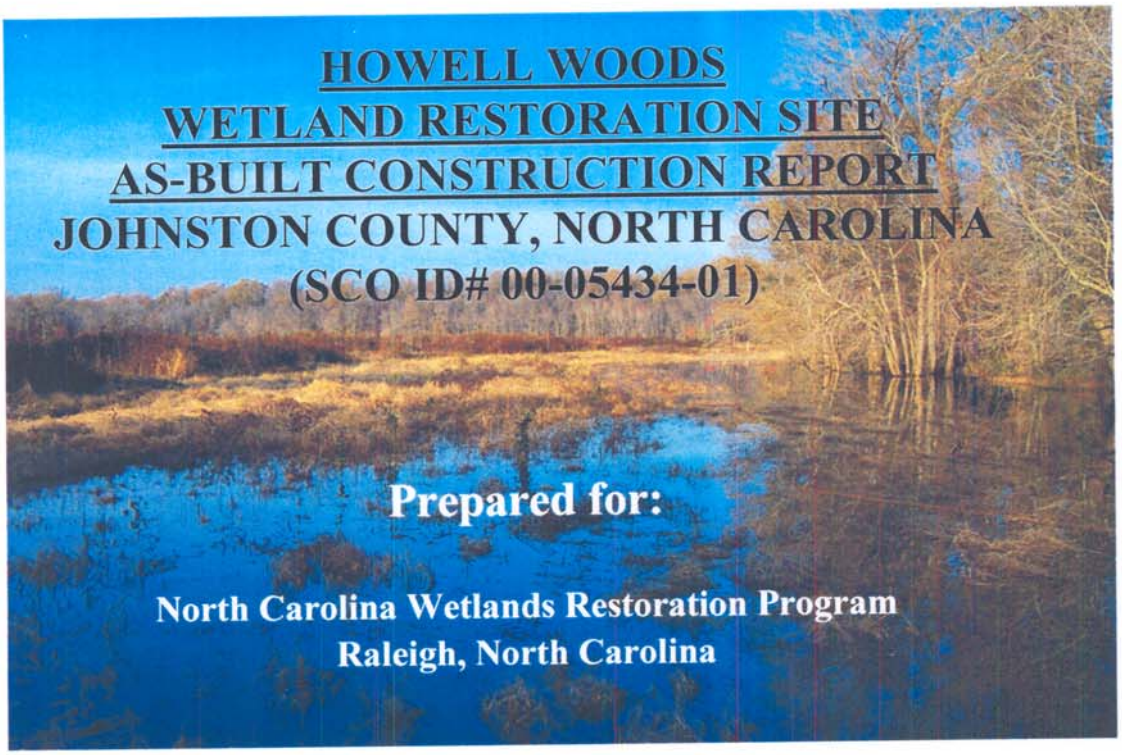

HOWELL WOODS WETLAND RESTORATION SITE AS-BUILT CONSTRUCTION REPORT JOHNSTON COUNTY, NORTH CAROLINA (SCO ID# 00-05434-01)

Prepared for:

North Carolina Wetlands Restoration Program
Raleigh, North Carolina

Prepared by:

EcoScience
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DECEMBER 2002

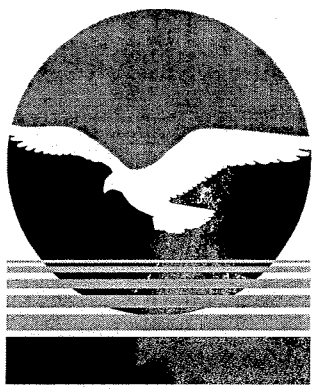
HOWELL WOODS WETLAND RESTORATION SITE
AS-BUILT CONSTRUCTION REPORT
JOHNSTON COUNTY, NORTH CAROLINA

(SCO ID# 00-05434-01)

Prepared for:

North Carolina Wetlands Restoration Program
Raleigh, North Carolina

Prepared by:



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DECEMBER 2002

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HOWELL WOODS WETLAND RESTORATION SITE
AS-BUILT CONSTRUCTION REPORT
JOHNSTON COUNTY, NORTH CAROLINA

1.0 INTRODUCTION

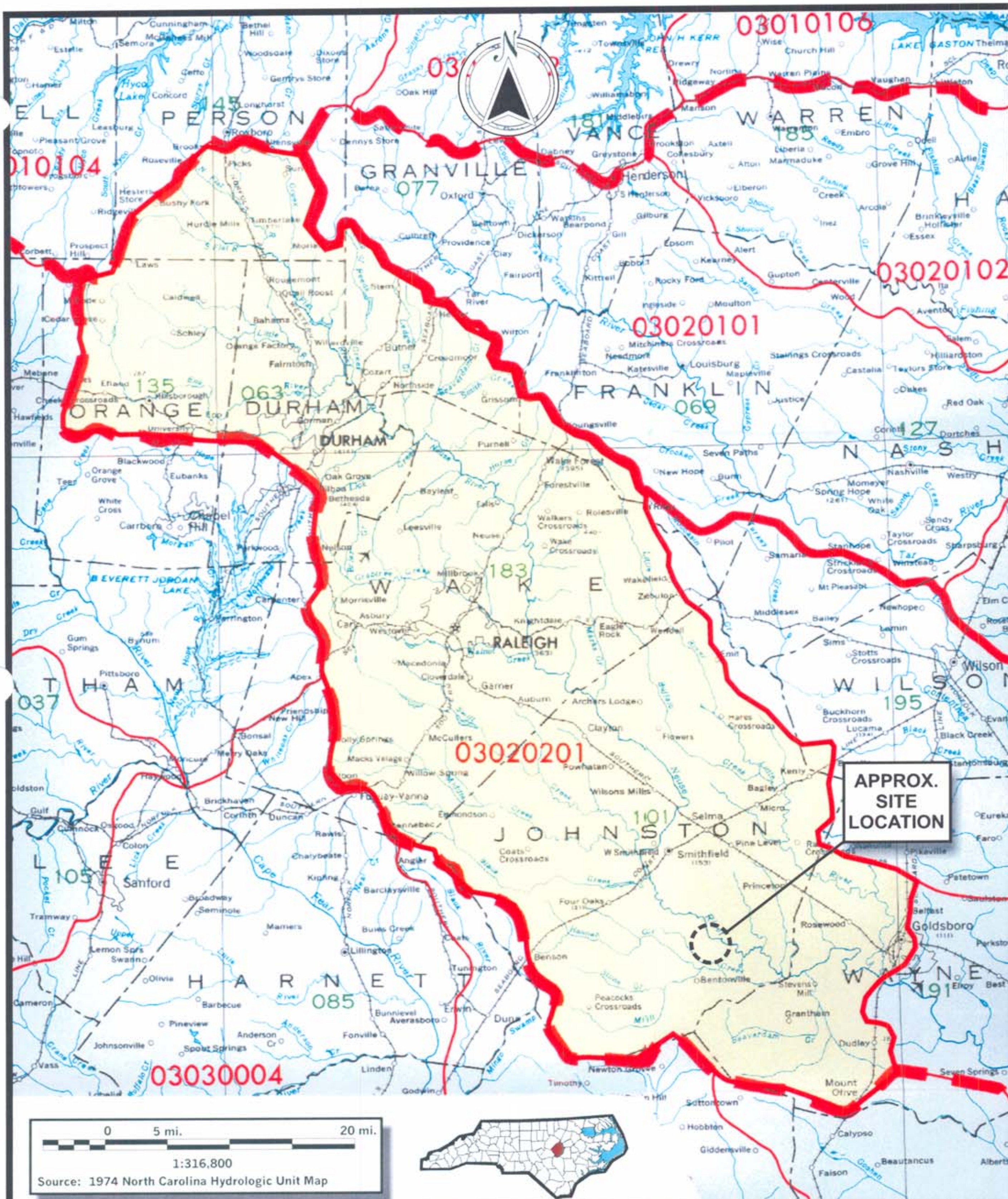
The N.C. Wetlands Restoration Program (WRP) has developed a wetland mitigation site within the western Coastal Plain region of the Neuse River watershed. As part of this effort, WRP has implemented the detailed mitigation plans for the Howell Woods Mitigation Site (Site), an approximately 140-acre tract located at the southern edge of the Neuse River floodplain. This region of the state is located within U.S. Geological Survey subbasin 03020201 (USGS 1974) (Figure 1). The Site is situated 15 miles south U.S. Interstate 95, and 10 miles east of U.S. Route 701, approximately 14 miles south of Smithfield (Figure 2).

The Site consists of a mixture of agricultural areas, fallow fields, and forested communities located at the outer edge of the primary Neuse River floodplain. The primary on-site hydrologic feature is a dredged and straightened canal, which extends for approximately 5400 linear feet through the Site. The canal lies in a northwest-to-southeast orientation and connects two man-made ponds and five secondary ditches. The canal and secondary ditches are unnamed tributaries associated with a complex network of streams and sloughs, which connect Gar Gut Creek, Mill Creek, and the Neuse River.

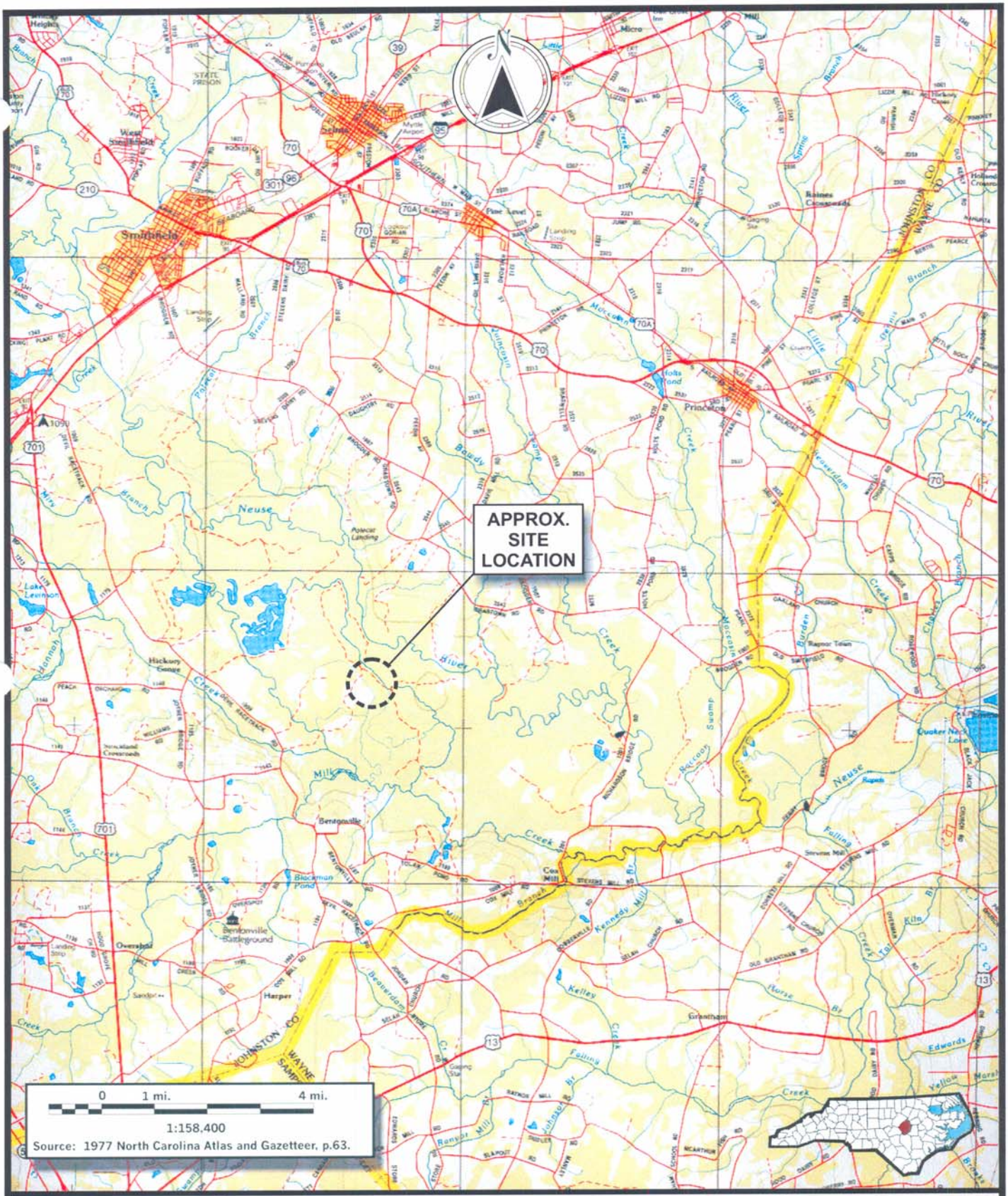
Land-use activities in the Site and adjacent tracts are limited due to frequent flooding from the Neuse River and poorly drained soils associated with the floodplain. Silviculture and a few isolated agricultural allotments appear to be the dominant land use. On-site land use is characterized by farming (agricultural row crops), hunting, and recreational activities associated with the Howell Woods Environmental Learning Center. Due to past and present land use activities, Site location, and watershed service area, the Site serves as an ideal area for wetland restoration and ecological improvement. After implementation, the Site is expected to restore approximately 32 acres of riverine wetland and enhance approximately 74 acres of riverine wetland within the Neuse River floodplain.

Experience shows that wetland restoration requires specialized knowledge, both from a design and construction perspective. As a relatively new science, the task of designing and implementing these systems necessitates field evaluations and on-the-spot alterations during the course of construction. Coastal Plain, large river floodplains, similar to the Site, are no exception. Several minor changes were made with respect to the original design in order to facilitate the process and ultimately increase the Site's chances for success.

The purpose of this project is to restore a natural hydrological regime, which supports hydric soils and hydrophitic vegetation, that will enhance water quality functions in the vicinity of the Site, and provide habitat for area wildlife. This document summarizes the step-wise implementation procedure used to restore the Site. Restoration construction activities were begun on June 18, 2002 and completed on July 19, 2002.



EcoScience Corporation Raleigh, North Carolina	**USGS SUB-BASIN** **HOWELL WOODS** **WETLAND RESTORATION SITE** Johnston County, North Carolina	Dwn. by: MAF Ckd by: WGL Date: DEC 2002 Project: 98-047.15	FIGURE 1



EcoScience Corporation
Raleigh, North Carolina

SITE LOCATION
HOWELL WOODS
WETLAND RESTORATION SITE
Johnston County, North Carolina

Dwn. by:	MAF
Ckd by:	WGL
Date:	DEC 2002
Project:	98-047.15

FIGURE 2

2.0 SUMMARY

2.1 Pre-Construction Conditions

The Site lies at the outer perimeter of the Neuse River floodplain at the base of the escarpment between the primary Neuse River floodplain and an elevated river terrace (Figure 3). Transitional areas between the floodplain and terrace are typically characterized by depressional sloughs which pond water for extensive periods of time. Ponded depressions, swamps, and sloughs occur throughout the 3.5-mile wide floodplain and are characterized by cypress-gum associations. Elevated, well-drained, portions of the floodplain support bottomland hardwood forests and mesic upland slope forests dominated by oaks and ashes. The Site is located within the Gar Gut watershed: Gar Gut is a slough-like tributary that meanders in a southeasterly direction through this section of the Neuse River floodplain, receiving drainage from a network of small streams, sloughs, ditches, and forested swamps.

The Gar Gut watershed covers an area of approximately 6300 acres (Figure 4). A majority of the watershed remains forested as mature, climax hardwood systems covering large, contiguous areas. Forested areas on uplands and along mesic slopes bounding the watershed are interspersed with large tracts of cleared land supporting timber harvest and cultivation of sorghum, tobacco, and sweet potatoes. The basin rim also supports low-density residential communities adjacent to Devils Racetrack Road (SR 1009). Land use within the watershed is not expected to change considerably because of its poor suitability for development and agricultural production.

Streams of the Gar Gut watershed traverse the Site, dividing the area into two sections. The northeastern portion (approximately 113 acres) of the Site supports mature swamp forest and bottomland hardwood forest, while the southwestern section (approximately 20 acres) was cleared for agricultural production.

2.2 Project History

In the winter of 1998, WRP contacted EcoScience Corporation (ESC) and requested a detailed mitigation plan be conducted for the Site. Detailed mitigation studies were completed in the spring of 2002. Upon completion of the detailed mitigation plan and issuance of permits, construction plans and bid documents were developed and the project was bid on May 17, 2002. Backwater Environmental, a subsidiary of Osborne Co. Inc., was awarded the construction contract and work was initiated on June 18, 2002. Information on project managers, owners, State Construction Officer, and contractors follows.

Designer Information
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Raleigh, North Carolina 27604
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Jeff Jurek, Implementation
1619 Mail Service Center
Raleigh, North Carolina 27699-1619
(919) 733-5316

Contractor Information
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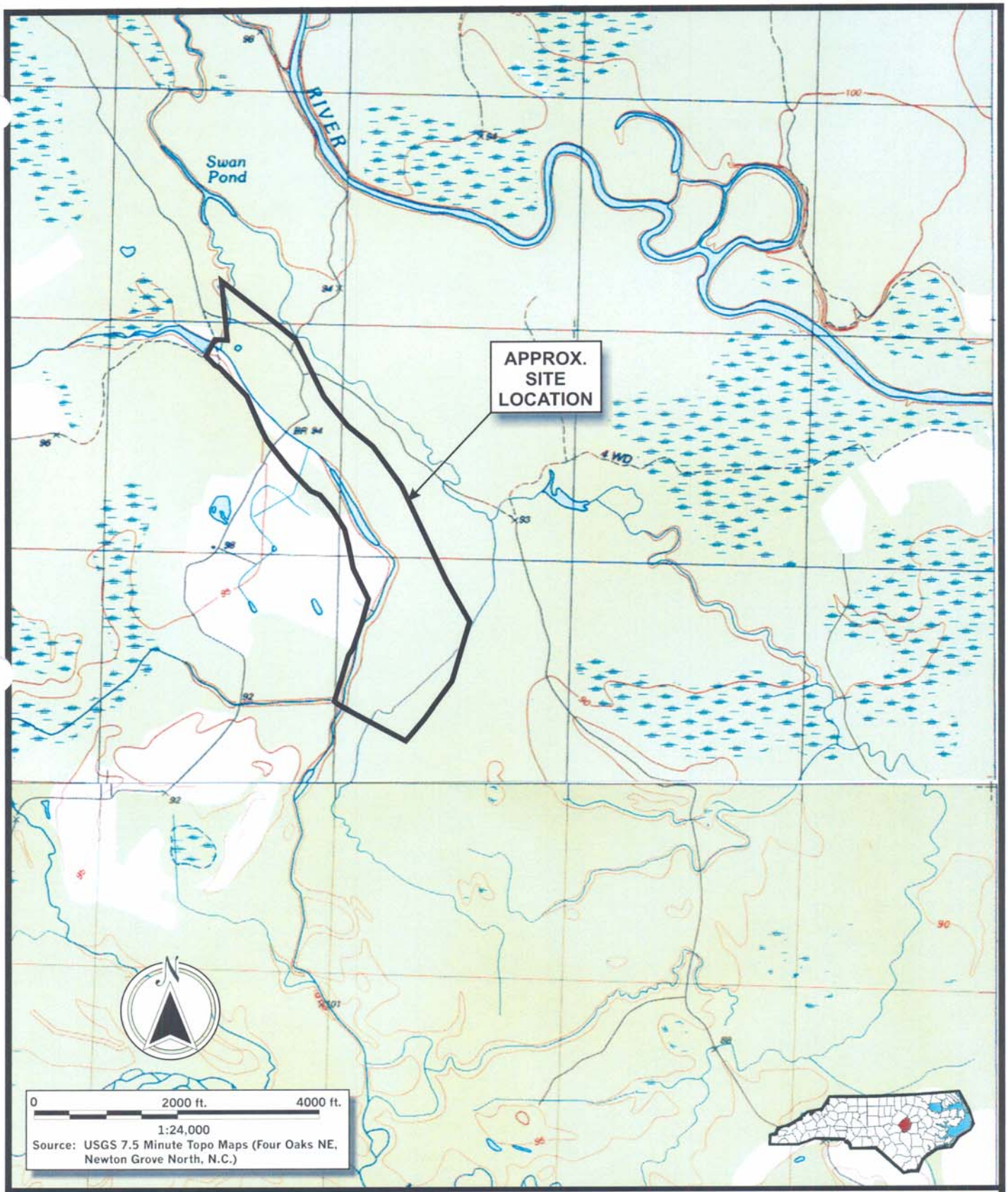
(919) 523-4375

State Construction Officer Information
Jerry Rodgers
301 N. Wilmington Street, Suite 450
Raleigh, North Carolina, 27699-1307
(919) 733-7962

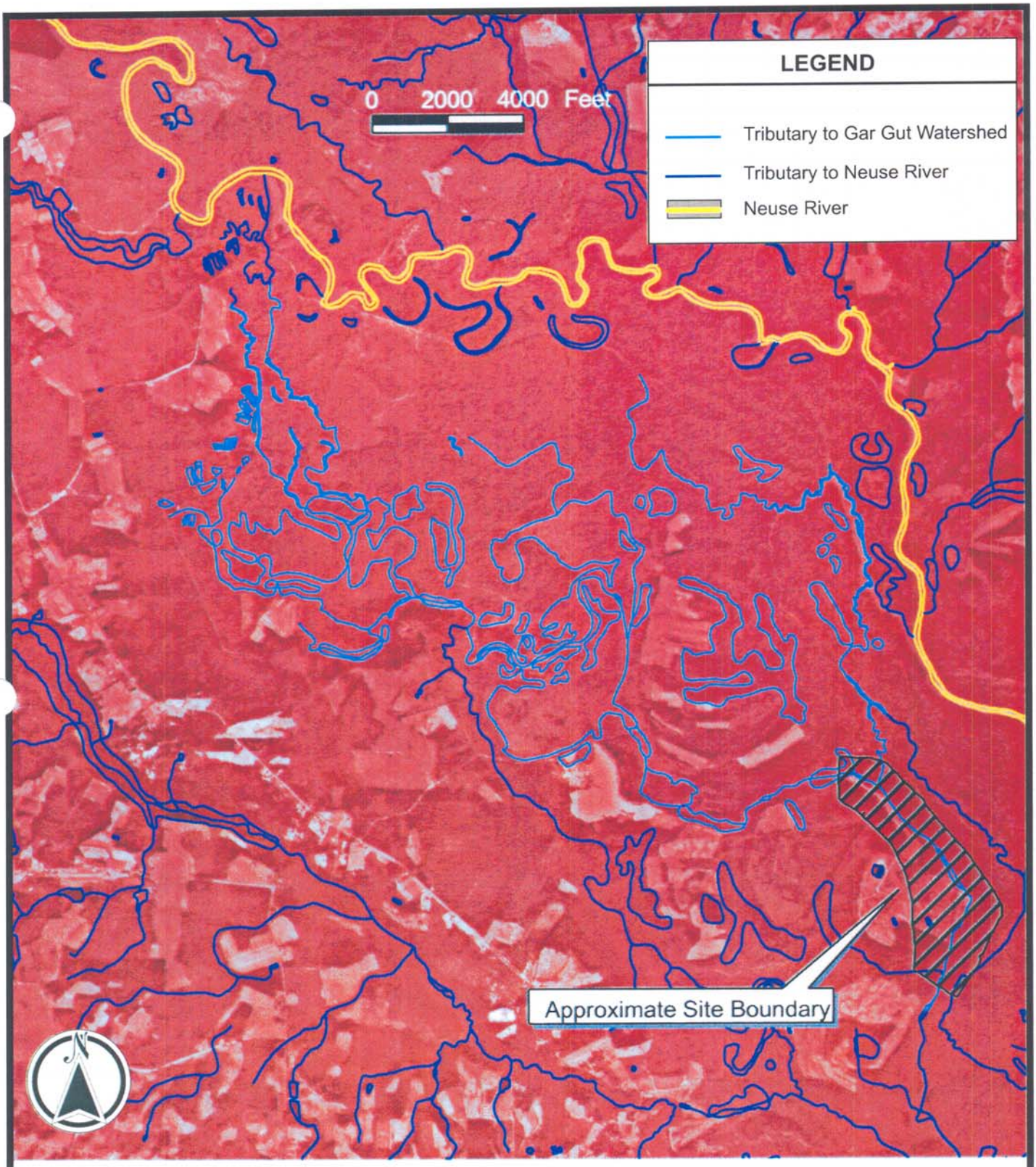


EcoScience Corporation
Raleigh, North Carolina

TOPOGRAPHY
HOWELL WOODS
WETLAND RESTORATION SITE
Johnston County, North Carolina

Dwn. by:	MAF
Ckd by:	WGL
Date:	DEC 2002
Project:	98-047.15

FIGURE 3



EcoScience Corporation
Raleigh, North Carolina

GAR GUT WATERSHED LAND USE
HOWELL WOODS
WETLAND RESTORATION SITE
Johnston County, North Carolina

Dwn. by:	MTC
Ckd by:	WGL
Date:	DEC 2002
Project:	98-047.15

FIGURE 4

Major Equipment Used in Wetland Restoration Activities

Three major types of heavy equipment were used during construction of the Site: Track Hoe, Bull Dozer, and Articulated Dump Truck. Task descriptions are listed below.

Bull Dozer

- Vegetation Stripping and Topsoil Stockpiling
- Road maintenance and Grading
- Ditch Backfill and Compaction

Track-Hoe

- Littoral Shelf Excavation
- Clearing and Grubbing
- Ford Installation
- Ditch Plug Installation

Articulated Dump Truck

- Soil Hauling and Stockpiling
- Ditch Backfilling
- Soil Compaction

3.0 MITIGATION ACTIVITIES

The primary goals of this restoration plan include: 1) maximizing the area returned to historic wetland function; 2) enhancing the water quality functions in Gar Gut Creek and Mill Creek; and 3) re-establishing a functioning backwater slough system which extends through developing bottomland hardwood forests.

Primary activities designed to restore the backwater slough complex include restoration of wetland hydrology, littoral shelf creation, and wetland vegetative community restoration. A monitoring plan is subsequently outlined in Section 4 of this document. In total, approximately 32 acres of jurisdictional, riverine wetland are expected to be restored through ditch backfilling/plugging, including approximately 4 acres of jurisdictional wetland creation through littoral shelf excavation. In addition, approximately 74 acres of jurisdictional wetland are expected to be enhanced hydraulically by proposed mitigation activities.

3.1 Wetland Hydrology Restoration

Site alterations designed to restore characteristic groundwater wetland hydrology include: 1) ditch cleaning prior to backfill; 2) impervious ditch plug construction; 3) ditch/canal backfilling; 4) access road improvements; 5) littoral shelf creation; and 6) pond outfall structural upgrades (Figure 5).

3.1.1 Ditch and Canal Backfilling

The canal and adjacent ditches within the easement boundary were backfilled using material excavated from littoral shelves and isolated oxbow depressions (Photo 1). The ditches/canals were filled, compacted, and graded to the adjacent floodplain elevation.


Photo 1

Two man-made ponds were left within the Neuse River floodplain to maintain diverse aquatic habitat. The ponds were isolated from construction activities through the use of temporary, impermeable dikes. (Photo 2). Prior to backfilling water was pumped from ditches/canals into the forest using proper sediment collection measures.


Photo 2

Approximately 2400 linear feet of open ditch (five on-site ditches) and approximately 3700 linear feet of canal were backfilled within the project boundaries. Fill material for ditch backfill was obtained by excavating littoral shelves (Section 3.1.4) and/or shallow depressions within the outer floodplain edge. Excavated areas represent closed linear, sinuous depressions. In essence, the depressions are similar to abandoned stream reaches, ox-bow lakes, and shallow to deep ephemeral pools. These pools would be expected to stabilize and fill with organic material over time.

All exposed soil adjacent to backfilled ditches and canals was seeded with millet and covered with straw to prevent erosion (Photo 3-4). Soil borrow areas are mapped as Udorthents atop Altivista soils and may be more permeable than clay material in other locations; therefore, this material was utilized in conjunction with impermeable channel plugs and suitable floodplain clays.


Photo 3


Photo 4

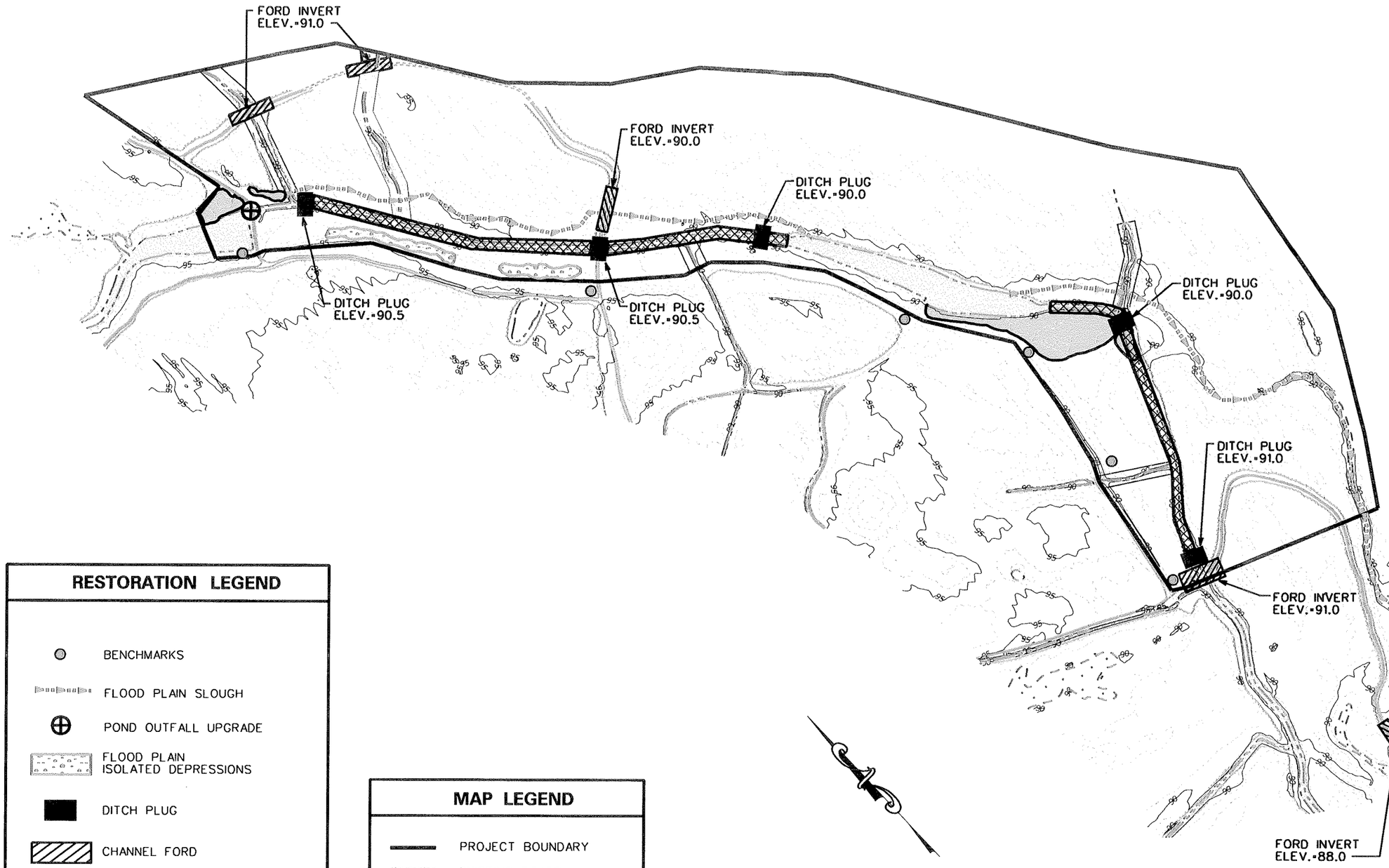
3.1.2 Ditch Plugs

Impermeable ditch plugs were installed along the main canal at five locations throughout the Site (Figure 5). The plugs consist of a core of impervious material lined with filter fabric. The plugs and are sufficiently wide and deep to form an imbedded overlap in the existing canal banks and canal bed (Figure 6). The plugs were designed to withstand erosive forces associated with river floods.


Photo 5

Channel Plug material was excavated from the adjacent floodplain, littoral shelves, and isolated depressions and stockpiled at select locations. Impermeable select material was placed in the canal in 6 to 8 inch lifts and compacted (Figure 6). At each plug location, a core was then excavated from the compacted material (Photo 5). The upstream face of the excavated core was then lined with filter fabric from top to bottom. Once the filter fabric was installed, the excavated core was backfilled and compacted. The channel plugs prevent backfilled material from functioning as a hydrologic conduit of on-site hydrology. Hydrological flows will instead be diverted into the historic floodplain and backwater sloughs.


Photo 6



RESTORATION LEGEND

- BENCHMARKS
- FLOOD PLAIN SLOUGH
- POND OUTFALL UPGRADE
- FLOOD PLAIN ISOLATED DEPRESSIONS
- DITCH PLUG
- CHANNEL FORD
- DITCH BACKFILL
- CANAL BACKFILL
- LITTORAL SHELF CREATION AREA

MAP COMPILED BY PHOTOGRAMMETRIC METHODS.

