SURFACE AND GROUNDWATER DYNAMICS CRITICAL TO THE MAINTENANCE OF SUBALPINE RIPARIAN WETLANDS

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CHAPTER I

INTRODUCTION

Interest in riparian area management has increased in the western United States, due largely to the multiple use land management concept that government agencies work under. The complexity of the management problem is increased by the varied and often conflicting demands riparian users have for different, superior quality products, and by the extent that these demands exceed supply.

Riparian zones are frequently graphically depicted as having a definite spatial organization. Vegetation is distributed along a topographic gradient from the wettest sites near the water source to the drier sites most distant from the water source. Although this relationship has been hypothesized, actual identification and quantification of the gradient has not been intensively studied.

Additional questions relate to the nature of the gradient, and the roles of surface water and groundwater in the riparian ecosystem. Do obligate hydrophytes prefer areas adjacent to surface water sources, or is groundwater a more limiting factor? Also, what are the processes that control the surface water/groundwater interface? Agencies and groups involved in the development, management and restoration of wetlands seek answers to questions such as these, attempting to identify and quantify how much of the available water in the arid regions of the west can be appropriated without damaging important wetland resources.

A current question in riparian management concerns the need for instream flows to maintain riparian habitat. The role of periodic out-of-channel events to maintain riparian communities has not been investigated. Also, little research has been conducted to establish relationships between groundwater, surface water and existing riparian communities. This research will begin to address these relationships in one particular altitudinal zone.

The objectives of this research are to: 1.) compare the groundwater regimes of intermittent and perennial stream reaches and test the null hypothesis of equality of groundwater for different surface water flow characteristics; 2.) compare the groundwater regimes associated with different subalpine plant communities and test the null hypothesis of equal depth-to-groundwater regimes for all communities; and 3.) determine optimal depth-to-groundwater relationships for three subalpine plant species, <u>Deschampsia cespitosa</u>, <u>Carex aquatilus</u>, and <u>Salix</u>

planifolia, and express these relationships in a habitat suitability format.

CHAPTER II

LITERATURE REVIEW

OVERVIEW

The need for this research is documented in the Executive Summary of Wetland Creation and Restoration (Kusler and Kentula, 1990). The inadequacy of the available science base with respect to wetland restoration, and particularly the need for basic scientific research conducted on natural as well as altered systems is noted. The most critical research need identified was the "hydrologic needs and requirements of various plants ..., minimum water depths, and the role of infrequent hydrologic events such as floods and long term fluctuations in water levels."

In a study similar to this, Grootjans and Ten Klooster (1980) investigated the role of groundwater in four 'semi-natural' plant communities in the Netherlands. Pre- and post-drainage mean and median depths to groundwater explained observed post-drainage changes in vegetation over a seven year period. Groundwater data available in the literature was used to develop cumulative frequency analyses of differences in groundwater regimes in Dutch nature reserves. The authors speculated that cumulative frequency 'duration' analysis was a critical characterization of the groundwater regime in wet habitats. Similar studies in U.S. literature were not found. A segmented review of literature pertinent to this study follows.

HYDROLOGY

SURFACE WATER-GROUNDWATER INTERACTIONS. Little quantitative research is available at this time on the specifics of groundwater-surface water interactions and natural plant communities at any elevation in the central Rocky Mountains. Ischinger and Schneller-McDonald (1988) cite the relative dearth of publications in the U.S. Fish and Wildlife wetlands data base that deal with non-coastal freshwater wetlands in the West (7.9% of the national data base; 79 of 1000 articles). Only one-quarter of the western literature is experimental in nature. They list interrelationships between surface and groundwater hydrology and plant communities as a primary research need.

Boelman (1989) modeled groundwater-surface water interactions with riparian vegetation on a losing stream in the cold desert of Wyoming. He found that the phreatic surface of the associated groundwater was nearest the ground surface in reaches of the stream that had associated riparian areas in an improved condition. In contrast, in reaches of the stream where riparian conditions were poor or degraded, there was a corresponding drop in the phreatic surface of the groundwater. Boelman (1989) also found that the amount of stored water in the improved riparian areas was more than double that of the degraded riparian areas. This has obvious implications for water yield and recharge. Davis, et al (1990), described the plant community-surface water-groundwater relationships in a wetland associated with perennial springs and headwater streams (cienega). Non-recording groundwater wells were installed to document groundwater elevation and continuous water level recorders maintained stream stage records. Soil moisture content was monitored using Time Domain Reflectometry (TDR). Soil texture was also sampled and plant community structure was determined using a Daubenmire scheme to estimate cover. Data were analyzed using geographic information systems pcArc/Info and Map Analysis Package.

Davis, et al (1990) determined the cienega was groundwater dependent, and the stream was dependent on a nearby spring for perennial channel flow (effluent system). When mapped, 'several' plant communities were found to coincide with varying groundwater levels in the cienega.

Novitzki (1978) used hydrologic characteristics of wetlands to develop a classification system. Four categories were identified depending on the source of inflow and the permeability of the substrate: 1.) surface-water-slope wetlands, 2.) surface-water-depression wetlands, 3.) groundwater-depression wetlands, and 4.) groundwater-slope wetlands. Brown and Stark (1987) used a water budget technique to classify the hydrologic regimes of two wetlands in Minnesota and Wisconsin according to Novitzki (1978).

STREAMFLOW. The role of streamflow in wetland hydrology was studied by Platts et al (1985), Dougherty, et al (1987), and Kraeger-Rovey (1991). Dougherty, et al (1987) distinguishes between wetlands where overbank flooding occurs or where main channel water levels influence the hydrologic regime, and wetlands that are supported by a hydrologic regime independent of main channel stage. Groundwater gradient, stream channel character (gaining or losing stream), non-synchronous fluctuations of groundwater and streamflow levels, and variation in water quality between groundwater and surface water were supportive evidence for distinguishing between these wetland types. Main channel influences on wetlands were overbank flooding, stream stage effects on groundwater levels, and channel damming by beaver or ice jams.

Kraeger-Rovey (1991) studied two stream systems in the Havasu National Wildlife Refuge and the Tonto National Forest to determine the minimum streamflow requirements to maintain the ecosystems. Kraeger-Rovey hypothesized wide, upstream valleys had previously been flow attenuators and supplied the streams with their perennial baseflow. Both streams studied were subject to recent upstream groundwater pumping for irrigation and a subsequent reduction in streamflow in both channels was noted, to the point that the previously perennial streams became intermittent.

Shallow pits were dug to determine interactions between surface and groundwater. Stream bed samples were collected downstream from the point of zero channel flow, and presence of a 'cemented' surface layer of fines was noted. Kraeger-Rovey hypothesized that this layer could have effects on surface water-groundwater exchange, and concluded provisions for maintenance of a perennial streamflow might not be sufficient to maintain the ecosystem.

The effect of flood events on two streams in northeast Nevada and one in northeast Utah during 1978-1984 was studied by Platts, et al. (1985). During this period the study streams had flood occurrences estimated conservatively as 50 year events. Platts, et al. concluded that the flood events contributed to streambank destruction in an inverse relationship with streambank vegetation present. Where vegetation was abundant, flood impacts were less. Stream adjustments occur as a result of flood flows; and when these adjustments occur, riparian habitats are altered.

<u>HYDROLOGIC METHODS</u>. The use of groundwater well

networks in wetland hydrology is common. Both Henszey (1988) and Boelman (1989) used shallow groundwater wells for monitoring groundwater with excellent results. Henszey added a grid pattern to present three dimensional relationships. The technique is currently in use in a study of the Platte River in Nebraska, also through the Wyoming Water Resources Center (Wesche, et al, 1990). Others have used groundwater wells to investigate stream stage-groundwater elevation relationships (Crist, 1990; Glover, 1990; Cooper, 1990).

SUBALPINE VEGETATION

Subalpine zones were reported between 9,000 and 11,000 ft in the Medicine Bow Mountains of Southeast Wyoming, but best developed between 9,800 and 10,600 ft (Oosting and Reed, 1952). Daubenmire (1943) described the subalpine zone as occupying 2,000 ft of elevation in the central Rocky Mountains. The general vegetative communities of the Rocky Mountain subalpine zone were also described by Daubenmire (1943), and of the Medicine Bows in particular by Hanna (1934), and Oosting and Reed (1952). In addition, Daubenmire (1943) reported very few species capable of growth throughout all altitudinal zones, and noted the existence of true shrub communities on wet, boggy soil. These communities were dominated by *Betula glandulosa*, (bog birch) and *Salix* spp. (willow). Oosting and Reed (1952) concurred, reporting the basic uniformity of subalpine vegetative communities, describing them as 'floristically simple'.

Nelson (1984) provides a comprehensive description of the flora of the Medicine Bow Range. A dichotomous key is provided for plant identification, developed from Hitchcock (1969). Nomenclature in this thesis will follow Nelson (1984).

PLANT-WATER RELATIONS

HISTORICAL. Meinzer (1927) presents an historical account of plant-groundwater relations in desert regions. The paper is a compilation of the author's works on plants as indicators of groundwater, various species of plants that he classifies as 'plants that feed on groundwater', and the value of plants as indicators of water quality. *Salix* spp. is listed.

IMPORTANT RIPARIAN SPECIES. *Salix* is a dominant shrub genus in subalpine riparian areas in the Snowy Range (Skinner, 1974), and many species of the genus are important as wildlife browse (Stubendeick, et al, 1986, Anderson and Ohmart, 1985). Its rooting habits make it an important species in streambank stabilization (Groenveld and Griepentrog, 1985). *Salix planifolia* is an abundant riparian shrub species in the subalpine riparian areas of the Snowy Range (Nelson, 1984).