MAP LEGEND

- PROJECT BOUNDARY
- EXISTING ROADS
- APPROX. MINOR CONTOUR
- APPROX. MAJOR CONTOUR
- WOODS
- OPEN WATER

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

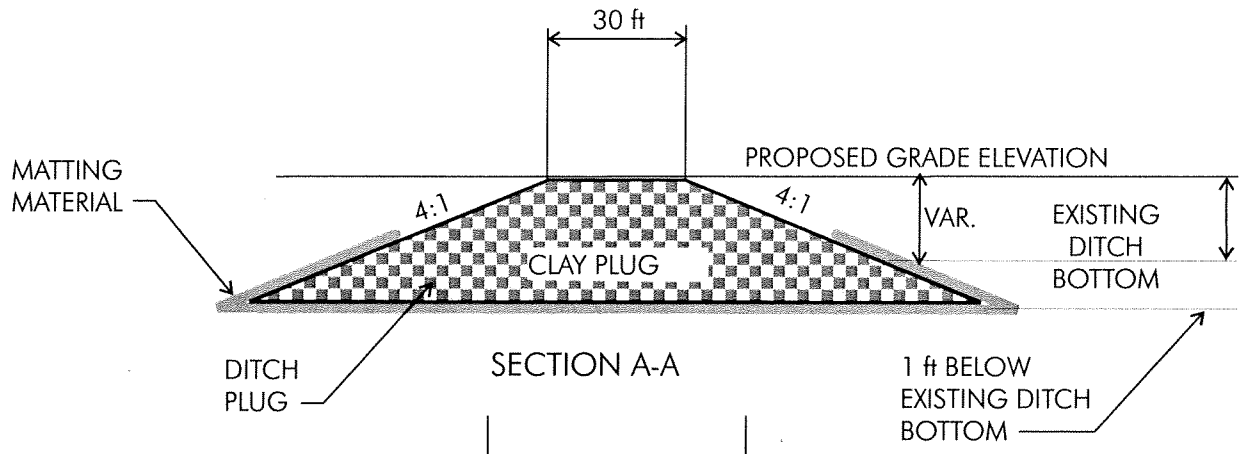
Project:
HOWELL WOODS
WETLAND RESTORATION AS-BUILT PLAN
JOHNSTON COUNTY, NORTH CAROLINA

Title:
WETLAND RESTORATION ACTIVITIES

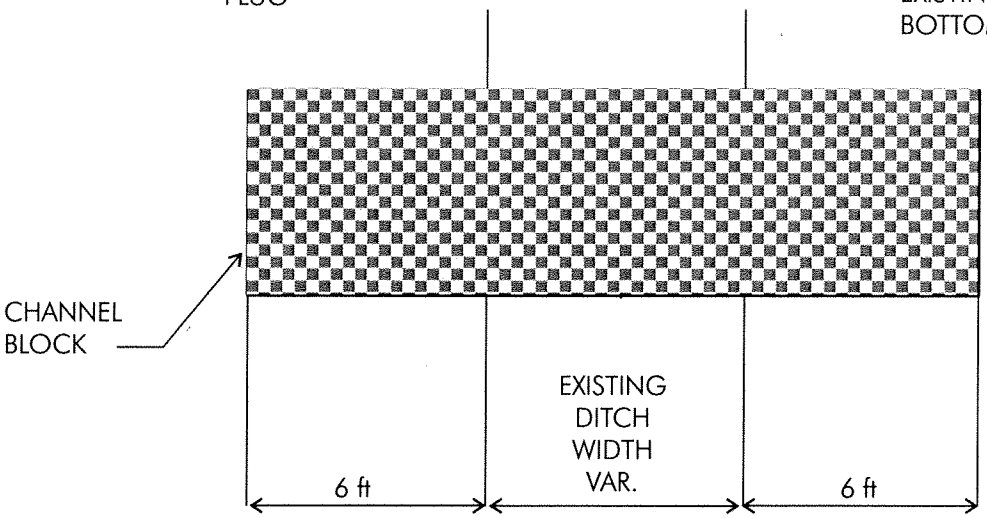
Dwn By:	Date:
MAF	DEC 2002
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.15

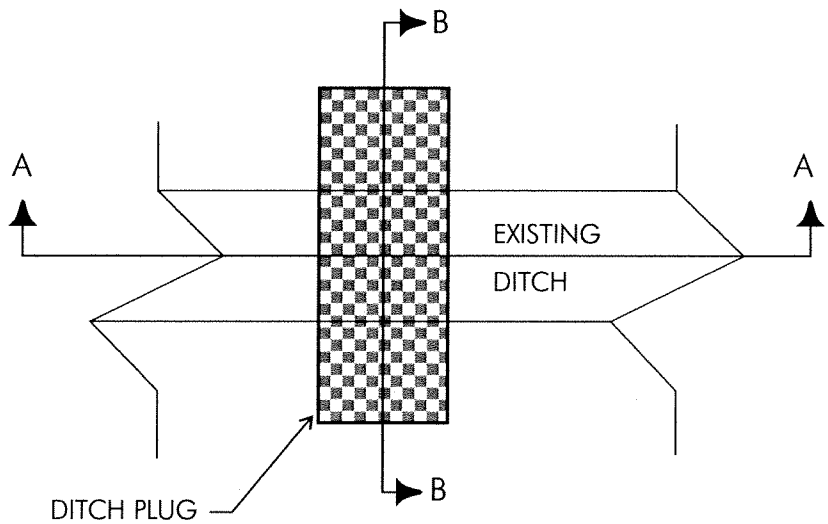
FIGURE
5



SECTION A-A



SECTION B-B



PLAN VIEW OF EXISTING DITCH WITH CHANNEL BLOCK

EcoScience Corporation

TYPICAL CROSS-SECTION: IMPERVIOUS DITCH PLUG
HOWELL WOODS MITIGATION SITE
Johnston County, North Carolina

Figure: 6
Project: 98-047.15
Date: DEC 2002

3.1.3 Littoral Shelf Creation

Littoral shelves were excavated adjacent to the upper and lower man-made ponds. These previously upland areas are depicted on Figure 5. The shelves were created to incorporate a freshwater marsh component into the restoration site. Littoral shelves provide a subaqueous bench adjacent to open water environments. The littoral shelves are approximately 1-3 feet below normal pool elevations, with microtopography ranging to, and just above, the water surface.

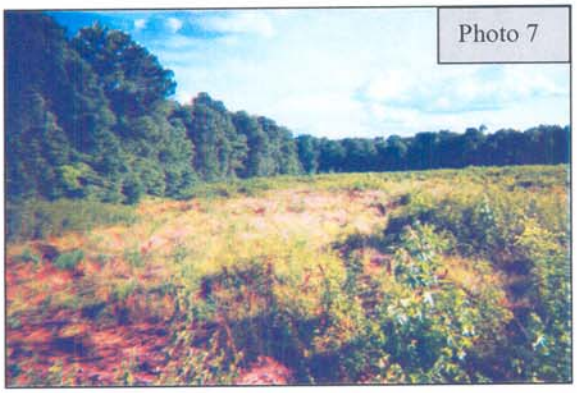


Photo 7

Construction of the littoral shelves was conducted to promote suitable habitat for establishment of emergent wetland species. Initially, topsoil (A horizon) and vegetation were removed from the ground surface and stockpiled (Photo 7 and 8). After stockpiling the A horizon and vegetation, the subsurface (B horizon) was excavated to the target range of the littoral shelf elevations (Photo 9). The excavated B-horizon was stockpiled and used as backfill for the canal and ditches. Surficial soils and stripped vegetation were redistributed across the littoral shelf (Photo 10). Surficial soils and vegetation were distributed to diversify microtopography within the littoral shelf. Based on GPS data, approximately 4 acres of littoral shelf was created within the site boundary (Figure 5).


Photo 8


Photo 9

The upstream littoral shelf, above and to the north of the pond, measures approximately 0.6 acre. The downstream littoral shelf, adjacent to the downstream pond, measures approximately 3.4 acres. Water depth on these littoral shelves will vary between 0.5 and 3 feet.


Photo 10

3.1.4 Pond Outfall Structure

The pond outfall structure was upgraded with a structure to meet hydrological constraints and help deter beaver from damming normal flows from the pond. The outfall structure was subject to restrictions under the North Carolina Dam Safety Law of 1967 (GS 143-215.23).

In an effort to reduce impacts from resident beavers, the structure was designed with three intake pipes that are expected to reduce on-site maintenance and clearing (Photo 11 and 12). The structure is expected to establish a pond water surface elevation of 90.8 feet above sea level, thereby hydrating the littoral shelf. Installation of the structure was performed as a good faith effort by WRP to the Howell Woods Environmental Learning Center and resulted in no additional mitigation credit at the Site.


Photo 11


Photo 12

3.1.5 Channel Ford Construction

Four channel fords were constructed within the Site and one channel ford was constructed off-site at the downstream reach of the slough (Figure 5). Channel fords were constructed to minimize road washout and allow access to the all regions of the property without restricting surface water flows. The fords consist of a shallow depression in the existing slough and tributary where vehicular crossings can be made. A typical ford design is depicted in Figure 7, and construction sequencing is depicted in Photos 13-18.

Ford construction was initiated by excavating the approach grades on each side of the slough channel. The ford approaches are approximately 30 feet in length and are graded at an approximately 15:1 slope. Once the approaches were excavated, the ford was covered with filter


Photo 13


Photo 14

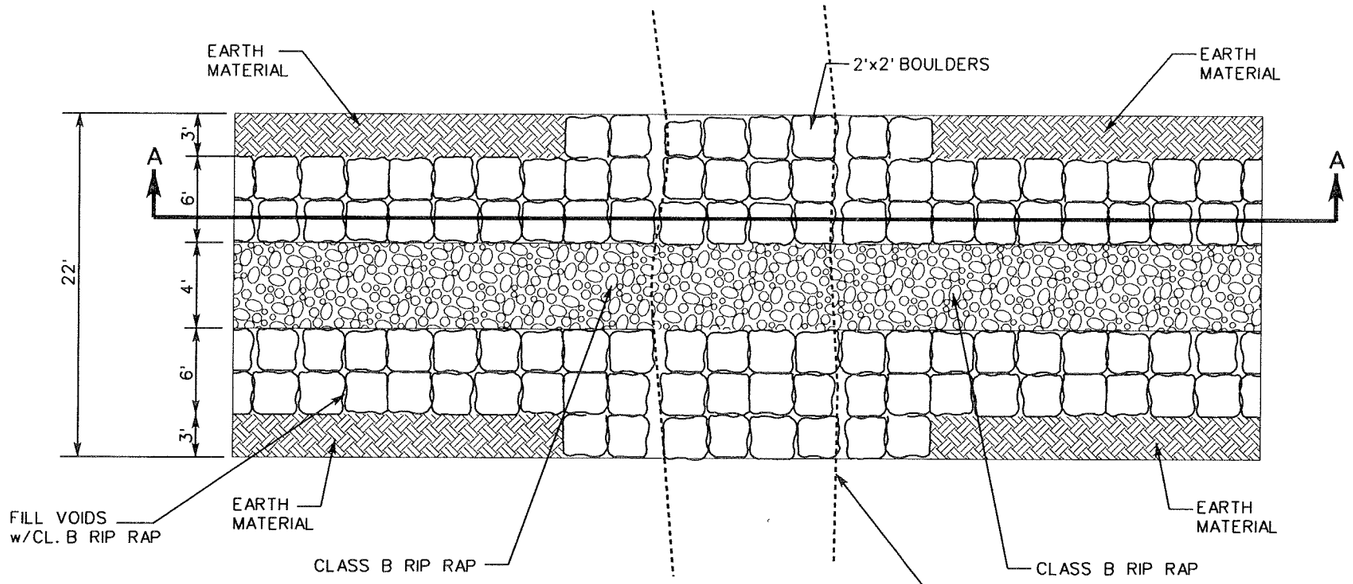

Photo 15


Photo 16

Photo 17

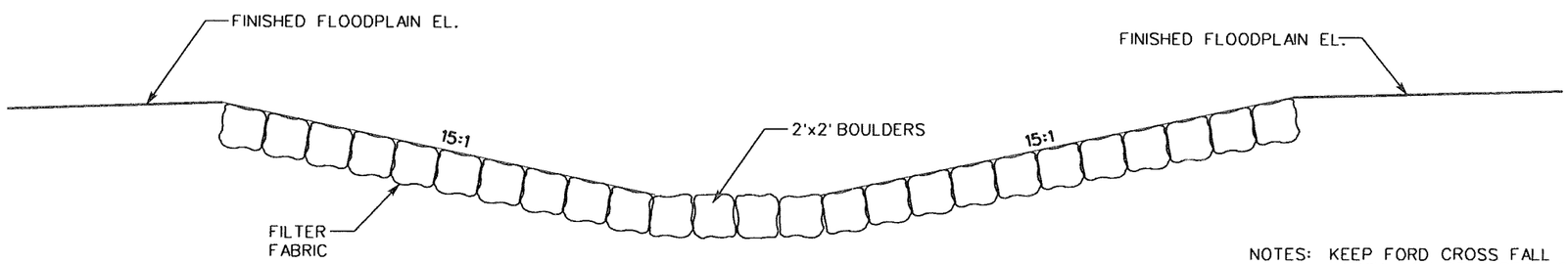

Photo 18

PERMANENT FORD



PLAN VIEW

N.T.S.



NOTES: KEEP FORD CROSS FALL WITHIN 1-2% OF STREAM GRADIENT

FILL VOIDS IN 2'x2' BOULDERS WITH CLASS B RIP RAP TO CREATE DRIVEABLE SURFACE

SECTION A-A

N.T.S.

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
WETLAND RESTORATION AS-BUILT PLAN
JOHNSTON COUNTY, NORTH CAROLINA

Title:
CONSTRUCTED FORD DESIGN

Dwn By:	Date:
MAF	DEC 2002
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.15

FIGURE
7

fabric. Filter fabric was subsequently, toed into a trench on the upstream edge of the ford. Boulders were placed on the filter fabric and keyed into the slough bed. Boulders covered the channel bed and approach arms to reduce the risk of channel erosion around the ford bed. The bed elevation of the ford is equal to the bed elevation of the slough channel above and below the ford to reduce the risk of headcutting. After the boulders were in place, rip-rap and small boulders were placed along the ford and compacted into small holes and soil surfaces adjacent to the boulders.

3.2 Wetland Community Restoration

Restoration of wetland forest communities provides habitat for area wildlife and allows for development and expansion of characteristic wetland dependent species across the landscape. Ecotonal changes between community types contribute to diversity and provide secondary benefits, such as enhanced feeding and nesting opportunities for mammals, birds, amphibians, and other wildlife.

The Site was initially planted in March of 2000. Land acquisition, in an effort to extend the easement from approximately 40 acres to the current approximately 140 acres, resulted in construction delays until the summer of 2002. Once construction activities were complete, portions of the Site which were disturbed by excavation or compaction from equipment were re-planted in the winter of 2002. A description of each planting phase follows.

2000 Planting

On Thursday, March 16, 2000, the Site was re-vegetated with native, wetland-adapted tree species.

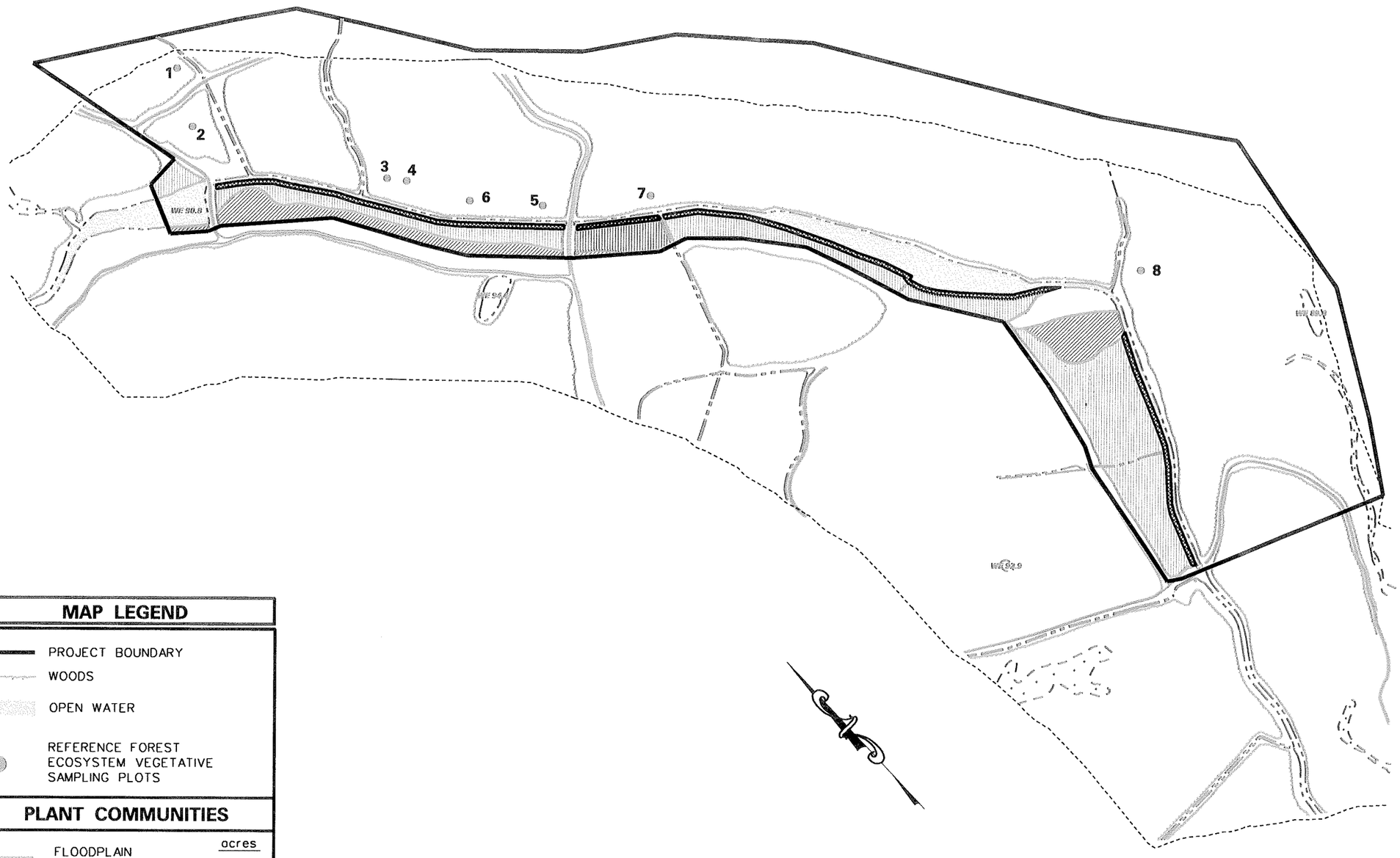
Planting Process

9600 seedling trees were purchased from the North Carolina Forestry Service Division of Forest Resources and received at Claridge Nursery in Goldsboro on Wednesday, March 15, 2000. The seedlings, separated by species into bags of 100 trees each, had been stored in a darkened, refrigerated warehouse. The seedlings were separated by species and grouped into three primary associations based on landscape positioning for planting: 1) stream edge; 2) floodplain; and 3) mesic slope (Figure 8). The seedling roots were wetted and root-pruned as the groups of trees were randomized and put back into bags for the planting crews. The following morning a 10-person crew planted the seedlings according to the planting plan using metal dibble shovels. Tree spacing is approximately 10 feet.

Soil preparation consisted of mowing existing vegetation, followed by scarifying with a 12-inch disc pulled by a tractor (single pass). Howell Woods personnel scarified the site the day prior to planting. The condition of the top 1-2 inches of soil was dry, but below 2 inches, the soil was sufficiently moist. Scarification facilitated the planting effort; however, the extent of scarification does not appear to have increased soil or sub-soil surface complexity.

Species Distribution

Species assemblages were determined by both the topography and soils of the Site. Wehadke soil (hydric) occurs along the stream and is indicative of the frequently flooded, poorly drained Neuse River floodplains. Altavista and State loams (non-hydric) are found on escarpments and upland slopes. The boundaries of these soils largely determined the boundaries of the species assemblages, described below (and illustrated in Figure 8). An unplanted buffer of 25 feet was



MAP LEGEND

- PROJECT BOUNDARY
- WOODS
- OPEN WATER
- REFERENCE FOREST ECOSYSTEM VEGETATIVE SAMPLING PLOTS

PLANT COMMUNITIES

	acres
FLOODPLAIN BOTTOMLAND HARDWOOD	12.5±
STREAM EDGE	2.2±
MESIC UPLAND SLOPE	4.1±

MAP COMPILED BY PHOTOGRAMMETRIC METHODS.

250 0 250 500 750
SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
WETLAND RESTORATION AS-BUILT PLAN
JOHNSTON COUNTY, NORTH CAROLINA

Title:
PLANTING AREAS (2000)

Dwn By:	Date:
MAF	NOV 2002
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.15

FIGURE
8

maintained along all roads either crossed or paralleled by the planting plan. An area of approximately 2 acres was left unplanted due to the scheduled installation of structures within the Site.

Eleven tree species were planted, they are as follows (with planted quantity):

Water Oak (*Quercus nigra*)	1000
Water Tupelo (*Nyssa aquatica*)	1000
White Oak (*Quercus alba*)	500
Mockernut Hickory (*Carya tomentosa*)	400
Yellow Poplar (*Liriodendron tulipifera*)	400
Bald Cypress (*Taxodium distichum*)	1200
Sycamore (*Platanus occidentalis*)	900
Willow oak (*Quercus phellos*)	1000
Green Ash (*Fraxinus pennsylvanica*)	800
River Birch (*Betula nigra*)	500
Cherrybark Oak (*Quercus pagota*)	1900
	Total 9600

Three species-assemblages were identified to be planted throughout the approximately 20-acre Site. These assemblages include a **stream edge** group (very wet), a **floodplain** group (wet), and a **mesic upland slope** group (moderately wet). The stream edge group consists of bald cypress, river birch, and water tupelo. The flood plain group consists of water oak, willow oak, cherrybark oak, green ash, sycamore, yellow poplar, river birch, water tupelo and, bald cypress. The upland slope group includes cherrybark oak, white oak, mockernut hickory, sycamore, and yellow poplar.

2002 Planting

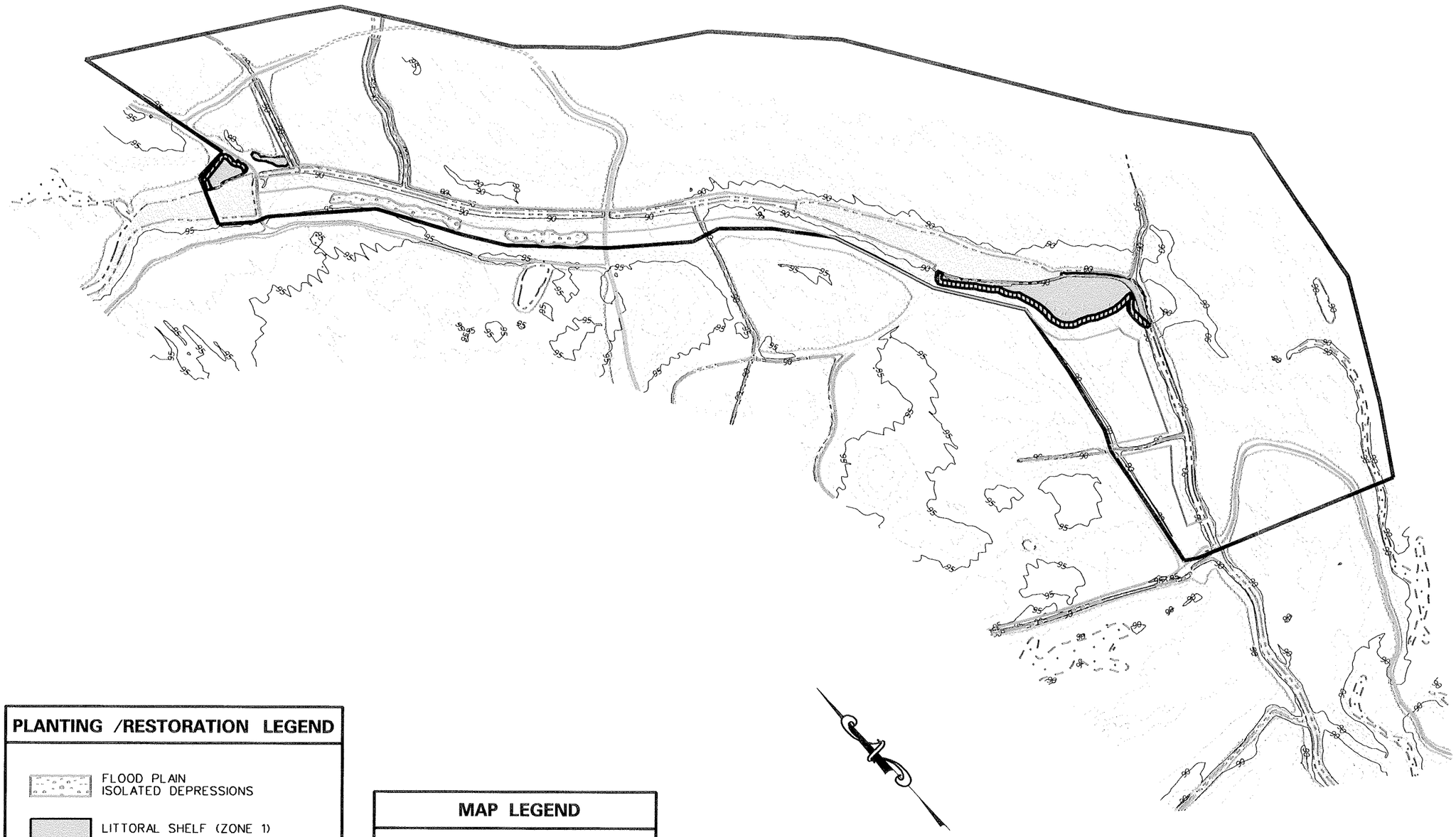
On December 11, 12, and 13, 2002, portions of the Site, which were impacted by construction activities, were re-vegetated with native, wetland-adapted tree and freshwater marsh species.

Planting Process

32,060 seedling trees and freshwater herbaceous sprigs were purchased and grouped into three primary associations based on landscape positioning for planting: 1) bottomland hardwood forest; 2) littoral shelf, zone 1; and 3) littoral shelf, zone 2 (Figure 9). Tree spacing was approximately 10 feet and freshwater herbaceous sprig spacing was approximately 4 feet.

Species Distribution

Species assemblages were determined primarily to topographic location and soils of the Site (Figure 9). Species expected for supplemental planting are listed in Table 1.



PLANTING /RESTORATION LEGEND

- FLOOD PLAIN ISOLATED DEPRESSIONS
- LITTORAL SHELF (ZONE 1)
- LITTORAL SHELF (ZONE 2)
- BOTTOMLAND HARDWOOD FOREST
- OPEN WATER

MAP COMPILED BY PHOTOGRAMMETRIC METHODS.

MAP LEGEND

- PROJECT BOUNDARY
- EXISTING ROADS
- APPROX. MINOR CONTOUR
- APPROX. MAJOR CONTOUR
- WOODS

250 0 250 500 750
SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
WETLAND RESTORATION AS-BUILT PLAN
JOHNSTON COUNTY, NORTH CAROLINA

Title:
PLANTING AREAS (2002)

Dwn By:	Date:
MAF	DEC 2002
Ckd By:	Scale:
WGL	1" = 500'

ESC Project No.: 98-047.15

FIGURE
9

Table 1
2002 Planting Plan

Common Name	Scientific name	Bottomland Hardwood Forest	Littoral Shelf Zone 1	Littoral Shelf Zone 2	Total
Area (acres)		**14.2**	**2.52**	**0.86**	**17.58**
Species		**# planted (% total)**	**# planted (% total)**	**# planted (% total)**	**# planted**
Water Oak	*(Quercus nigra)*	1000 (11)			1000
Cherrybark Oak	*(Quercus pagota)*	2000 (22)			2000
Overcup Oak	*(Quercus lyrata)*	600 (7)			600
Willow oak	*(Quercus phellos)*	800 (9)			800
Yellow Poplar	*(Liriodendron tulipifera)*	300 (3)			300
Bald Cypress	*(Taxodium distichum)*	1200 (13)			1200
Sycamore	*(Platanus occidentalis)*	700 (8)			700
Water Tupelo	*(Nyssa aquatica)*	1000 (11)			1000
Green Ash	*(Fraxinus pennsylvanica)*	1000 (11)			1000
River Birch	*(Betula nigra)*	300 (3)			300
Woolgrass	*(Scirpus cyperinus)*		8825 (37)		8825
Narrow-leaf Sagittaria	*(Sagittaria subulata)*		2146 (9)		2146
Cow Lilly	*(Nuphar lutea)*		2146 (9)		2146
Lizards Tail	*(Saururus cernuus)*		2146 (9)		2146
Duck Potato	*(Sagittaria latifolia)*		2146 (9)		2146
Water Weed	*(Elodea canadensis)*		2146 (9)		2146
Arrow Arum	*(Peltandra virginica)*		2146 (9)		2146
Pickerelweed	*(Pontederia cordata)*		2146 (9)		2146
Wax Myrtle	*(Morella cerifera)*			407 (17)	407
Buttonbush	*(Cephalanthus occidentalis)*			910 (38)	910
Fetterbush	*(Lyonia lucida)*			49 (2)	49
Inkberry	*(Ilex glabra)*			569 (24)	569
Redbay	*(Persea borbonia)*			459 (19)	459

4.0 MONITORING PLAN

The proposed Monitoring Plan is expected to consist of a comparison between hydrology model predictions, regulatory wetland criteria, and supplemented by data from on-site reference wetlands. The monitoring plan is conceptually depicted in Figure 10. Wetland monitoring will entail analysis of two primary parameters: vegetation and hydrology. Monitoring of restoration and enhancement efforts will be performed until success criteria are fulfilled.

4.1 Hydrology Monitoring

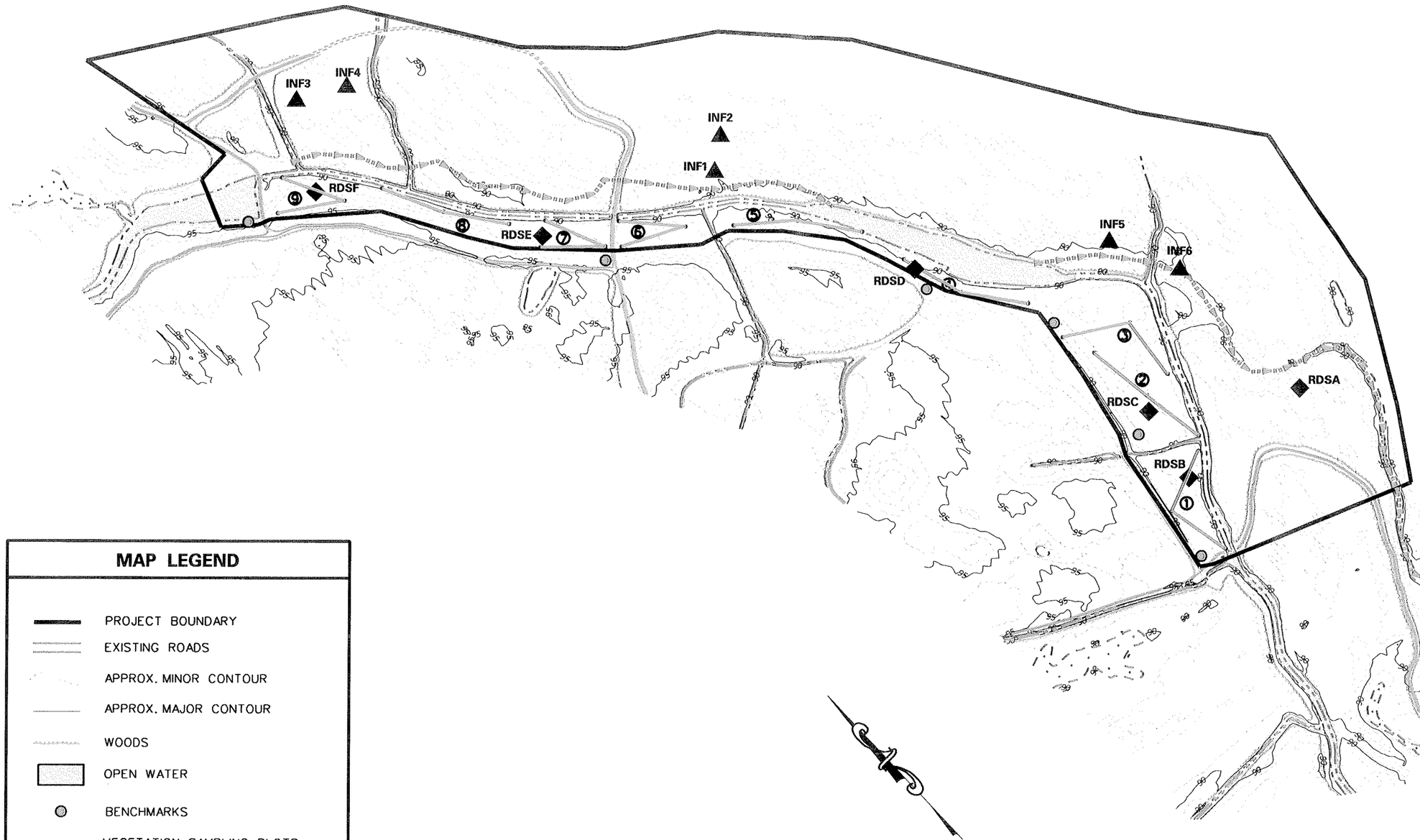
Currently, 12 continuously recording groundwater gauges occur within the Site (Figure 10). Two additional reference groundwater gauges have been installed approximately 0.25 mile upstream from the Site. The groundwater gauges have been installed in accordance with specifications in U.S. Army Corps of Engineers' (COE), Installing Monitoring Wells/Piezometers in Wetlands (WRP Technical Note HY-IA-3.1, August 1993). Monitoring gauges were set to a predetermined depth of approximately 40 inches below the soil surface in order to obtain a more accurate depiction of perching across low permeability, subsurface (B horizon) soil layers. Since the 1999 installation date, the gauges have been downloaded monthly in order to describe pre-construction hydrology conditions. Previous groundwater gauge data, including gauge locations and graphical depictions of groundwater elevations, are included in Appendix A. Hydrological sampling will be performed on-site and within reference areas throughout the year to compare pre- and post-construction conditions.

4.2 Wetland Vegetation Monitoring

Restoration monitoring procedures for vegetation are designed in accordance with U.S. Environmental Protection Agency (EPA) guidelines enumerated in Mitigation Site Type (MiST) documentation (EPA 1990) and COE Compensatory Hardwood Mitigation Guidelines (DOA 1993). A general discussion of the restoration-monitoring program is provided.

In the fall of 2001, vegetation monitoring plots were established and sampled within the 20-acre Site. The sample plots were randomly placed within the planted areas. Sample plots were correlated with hydrological monitoring locations to provide point-related data on hydrological and vegetation parameters. In each sample plot, vegetation parameters were monitored including species composition and species density. Visual observations of percent cover of shrub and herbaceous species were also recorded. Subsequently, quantitative sampling of vegetation will be performed between September 1 and October 30 after each growing season until the vegetation success criteria is achieved.

Each sample plot is composed of two 300-foot transects extending from a central point. Plot width along the transects extend 4 feet on each side of the central line, providing a 0.11-acre plot sample (600 feet x 8 feet). The total area sampled thus comprises 0.99 acre, approximately 5.5 percent of the total planted area. The center and end points of each plot are permanently established with labeled, white, polyvinyl chloride (PVC) pipes.



MAP LEGEND

- PROJECT BOUNDARY
- EXISTING ROADS
- APPROX. MINOR CONTOUR
- APPROX. MAJOR CONTOUR
- WOODS
- OPEN WATER
- BENCHMARKS
- VEGETATION SAMPLING PLOTS (MONITORING TRANSECTS)
- INFINITY GROUNDWATER GAUGES
- REMOTE DATA SYSTEMS GROUNDWATER MONITORING GAUGES
- FLOOD PLAIN SLOUGH

MAP COMPILED BY PHOTOGRAMMETRIC METHODS.

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
WETLAND RESTORATION AS-BUILT PLAN
JOHNSTON COUNTY, NORTH CAROLINA

Title:
MONITORING PLAN

Dwn By:	Date:
MAF	DEC 2002
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.15

FIGURE
10

5.0 SUCCESS CRITERIA

5.1 Vegetation Success Criteria

Success criteria are dependent upon density and growth of "Character Tree Species." Characteristic species include planted elements along with natural recruitment of tree species with a wetland status (FAC or wetter) and/or species identified in reference ecosystems. All canopy tree species planted and identified in the reference wetland will be utilized to define "Character Tree Species" as termed in the success criteria.

An average density of 320 stems-per-acre of Character Tree Species must be surviving in the first three monitoring years. Subsequently, 290 character tree species-per-acre must be surviving in year 4, and 260 character tree species-per-acre in year 5. Planted species must represent a minimum of 30 percent of the required stem per acre total (96 stems/acre). At least five characteristic tree species must be present, and no species can comprise more than 20 percent of the stem total.

If vegetation success criteria are not achieved based on average density calculations from combined plots over the entire restoration area, supplemental planting will be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

No quantitative sampling requirements are proposed for herb and shrub assemblages. Development of a forest canopy over several decades and restoration of wetland hydrology will dictate success in migration and establishment of desired wetland understory and groundcover populations.

5.2 Hydrology Success Criteria

Target hydrological characteristics include a minimum regulatory wetland hydrology criteria, based upon reference groundwater modeling. Evaluation of success criteria will also be supplemented by groundwater gauge data and comparison between on-site restoration areas and reference wetlands.

Regulatory Criteria

Target hydrological characteristics during years with average rainfall include saturation or inundation (free water) within one foot of the soil surface for at least 12.5 percent of the growing season. This hydroperiod translates to saturation for a minimum, 28-day consecutive period during the growing season, extending from March 21 through November 4 (USDA 1994). Upper landscape reaches and hummocks within wetland areas may exhibit surface saturation/inundation between 5 percent and 12.5 percent of the growing season. These 5 to 12.5 percent areas are expected to support hydrophytic vegetation within hydric soils. If wetland parameters are marginal as indicated by vegetation and hydrology monitoring, consultation with COE personnel will be undertaken to determine jurisdictional extent in these areas.

Reference Criteria

Alternatively, hydrology success criteria may be established through groundwater gauge data from a reference wetland. Two groundwater gauges have been installed upstream from the Site which are not impacted by ditching and dredging activities. Comparison of on-site groundwater gauges to reference groundwater gauges should target hydrologic success beyond the scope of regulatory criteria.

6.0 CONTINGENCY

In the event that vegetation or hydrology success criteria are not fulfilled, a mechanism for contingency will be implemented. For vegetation contingency, replanting and extended monitoring periods will be implemented if community restoration does not fulfill minimum species density and distribution requirements.