The genus *Carex* occupies a wide variety of hydrologic niches in the subalpine, ranging from windswept ridges to water's edge (Nelson, 1984). *Carex aquatilus* is an rhizomatous obligate hydrophyte important in riparian soil stabilization, and is found recolonizing high altitude mine tailing sites (Keammerer, 1988).

Deschampsia cespitosa (tufted hairgrass) is a dominant subalpine bunch grass (Skinner, 1974; Nelson, 1984) as well as being an excellent browse species (Stubendieck, 1986). Brown (1988) found that ecotypic variability and its tolerance for acid soil conditions make *D. cespitosa* an excellent species for high altitude mine land reclamation. Kaemmerer (1988) also documents the colonization of *D. cespitosa* on mine sites in Colorado, and observed the acid tolerance of the species, noting that it was the most commonly encountered grass on moist tailings sites.

Henszey (1988) investigated the effects of streamflow augmentation on a riparian system associated with an ephemeral stream channel in the montane region of southeastern Wyoming. Augmentation was required to mitigate the loss of riparian habitat due to trans-basin diversion for municipal use. He reported that while riparian vegetation was abundant on the ephemeral channel, augmented flow resulted in changes in groundwater levels and a consequent change was observed in herbaceous vegetation. Changes in species composition of three dominant species, Carex spp. (sedges), D. cespitosa , and Calamagrostis neglecta (slimstem reedgrass) were observed.

Cooper (1990) investigated the wetlands associated with the Big Meadows region of Rocky Mountain National Park. He mapped piezometric surface and plant communities, and hypothesized a relationship between groundwater and the spatial organization of plant communities in these wetlands.

A classification of Snowy Range Observatory (SRO) subalpine meadows was done by Skinner (1974). Meadows were differentiated as wet, moist, or dry. The author characterized the wet meadow type as having a water table at or above the surface of the ground. Additionally, he identified these meadows as having an evident shrub community composed primarily of Salix spp. and Betula glandulosa. The dominant herbaceous species in these wet meadows by percent cover were Carex spp. (sedge), and D. cespitosa.

SPECIES WATER REQUIREMENTS. Water table depth and production of D. cespitosa were investigated by Rahman (1976). He concluded that Deschampsia is common on wet soils because of tolerance of poor soil aeration, and may be excluded on more mesic sites by competition for light. Beetle (1961), concluded that Deschampsia cespitosa tended to occupy sites where the more water tolerant species of Carex were less frequent. Similarly, Funk, et al (1990) studied C. aquatilus, Eriophorum angustifolium, and

Eriophorum scheuchzeri (cotton-grass) at three different water table depths (surface, -3.94, and -13.79 in). The author reported Carex aquatilus was significantly less productive at -13.79 in. Growth variation was primarily expressed as variation in leaf area and growth duration.

CHAPTER III

DESCRIPTION OF STUDY AREA

OVERVIEW

The Snowy Range Observatory (SRO) is a densely instrumented research watershed located in the Medicine Bow Mountains of Southeastern Wyoming (Figure 1). The original charge of the SRO is and remains "the long-term study of the hydrologic cycle in a high mountain watershed". Wesche (1982) details the history of the SRO and summarizes data through 1981. In this publication, Wesche points out the decline in the condition of the instrumentation beginning in the mid-1970's for a five year period. A consequent decline in the reliability and completeness of the data is noted in this time frame. Condition of the observatory infrastructure was improved beginning in 1979, enhancing data completeness and reliability. Accordingly, a great deal of data is already in existence for a 25 year period of record, and contributed greatly to this study. Specifically, there currently are 20 operating Belfort

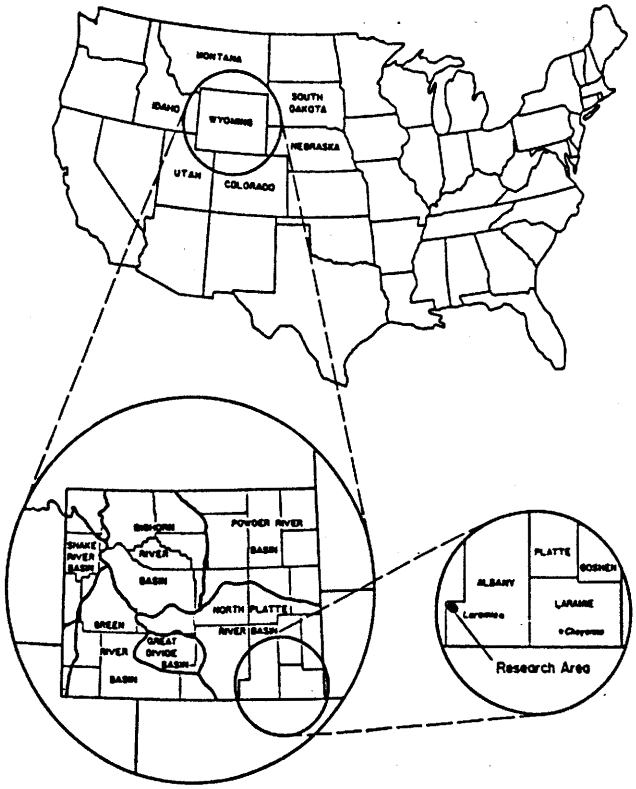


Figure 1. Location of the Snowy Range Observatory.

weighing-bucket type precipitation gages, six climate stations (air temperature, wind and relative humidity), and seven streamflow gaging stations. Instrumentation ranges in elevation from approximately 8500 ft above mean sea level (msl) near Centennial, Wyoming, to over 11,000 ft above msl at the Lost Lake precipitation station.

STUDY REACHES

This study is located on two streams within the Observatory, Telephone Creek and Nash Fork Creek. Both have origins at elevations over 10,500 ft and flow easterly. Telephone Creek flows into Nash Fork Creek, which continues another 4.5 miles before its confluence with the Little Laramie River at 8,800 ft. Two reaches were investigated on Telephone Creek, above Towner Lake and above Mill Pond. Two reaches were also investigated on the Nash Fork watershed, one below Little Brooklyn Lake, and another on an unnamed intermittent tributary that enters Nash Fork Creek just upstream of the main channel study reach (Figure 2). With the exception of the intermittent study reach, all have historic stream flow gaging stations within 1 mile. The two study reaches on Telephone Creek have gages within 100 ft.

Both Telephone Creek and Nash Fork Creek have snowmelt runoff dominated hydrographs typical of the Central Rocky Mountains. Flow is low throughout the year with the exception of the months of May through July when the majority of the preceding winter's snowfall enters the stream channel as runoff (Figure 3, page 19). Eighty-five percent of the time flows are between 1 and 10 cubic feet per second (cfs). The remaining fifteen percent of the time corresponds to the hydrograph peak when flows are between 10 and 90 cfs.

Stream channels in both Telephone Creek study reaches are type "C" channels having overall gradients less than 1.5% (Rosgen, 1985). The Nash Fork study reach has channel gradient greater than 1.5% in the study reach, making it a type "B" channel.

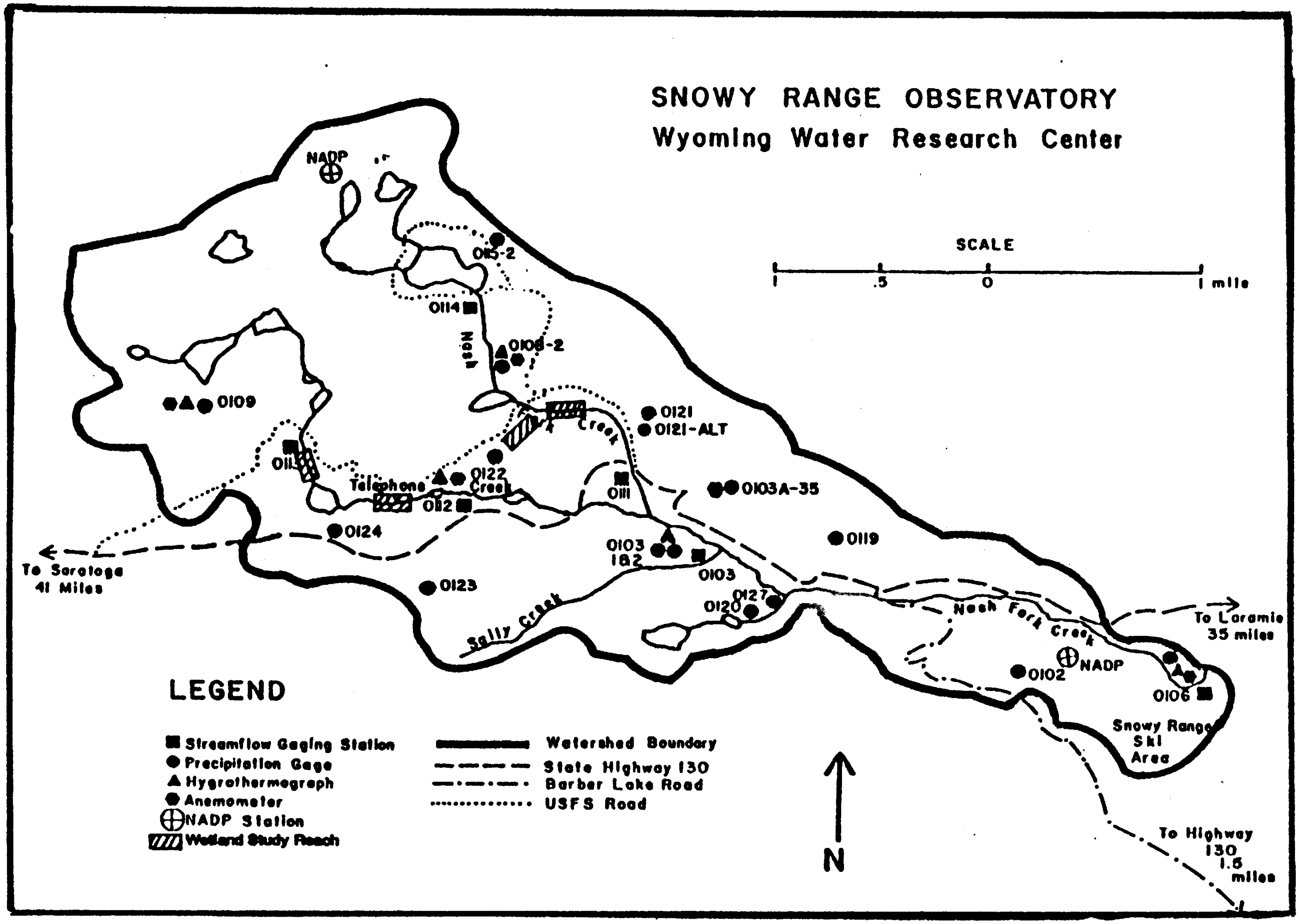


Figure 2. Location of Study Reaches and Hydrologic Instrumentation, Snowy Range Observatory.