Hydrological contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology restoration is not achieved. Wetland surface modification, including construction of ephemeral pools, represents a likely mechanism to increase the floodplain area that supports jurisdictional wetlands. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until the Hydrology Success Criteria are achieved.

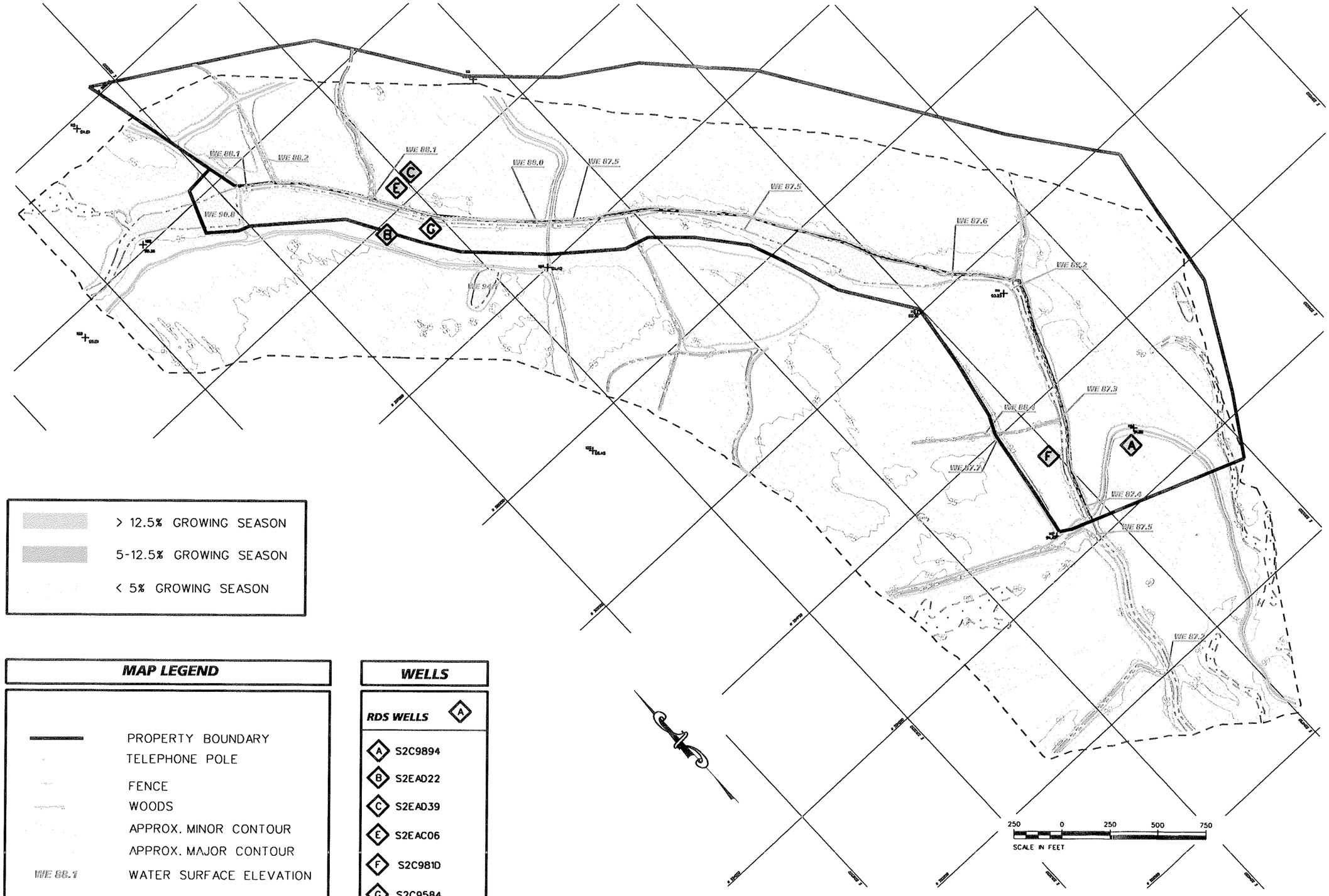
7.0 REFERENCES

Department of the Army (DOA). 1993 (unpublished). Corps of Engineers Wilmington District. Compensatory Hardwood Mitigation Guidelines (12/8/93).

United States Department of Agriculture (USDA). 1994. Soil Survey of Johnston County, North Carolina. Natural Resource Conservation Service.

United States Geological Survey (USGS). 1974. Hydrologic Unit Map - 1974. State of North Carolina.

Appendix A
(Historic Well Data)



	> 12.5% GROWING SEASON
	5-12.5% GROWING SEASON
	< 5% GROWING SEASON

MAP LEGEND

	PROPERTY BOUNDARY
	TELEPHONE POLE
	FENCE
	WOODS
	APPROX. MINOR CONTOUR
	APPROX. MAJOR CONTOUR
WE 88.1	WATER SURFACE ELEVATION

WELLS

RDS WELLS (A)

A	S2C9894
B	S2EAD22
C	S2EAD39
E	S2EAC06
F	S2C981D
G	S2C9584

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
JOHNSTON COUNTY, NORTH CAROLINA

Title:
WELL LOCATIONS (1999)

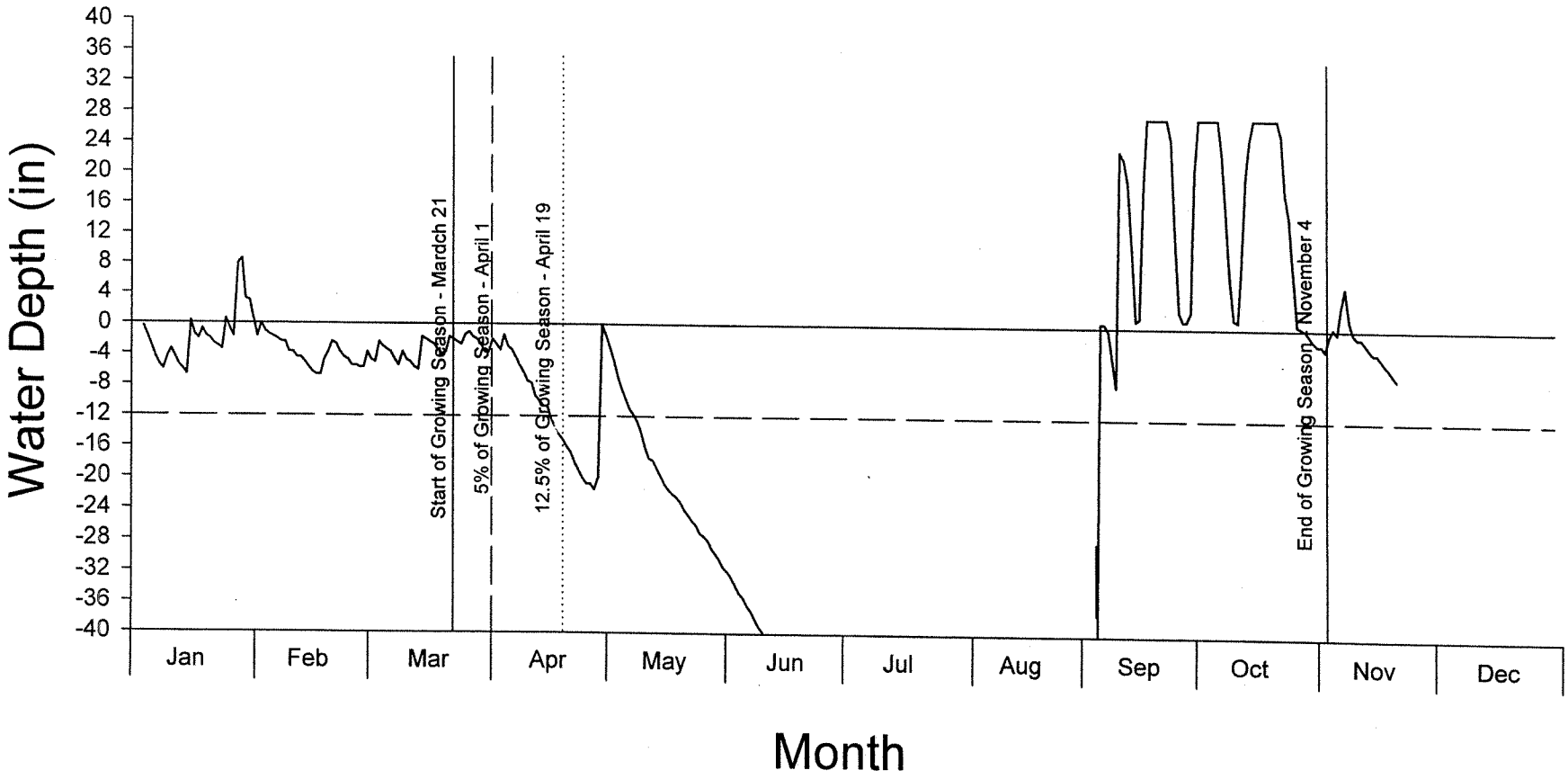
Dwn By: MAF	Date: OCT 2001
Ckd By: WGL	Scale: 1"= 500'

ESC Project No.: 98-047.13

FIGURE
A

Howell Woods Wells 1999

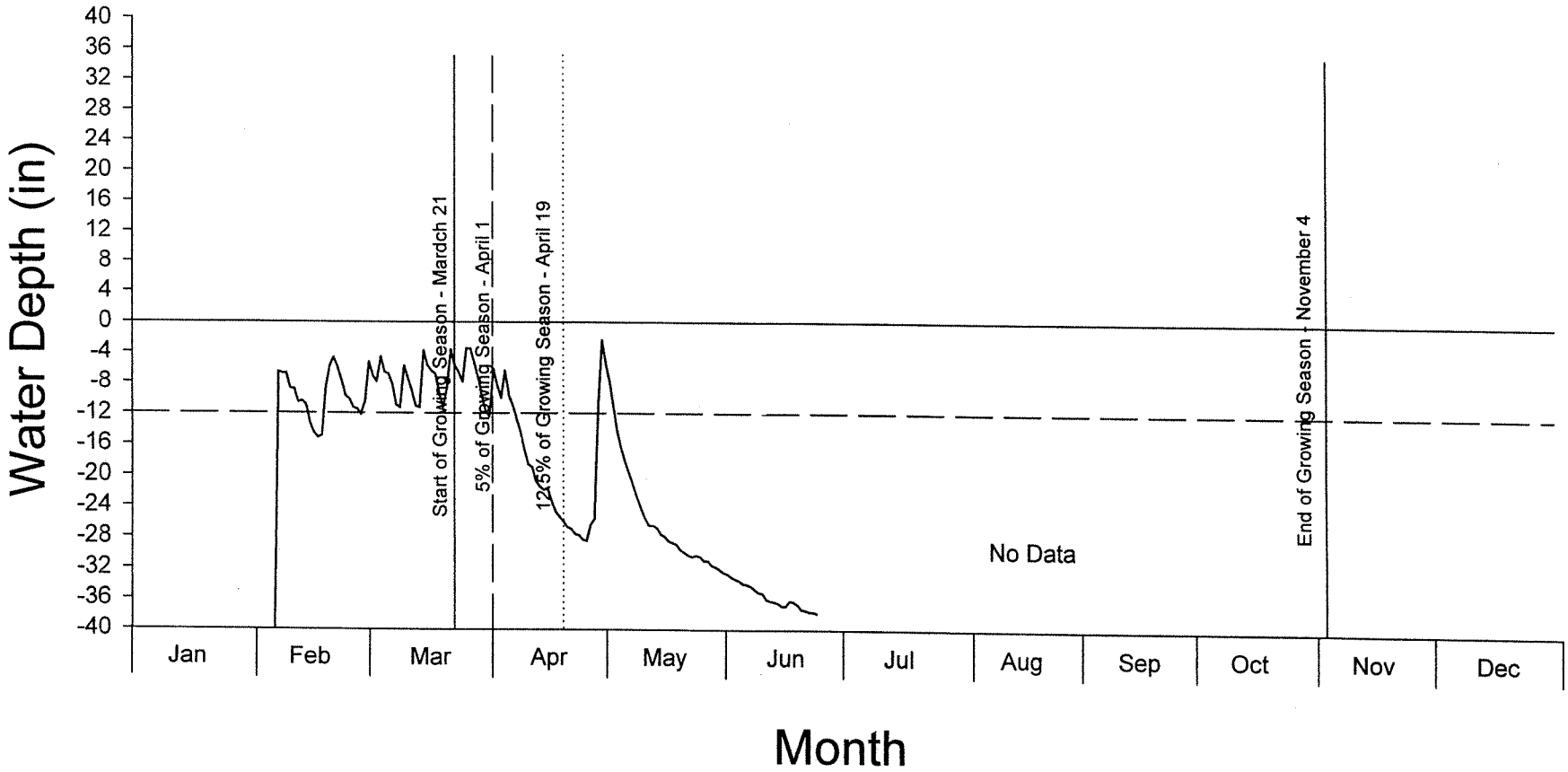
RDS Well - A



* Breaks indicate out of range

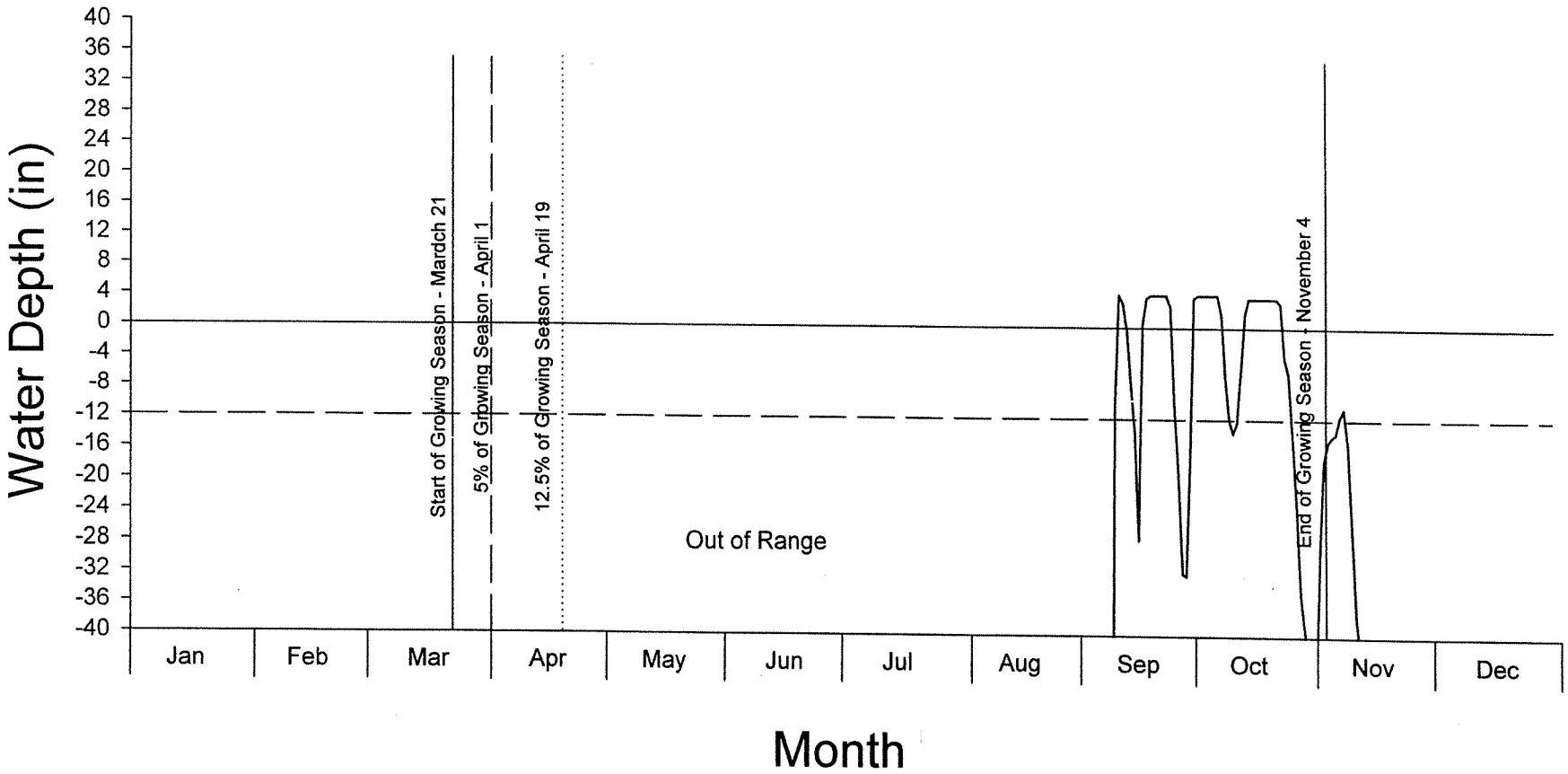
Howell Woods Wells 1999

RDS Well - B



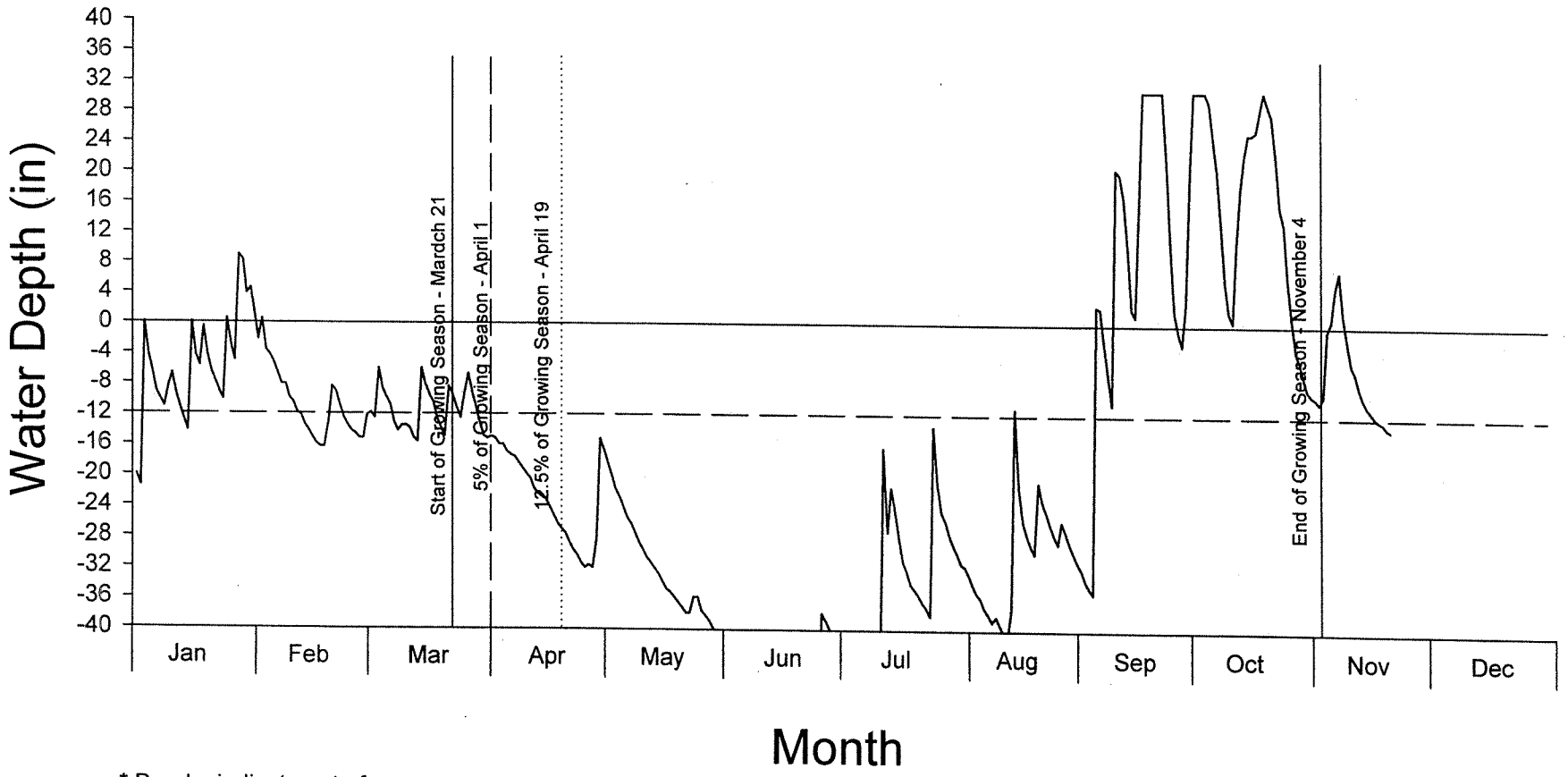
Howell Woods Wells 1999

RDS Well - C



Howell Woods Wells 1999

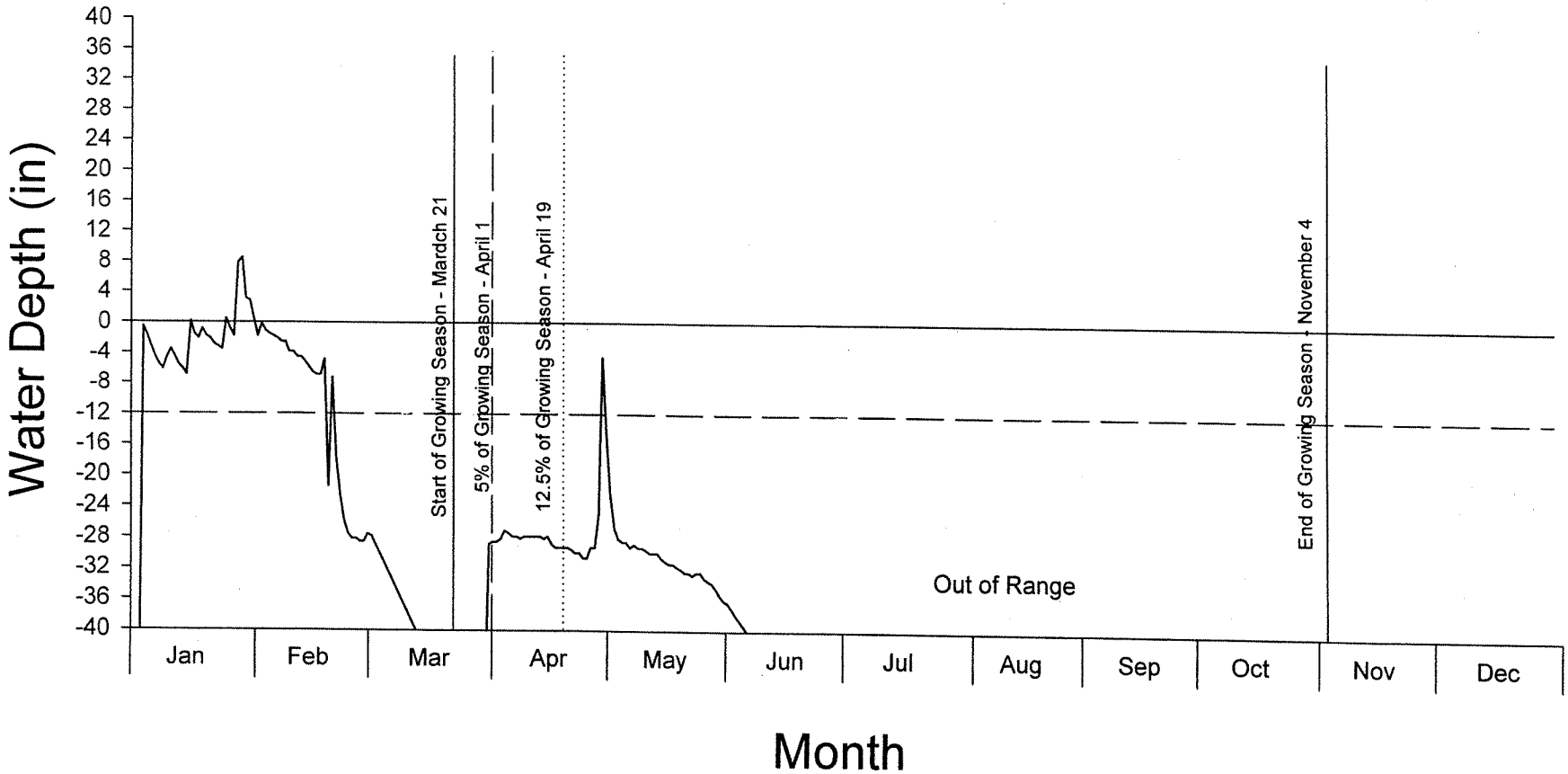
RDS Well - F



* Breaks indicate out of range

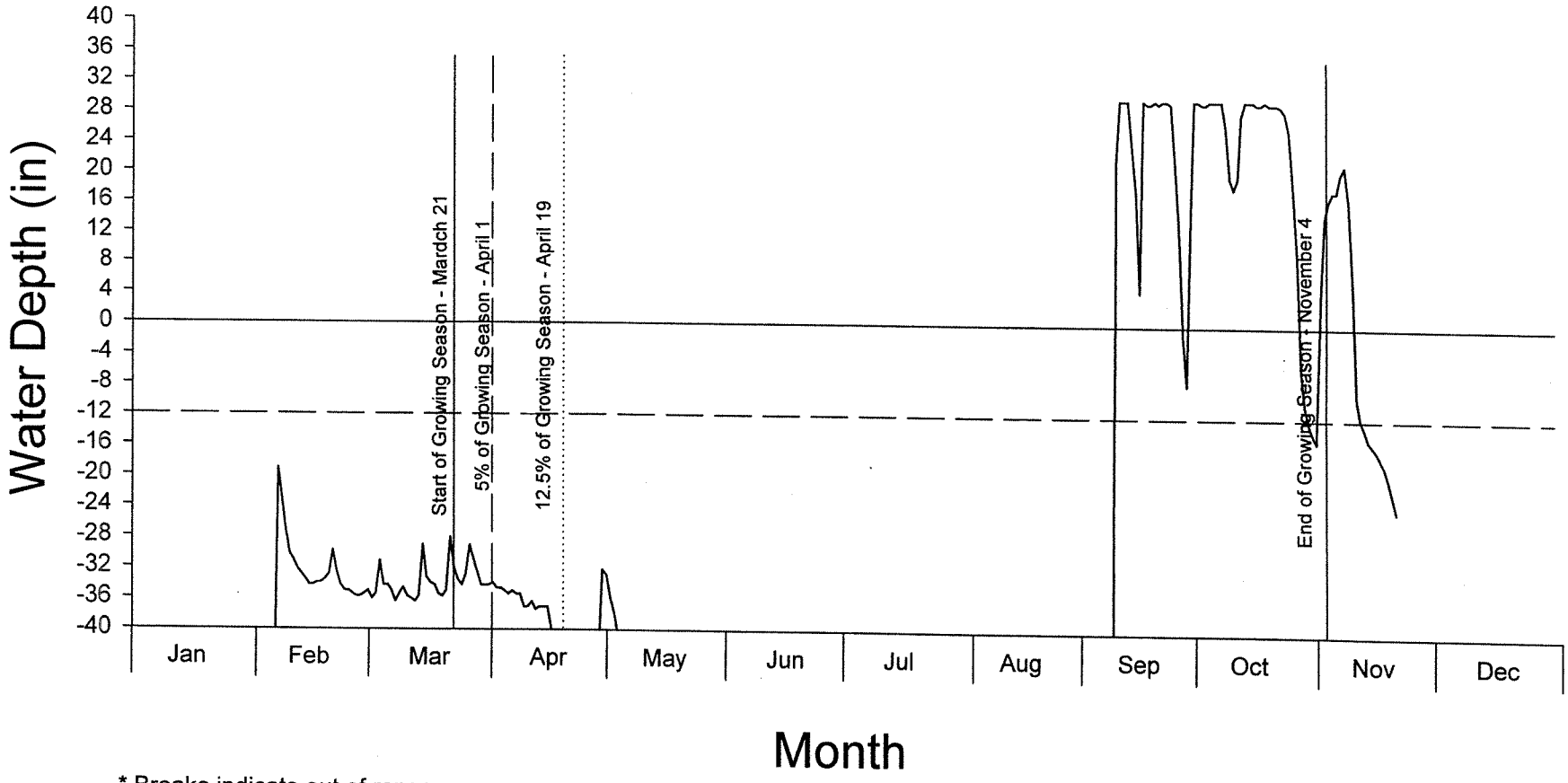
Howell Woods Wells 1999

RDS Well - G



Howell Woods Wells 1999

RDS Well - E



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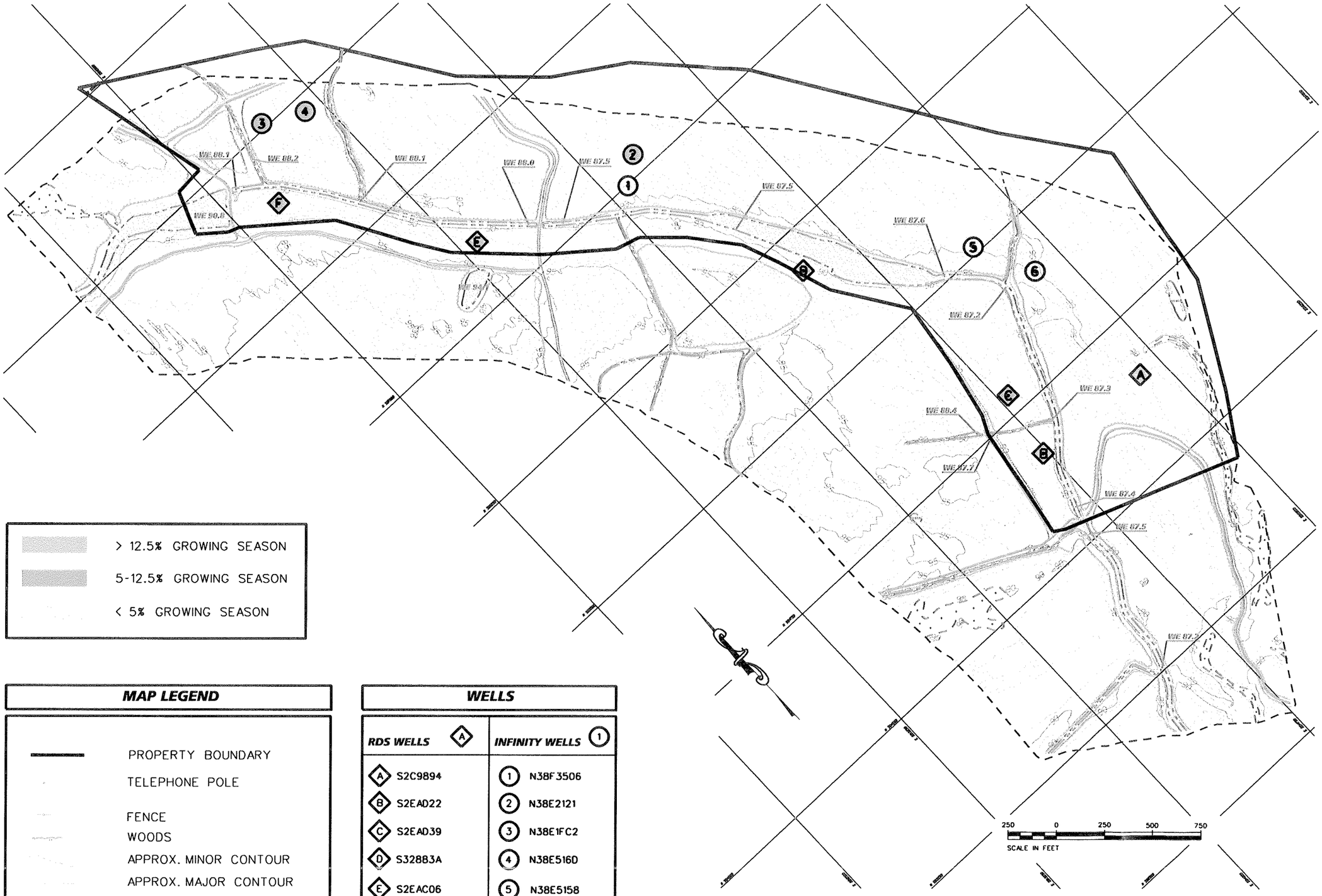

	> 12.5% GROWING SEASON
	5-12.5% GROWING SEASON
	< 5% GROWING SEASON

MAP LEGEND

	PROPERTY BOUNDARY
	TELEPHONE POLE
	FENCE
	WOODS
	APPROX. MINOR CONTOUR
	APPROX. MAJOR CONTOUR
WE 88.1	WATER SURFACE ELEVATION

WELLS

RDS WELLS		INFINITY WELLS	
A	S2C9894	1	N38F3506
B	S2EAD22	2	N38E2121
C	S2EAD39	3	N38E1FC2
D	S32883A	4	N38E516D
E	S2EAC06	5	N38E5158
F	S2C981D	6	N38E4C8E

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

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Title:
WELL LOCATIONS (2000)

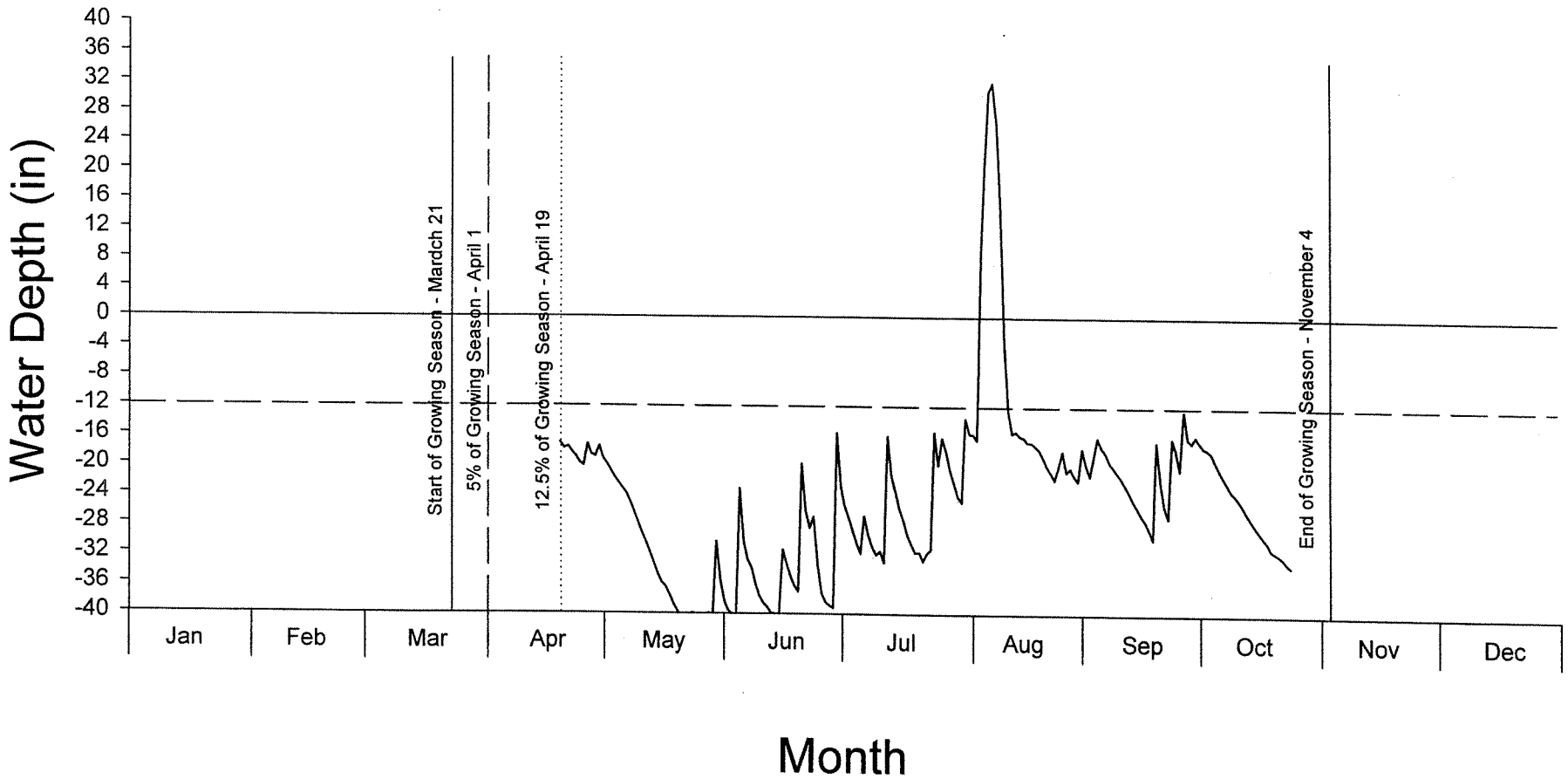
Dwn By:	Date:
MAF	OCT 2001
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.13

FIGURE
B

Howell Woods Wells 2000

Infinity Well - 1

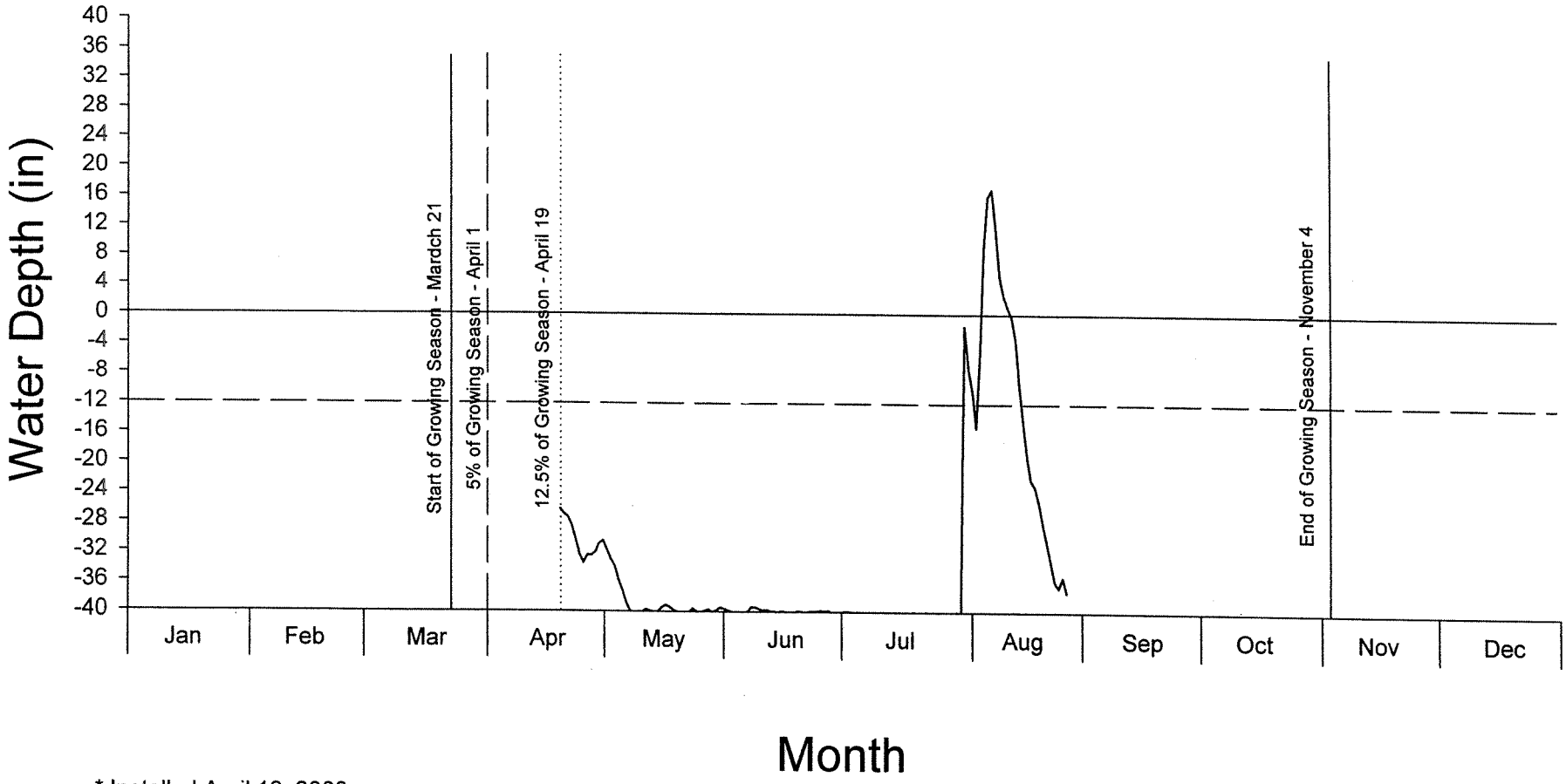


* Installed April 19, 2000

* Breaks indicate out of range

Howell Woods Wells 2000

Infinity Well - 2

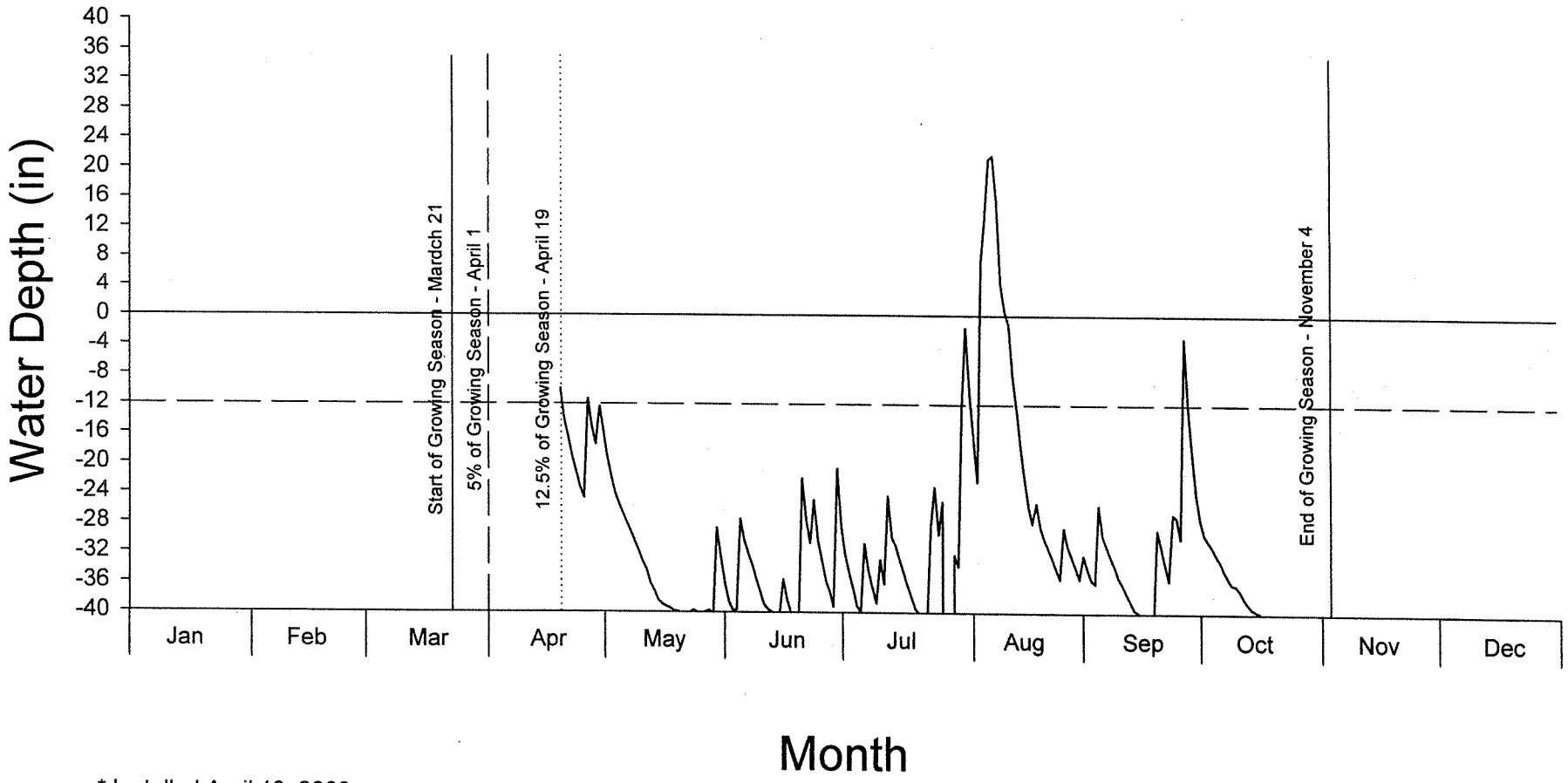


* Installed April 19, 2000

* Breaks indicate out of range

Howell Woods Wells 2000

Infinity Well - 3

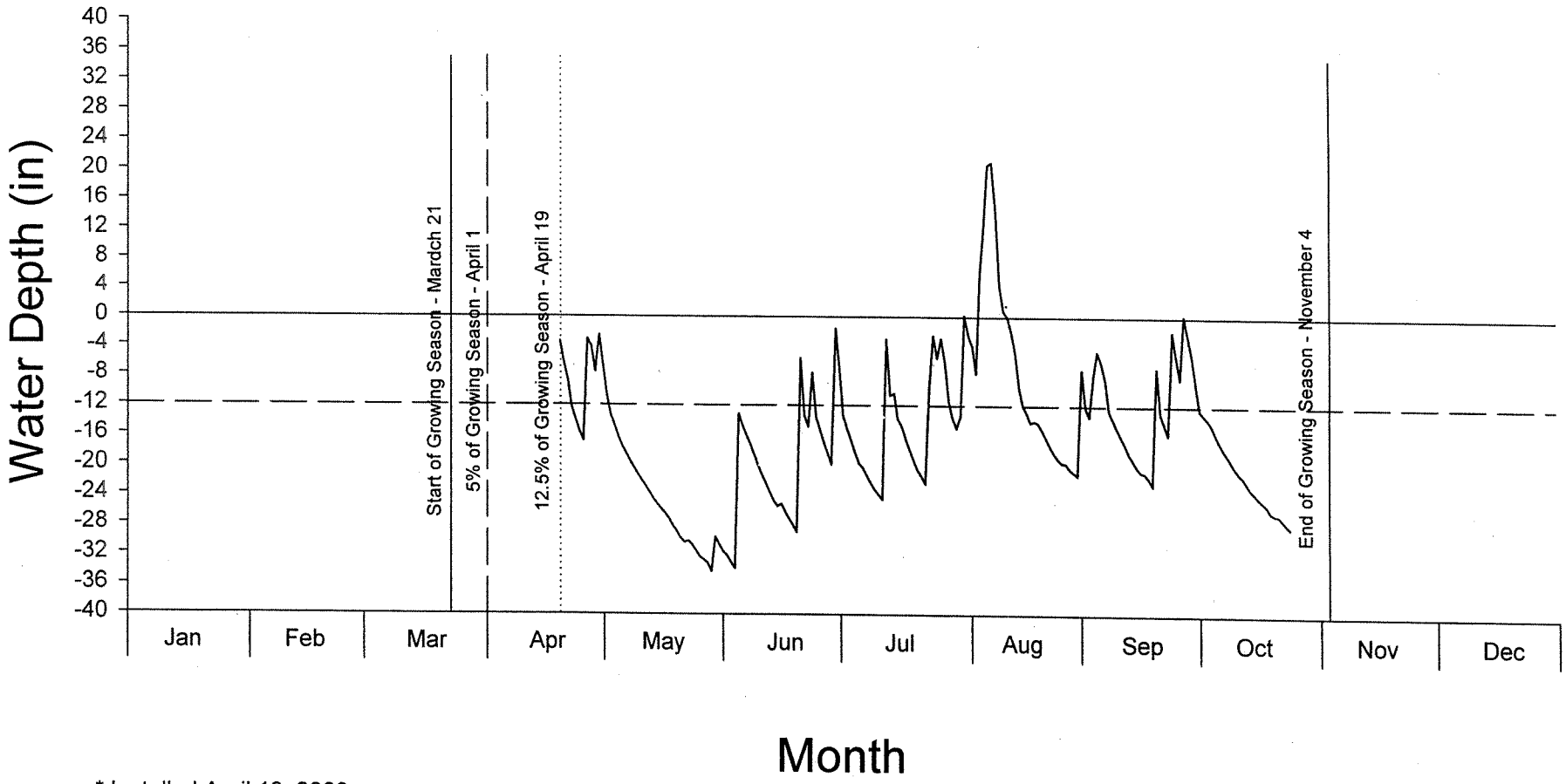


* Installed April 19, 2000

* Breaks indicate out of range

Howell Woods Wells 2000

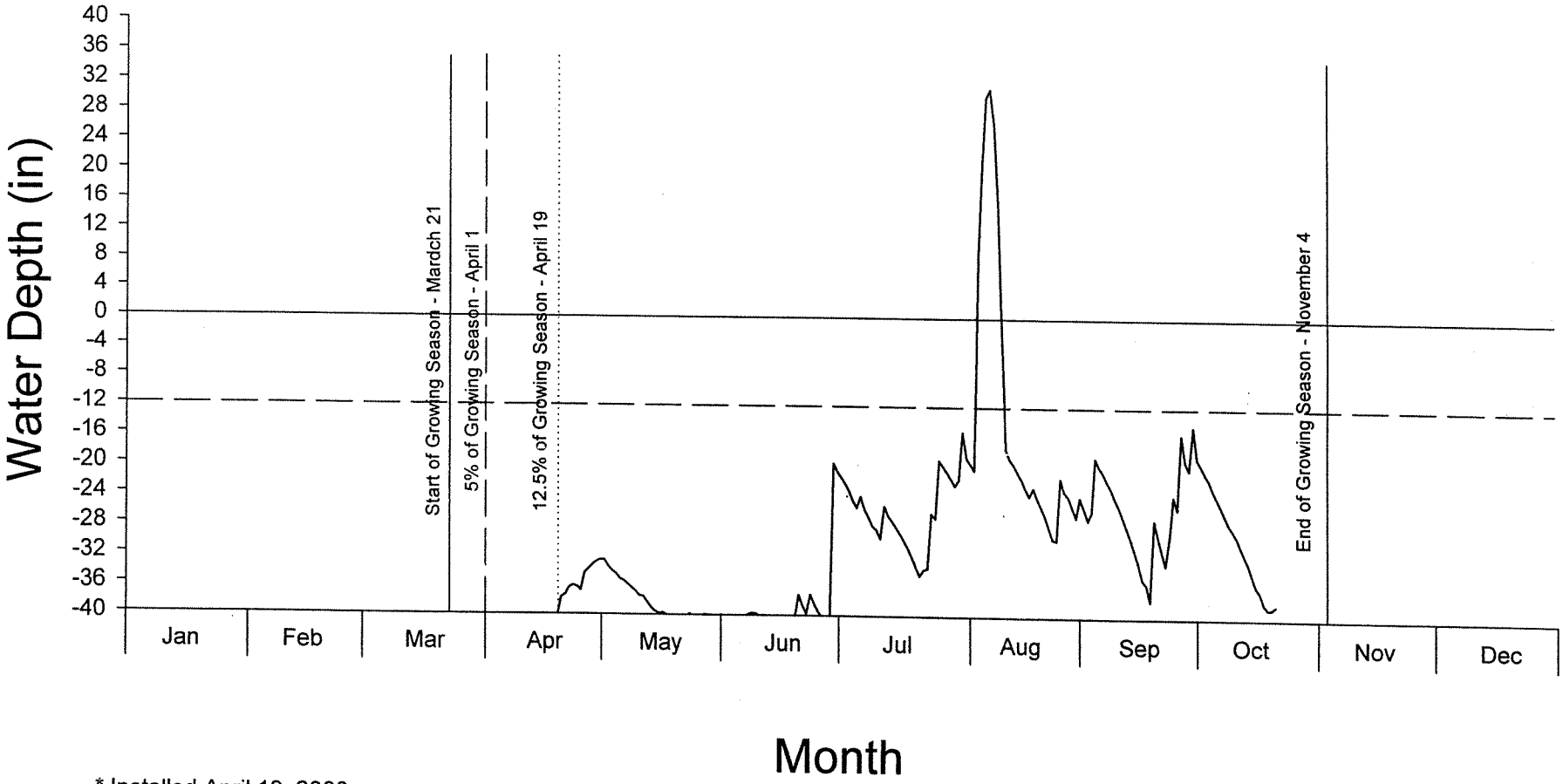
Infinity Well - 4



* Installed April 19, 2000

Howell Woods Wells 2000

Infinity Well - 5

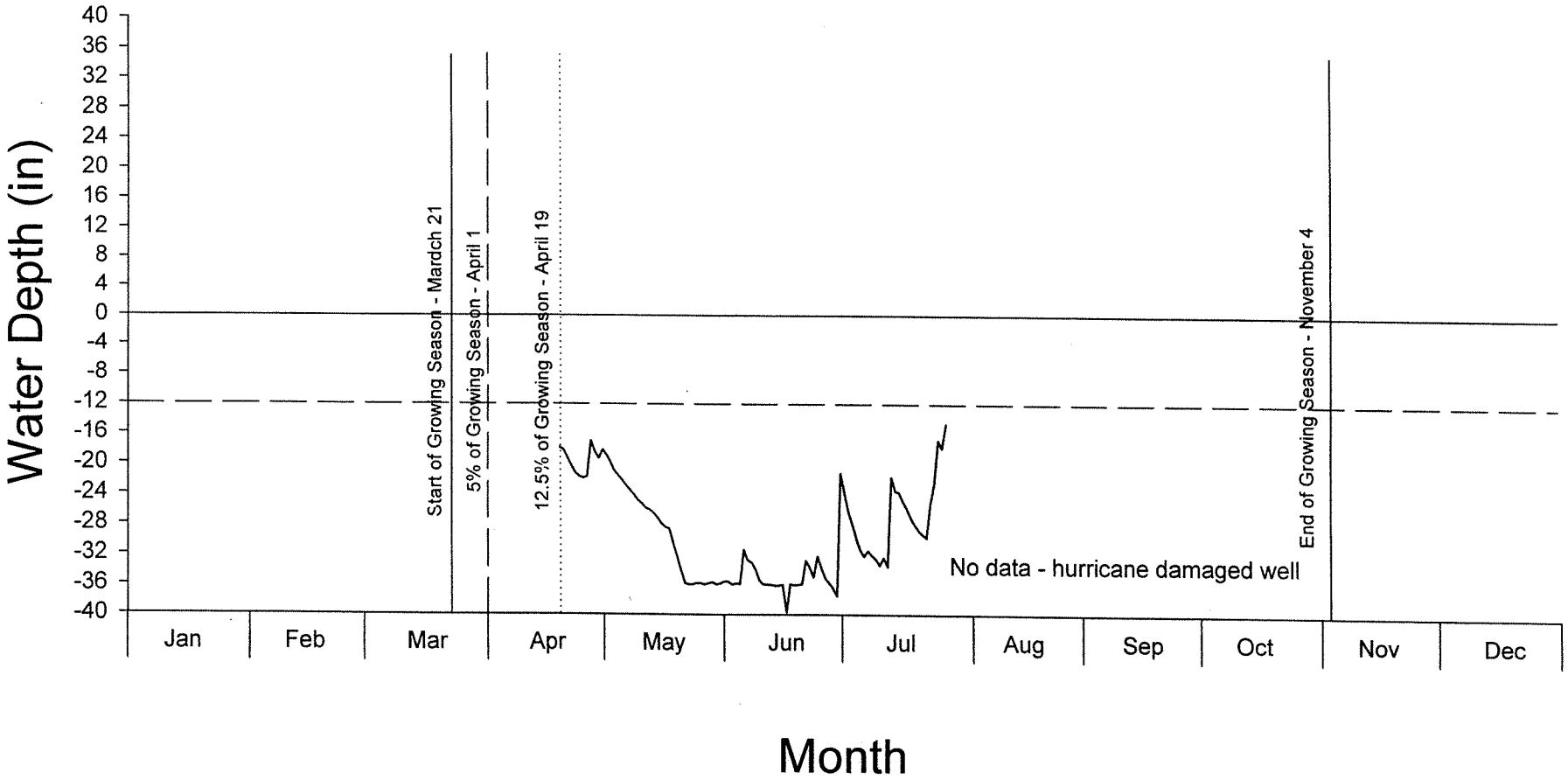


* Installed April 19, 2000

* Breaks indicate out of range

Howell Woods Wells 2000

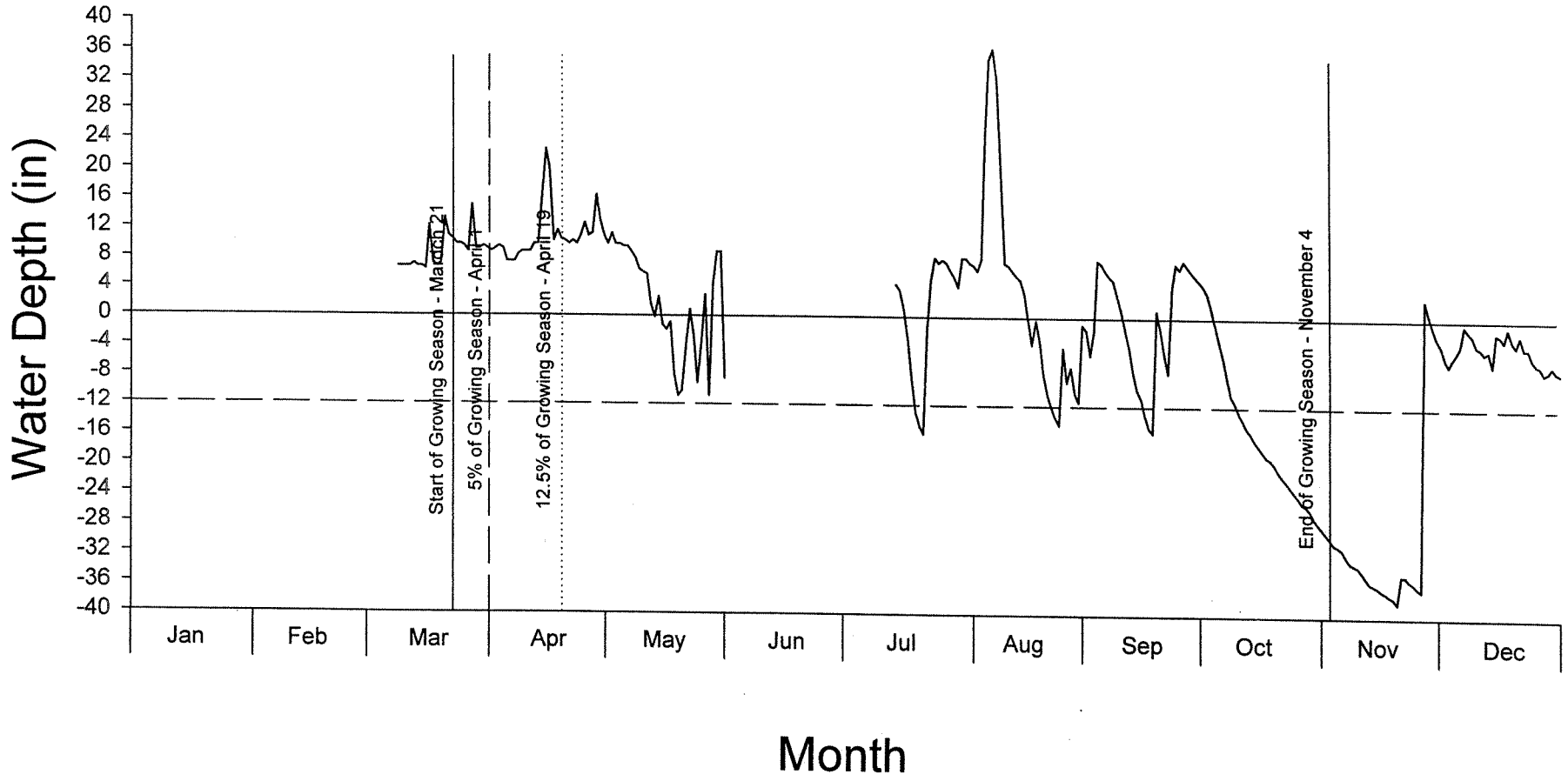
Infinity Well - 6



* Installed April 19, 2000

Howell Woods Wells 2000

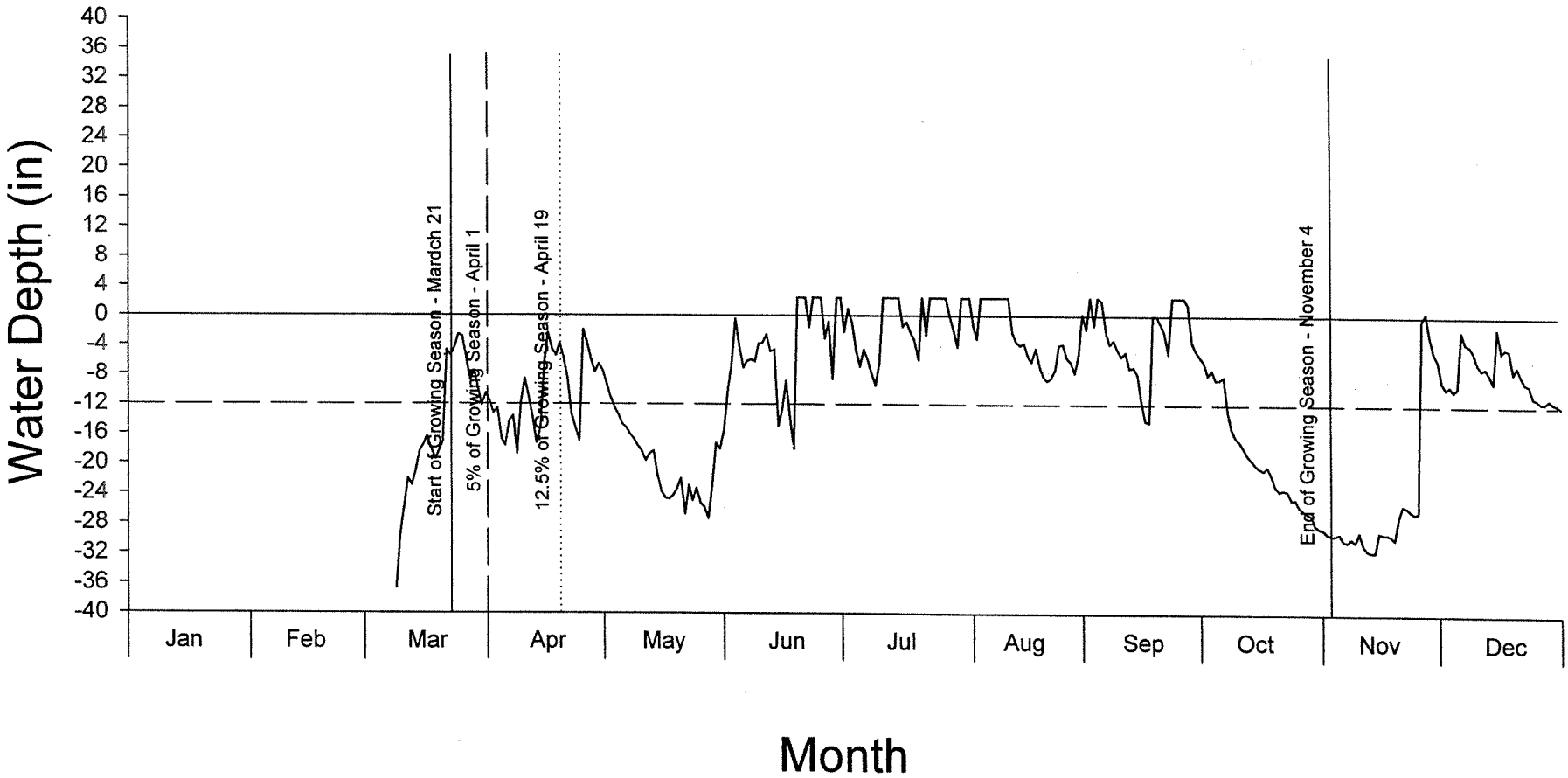
RDS - Well A



* Breaks indicate missing data

Howell Woods Wells 2000

RDS - Well B



Howell Woods Wells 2000

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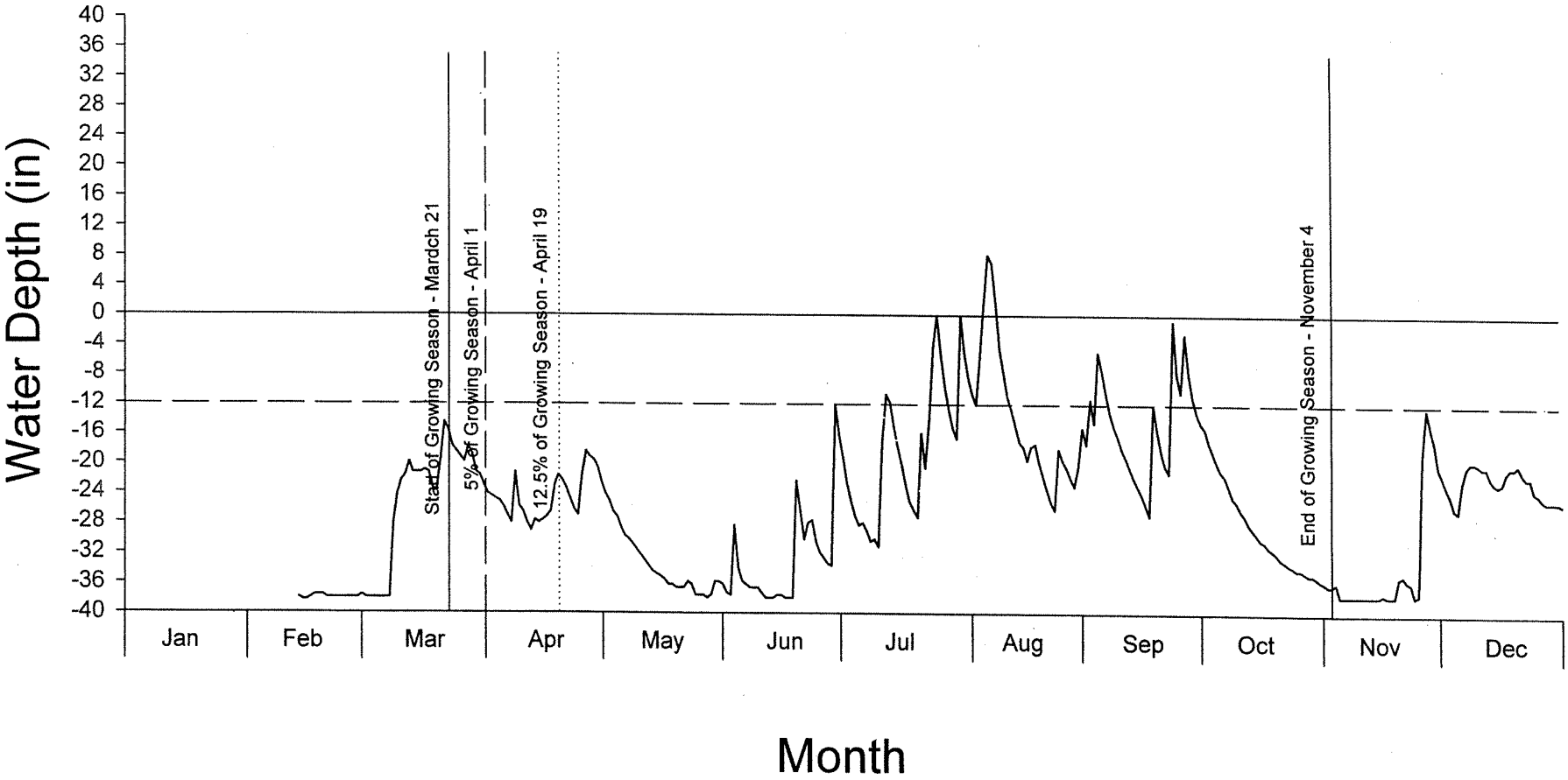
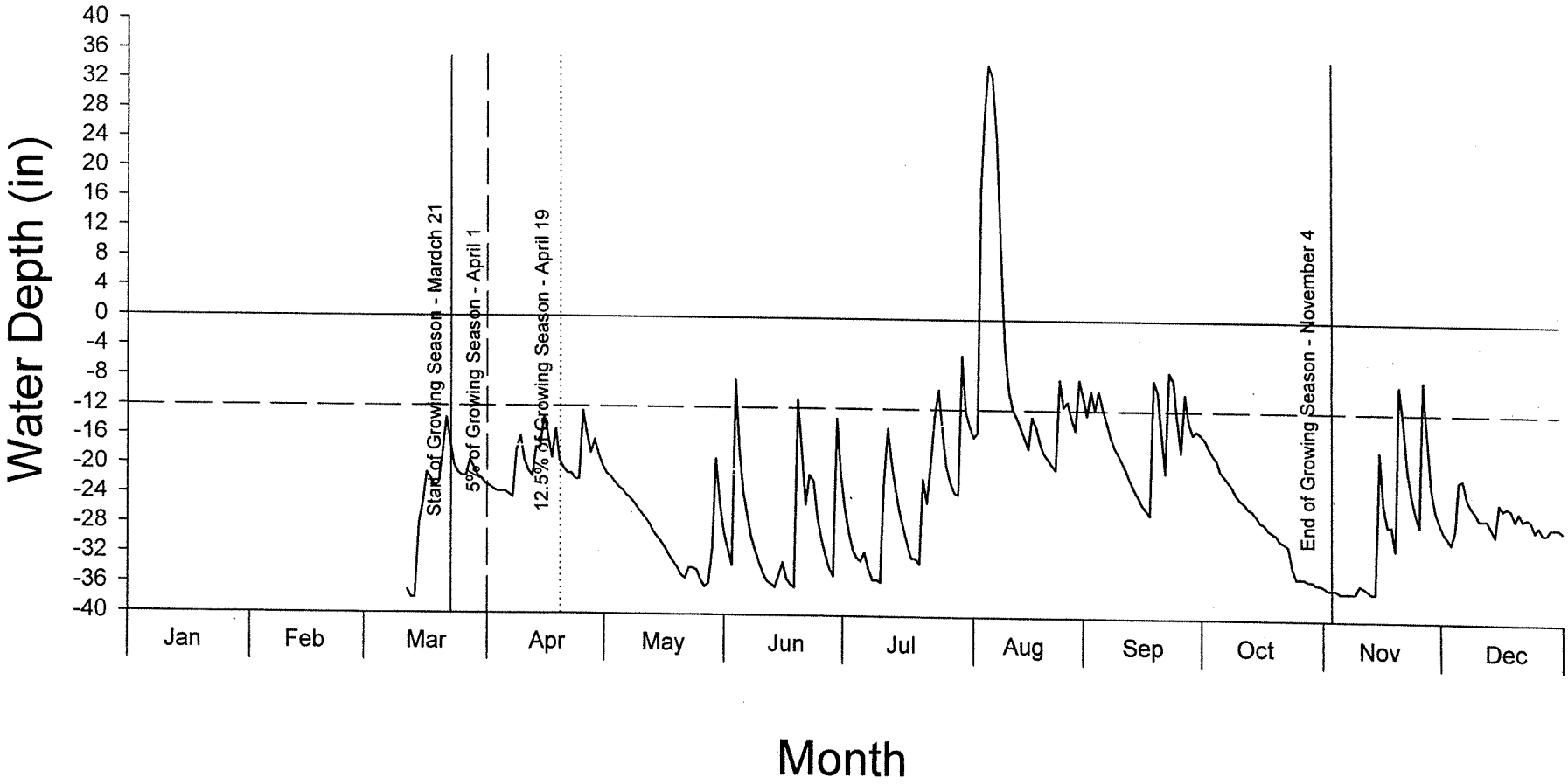