CLIMATE AND WEATHER

Precipitation in the Nash Fork and Telephone Creek watersheds occurs primarily in the winter months (December-March) as snowfall. Since this snowfall is related to frontal passages, its spatial distribution is relatively even at a given elevation. Precipitation amounts for the Little Brooklyn Lake station (W.W.R.C. #0108)(Figure 2), elevation 10,360 ft, from 1967-1981 averaged 48.5 inches (Wesche, 1982). This average has fairly large annual variability. The wettest years since 1967 at the #0108 precipitation gage were 1982 and 1983, when 57.9 and 66.8 in. of precipitation fell. In contrast, 1991 saw 41.8 inches of precipitation, 85% of the mean.

Mean extreme temperatures in July at WWRC #0108 (Figure 2) range from highs of 72 degrees to lows of 29 degrees Fahrenheit. January mean extremes range from 29 to lows of -7 degrees Fahrenheit. Relative humidities are typically lowest in June and highest in March (Wesche, 1982).

GEOLOGY AND SOILS

The Snowy Range is classified geomorphically as high mountains having less than 20 percent gently sloping terrain (Mears and Marston, 1991). Formation of the Snowy Range occurred during the Laramide Orogeny (late cretaceous), and portions were heavily glaciated during the Pleistocene epoch (Mears and Marston, 1991). Soils of the Snowy Range are

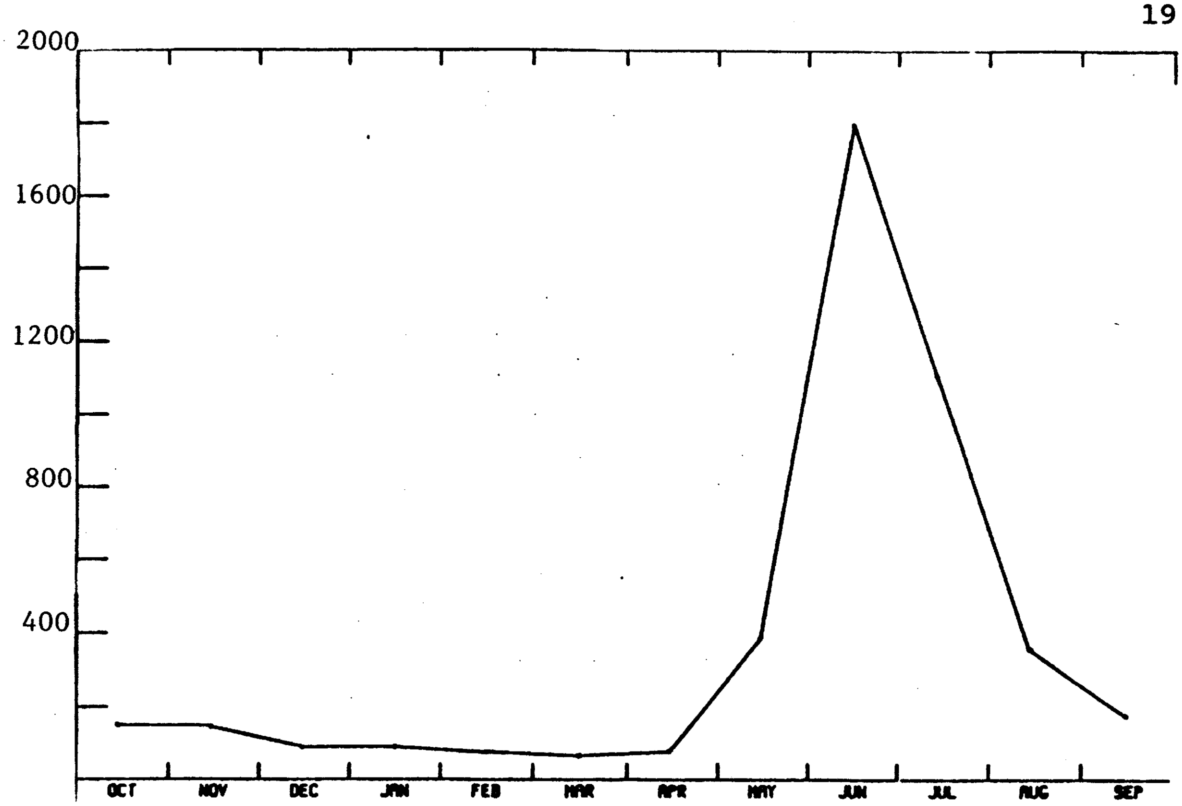


Figure 3. A Typical Hydrograph for the Snowy Range Observatory. Mean Monthly Streamflow (ac-ft) for Nash Fork Creek Between 1968 and 1981 (from Wesche, 1982).

generally colluvial, alluvial or glacial in pedogenesis (Reider, 1991).

LAND USES

Historic uses of the Snowy Range were primarily as a source of timber for the transcontinental railroad and hunting and trapping for the fur trade. During the period of western expansion, some minerals were discovered and exploited, primarily gold and silver (Thybony, et al, 1986).

Today the land is administered by the U.S. Department of Agriculture, Medicine Bow National Forest. Uses are determined by public lands policy and include timber, grazing and recreation. In the vicinity of the study reaches the most important uses are recreation (camping, hunting, fishing and summer homes) and sheep grazing.

CHAPTER IV

METHODS

OVERVIEW

Four stream reaches were selected for study in the Snowy Range Observatory (SRO) in August 1990. Criteria for reach selection were flow characteristics, proximity to an existing streamgage, and the presence of a well developed riparian community. Three study reaches were placed on perennial stream segments, and a single study reach was placed on an intermittent channel. Of the three perennial study reaches, two were on Telephone Creek ('Mill Pond' and 'Upper Telephone'), and one was on Nash Fork Creek ('Nash Fork'). The intermittent reach was in the Nash Fork Creek drainage and named 'Towner Lake Road' (Table 1).

LAND SURVEYING

Topography was surveyed during the month of July and early August, 1991. Surveying was done to intensively map each of the meadow's topography, and to delineate plant

Table 1. Study Reach Characteristics. Average Annual Flow (Q_{aa}) Based on Years with Complete Daily Data Since 1967. Surface Water Characteristics are Either Perennial or Intermittent. Reach Slope is Change in Elevation of the Land Surface (Upstream to Downstream), Divided by the Total Length of the Reach. Basin Area is the Land Area that Will Collect Runoff and Concentrate it in the Stream Reach.

Reach	Surface Water	Reach Slope (%)	Basin Area (mi^2)	Q_{aa} (cfs)
Mill Pond	Perennial	1.5	2.0	5.8
Nash Fork	Perennial	3.9	2.1	5.9
Upper Telephone	Perennial	0.8	1.5	4.7
Towner Lk. Road	Intermittent	1.5	1.3	***

*** - No Long-term Record Exists.

communities. Principal benchmarks were established in each of the four meadows and assigned an arbitrary elevation of 100 ft. Rod shots were taken from a series of satellite benchmarks around the perimeter of the meadows. Each satellite benchmark was located from the principal benchmark, providing thorough coordinate and elevational coverage of each riparian reach. A total of over 1700 rod shots were made in the four study reaches. At each rod shot a visual plant community identification was made to map general vegetation communities. From this intensive surveying, a high resolution map of topography and plant communities was developed in each study reach.

Groundwater wells were surveyed at ground level immediately adjacent to the well and at the measuring point on the well casing. Depth-to-groundwater was measured by inserting an electronic probe (Henszey, 1991) into the well and recording the depth-to-groundwater at the measuring point on the well casing. A relative value of piezometric head in the unconfined aquifer could then be established by subtracting the measured depth to groundwater minus the surveyed height of the well casing above the ground from the surveyed elevation of the ground surface adjacent to the well. In addition to topographic surveying, stream channels were surveyed in the three study reaches to detail channel profiles. Channel geometry obtained from this survey was used in the calculation of bankfull discharge for the stream reaches using the Slope-Area method (Dalrymple and Benson, 1976).

HYDROLOGIC METHODS

GROUNDWATER MONITORING NETWORK. Establishment of a shallow groundwater well grid was completed in all four meadows by late September, 1990. Three transects were selected per meadow, with 5 or 6 wells per transect. Transects were identified as A, B, or C. The A transect was the furthest upstream, the B transect intermediate and the C transect furthest downstream. A total of 69 wells were installed. Well numbers were assigned to each well based on the distance each well was from the right outside transect stake. Wells were spatially oriented to be representative of the topographic gradient on either side of the stream and the various plant communities present.

Wells were hand excavated with a shovel and auger to intersect the unconfined aquifer. In most cases, the wells were constructed to intersect 2-3 ft of the aquifer. However, it was difficult to be consistent with well depth due to the extremely rocky nature of the sites. The wells were established in late August and early September when the water table was at or near its yearly minimum. Installed well depths below ground surface ranged from 3 to over 6 ft.

Groundwater wells were cased using 2 in. PVC pipe and were fully slotted along their buried depth at the location of aquifer intersection. A measuring point was notched on the exposed mouth of the well using a file, to insure a constant point of measurement. The well casing was then installed in the well hole and soil was backfilled in the opposite order of removal to approximate the original soil profile. PVC caps were installed on the exposed well mouths to prevent precipitation entry. Additionally, each of the 69 wells were cemented at the soil surface in early June of 1991, to minimize overland flow or standing water from seeping down the well casing.

One well per transect was continuously recorded using a Stevens type F-1 water level recorder. All continuous recorders were installed and in operation by June 13th, 1991, and continued in operation until September 19th, 1991. Each non-recorded well was measured 28 times during the summer of 1991, at a minimum frequency of one time per week. Each recorded well produced a reducible pen trace for the entire sampling period with the exception of a single groundwater well and the newly established stream gage in the Nash Fork study reach, which were vandalized on July 19th and not discovered until 4 days later. On these two charts, depth-to-groundwater and stream stage values were estimated for the missing data using correlation techniques with nearby groundwater wells and the downstream stream gage. Confidence in the derived values for these dates is high since streamflow was approaching base levels.

SURFACE WATER. Existing stream gaging stations were used to develop surface water characteristics on two of the three perennial reaches. For the Nash Fork perennial reach, a temporary stream gage was established on June 6th, 1991 to provide reliable stage-discharge relationships for the study period. During the summer of 1991, streamflow was measured at the new gage 8 times using the current meter-midsection method (Buchanan and Somers, 1965), on the rising, crest and receding limbs of the hydrograph. From these measurements, and the associated stream stage readings taken at the time of the flow measurement, a rating table was established for the 'Nash Fork Below Intermittent' streamgage. No streamgage was established at the intermittent study reach.

The existing stream gages for the two reaches on Telephone Creek are maintained as part of the Wyoming Water Resource Center's Snowy Range Observatory, and are numbered 0113 for the Telephone Creek above Towner Lake gage and 0112 for the Telephone Creek above Mill Pond gage (Figure 2). These two stream gages are within 100 yards of the 'Mill Pond' and 'Upper Telephone' riparian study reaches. For these two gages existing rating curves were updated to include 1991 data. Rating curves for the three perennial reaches all have coefficients of determination (r^2) of greater than or equal to 0.92, with the lowest value at the newly established 'Nash Fork Below Intermittent' gage (Table 2).

Table 2. Stage-Discharge Relationships for the Three Nash Fork and Telephone Creek Stream Gages.

Station	Correlation Equation	r^2
Telephone Ck. Above Mill Pond	Log Q = 1.33 + 1.6*(Log Stage)	.99
Nash Fork Below Intermittent	Log Q = .433 + 3.05*(Log Stage)	.92
Telephone Ck. Above Towner Lk.	Log Q = 1.32 + 1.45*(Log Stage)	.99

The period of record for each stream gage associated with each study reaches was examined. Years having complete records were used in the development of flow-duration curves for the study reaches. Reliability of these flow-duration curves is improved with longer periods of record (Ponce, 1989). Consequently, a minimum of 10 years of complete records was considered adequate. Flow-duration curves were developed for the 0111 and 0112 gages (Figure 2), based on a 10 and 11 year period of record, respectively. Flow-duration curves were developed for the 0113 stream gage associated with the Upper Telephone study reach, based on nine complete years of data, and by correlating with the 0112 (Mill Pond) gage to fill in 1 days missing data for each of 2 additional years. The Mill Pond gage is less than one stream mile below the Upper Telephone study reach and has the requisite period of record.

The Slope-Area method was used to calculate bankfull discharge for each stream reach. Bankfull discharge can be determined using techniques derived from open-channel flow formulas (Ponce, 1989), and the Slope-Area method (Dalrymple and Benson, 1976) is one such technique. Reach length, fall, wetted perimeter and flow area, and average value of Manning's 'n' are required in the equation (english, consistent units):

$$Q_{(BF)} = \frac{1.49}{n} A R^{2/3} S^{1/2},$$

where,

A = cross-sectional channel area;

R = cross-section area / wetted perimeter;

S = energy slope;

$Q_{(BF)}$ = bankfull discharge (cfs);

n = a channel roughness coefficient that is related to the channel's resistance to flow. Accuracy of the method increases as reach length increases (Ponce, 1989). Water slope was used to approximate energy slope and Manning's 'n' was estimated from a table developed by Chow (1959). Values of bankfull discharge for the reaches was compared to flood frequency analysis to determine the occurrence of overbank flooding.

GROUNDWATER. Depths-to-groundwater from all wells were used to develop a map of the piezometric surface for each of the study reaches. Values of piezometric head for each well were used in a grid program using Statistical Applications for Scientists (SAS) SAS/GRAPH Proc G3GRID and Proc GCONTOUR. Values of total head were assigned to each cell in the grid using Proc G3GRID. Values were assigned using a weighted linear interpolation of the three nearest well values, except where a well fell within a grid cell. In this case, the value of head at the well was used as the value of total head for that cell. The grid values were then contoured using Proc GCONTOUR to develop isohyets of head values for the water table aquifer in each study reach on each of the 28 sampling dates that represented a complete data set. Comparisons of water table elevation by date could easily be made as the growing season progressed.

Data from the continuously monitored wells were used to develop cumulative frequency distributions for depth-to-groundwater. These plots have a similar format to flow-duration curves, but represent the percent of time that a given depth-to-groundwater is equalled or exceeded. These depth-duration curves were developed from the data recorded during the 1991 field season.

The data sets of the point sampled wells were then expanded using linear correlation. Each of the point-sampled groundwater wells was compared to the continuously monitored wells that were located in the same vegetative community. Coefficient of Determination (r^2) was the factor evaluated for best correlation. Using this correlation technique, full daily data sets were developed for each of the point-sampled wells from the data set of its most closely correlated continuously monitored well (Appendix C).

Due to late season beaver activity affecting measured depths-to-groundwater, only the continuously monitored Mill Pond C transect well was used. The streamside B transect wells were omitted in this procedure for the same reason. Similarly, due to extreme snow deposition on the Upper Telephone study reach, and runoff lasting well into July, wells number C12, B8, and B38 were also excluded. Finally, a single additional well in the Mill Pond study reach, number A39, was excluded because it was a lone well representing a community type.

Cumulative frequency distributions were calculated for the expanded data sets to develop depth-to-groundwater duration curves. The D_{40}, D_{50}, D_{75}, and D_{90} depths-to-groundwater were selected as diagnostic statistics for the plant communities around the wells. Depths-to-groundwater that were equalled or exceeded less than 40% of the time were found to represent predominantly saturated conditions in all meadows.

VEGETATION

COMMUNITIES. Vegetation community maps were developed during topographic surveying. Communities were classified as Upland Grass/Forb, Open Canopy Willow, Closed Canopy Willow, Tree, or Sedge. In the Mill Pond perennial meadow an additional vegetative community was mapped that was unique to that meadow, the Encroaching Spruce community. In the Nash Fork perennial meadow, *Salix planifolia* occurred in two distinct heights. Accordingly, Nelson (1984) identified two different sub-species of *Salix planifolia*, var *planifolia*, and var *monica*. The height for the sub-species is the diagnostic characteristic, and thus led to the mapping of a Closed Canopy Tall Willow, and a Closed Canopy Short Willow, characteristic of var *planifolia* and var _monica_, respectively.

IMPORTANT RIPARIAN PLANT SPECIES. Three important riparian species, _Salix_ _planifolia_, _Carex_ _aquatilus_, and _Deschampsia_ _cespitosa_ were chosen to attempt to clarify species water requirements of individual plants using the habitat suitability techniques of Bovee (1986). These important species were selected to represent a cross-section of plant forms, for their importance in stream bank stabilization (Groenveld and Griepentrog, 1985), for their relative importance to wildlife (Anderson and Ohmart, 1985) and to represent an apparent gradient in hydrologic requirements. Although all three species tend in water requirements toward the moist end of the hydrologic gradient, the following pattern is frequently observed in the subalpine:

_D_. _cespitosa_----------> _S_. _planifolia_---------> _C_. _aquatilus_
Mesic <--->Hydric

SAMPLING. Vegetation frequency sampling was done at plots associated with each of the groundwater wells, using a variation of the method detailed in the U.S.D.A. Forest Services Region Four Range Analysis Handbook (U.S. Forest Service, 1986). Ten plots were located around each well, in a radial pattern at a radius of 5 feet. The plots were positioned at 0, 36, 72, 108, 144, 180, 216, 252, 288, 324 degrees from the transect line (Figure 4). Each plot center was then flagged and the frequency frame centered on the flag. The vegetation frame consisted of 4 nested frames, each of a different size (Figure 5). The smallest frame, number 4, was 3.88 in^2 (25 cm^2), the number 3 frame was 96.88 in^2 (625 cm^2), the number 2 frame was 193.7 in^2 (1250 cm^2), and the number 1 frame was 387.3 in^2 (2500 cm^2).