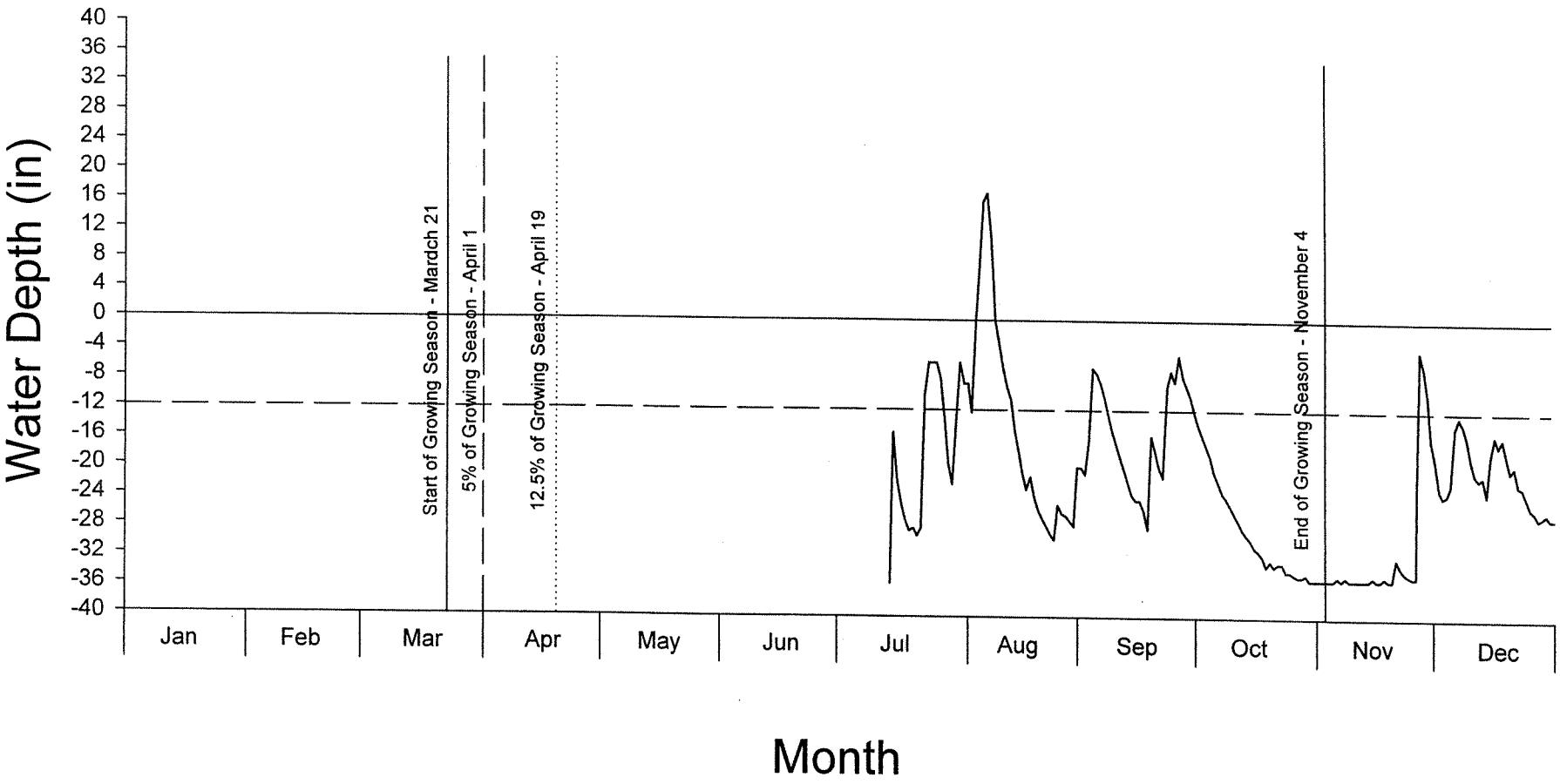
Howell Woods Wells 2000

RDS - Well D



Howell Woods Wells 2000

RDS - Well E



* Re-installed July 14th, 2000

Howell Woods Wells 2000

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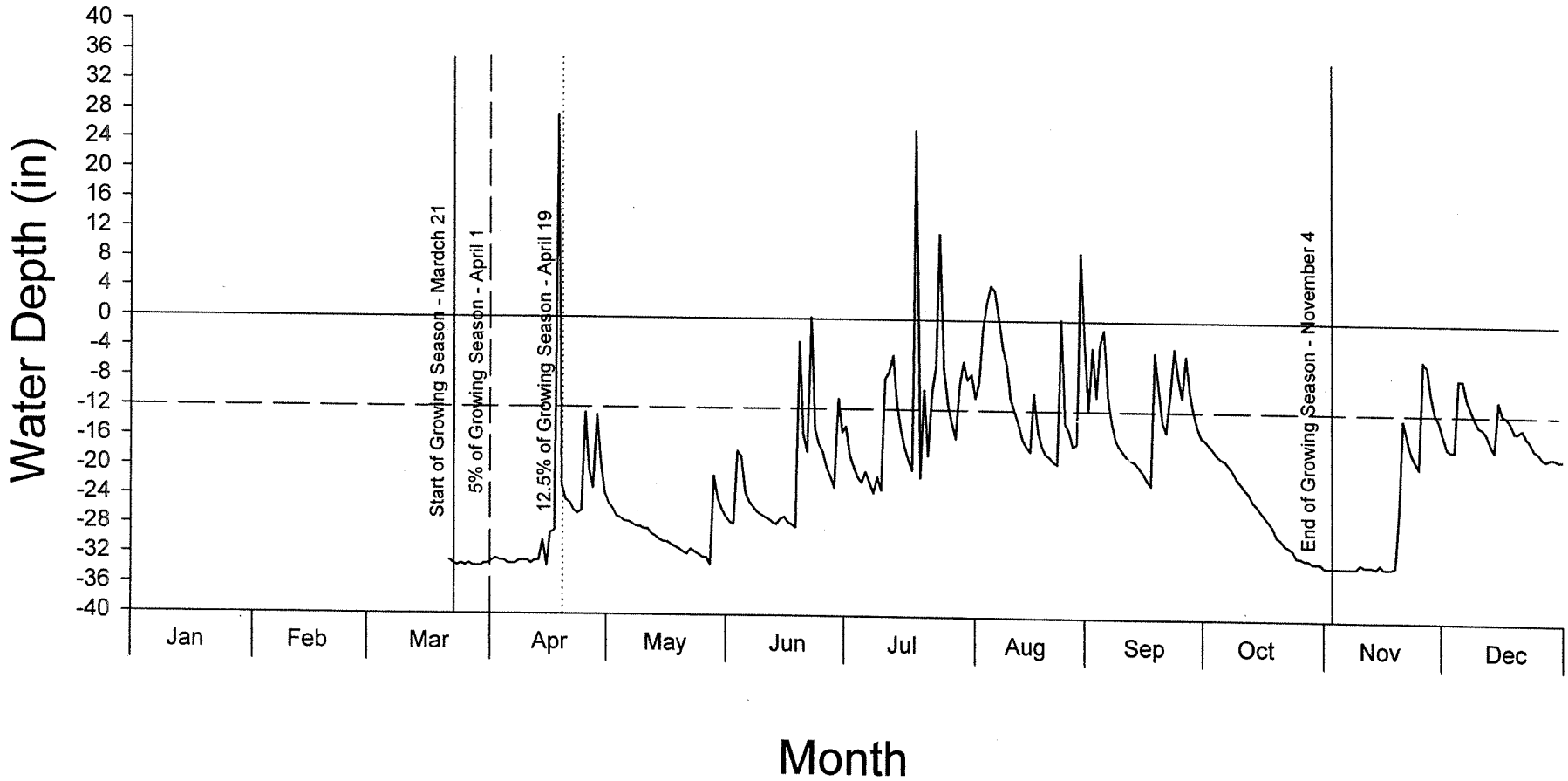
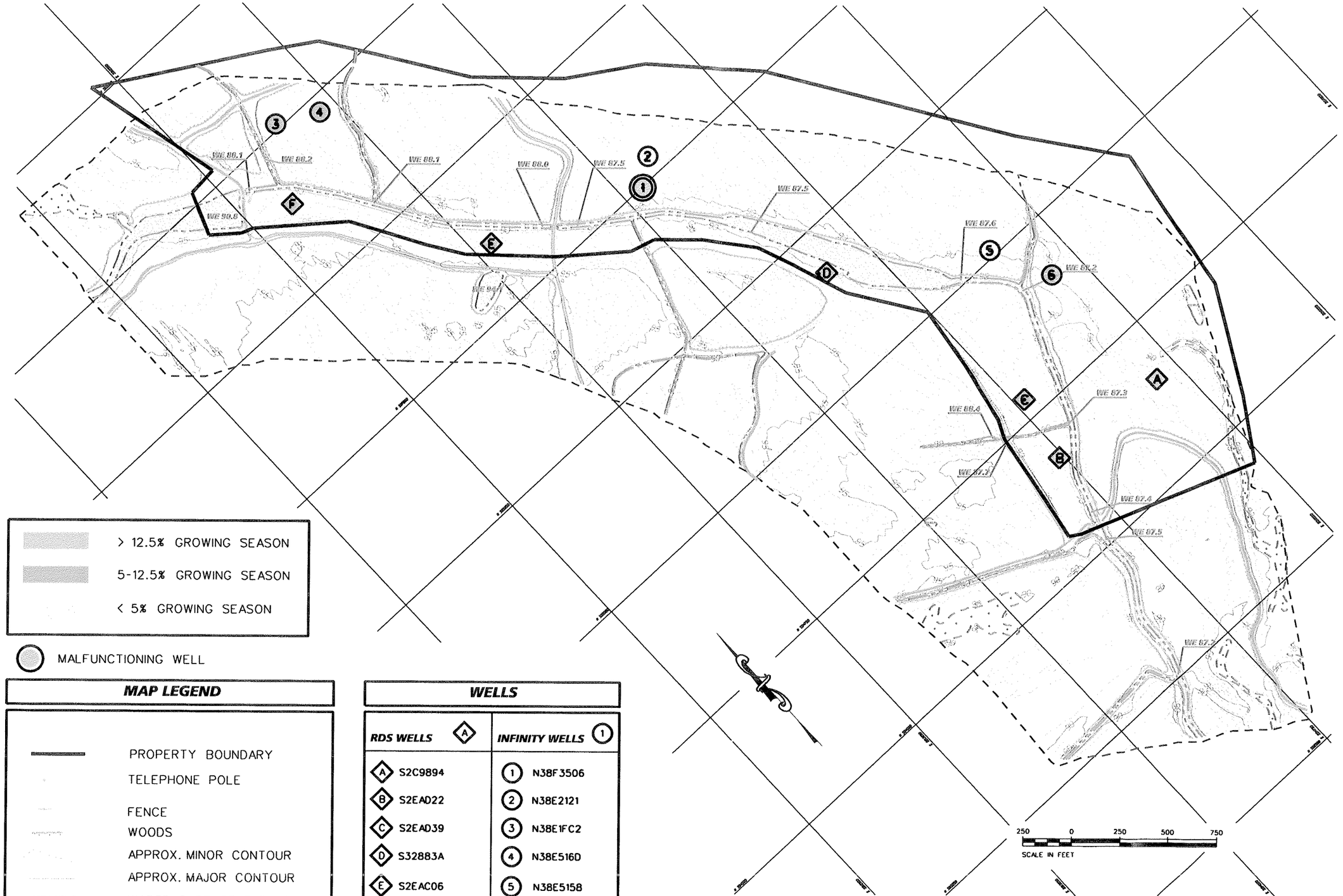




> 12.5% GROWING SEASON

5-12.5% GROWING SEASON

< 5% GROWING SEASON

MALFUNCTIONING WELL

MAP LEGEND

- PROPERTY BOUNDARY
- TELEPHONE POLE
- FENCE
- WOODS
- APPROX. MINOR CONTOUR
- APPROX. MAJOR CONTOUR
- WE 88.1 WATER SURFACE ELEVATION

WELLS

RDS WELLS		INFINITY WELLS	
A	S2C9894	1	N38F3506
B	S2EAD22	2	N38E2121
C	S2EAD39	3	N38E1FC2
D	S32883A	4	N38E516D
E	S2EAC06	5	N38E5158
F	S2C981D	6	N38E4C8E

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
JOHNSTON COUNTY, NORTH CAROLINA

Title:
WELL LOCATIONS (2001)

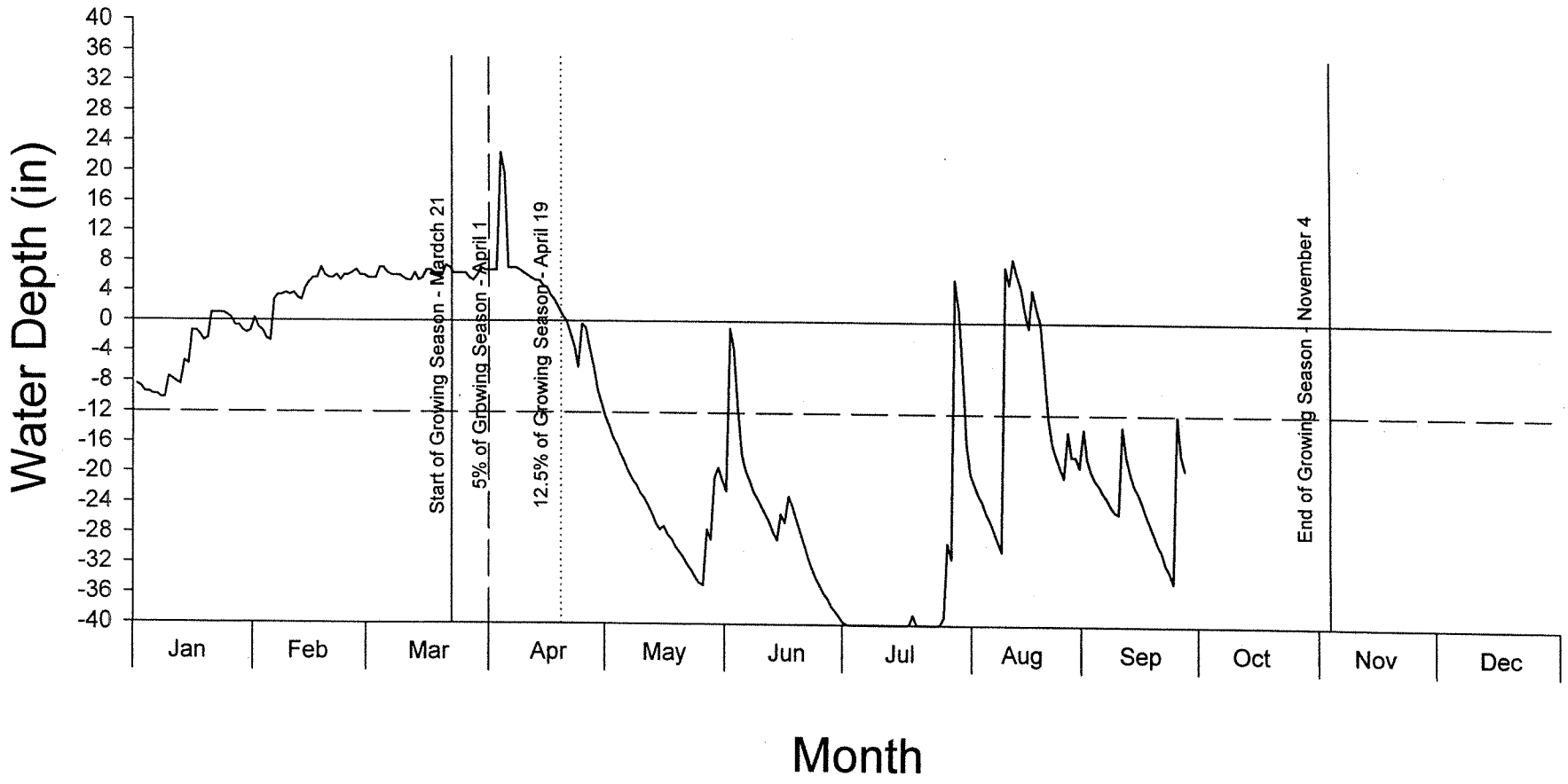
Dwn By:	Date:
MAF	OCT 2001
Ckd By:	Scale:
WGL	1" = 500'