Plants rooted in or with canopy occurring over (shrubs only) each of the 4 nested frames was recorded at each of the 10 points surrounding each well. Thus, plants that occurred on or over the smallest frame were give a value of 4, next smallest 3, next 2, and largest 1. Values for each

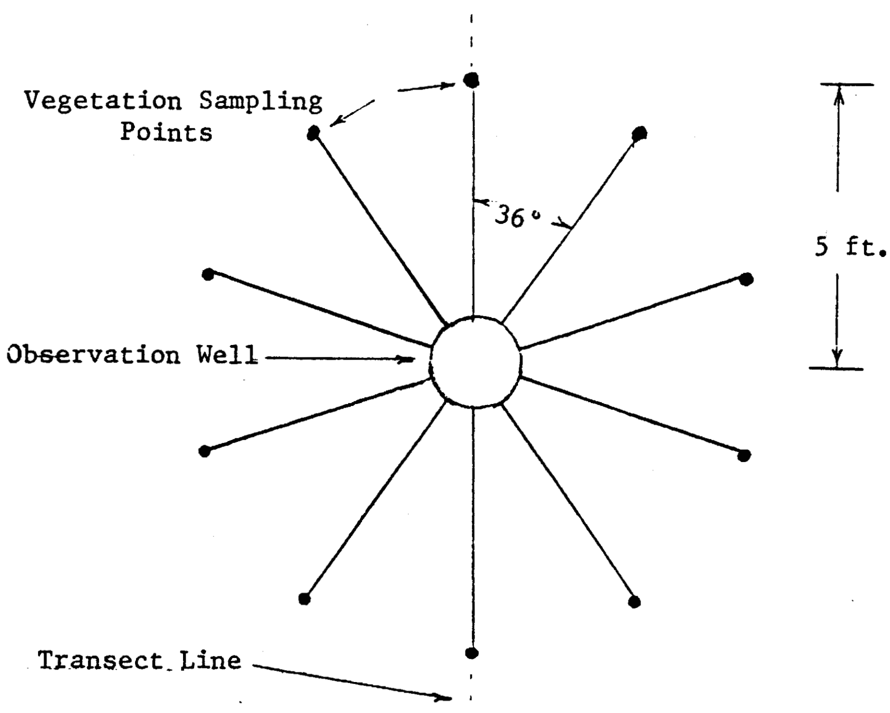


Figure 4. Vegetation Sampling Scheme Around Each Well.

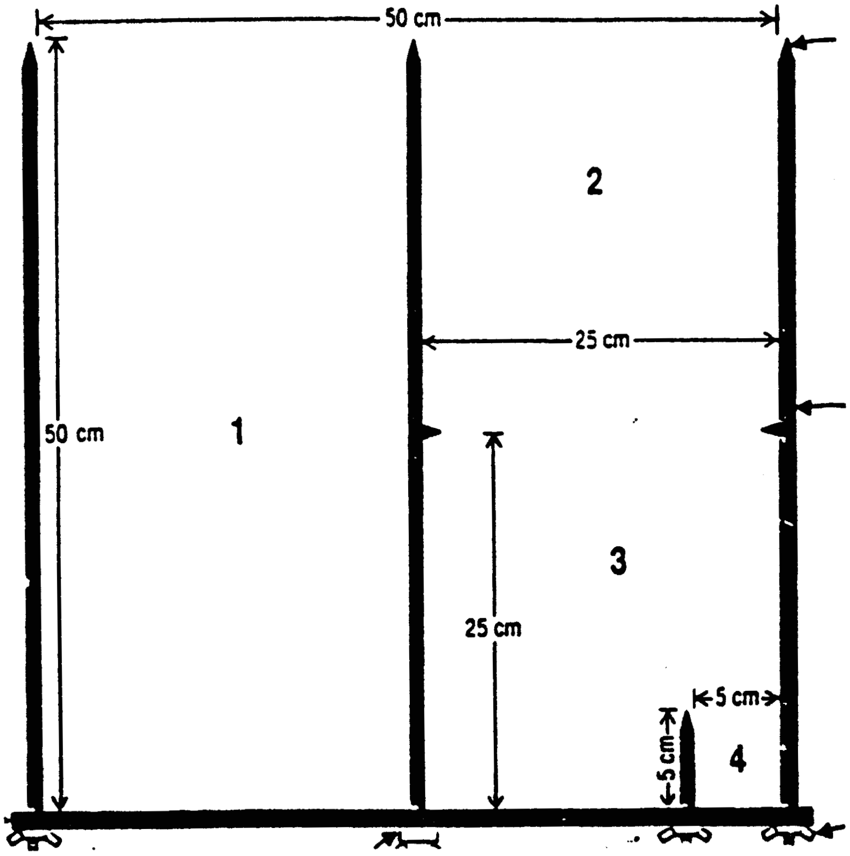


Figure 5. U.S. Forest Service Nested Frequency Frame. Plants Rooted in or Shrubs with Canopies Over Each of the 4 Nested Frames were Considered "In" that Frame, and Assigned that Score.

plant were then totaled for all ten sampling points around each well to arrive at a raw score for that plant at each well (Appendix B). The highest possible score for each plant at each well was 40. Percent frequency at each well using the U.S. Forest Service method therefore was,

$$\% \text{ Frequency} = \frac{\text{total score}}{\text{total possible score}} \times 100.$$

Since frequency is defined by Brown (1954) as the 'relation between the number of sampling units in which the species is present to the total number of sampling units', or algebraically,

$$\% \text{ Frequency} = \frac{\text{total samples 'present'}}{\text{total samples}} \times 100$$

the Forest Service method is more correctly called a frequency index.

To normalize the raw score for each plant at each well, the scores were divided by 40 to produce a value from 0-1 for each plant at each well. This normalized score was used as the basic plant abundance parameter in the development of the suitability curves for the selected important riparian plant species.

This sampling technique allowed for the development of an extensive species list associated with each well, each identified community, and for each of the 4 stream reaches. Plants observed, but not occurring within the sampling scheme were recorded and added to the list. Plants that were lumped at the frequency sampling level were broken out when the species list was developed (Appendix A).

SUITABILITY. The computed normalized frequency scores for *Salix planifolia*, *Carex aquatilus*, and *Deschampsia cespitosa* at each well were plotted against depths-to-groundwater at 1/2 ft intervals for each duration (D_{40}, D_{50}, D_{75}, and D_{90}). Scores for each depth interval at each duration were averaged, then these averages divided by the highest interval score. This allowed maximum scores for each species to equal 1.0. My objective was to present a relationship that described the hydrologic requirements of each selected important riparian species. This technique, commonly used in fisheries habitat management, develops a 'suitability' curve for the plant species with respect to its water requirements.

DATA LAYERING

The development of computers and computer software has made it much easier to manipulate, store and analyze large volumes of spatial data (Marble et al, 1984). Such computer-based applications are generally referred to as Geographic Information Systems (GIS), and rely on a variety of different computers and software to achieve the end product. The experimental design of this study lent itself well to a GIS method of data presentation. Each of the reaches is presented as four layers, using the surveyed topography of each reach as a base map (first layer)(Figure 6). Point location data showing groundwater wells, surface water and gaging locations is the second layer, followed by a map of plant community in the third layer. Three maps of piezometric surface for each study reach, presented separately, representing early, mid and late season ground water levels, constitute the fourth layer.

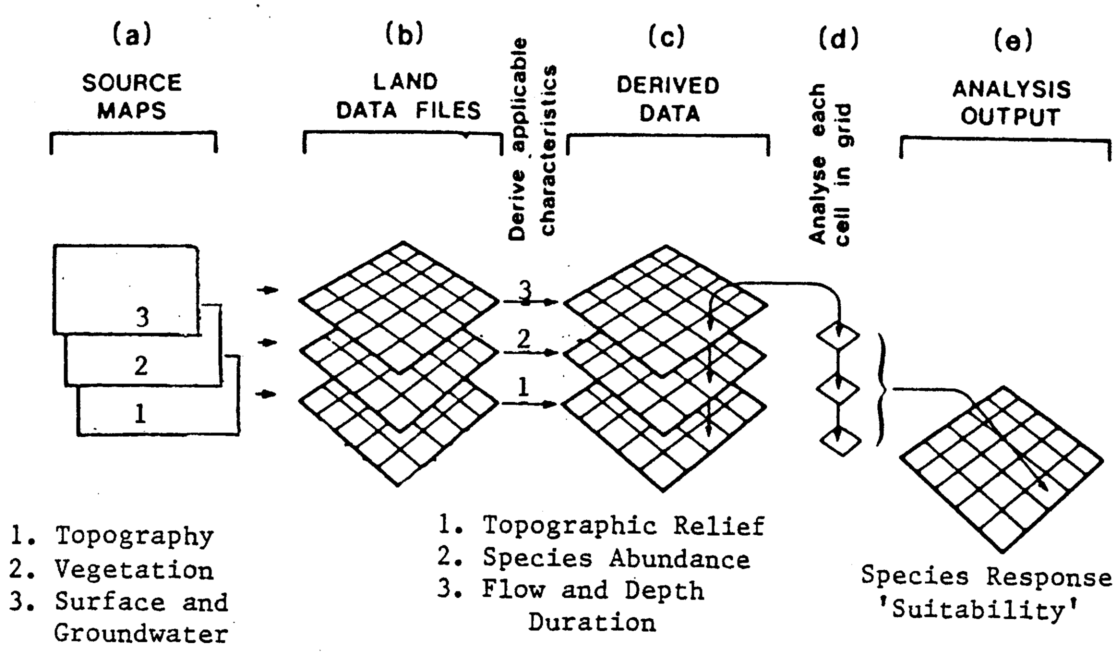


Figure 6. Data Layers and Final Output Parameter.

Frequency scores for the three important riparian plant species are evaluated through the layers of the grid to develop the final 'suitability' values for each important plant species.

STATISTICAL METHODS

Analysis of Variance (ANOVA) was used to test three different null hypothesis. The first was the equality of signature depths-to-groundwater for the four selected study reaches. This was done to determine if differences in surface water flow regime could cause detectable differences in signature depths-to-groundwater. Similarly, the null hypothesis of equality of signature depth-to-groundwater by plant communities was tested to determine if significant differences could be detected in groundwater levels associated with particular plant communities. Finally, a two-factor ANOVA was done to test the hypothesis of equality of normalized score for discretized signature depths-to-groundwater associated with *Deschampsia cespitosa*, *Carex aquatilus* and *Salix planifolia*.

CHAPTER V

RESULTS

DESCRIPTION OF RIPARIAN WET MEADOWS

TOWNER LAKE ROAD INTERMITTENT REACH. The study reach located on the intermittent channel is intermediate in size compared to the other study reaches, over 700 ft long and 550 ft wide. Contributing area for the basin was estimated at 1.3 square miles by planimetering the U.S.G.S. 1:24,000 quadrangle. The vegetation communities have a stratified pattern, from sedge near the center of the meadow to more xeric grass/forb communities near meadow margins (Figure 7). The wetland sedge community follows the meanders of the intermittent channel as well as being associated with topographic depressions. The plant communities change along an apparent topographic gradient from the meadow center outward.

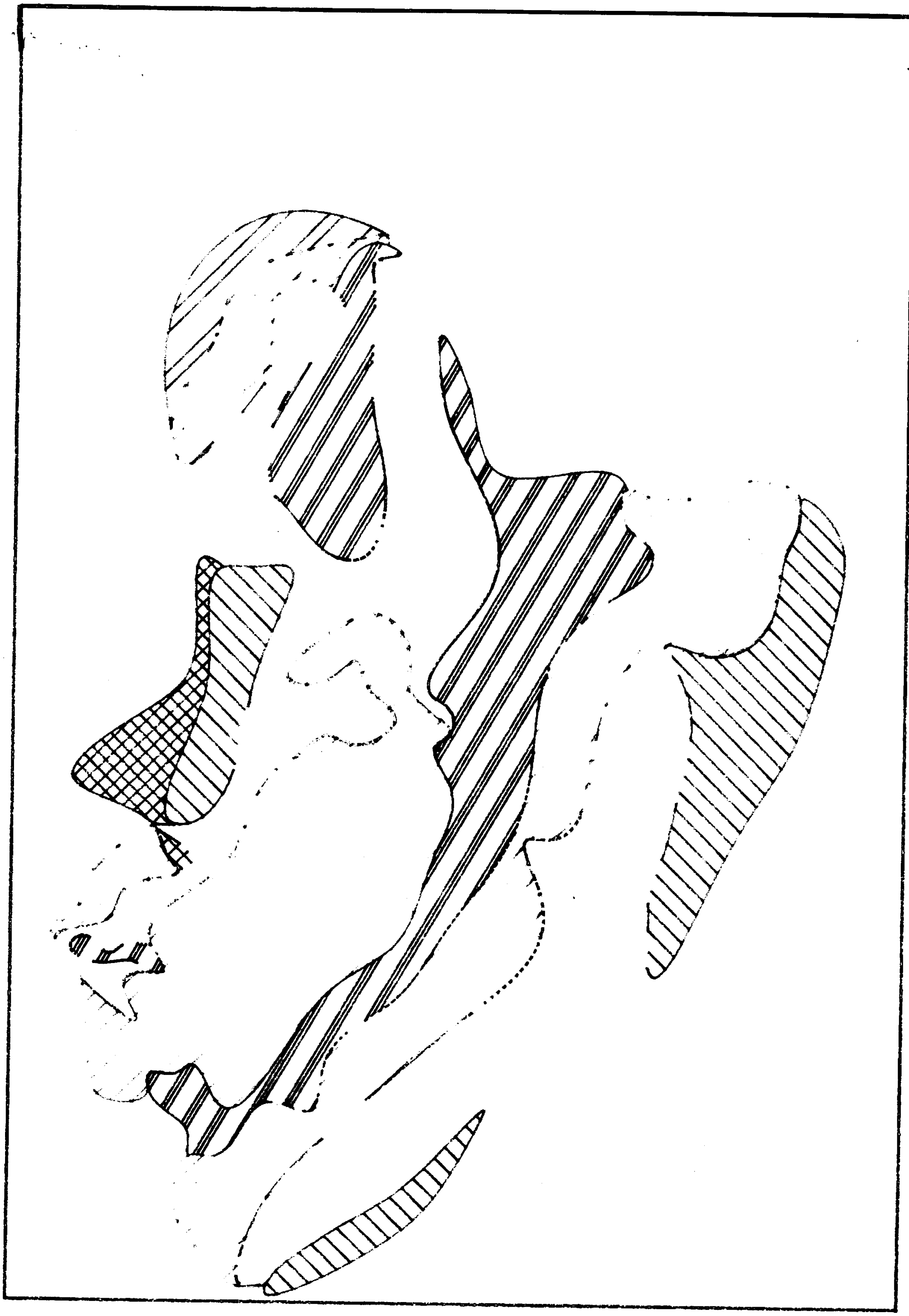
Groundwater elevation approaches ground surface near the intermittent channel early in the season. This relationship becomes less clearly defined later in the

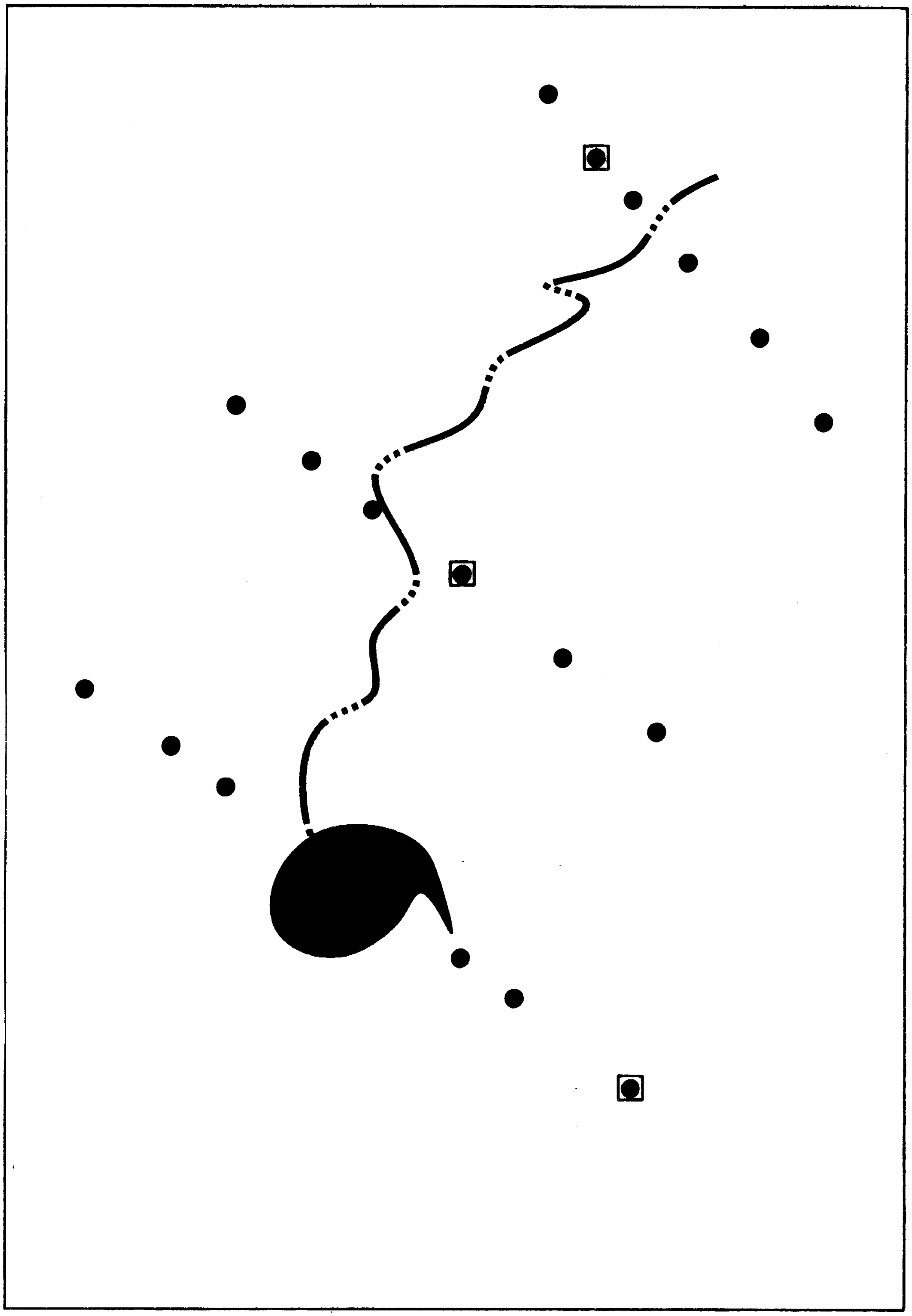
Figure 7. Topography of Towner Lake Road Intermittent Meadow

First Overlay. Ponded Areas, Stream Channel, Well Grid

Second Overlay. Vegetative Communities

1.) Green: Open Canopy Willow
2.) Red Shading: Upland Grass/Forb
3.) Yellow: Closed Canopy Willow
4.) Blue: Sedge
5.) Red Cross-Hatch: Tree