ESC Project No.: 98-047.13

FIGURE
C

Howell Woods Wells 2001

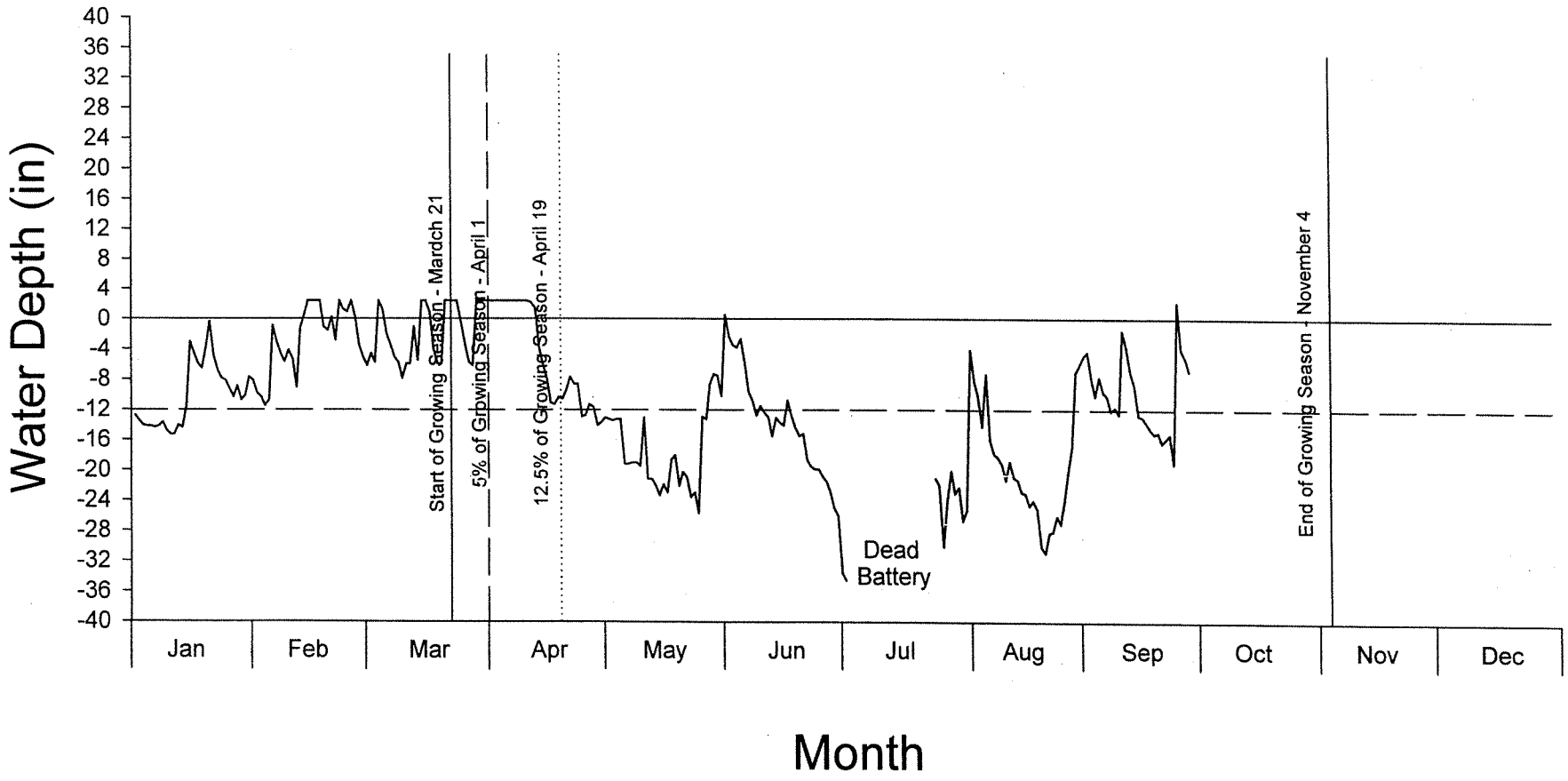
RDS - Well A



* Breaks indicate out of range

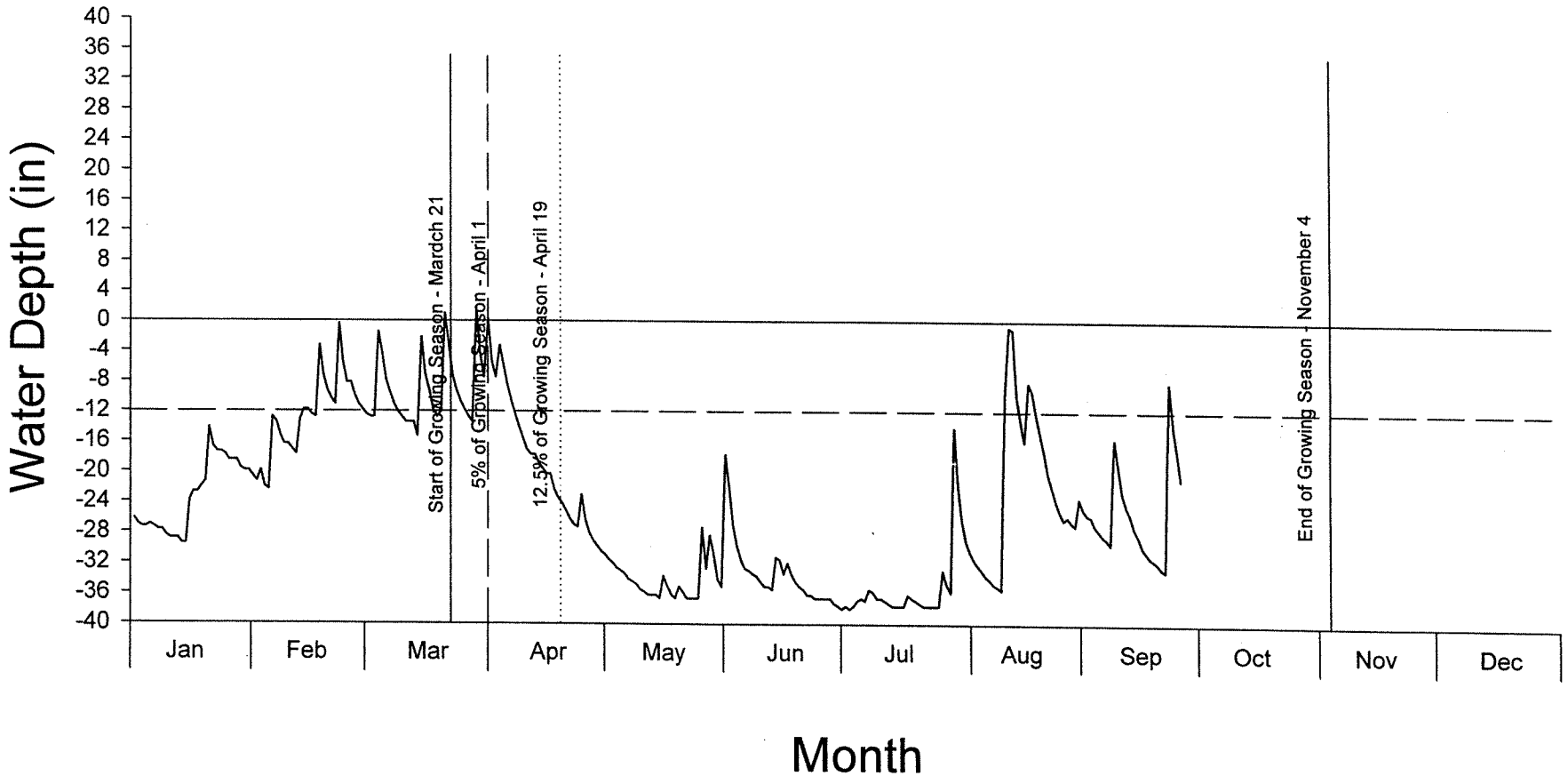
Howell Woods Wells 2001

RDS - Well B



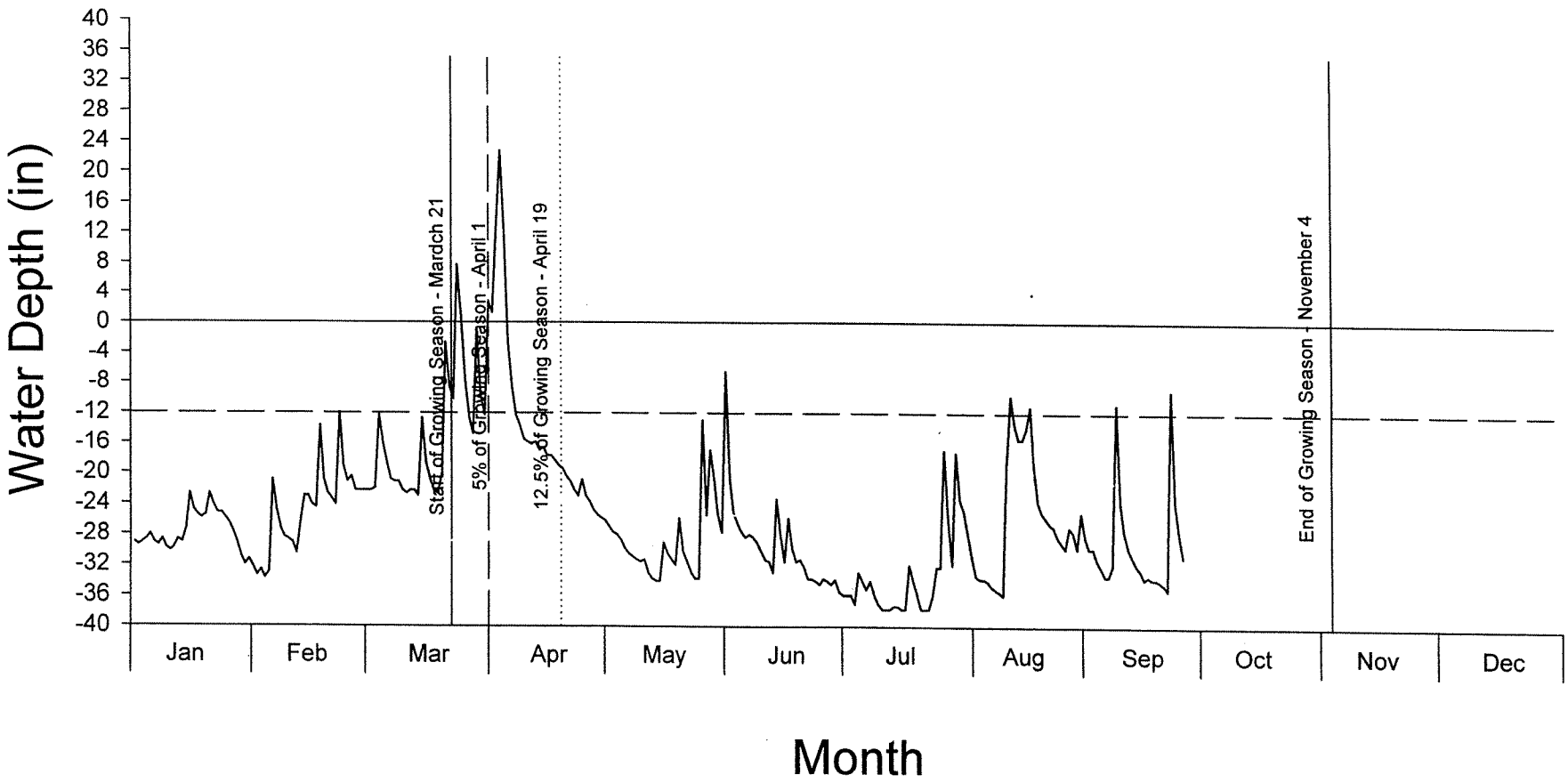
Howell Woods Wells 2001

RDS - Well C



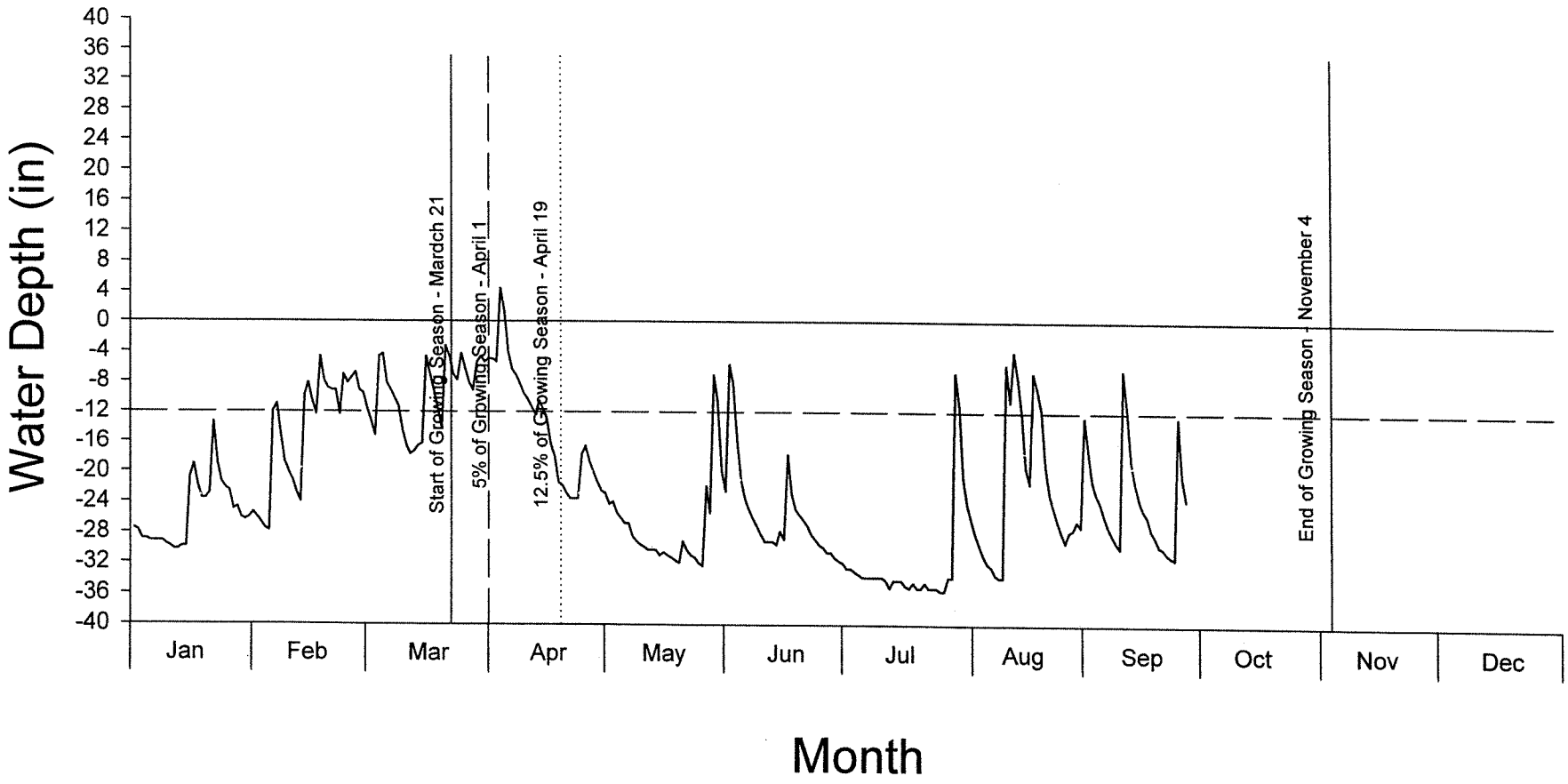
Howell Woods Wells 2001

RDS - Well D



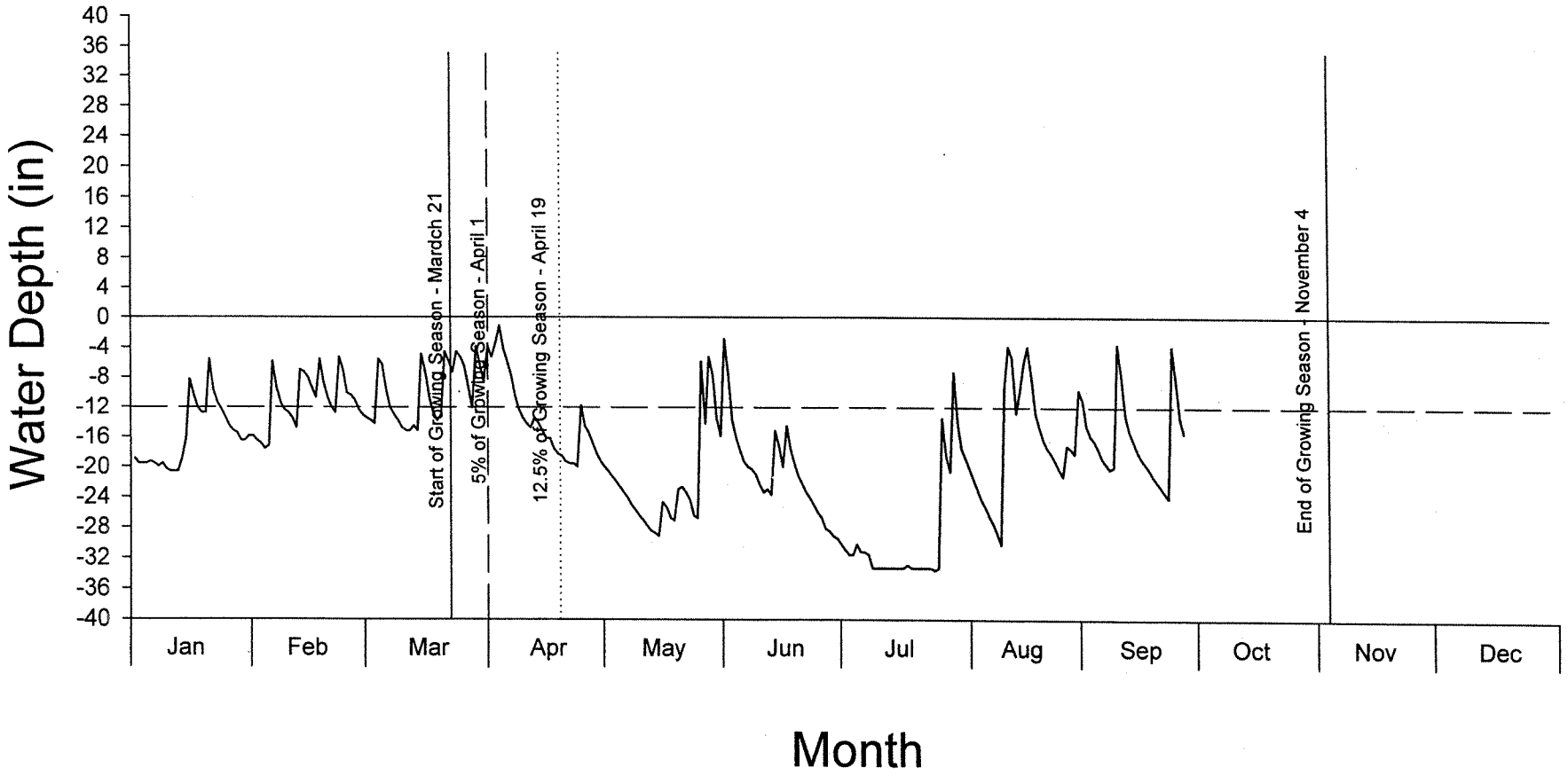
Howell Woods Wells 2001

RDS - Well E



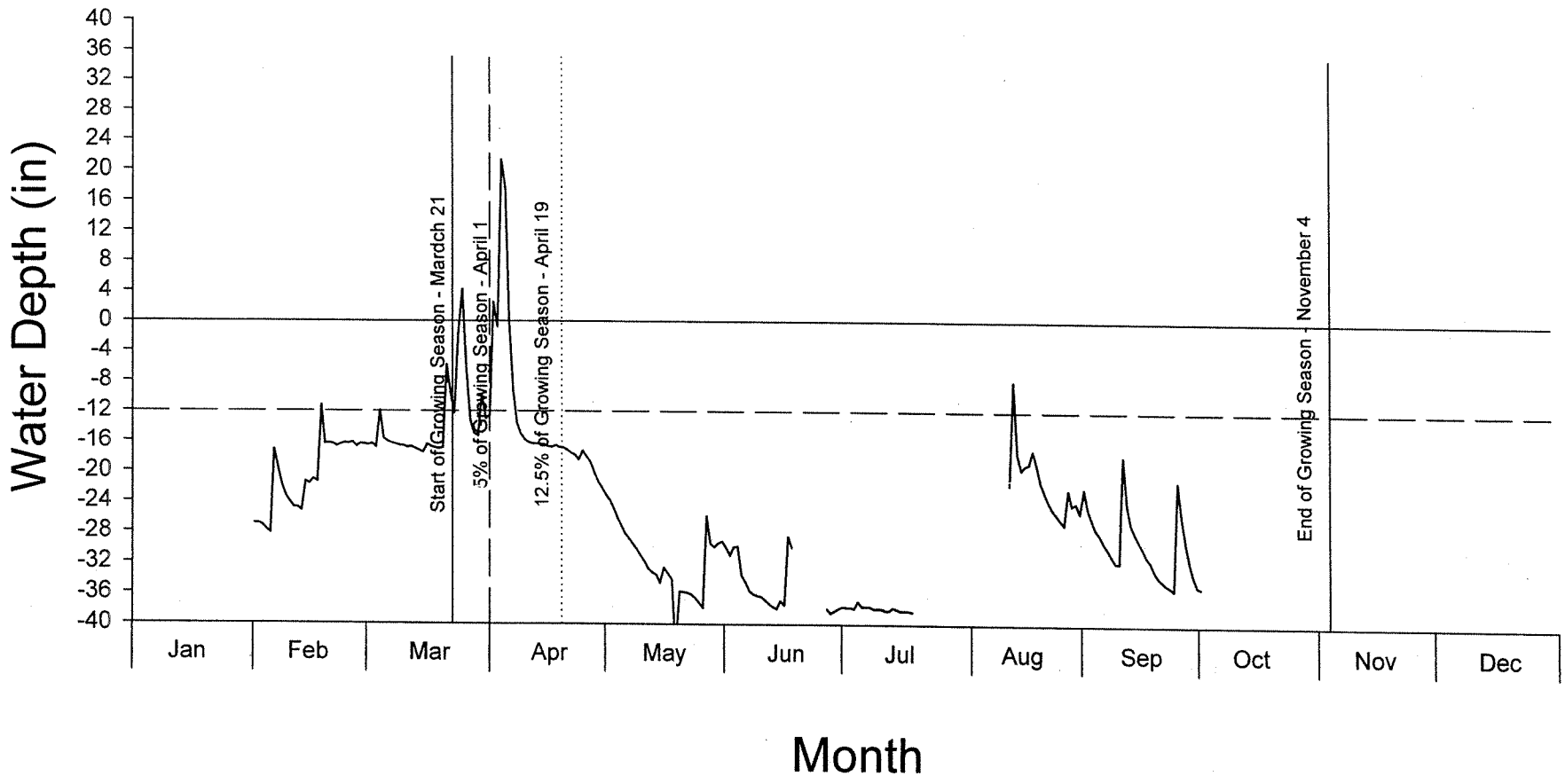
Howell Woods Wells 2001

RDS - Well F



Howell Woods Wells 2001

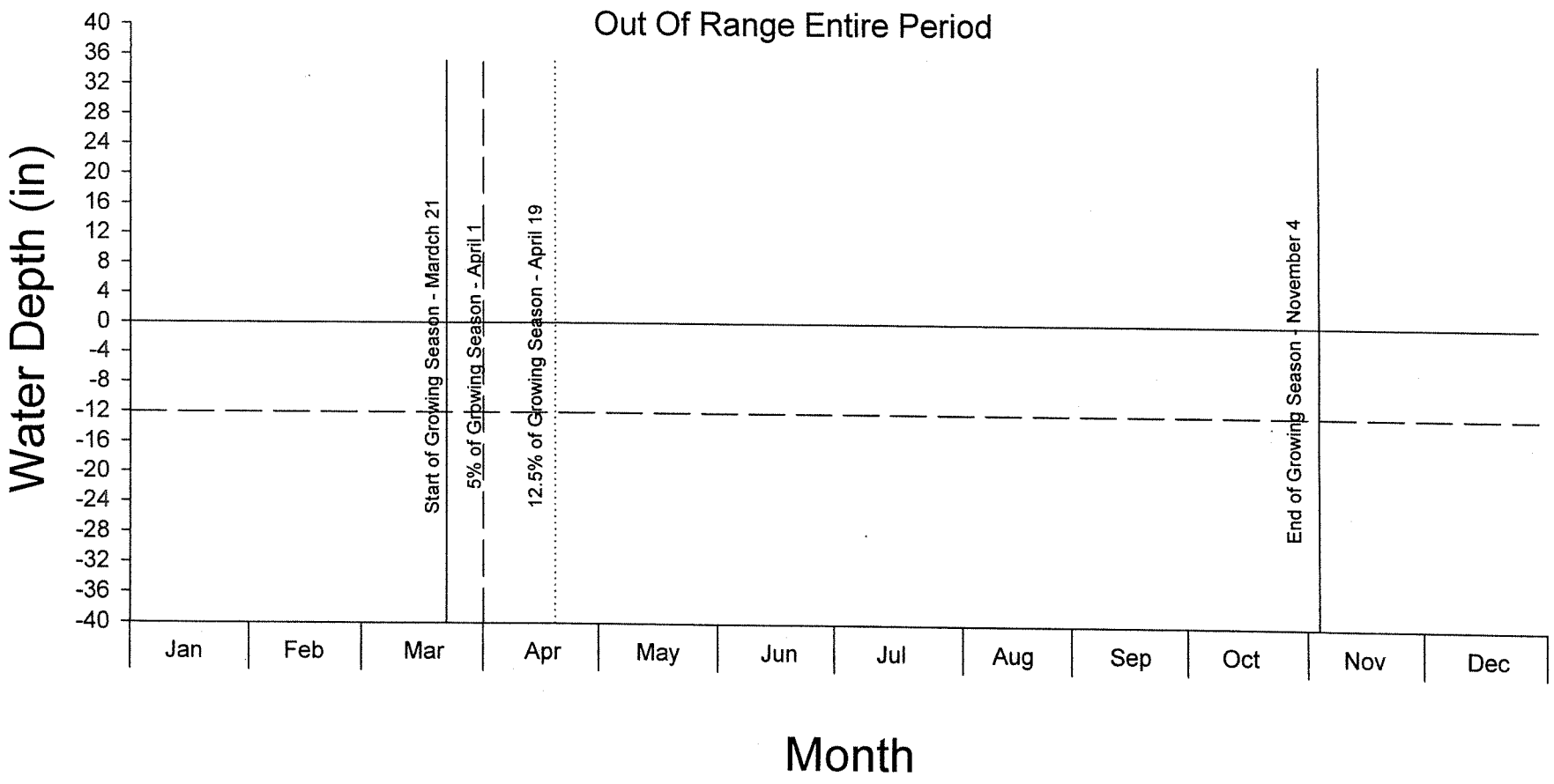
Infinity Well - 1



* Breaks indicate out of range

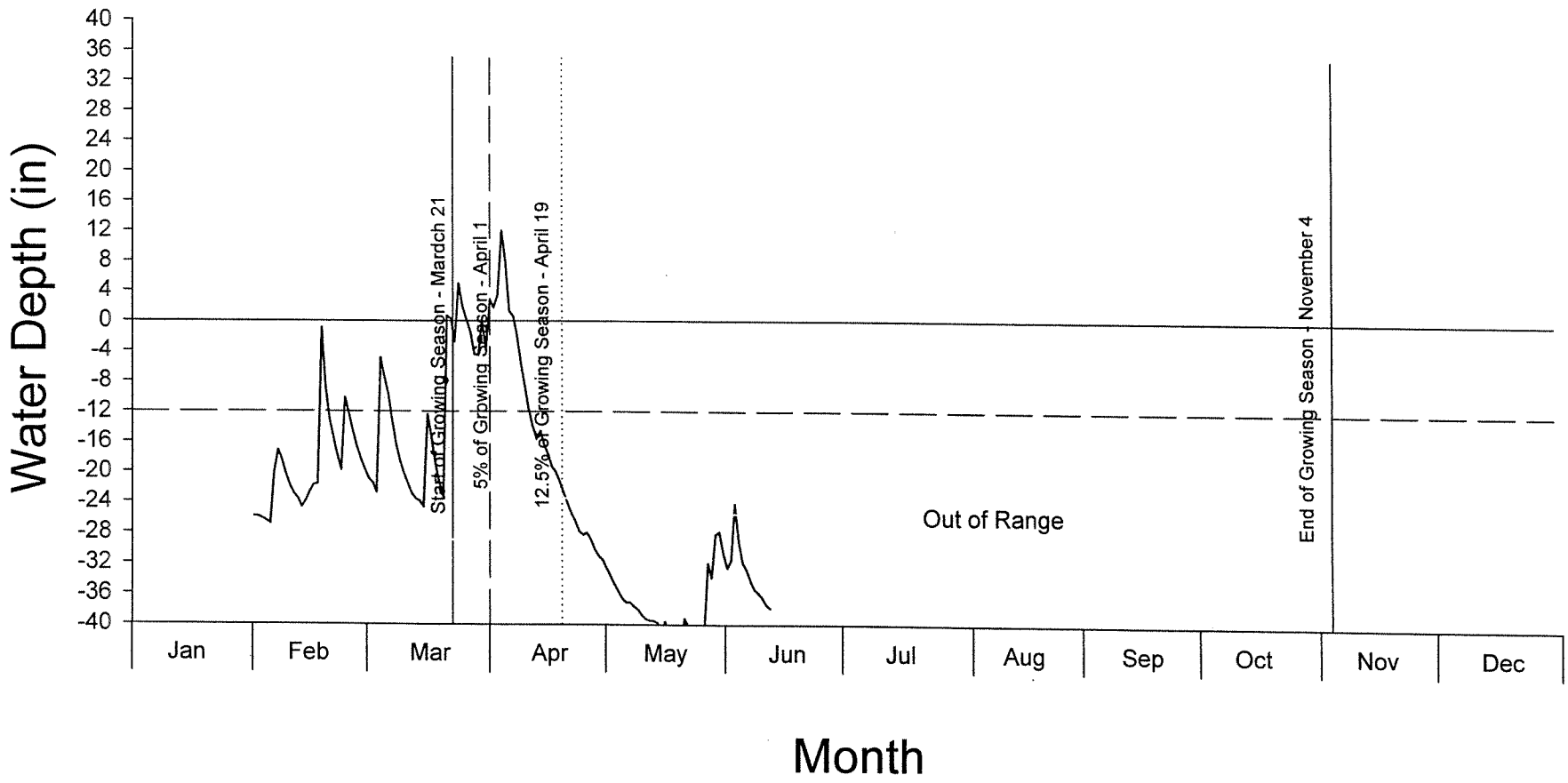
Howell Woods Wells 2001

Infinity Well - 2



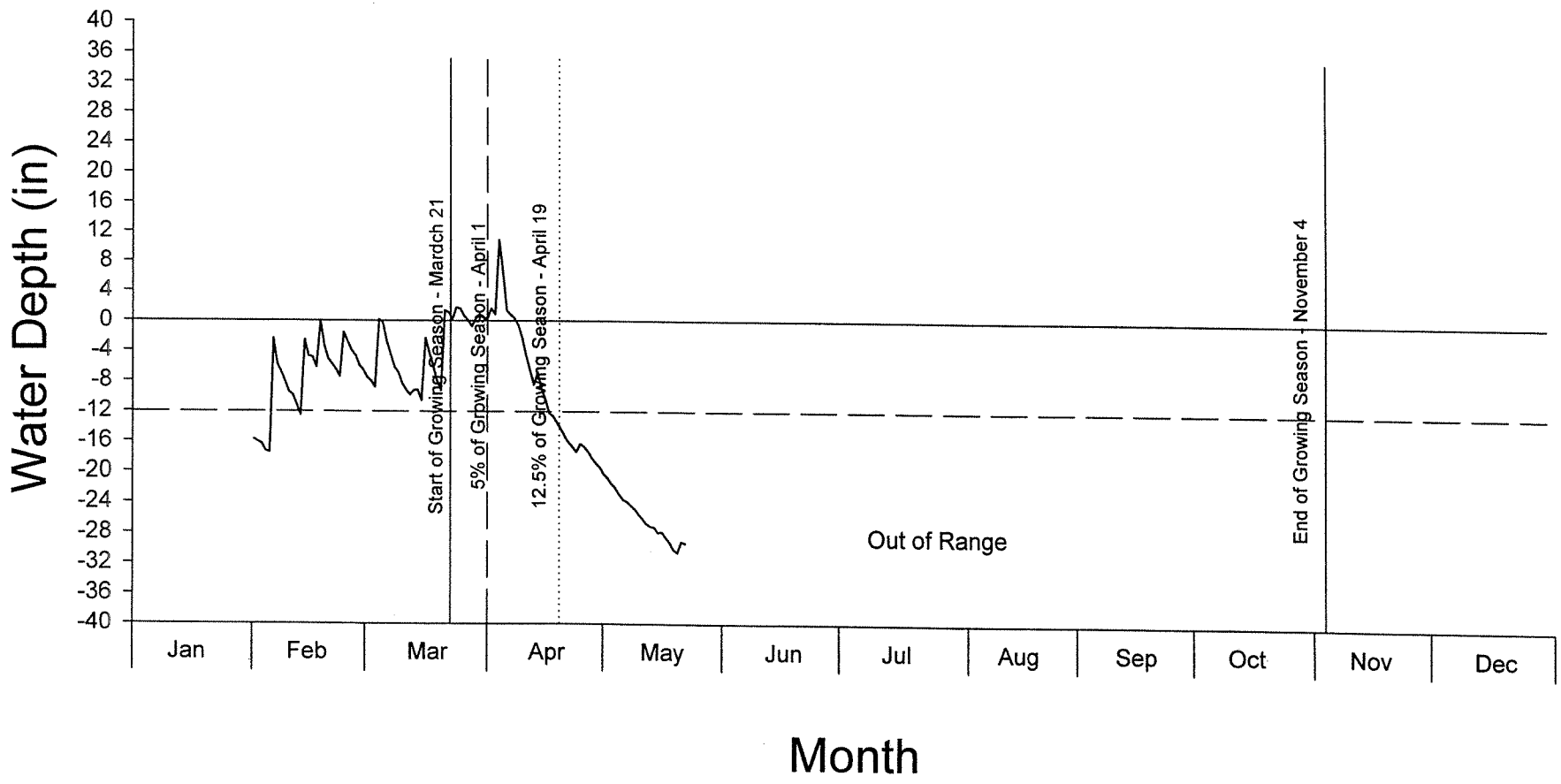
Howell Woods Wells 2001

Infinity Well - 3



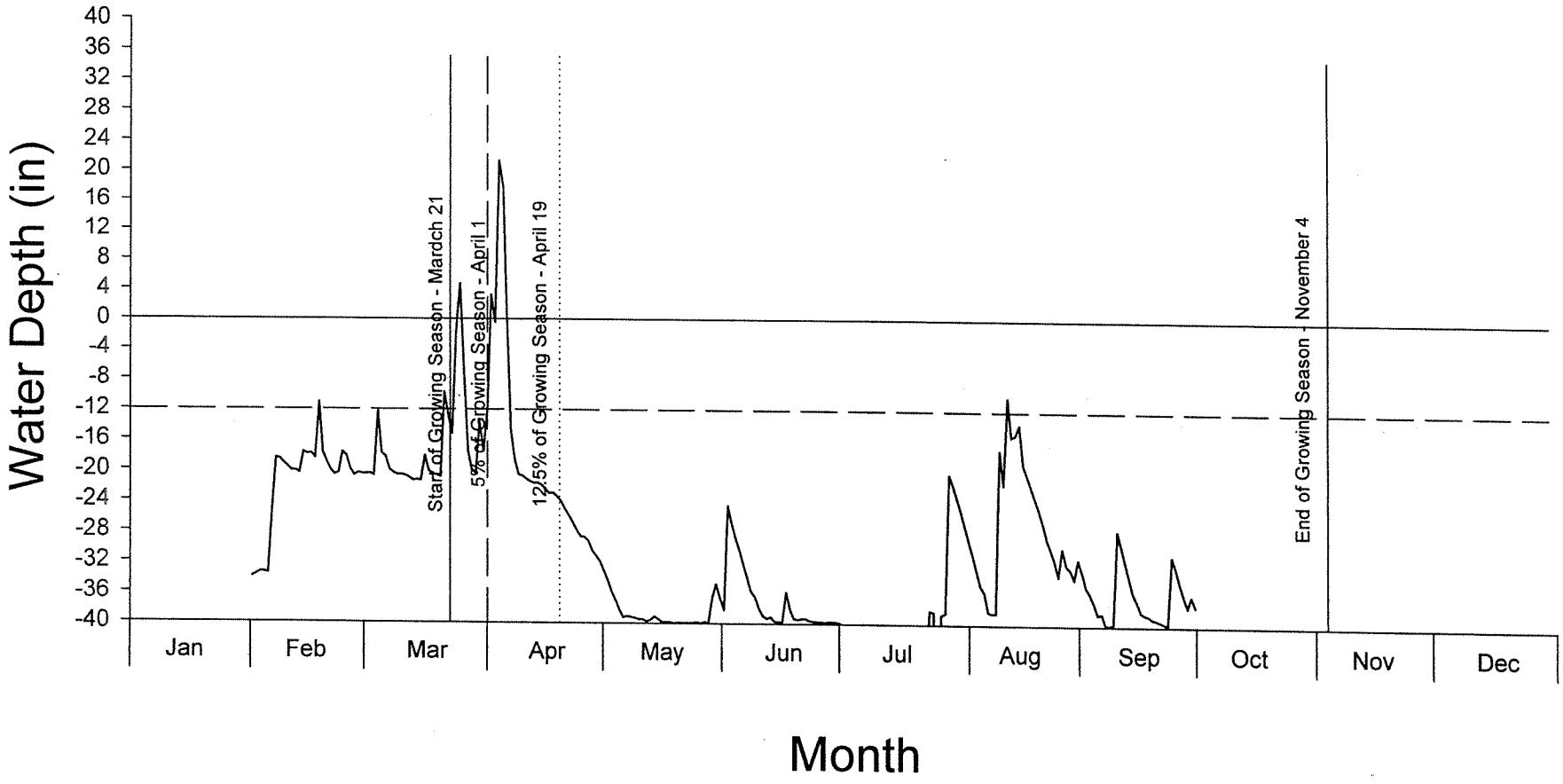
Howell Woods Wells 2001

Infinity Well - 4



Howell Woods Wells 2001

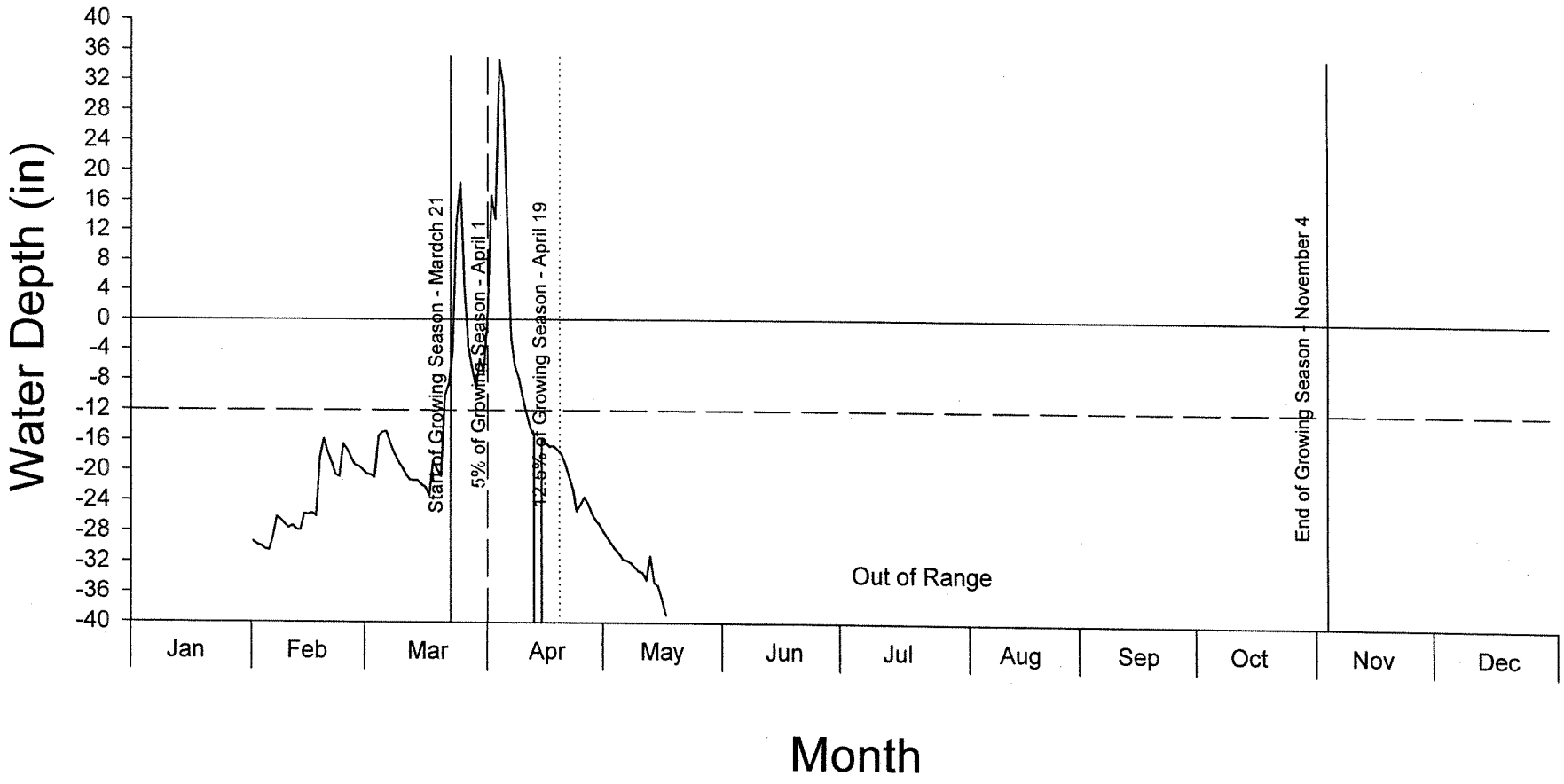
Infinity Well - 5

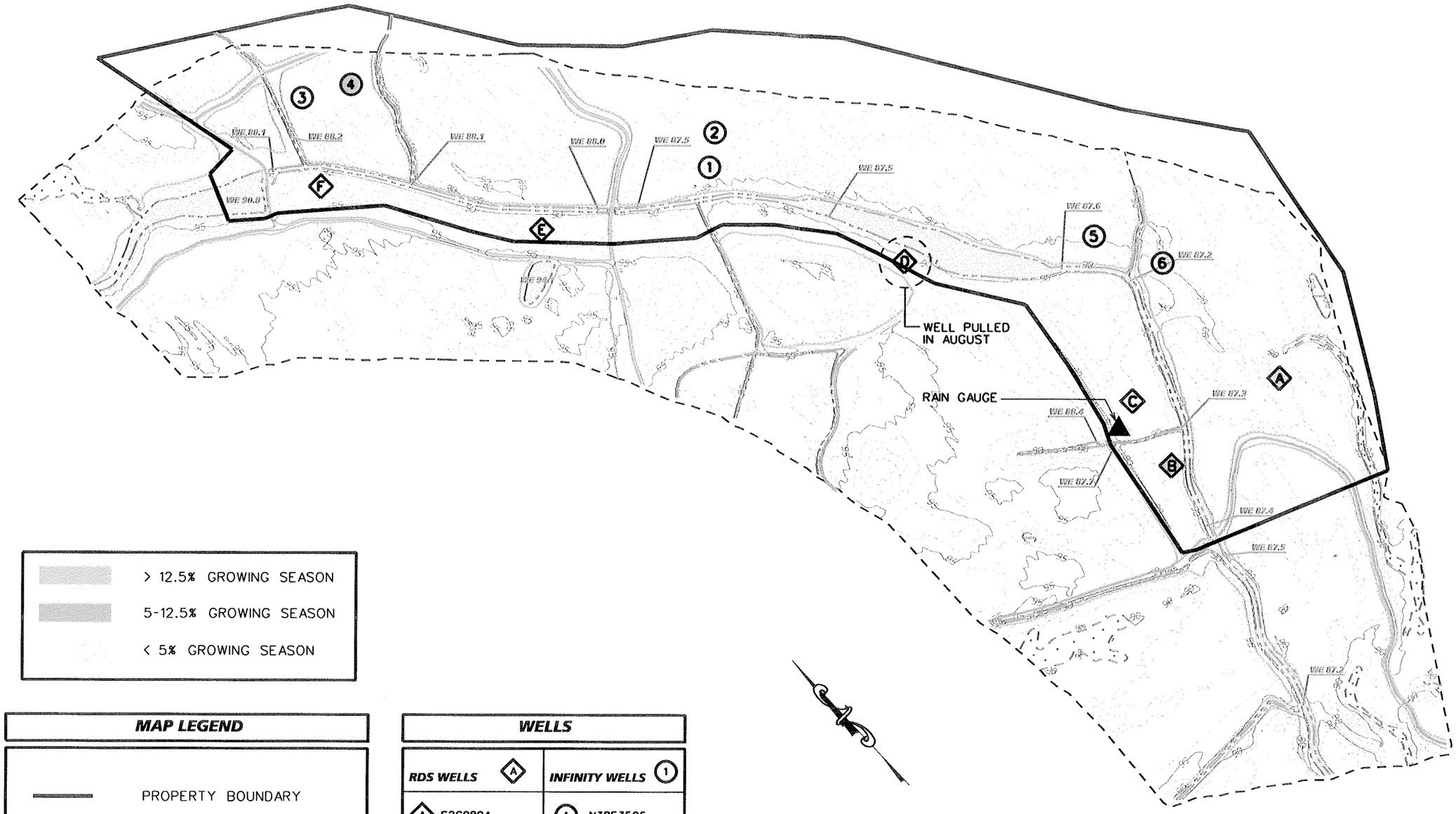


* Breaks indicate out of range

Howell Woods Wells 2001

Infinity Well - 6





> 12.5% GROWING SEASON

5-12.5% GROWING SEASON

< 5% GROWING SEASON

MAP LEGEND

- PROPERTY BOUNDARY
- TELEPHONE POLE
- FENCE
- WOODS
- APPROX. MINOR CONTOUR
- APPROX. MAJOR CONTOUR
- WE 88.1 WATER SURFACE ELEVATION

WELLS

RDS WELLS		INFINITY WELLS	
A	S2C9894	1	N38F3506
B	S2EAD22	2	N38E2121
C	S2EAD39	3	N38E1FC2
D	S32883A*	4	N38E516D
E	S2EAC06	5	N38E5158
F	S2C9810	6	N38E4C8E

*MALFUNCTIONING WELL PULLED IN AUGUST

250 0 250 500 750
SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
YEAR 1 MONITORING
JOHNSTON COUNTY, NORTH CAROLINA

Title:
WELL LOCATIONS (2002)

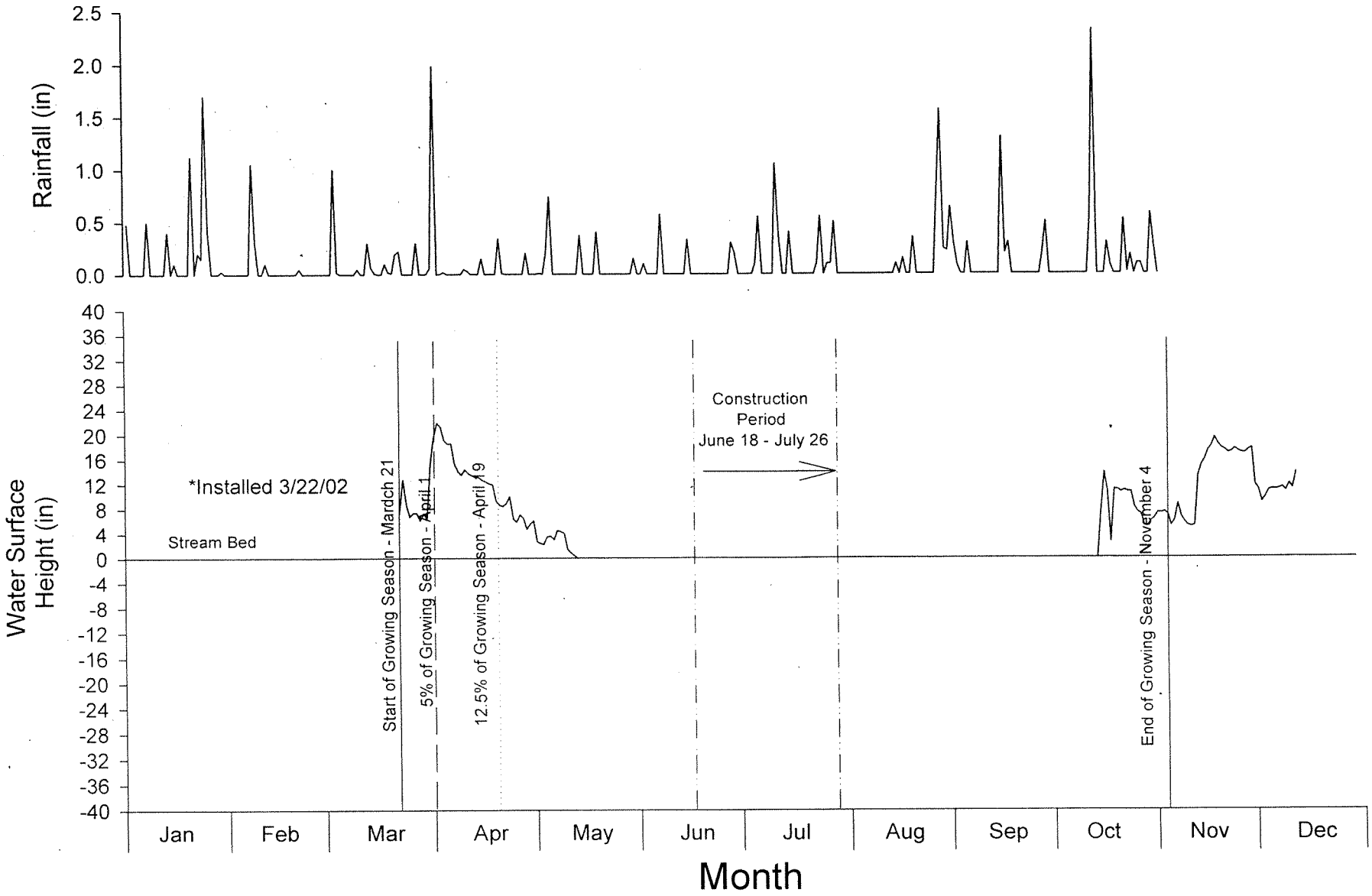
Dwn By:	Date:
MAF	DEC 2002
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.18

FIGURE
D

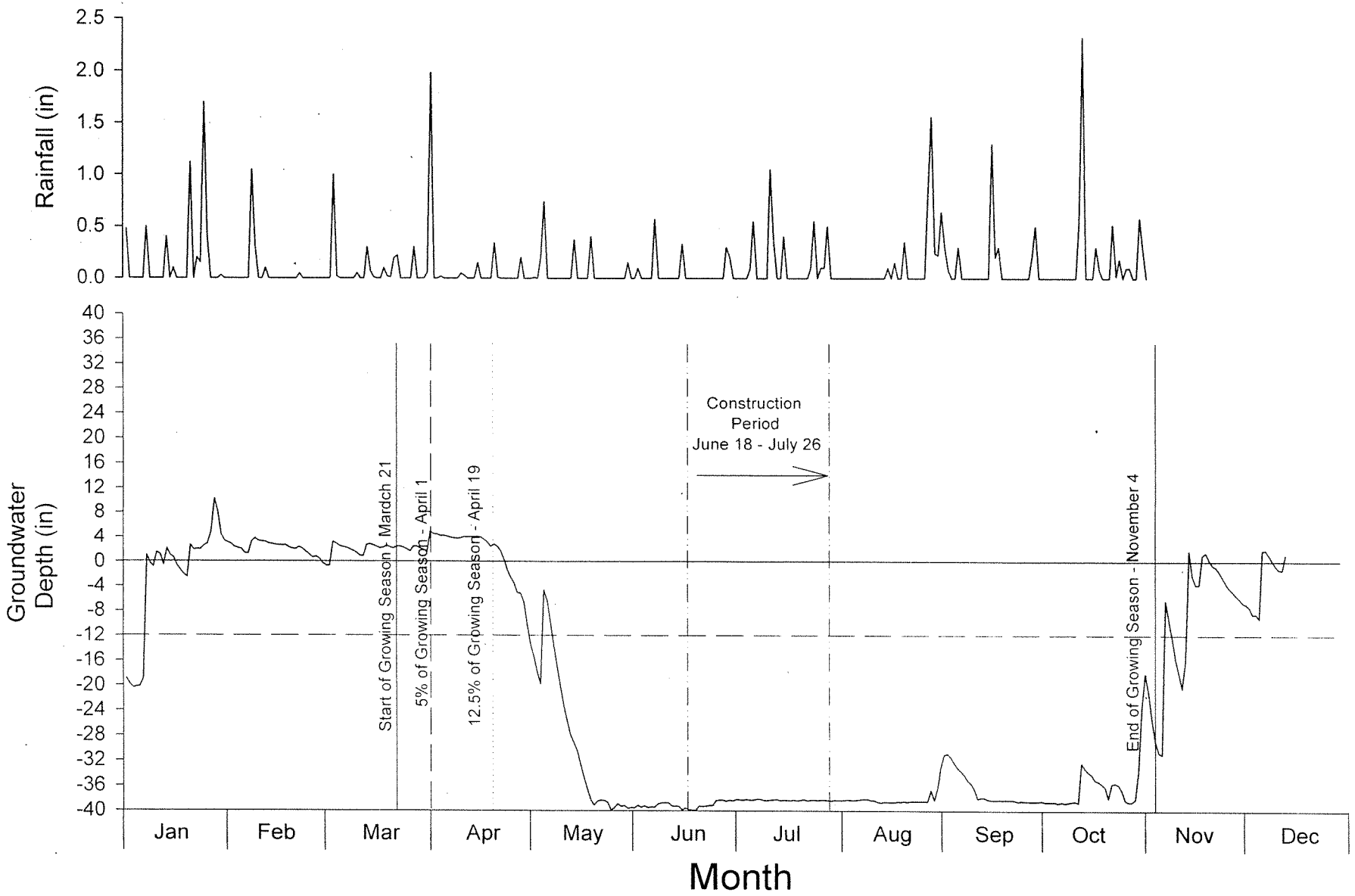
Howell Woods Wells 2002

Infinity - Reference Stream Gauge



Howell Woods Wells 2002

Infinity - Reference Well 1 N3B6A9F1



Howell Woods Wells 2002

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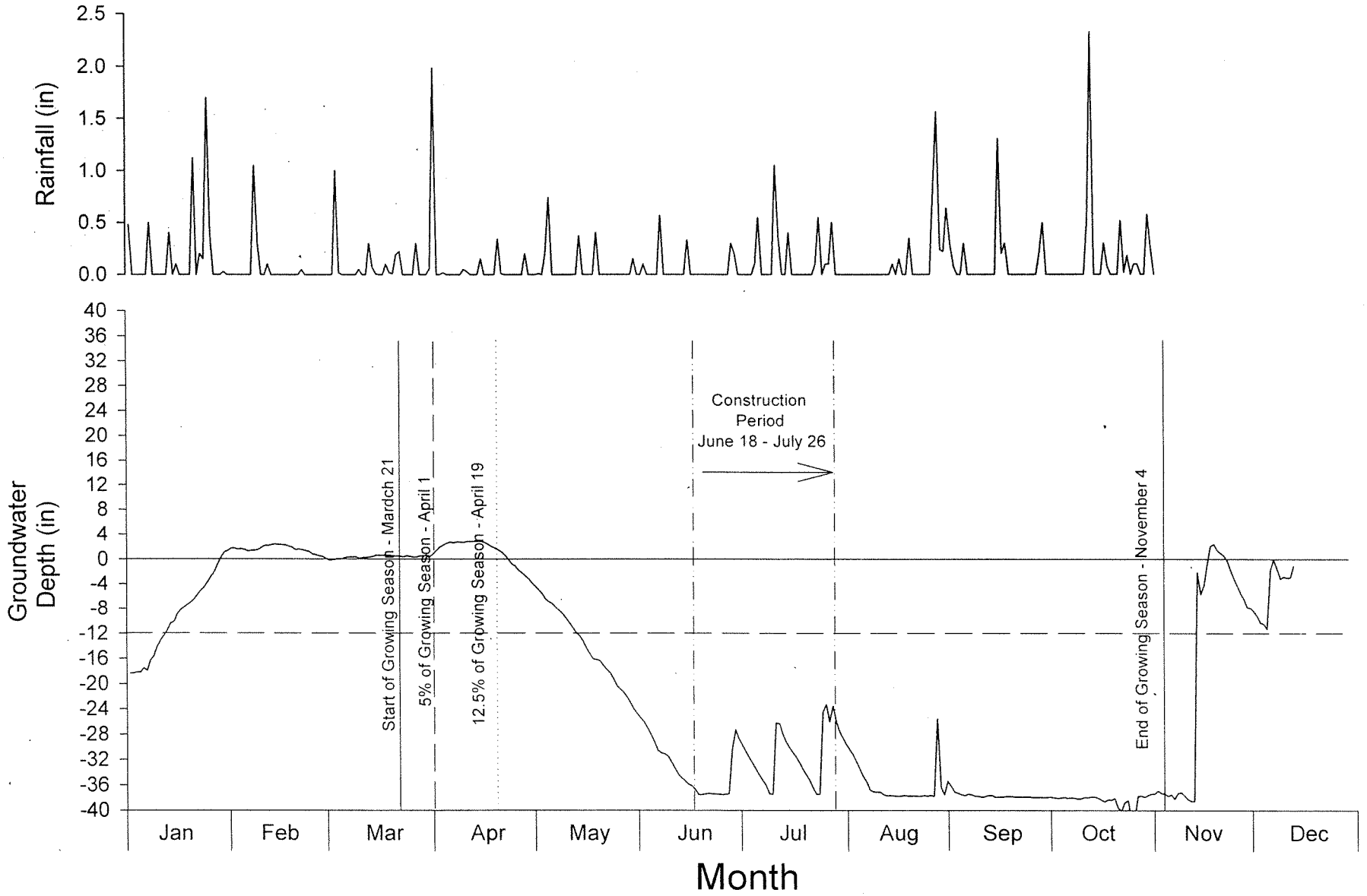