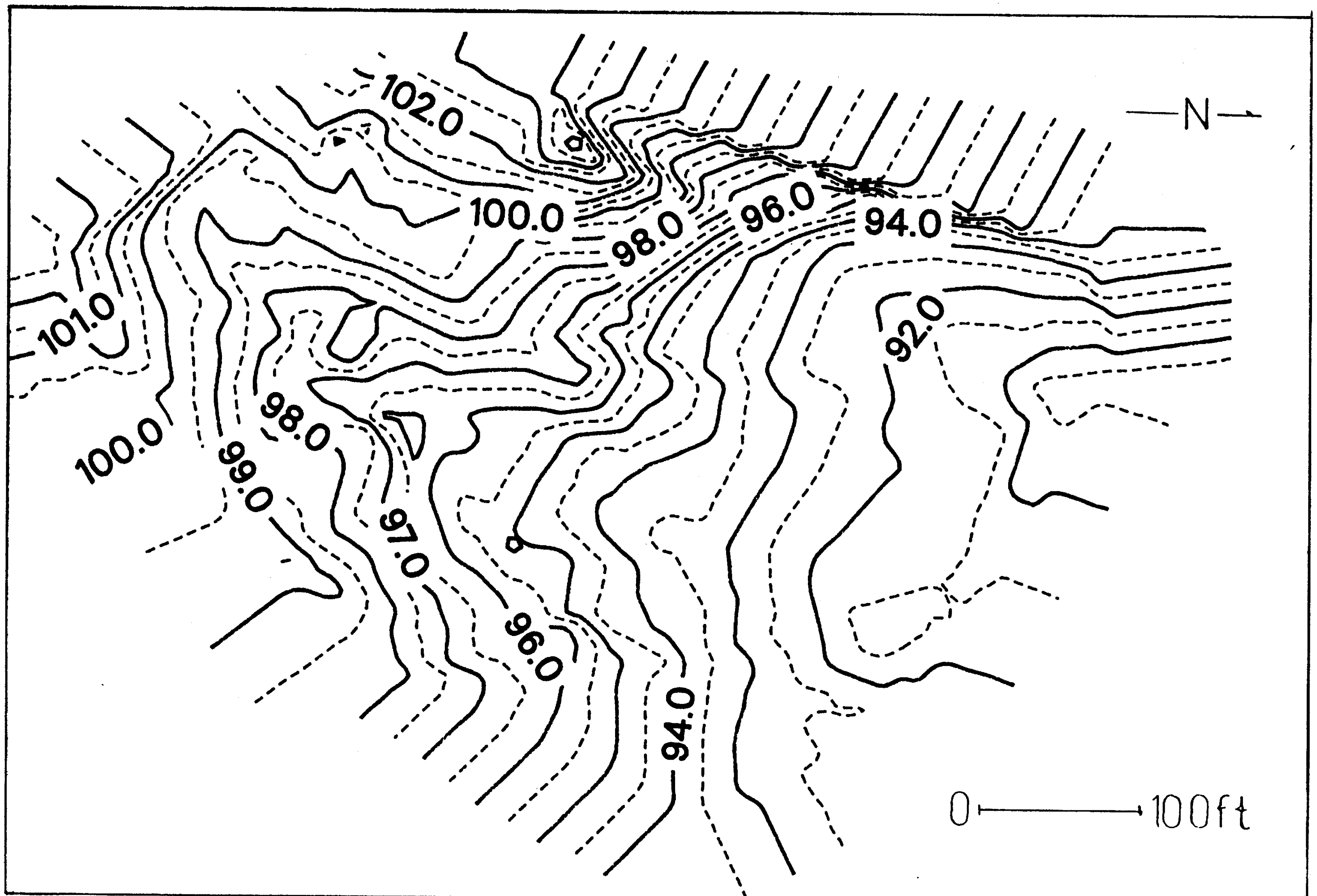
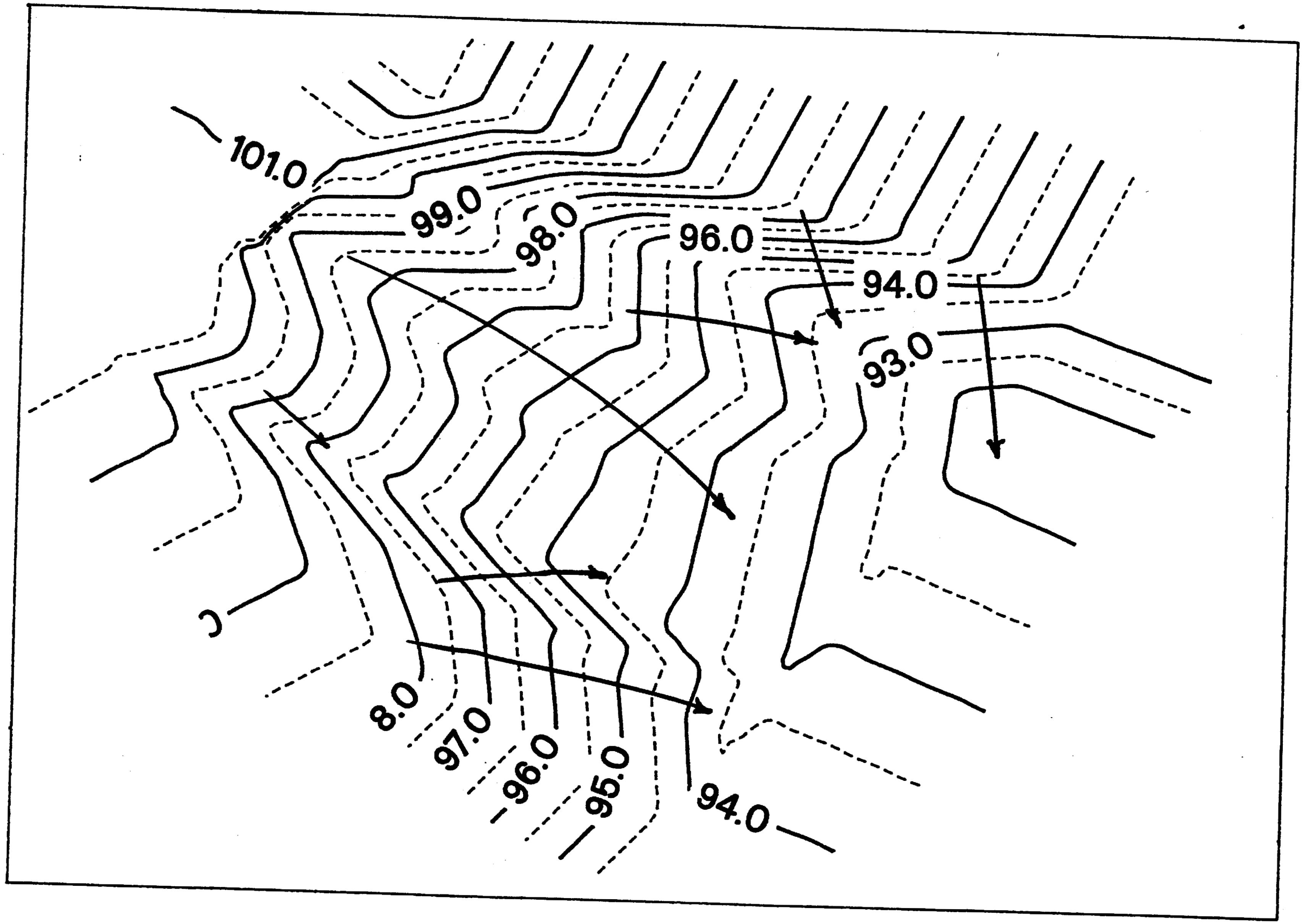

102.0
101.0
100.0
100.0
99.0
98.0
98.0
97.0
96.0
96.0
94.0
94.0
92.0
N
0 100ft

Figure 8. Surface Water, Stream Channel and Well Grid,
Towner Lk. Road Intermittent Study Reach.
Overlay: Piezometric Head, June 25th, 1991. Arrows Indicate
Direction of Isotropic Groundwater Movement.