Howell Woods Wells 2002

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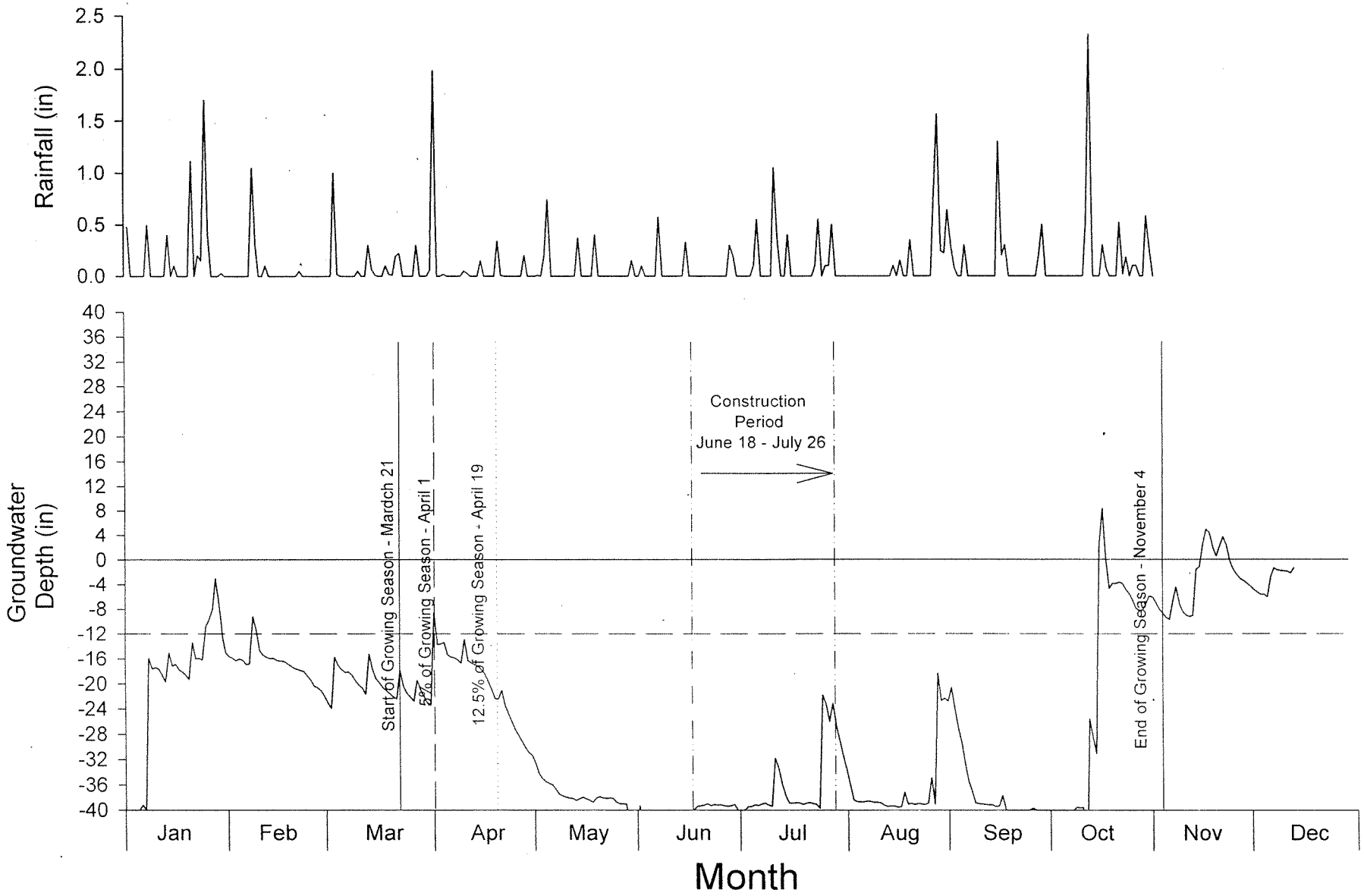

Howell Woods Wells 2002

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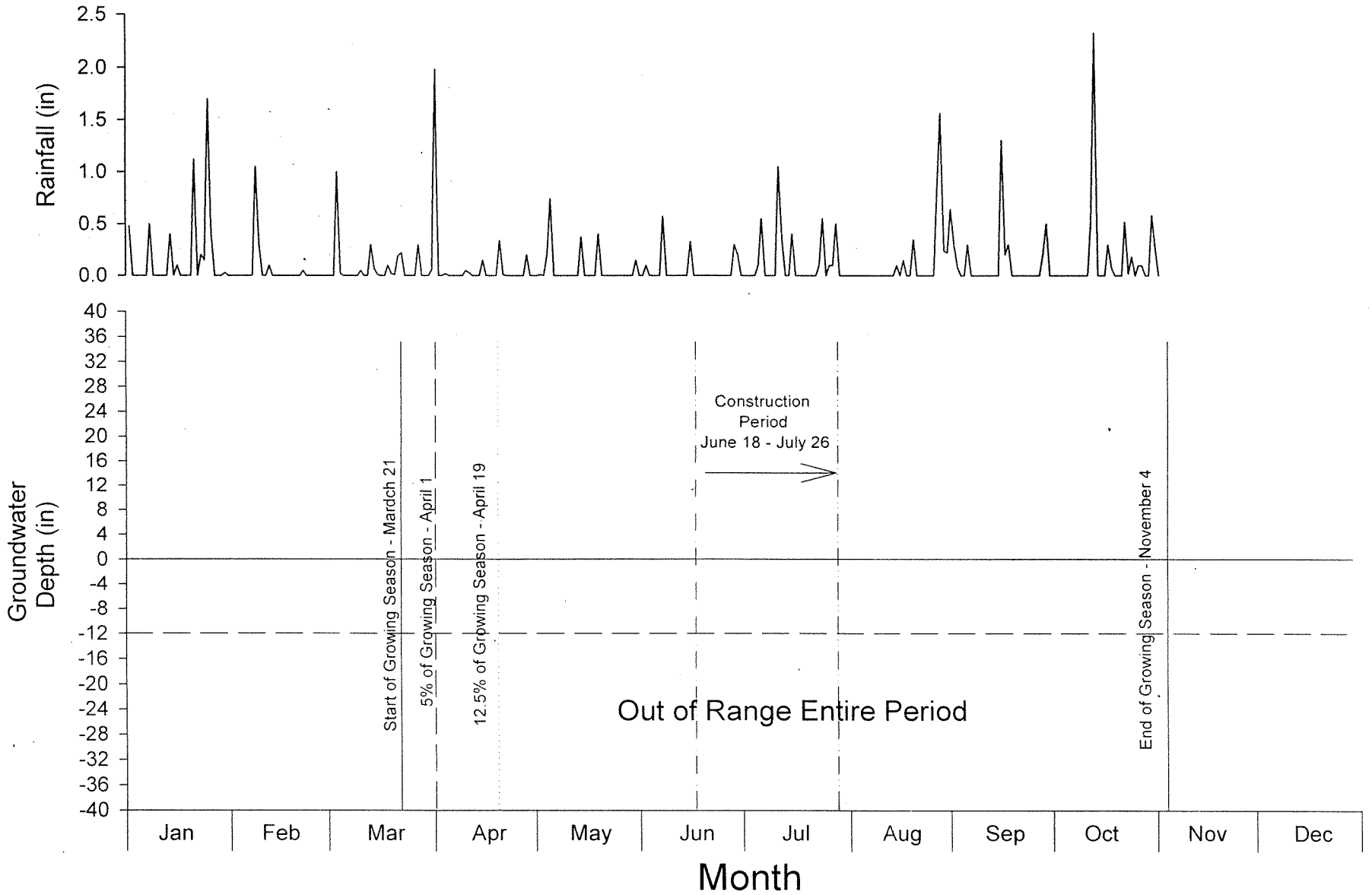

Howell Woods Wells 2002

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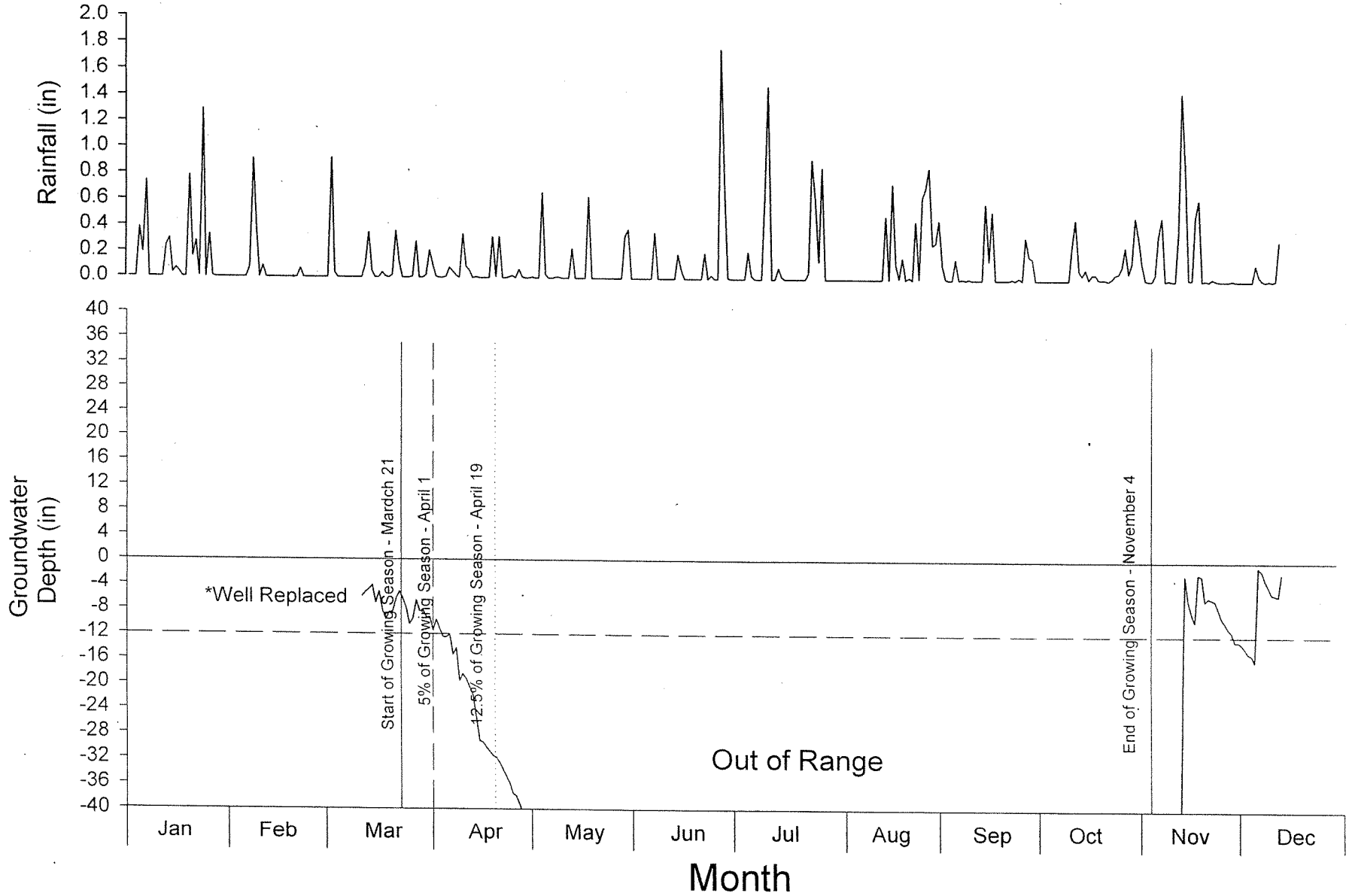

Howell Woods Wells 2002

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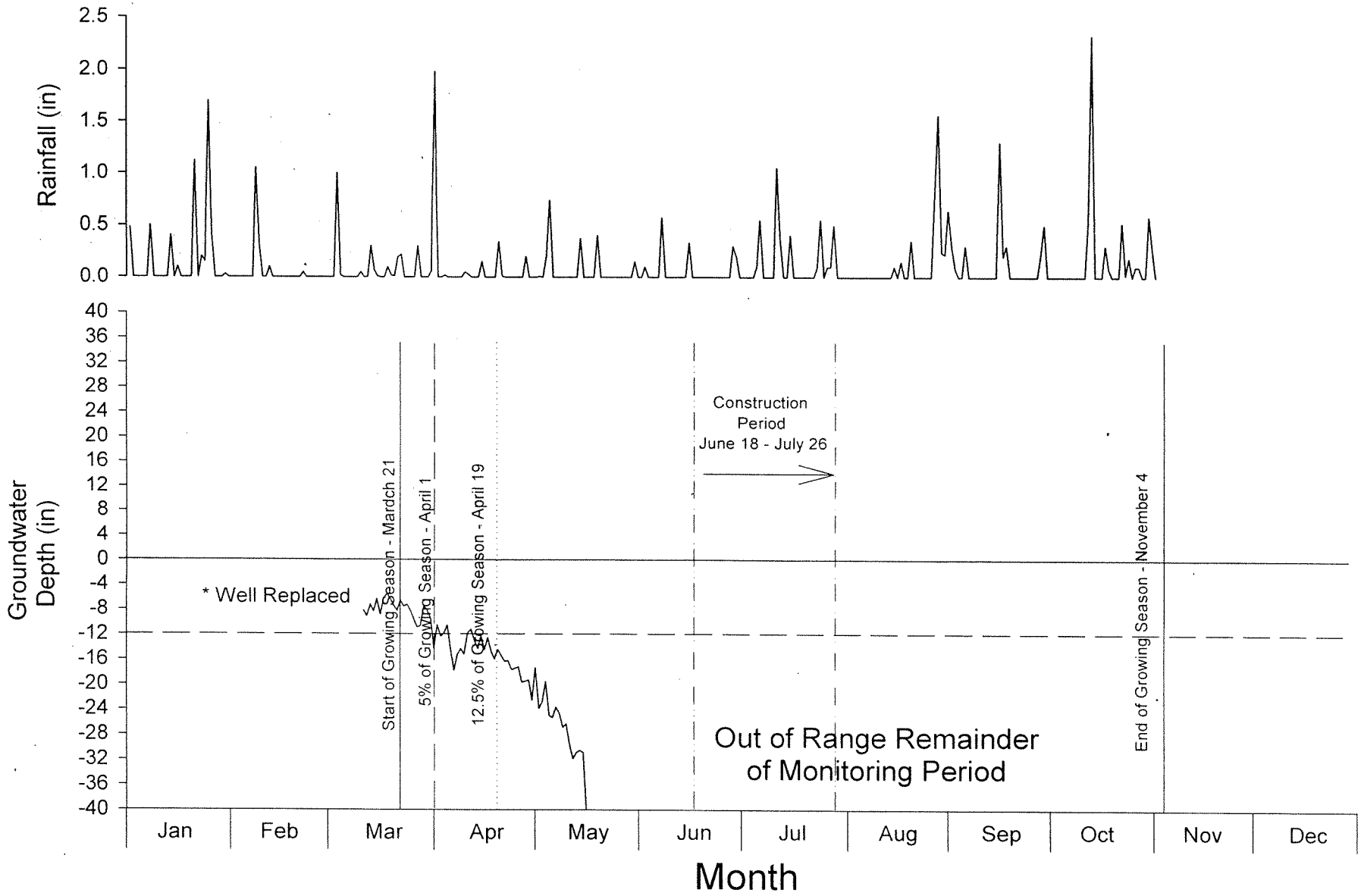

Howell Woods Wells 2002

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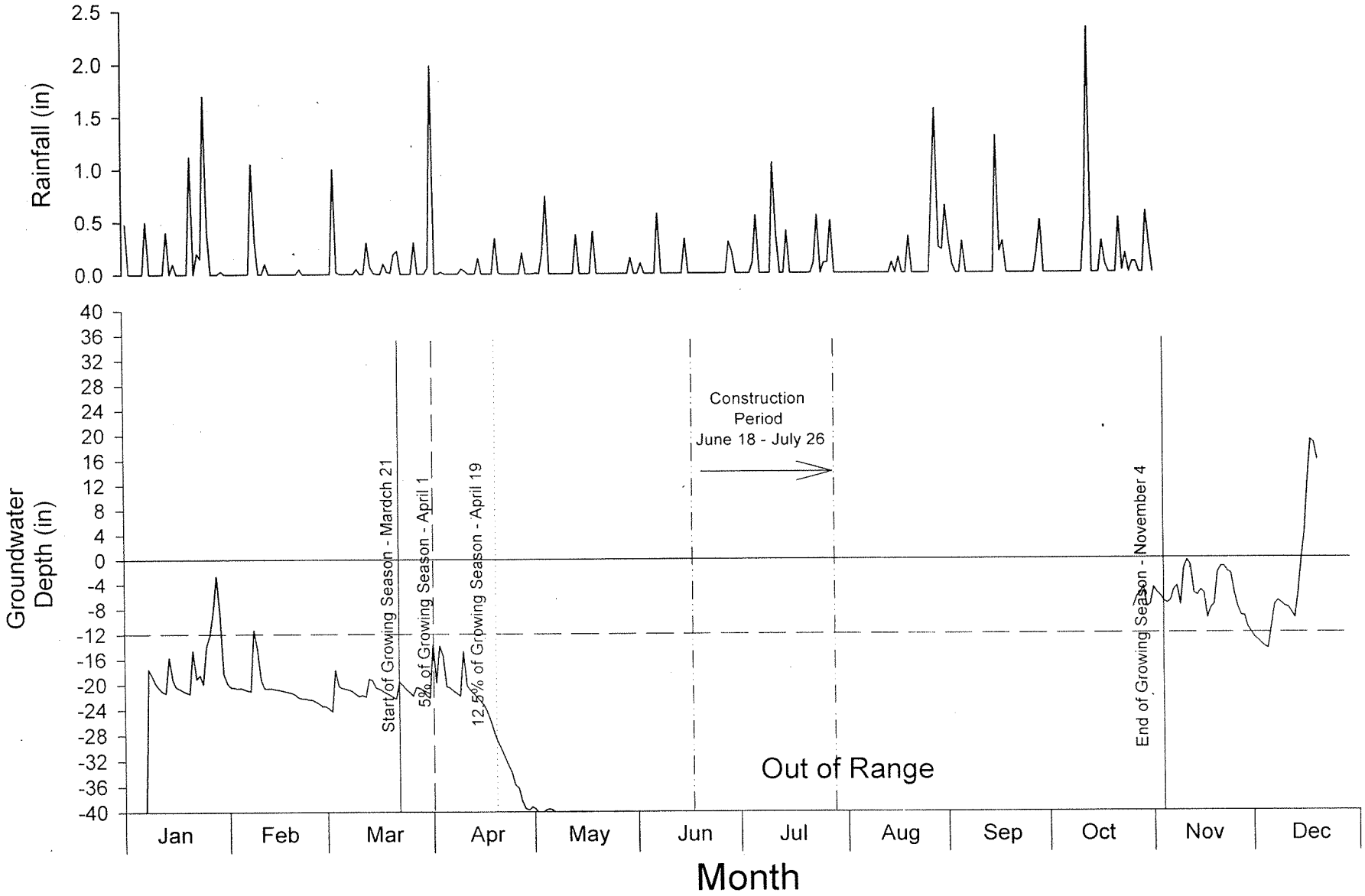

Howell Woods Wells 2002

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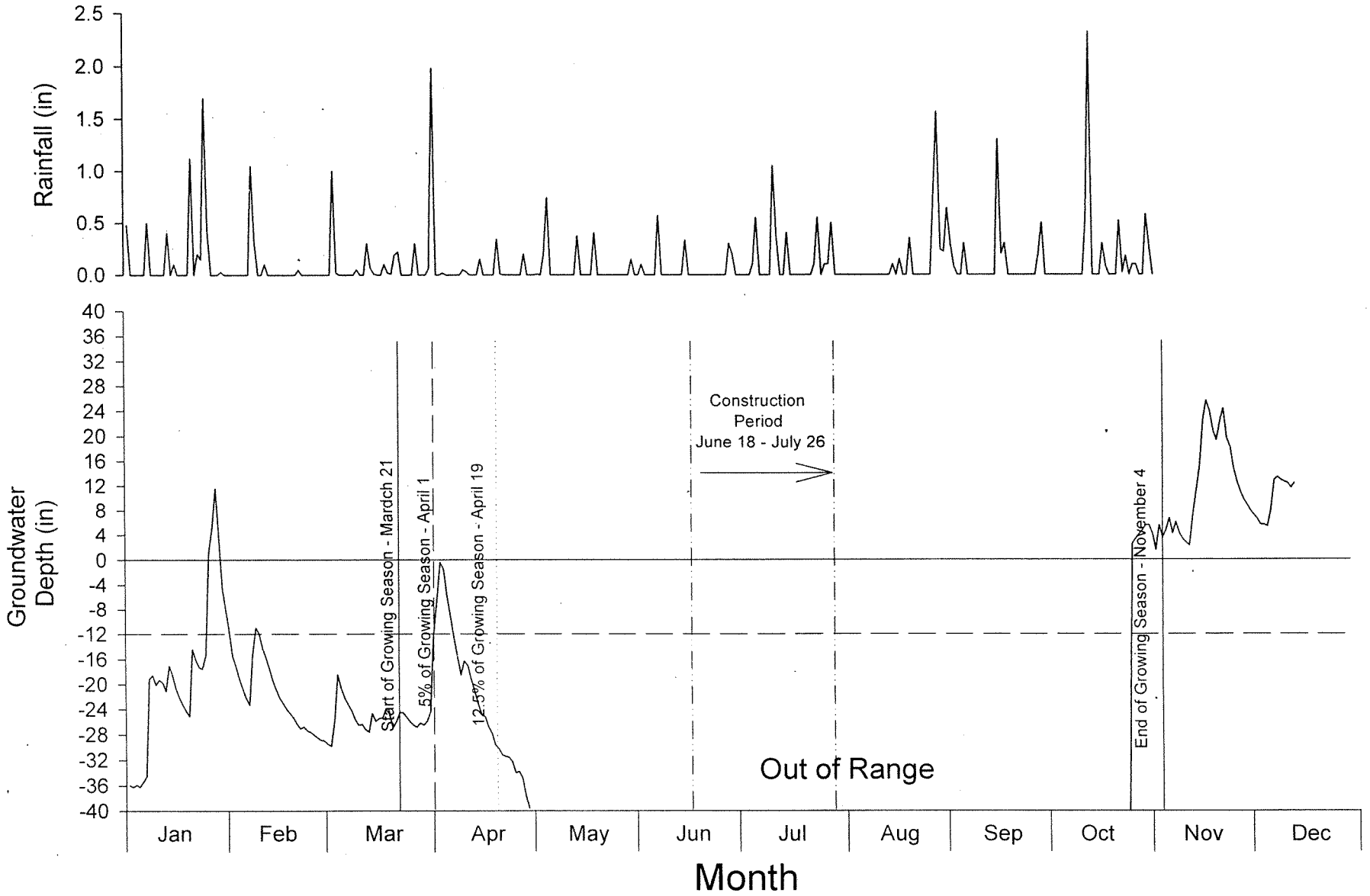
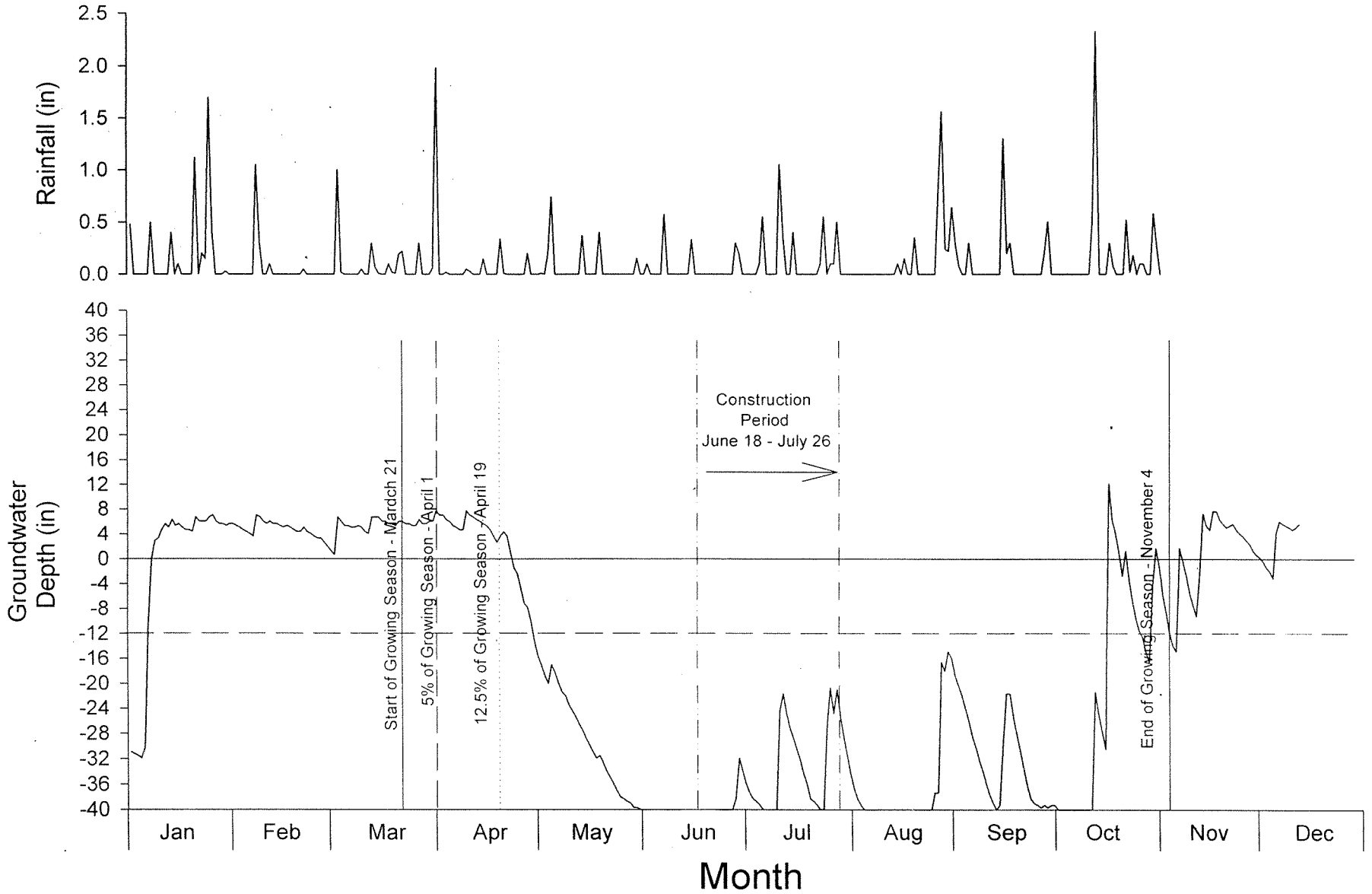


Howell Woods Wells 2002

RDS - Well A S2C9894



Howell Woods Wells 2002

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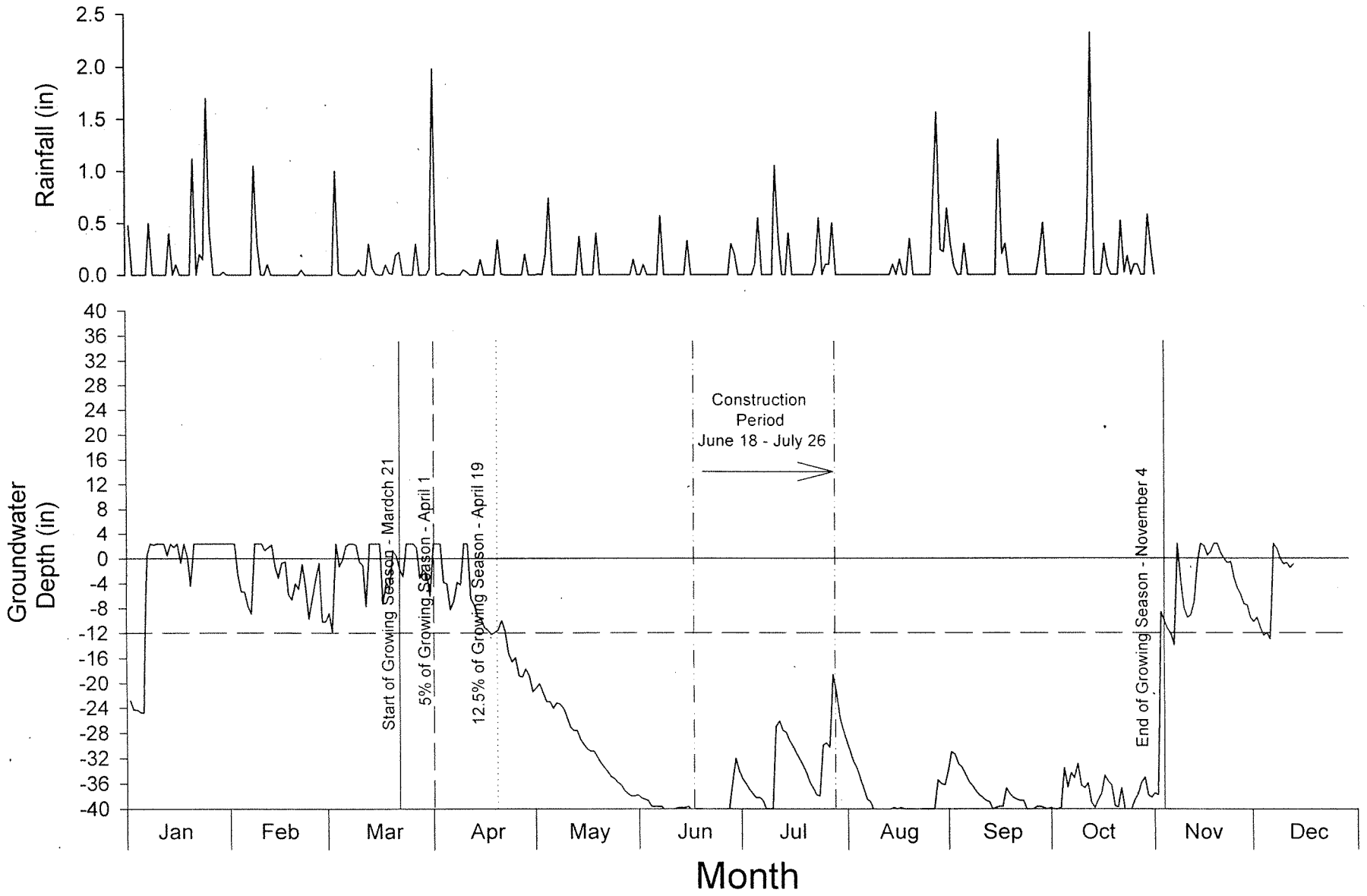

Howell Woods Wells 2002

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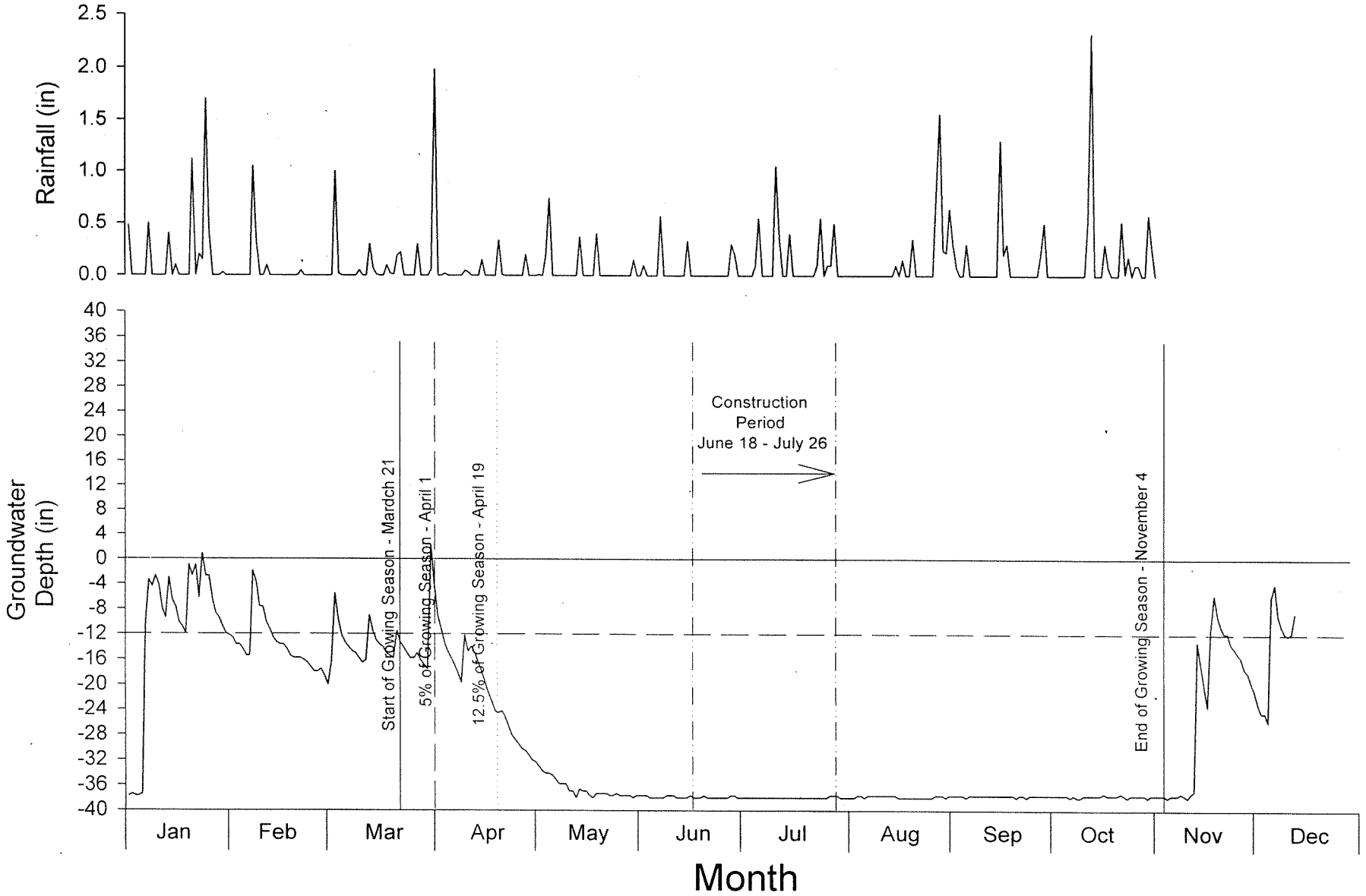

Howell Woods Wells 2002

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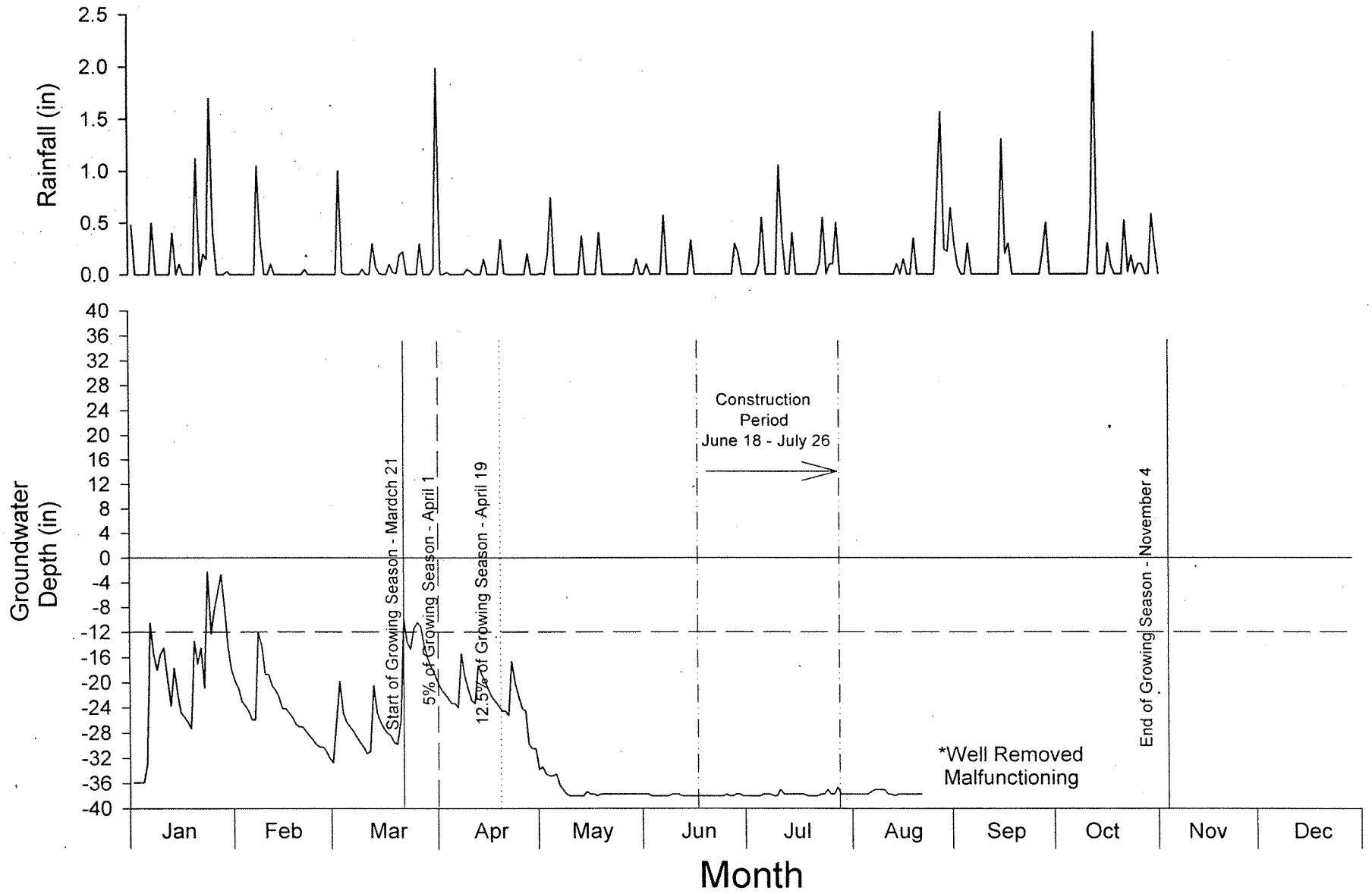

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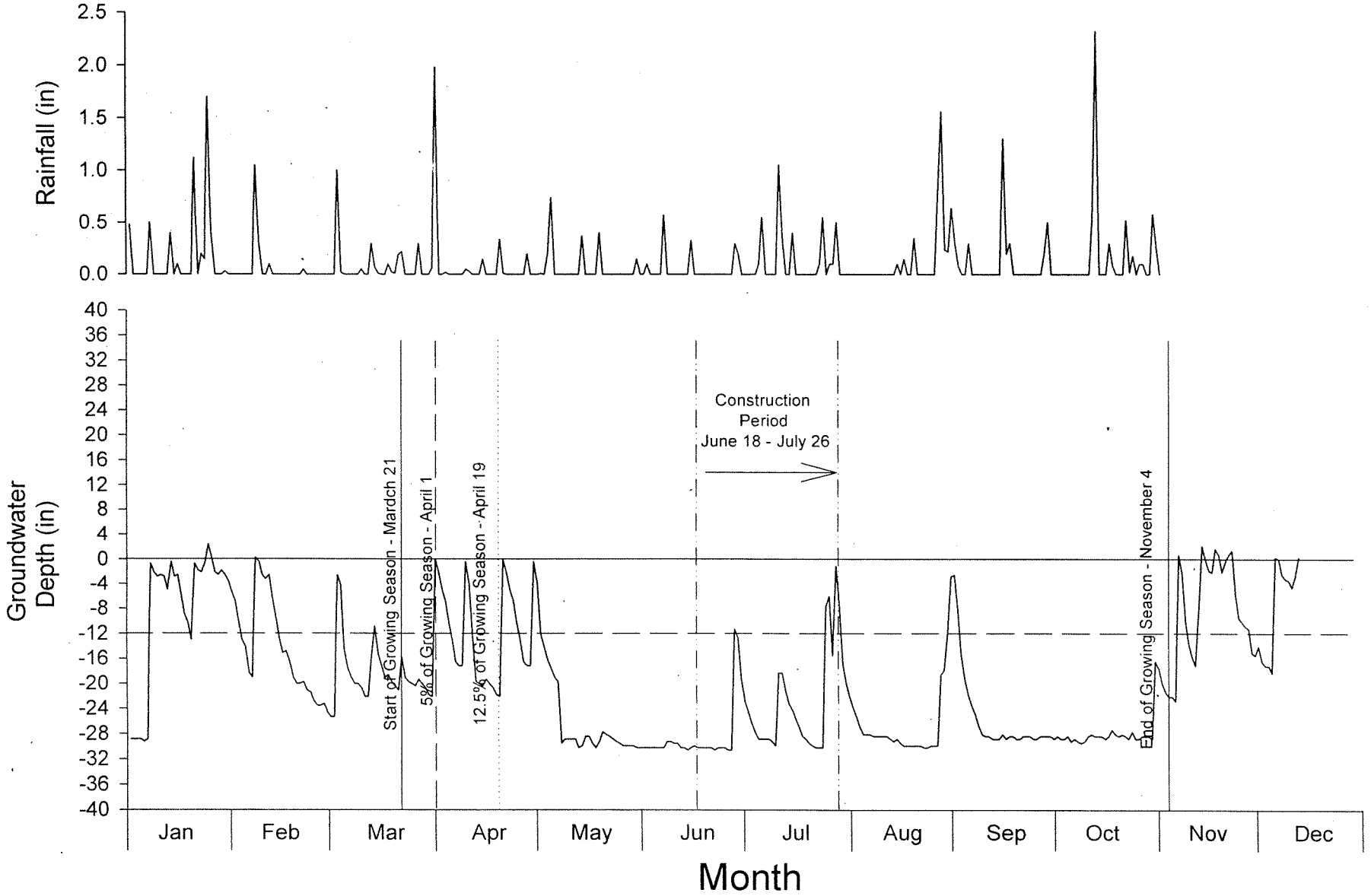

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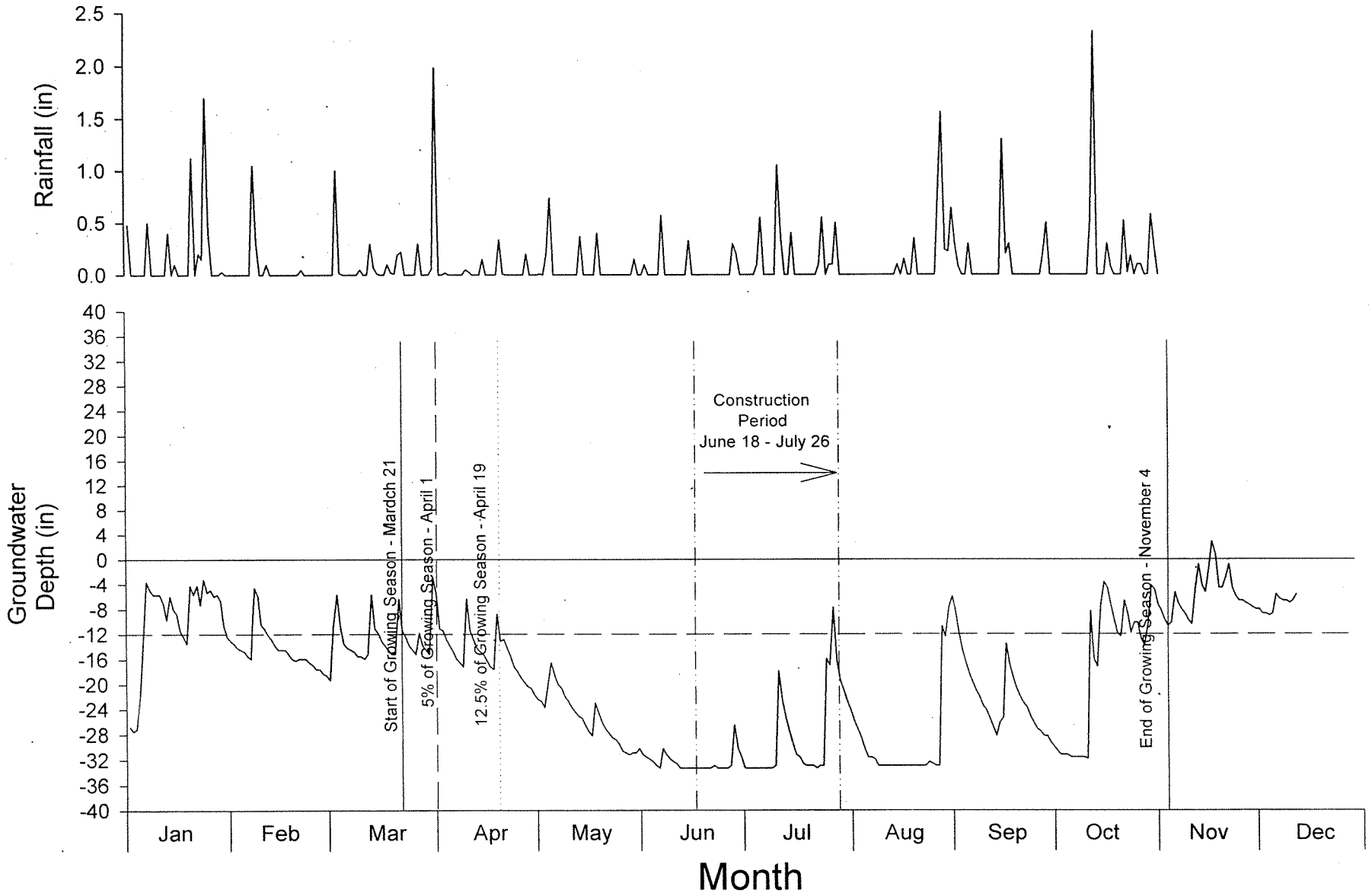


Appendix B
(2001 Vegetative Monitoring)

FALL 2001 VEGETATIVE SAMPLING

Quantitative sampling of vegetation was carried out in September 2001, approximately 18 months after the planting date. Nine sampling plots were randomly selected on mapping and permanently established in the field (Figure 22). Plot location was devised based on the proportional acreage of each re-vegetated plant community within the site (canal edge = 2 acres [11 percent]; floodplain bottomland hardwood =12 acres, [67 percent]; mesic upland slope = 4 acres [22 percent]).

Each sample plot is composed of two 300-foot transects extending from a central point. Plot width along the transect extends 4 feet on each side of the central line, providing a 0.11 acre plot sample (600 feet x 8 feet). The total area sampled thus comprises 0.99 acre, approximately 5.5 percent of the total planted area. The center and end points of each plot are permanently established with labeled, white polyvinyl chloride (PVC) pipes. All woody species rooted within the plot boundary were tallied by species and recorded regardless of height or diameter breast height (dbh). In order to compare sampling results to success criteria (see Section 6.4), collected data were analyzed to determine species composition, abundance, density, relative density, and survivorship.

One Year Monitoring Results and Discussion

Results of vegetative sampling are presented in Table 8. A total of 19 woody plant species were recorded within the nine sample plots, 10 (53 percent) of these being planted species. Planted species were estimated to account for a density of 481 stems/acre (26.2 percent) and recruit (volunteer) species accounted for a density of 1352 stems/acre (73.8 percent), for a combined, estimated stem density of 1833 stems/acre. Of the 11 species that were planted, one species, mockernut hickory, was not observed in any of the sample plots. Other planted species that were poorly represented were water oak (6 stems/acre), yellow poplar (5 stems/acre), and water tupelo (8 stems/acre). Green ash was the most abundant planted species, accounting for 257 stems/acre, 13.9 percent of the total density. However, a maximum of 67 stems/acre of green ash were planted, and therefore, volunteer green ash stems must account for a minimum of 190 stems/acre. If green ash recruits are not included in planted stem density, then planted stems account for a maximum density of 291 stems/acre and maximum survivorship of 55 percent.

Recruit saplings are dominated by American elm and winged elm (874 stems/ acre) which account for 47.6 percent of the overall stem density, followed by red maple (221 stems/acre), green ash (190 stems/acre), and sweetgum (148 stems/acre), which account for 29.5 percent of the overall stem density.

Considering that no characteristic tree species may account for more than 20 percent (64 stems/acre) of the minimum planted tree density (320 stems/acre), the maximum sampled density that may be applied toward success criteria is 469 stems/acre. This estimate includes jurisdictional wetland tree species that were not planted but were sampled in the reference plots. Therefore, characteristic tree density currently meet the minimum density requirement for proposed success criteria.

Many of the planted saplings showed signs of being browsed by whitetail deer, and foraging by feral pigs is evident throughout the planted region. Browsing/foraging by wildlife has likely contributed to low measured densities and poor survivorship of some planted species, and may be responsible for the absence of mockernut hickory. Also, as much as 85 percent of the planting zone supports extremely dense herbaceous cover of aster, smartweed, and blackberry. These species undoubtedly limit light, moisture, and nutrient availability for planted tree saplings. It

Table 1. Summary of first year, fall vegetation monitoring data. Howell Woods Wetland Mitigation Site, September 2001.

Common Name	Scientific Name	Density (stems/acre)	Relative Density (%)	Max. Density Allowed to Evaluate Success Criteria[1]	Percent of Total Allowable Density	Characteris -tic Species	Wetland Status	Comments[2]
Green Ash	*Fraxinus pennsylvanica*	257	13.9	64	13.6	yes	FACW	P, R,
Overcup Oak	*Quercus lyrata*	85	4.6	64	13.6	yes	OBL	P, R
Willow Oak[4]	*Quercus phellos*	39	2.1	39	8.3	yes	FACW-	P, R
Cherrybark Oak	*Quercus pagoda*	17	0.9	17	3.6	yes	FAC+	P, R
Water Oak	*Quercus nigra*	6	0.3	6	1.3	yes	FAC	P
Bald Cypress	*Taxodium distichum*	31	1.7	31	6.6	yes	OBL	P, R
American Sycamore	*Platanus occidentalis*	23	1.3	23	4.9	yes	FACW-	P, R
Tulip Poplar	*Liriodendron tulipifera*	5	0.3	5	1.1	yes	FAC	P, R
River Birch	*Betula nigra*	14	0.8	14	3.0	yes	FACW	P
Water Tupelo	*Nyssa aquatica*	8	0.4	8	1.7	yes	OBL	P, R
Mockernut Hickory	*Carya tomentosa*	0	0.0	0	0.0	yes	N/A	P
Hawthorn	*Cretagus* sp.	*63*	3.4	0	0.0	no	N/A	V
Red Maple	*Acer rubrum*	221	11.9	64	13.6	yes	FAC	V, R
Sweetgum	*Liquidambar styraciflua*	148	8.0	64	13.6	yes	FAC+	V, R
Persimmon	*Diospyros virginiana*	36	2.0	0	0.0	no	FAC	V
Hackberry	*Celtis laevigata*	9	0.5	0	0.0	no	FACW	V
American Elm	*Ulmus americana*	517	27.9	64	13.6	yes	FACW	V, R
Winged Elm	*Ulmus alata*	366	19.7	0	0.0	no	FACU+	V
Black Willow	*Salix nigra.*	1	0.1	1	0.2	yes	OBL	V, S
Loblolly Pine	*Pinus taeda*	4	0.2	4	0.9	yes	FAC	V, R, S
TOTAL		**1850**	**100.0**	**469**	**100.00**			

[1]Per the success criteria, the number of characteristic tree species elements must exceed 320 stems/acre. However, the maximum number of stems allowed to fulfill success criteria is limited to 20% of the 320 stem/acre total for hardwood species (64 stems/acre maximum by species). For softwood species, the maximum number of stems per/acre allowed is limited to 10% of the 320 stem/acre total (32 stems/acre by species). Characteristic species include planted species, softwood species, and volunteer species that have wetland status and were found in the reference forest.

[2]P = planted species; V = volunteer species; S = softwood species; R = found in reference forest.

should be noted, however, that the dense ground cover present at the site will have contributed to some observer bias (missed, uncounted stems) resulting in an underestimation of true stem density. Finally, the mesic soil requirements of planted species such as river birch, yellow poplar, and water tupelo are lacking in much of the floodplain bottomland and mesic slope zones of the planted area due to draining by the canal, and may be contributing to poor establishment of these species.

Appendix C
(2002 Mitigation Monitoring)

VEGETATION MONITORING

Restoration monitoring procedures for vegetation are designed in accordance with U.S. Environmental Protection Agency (EPA) guidelines enumerated in Mitigation Site Type (MiST) documentation (EPA 1990) and COE Compensatory Hardwood Mitigation Guidelines (DOA 1993). A general discussion of the restoration monitoring program is provided.

During the first year, prior to implementation of the restoration plans, vegetation receive cursory, visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed between September 1 and October 30 after each growing season until the vegetation success criteria is achieved.

Nine sample plots have been randomly placed within the Site (As-Built Construction Report, Figure 10). Sample plot distributions have been correlated with hydrological monitoring locations to provide point-related data on hydrological and vegetation parameters. In each sample plot, vegetation parameters to be monitored include species composition and species density.

Vegetative Success Criteria

In wetland areas, success criteria include the verification, per the wetland data form, that each plot supports a species composition sufficient for a jurisdictional determination. Additional success criteria are dependent upon density and growth of "Character Tree Species". Characteristic species include planted elements along with natural recruitment of tree species with a wetland status (FAC or wetter) and/or species identified in reference ecosystems. All canopy tree species planted and identified in the reference wetland will be utilized to define "Character Tree Species" as termed in the success criteria.

An average density of 320 stems per acre of Character Tree Species must be surviving in the first three monitoring years. Subsequently, 290 character tree species per acre must be surviving in year 4, and 260 character tree species per acre in year 5. Planted species must represent a minimum of 30 percent of the required stem per acre total (96 stems/acre). At least five characteristic tree species must be present, and no species can comprise more than 20 percent of the stem total.

If vegetation success criteria are not achieved based on average density calculations from combined plots over the entire restoration area, supplemental planting will be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

No quantitative sampling requirements are proposed for herb and shrub assemblages. Development of a forest canopy over several decades and restoration of wetland hydrology will dictate success in migration and establishment of desired wetland understory and groundcover populations.

Contingency

In the event that vegetation or hydrology success criteria are not fulfilled, a mechanism for contingency will be implemented. For vegetation contingency, replanting and extended monitoring periods will be implemented if community restoration does not fulfill minimum species density and distribution requirements.

2002 Vegetative Sampling

Quantitative sampling of vegetation was carried out in December 2002, approximately 2.5 years after an initial, pre-construction planting and immediately following the post-construction planting date. The nine sampling plots established in 2001 were located using GPS technology; however, variance in as-built construction from that of the proposed conceptual plan required relocating sections of three sample plots (plots 3-5). All nine plots are located within the floodplain bottomland hardwood community, although portions of two plots (plots 3 and 4) also include outer sections of Littoral Shelf, Zone 2 plantings.

Each sample plot is composed of two 300-foot transects extending from a central point. Plot width along each transect extends 4 feet on each side of the central line, providing a 0.11 acre plot sample (600 feet x 8 feet). The total area sampled thus comprises 0.99 acre, approximately 5.5 percent of the total planted area. The center and end points of each plot are permanently established with labeled, white polyvinyl chloride (PVC) pipes. All woody species rooted within the plot boundary were tallied by species and recorded regardless of height or diameter breast height (dbh). In order to compare sampling results to success criteria, collected data were analyzed to determine species composition, abundance, density, and relative density.

Year One Monitoring Results and Discussion

Results of vegetative sampling are presented in Table 1. A total of 19 woody plant species were recorded within the nine sample plots, 10 (53 percent) of these being planted species. Planted tree species (including those planted in 2000) were estimated to account for a density of 725 stems/acre (41.5 percent) and recruit (volunteer) species accounted for a density of 1022 stems/acre (58.5 percent), for a combined, estimated stem density of 1747 stems/acre. Cherrybark oak was the most abundant planted species, accounting for 207 stems/acre, followed by green ash (118 stems/acre), bald cypress (87 stems/acre), willow oak (83 stems/acre), and overcup oak (66 stems/acre). The least represented planted species were tulip poplar (17 stems/acre) and river birch (20 stems/acre). Recruit saplings are dominated by American elm and winged elm (743 stems/acre), which account for 42.5 percent of the overall stem density, followed by sweetgum (115 stems/acre), red maple (79 stems/acre), and hawthorn (52 stems/acre). Since sampling was conducted immediately following planting, measured densities are correlated with planted densities of each species within the bottomland hardwood component (see As-Built Construction Report).

Considering that no Characteristic Tree Species may account for more than 20 percent (64 stems/acre) of the minimum planted tree density (320 stems/acre), the maximum sampled density that may be applied

Appendix C, Table 1. Summary of first year (post-construction) vegetation monitoring data, Howell Woods Wetland Mitigation Site, December 2002.

Common Name	Scientific Name	Density (stems/acre)	Relative Density (%)	Max. Density Allowed to Evaluate Success Criteria[1]	Percent of Total Allowable Density	Characteristic Species	Wetland Status	Comments[2]
Green Ash	*Fraxinus pennsylvanica*	118	6.8	64	9.2	yes	FACW	P, R,
Overcup Oak	*Quercus lyrata*	66	3.8	64	9.2	yes	OBL	P, R
Willow Oak	*Quercus phellos*	83	4.7	64	9.2	yes	FACW-	P, R
Cherrybark Oak	*Quercus pagoda*	207	11.8	64	9.2	yes	FAC+	P, R
Water Oak	*Quercus nigra*	32	1.8	32	4.6	yes	FAC	P
Bald Cypress	*Taxodium distichum*	87	5.0	64	9.2	yes	OBL	P, R
American Sycamore	*Platanus occidentalis*	45	2.6	45	6.6	yes	FACW-	P, R
Tulip Poplar	*Liriodendron tulipifera*	17	1.0	17	2.6	yes	FAC	P, R
River Birch	*Betula nigra*	20	1.2	20	2.9	yes	FACW	P
Water Tupelo	*Nyssa aquatica*	49	2.8	49	7.2	yes	OBL	P, R
Hawthorn	*Cretagus* sp.	52	2.9	0	0.0	no	N/A	V
Red Maple	*Acer rubrum*	79	4.5	64	9.2	yes	FAC	V, R
Sweetgum	*Liquidambar styraciflua*	115	6.6	64	9.2	yes	FAC+	V, R
Persimmon	*Diospyros virginiana*	7	0.4	0	0.0	no	FAC	V
Hackberry	*Celtis laevigata*	10	0.6	0	0.0	no	FACW	V
American Elm	*Ulmus americana*	591	33.8	64	9.2	yes	FACW	V, R
Winged Elm	*Ulmus alata*	152	8.7	0	0.0	no	FACU+	V
Black Willow	*Salix nigra.*	3	0.2	3	0.5	yes	OBL	V, S
Loblolly Pine	*Pinus taeda*	14	0.8	14	2.0	yes	FAC	V, R, S
TOTAL		**1747**	**100.0**	**692**	**100.0**			

[1]Per the success criteria, the number of characteristic tree species elements must exceed 320 stems/acre. However, the maximum number of stems allowed to fulfill success criteria is limited to 20% of the 320 stem/acre total for hardwood species (64 stems/acre maximum by species). For softwood species, the maximum number of stems per/acre allowed is limited to 10% of the 320 stem/acre total (32 stems/acre by species). Characteristic species include planted species, softwood species, and volunteer species that have wetland status and were found in the reference forest.

[2]P = planted species; V = volunteer species; S = softwood species; R = found in reference forest.

toward success criteria is 692 stems/acre. This estimate includes jurisdictional wetland tree species that were not planted but were sampled in the reference plots. In addition, 15 of all species sampled are Characteristic Tree Species and planted species (41.5 percent) represent greater than 30 percent of the overall tree density. Therefore, characteristic tree density and species composition currently meet the minimum requirements for the proposed success criteria.

HYDROLOGY MONITORING

Currently, 12 continuously recording groundwater gauges occur within the Site (Figure 1 and Appendix A As-Built Mitigation Report). Two additional reference groundwater gauges and a stream flow gauge have been installed approximately 0.25 mile upstream from the Site. All groundwater gauges have been installed in accordance with specifications in U.S. Corps of Engineers', Installing Monitoring Wells/Piezometers in Wetlands (WRP Technical Note HY-IA-3.1, August 1993). Monitoring gauges were set to a predetermined depth of approximately 40 inches below the soil surface in order to obtain a more accurate depiction of perching across low permeability, subsurface soil layers (B horizon surface). Since the 1999 installation date, the gauges have been downloaded monthly in order to describe pre-construction hydrology conditions. Well data, including well locations and groundwater elevations, are included in Appendix A of the As-Built Mitigation Report. Hydrological sampling has been performed on-site and within reference areas throughout the year to compare pre- and post-construction conditions. A rainfall gauge has been placed at the Site to monitor precipitation levels and has been supplemented with precipitation data from the National Oceanic and Atmospheric Administration (NOAA).

Hydrology Success Criteria

Target hydrological characteristics include a minimum regulatory wetland hydrology criteria based upon reference groundwater modeling. Evaluation of success criteria will also be supplemented by groundwater gauge data and comparison between restoration and reference areas.

Regulatory Criteria

Target hydrological characteristics during years with average rainfall include saturation or inundation (free water) within one foot of the soil surface for at least 12.5 percent of the growing season. This hydroperiod translates to saturation for a minimum, 28-day consecutive period during the growing season, extending from March 21 through November 4 (USDA 1994). Upper landscape reaches and hummocks within wetland areas may exhibit surface saturation/inundation between 5 percent and 12.5 percent of the growing season. These 5 to 12.5 percent areas are expected to support hydrophytic vegetation within hydric soils. If wetland parameters are marginal as indicated by vegetation and hydrology monitoring, consultation with COE personnel will be undertaken to determine jurisdictional extent in these areas.

Reference Criteria

Alternatively, hydrology success criteria may be established through comparison of groundwater gauge data between the wetland restoration area and the reference wetland. Two groundwater gauges have been installed upstream of the Site in an area that has not been impacted by ditching and dredging activities. Comparison of on-site groundwater gauges with reference groundwater gauges should target hydrologic

success beyond the scope of Regulatory Criteria. If the Site exceeds 75 percent of the hydroperiod exhibited by the reference gauges, restoration credit will be requested from regulatory agencies from areas of the Site which are currently characterized by 5 percent and/or 12.5 percent of the growing season.

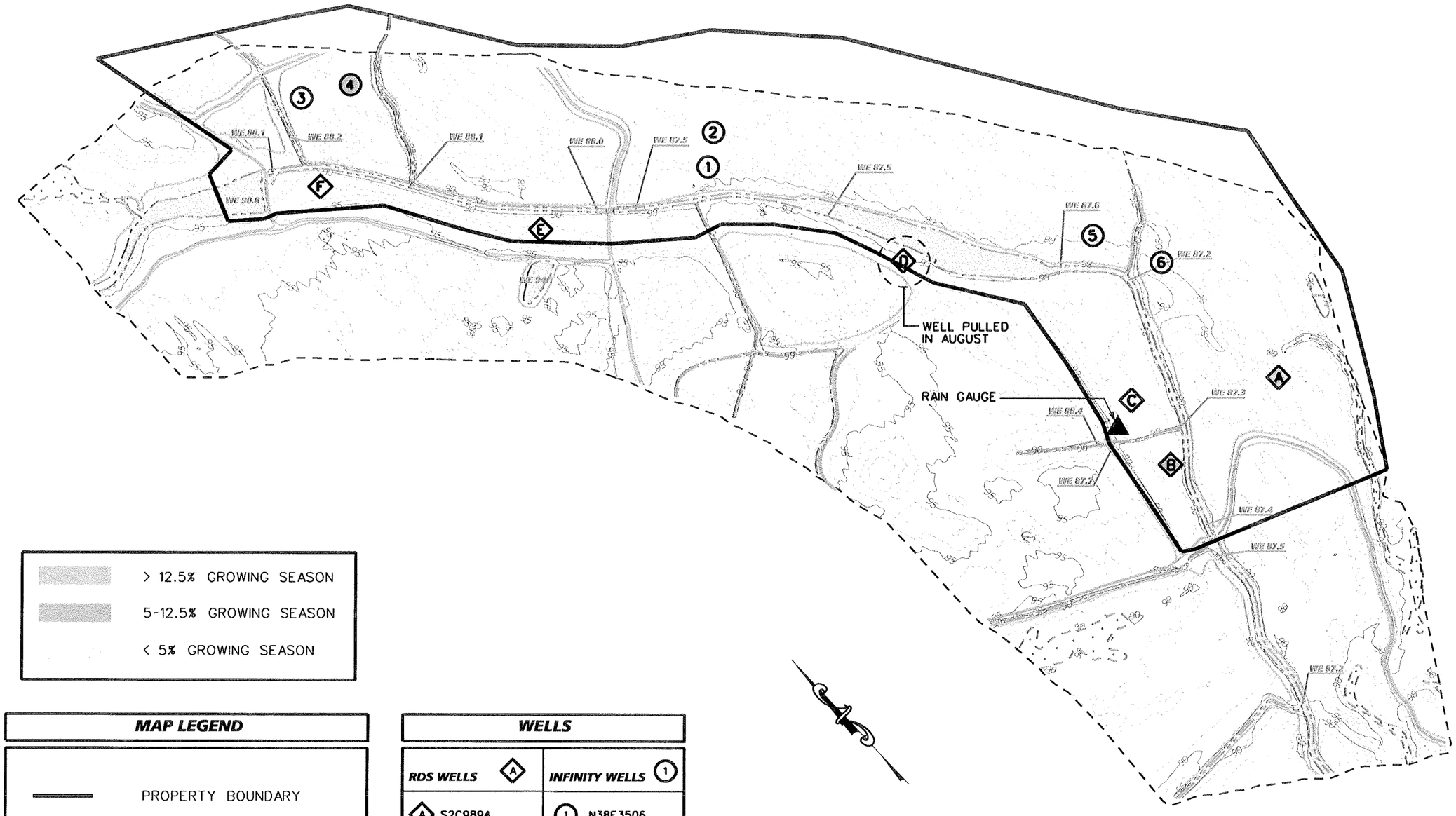
Contingency

Hydrological contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology restoration is not achieved. Wetland surface modification, including construction of ephemeral pools, represents a likely mechanism to increase the floodplain area that supports jurisdictional wetlands. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until the Hydrology Success Criteria are achieved.

Year One Monitoring Results and Discussion

Visual inspection of the Site in December 2002 implies that ground hydrology during periods of normal rainfall has been restored to previously dry forested and agricultural areas of the Site. Such indicators include 1) inundation of the constructed floodpain adjacent the relict channel, 2) ponding of swales and low relief microtopographic areas on outermost portions of the floodplain, 3) surface saturation on hummocks, and 4) complete inundation of the constructed littoral shelf regions. However, the well monitoring period following mid-season construction of the Site has not been of sufficient duration for determining groundwater levels during the wettest (earliest) period of the growing season. Furthermore, monitored groundwater levels and surface flow within the reference area dropped dramatically (during May 2002) prior to construction in June and remained at levels greater than 2 feet below the soil surface until the end of the growing season. Decreases in reference groundwater levels were expected during later, drier portions of the growing season, but in 2002 were exacerbated by exceptional drought in the region. Thus, during most of the 2002 growing season, insufficient inflow of ground and surface water to the Site prohibited the expected, gradual increases in ground water hydrology following construction activities.

Surface flow data and groundwater hydrology data from reference wells and nine (75 percent) of the Site wells do indicate, however, that with increased rainfall beginning in September and October, groundwater levels have raised to within 12 inches of the soil surface. Nonetheless, because of mid-season restoration construction during an exceptionally dry growing season, it is not possible at this time to accurately determine if groundwater sample locations within the constructed areas of the Site have met regulatory and/or reference success criteria.



> 12.5% GROWING SEASON

5-12.5% GROWING SEASON

< 5% GROWING SEASON

MAP LEGEND

- PROPERTY BOUNDARY
- TELEPHONE POLE
- FENCE
- WOODS
- APPROX. MINOR CONTOUR
- APPROX. MAJOR CONTOUR
- WE 88.1 — WATER SURFACE ELEVATION

WELLS

RDS WELLS	INFINITY WELLS
A S2C9894	1 N38F3506
B S2EAD22	2 N38E2121
C S2EAD39	3 N38E1FC2
D S32883A*	4 N38E516D
E S2EAC06	5 N38E5158
F S2C981D	6 N38E4C8E

*MALFUNCTIONING WELL PULLED IN AUGUST

250 0 250 500 750
SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client:
WETLANDS RESTORATION PROGRAM
Raleigh, North Carolina

Project:
HOWELL WOODS
YEAR 1 MONITORING
JOHNSTON COUNTY, NORTH CAROLINA

Title:
WELL LOCATIONS (2002)

Dwn By:	Date:
MAF	DEC 2002
Ckd By:	Scale:
WGL	1"= 500'

ESC Project No.: 98-047.18

APPENDIX C
FIGURE
1