101.0
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98.0
96.0
94.0
93.0
8.0
97.0
96.0
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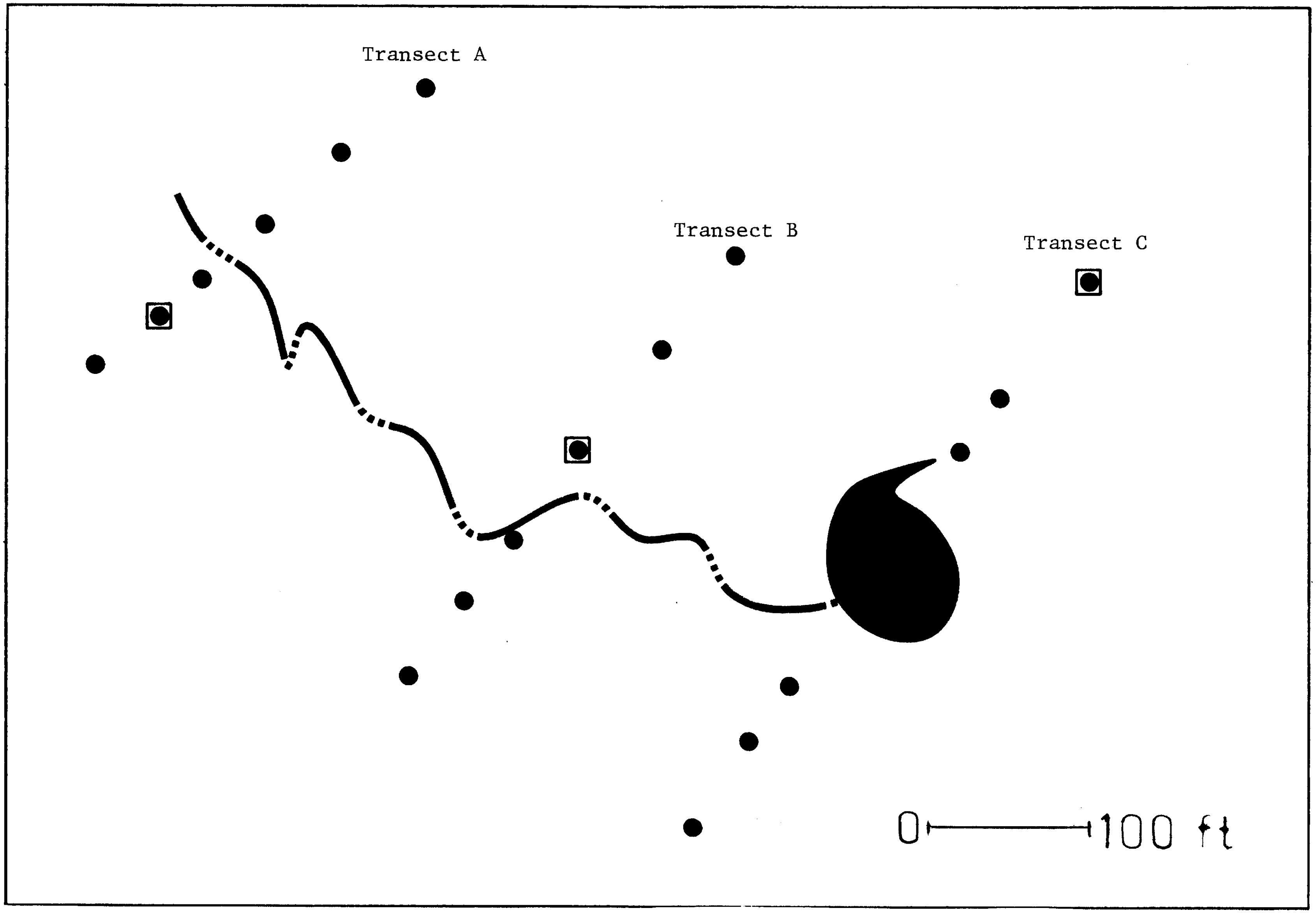
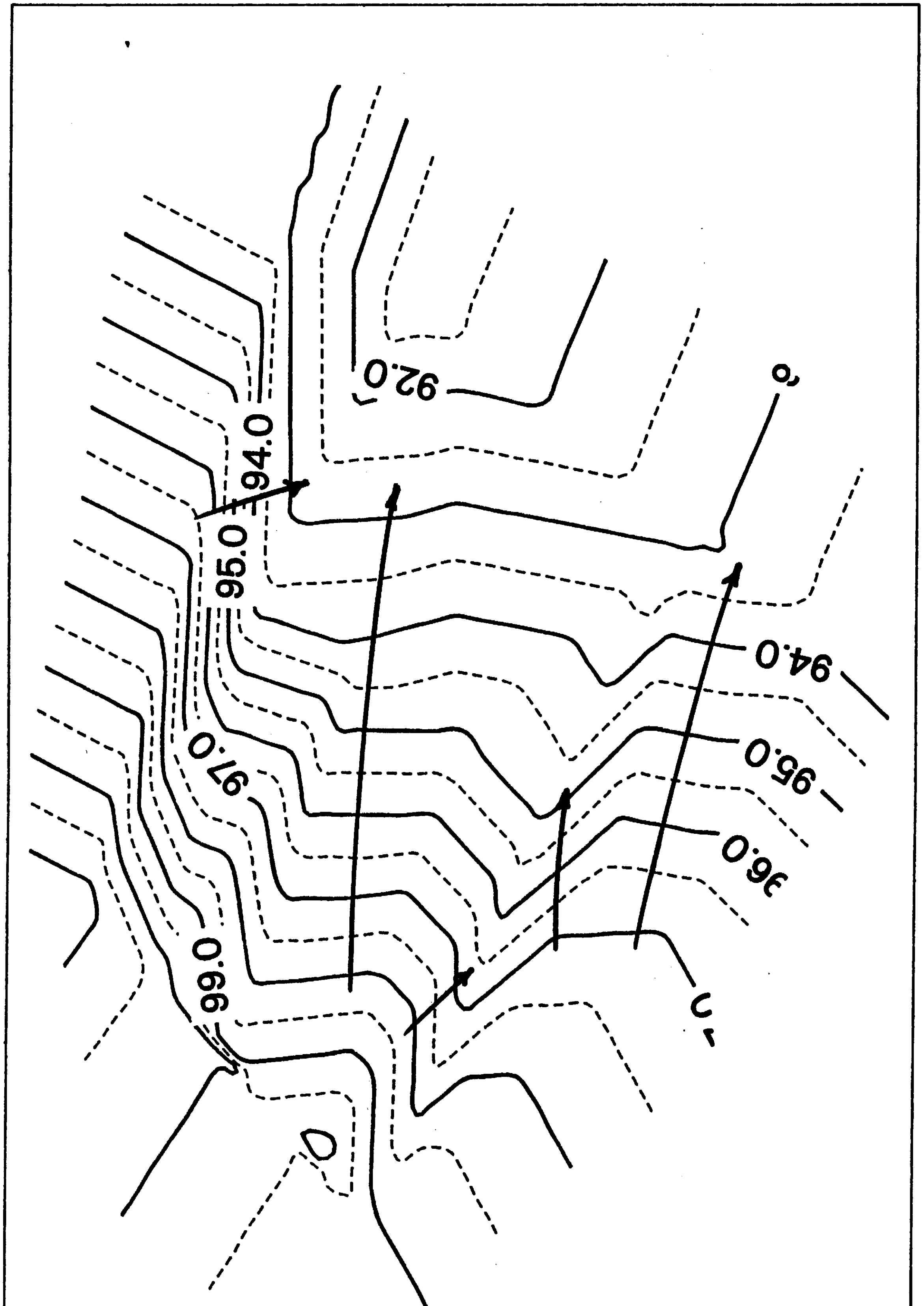

Transect A
Transect B
Transect C
0 100 ft

Figure 9. Surface Water, Stream Channel and Well Grid, Towner Lk. Road Intermittent Study Reach.
Overlay: Piezometric Head, July 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.



92.0
94.0
95.0
97.0
99.0
94.0
95.0
96.0

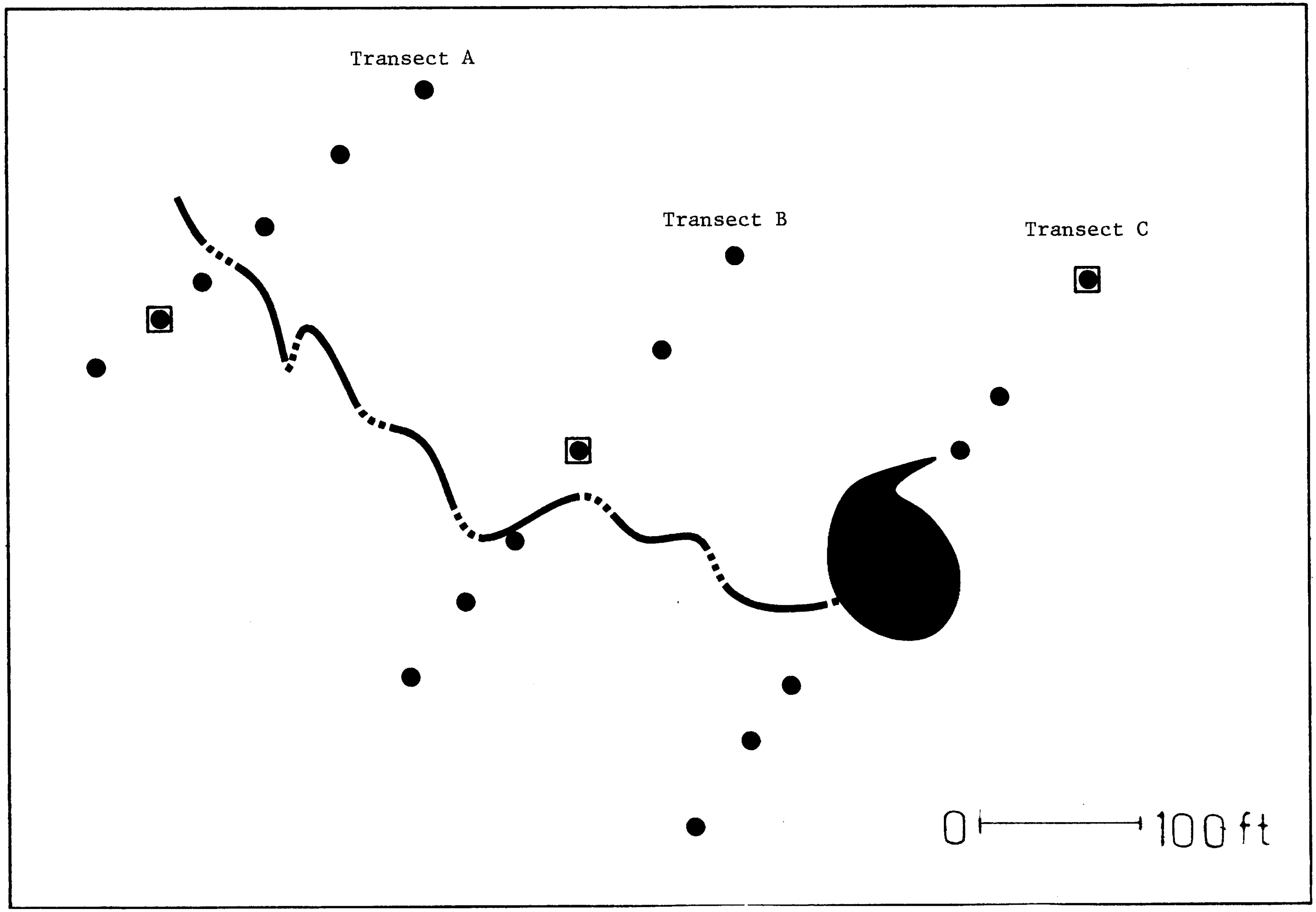
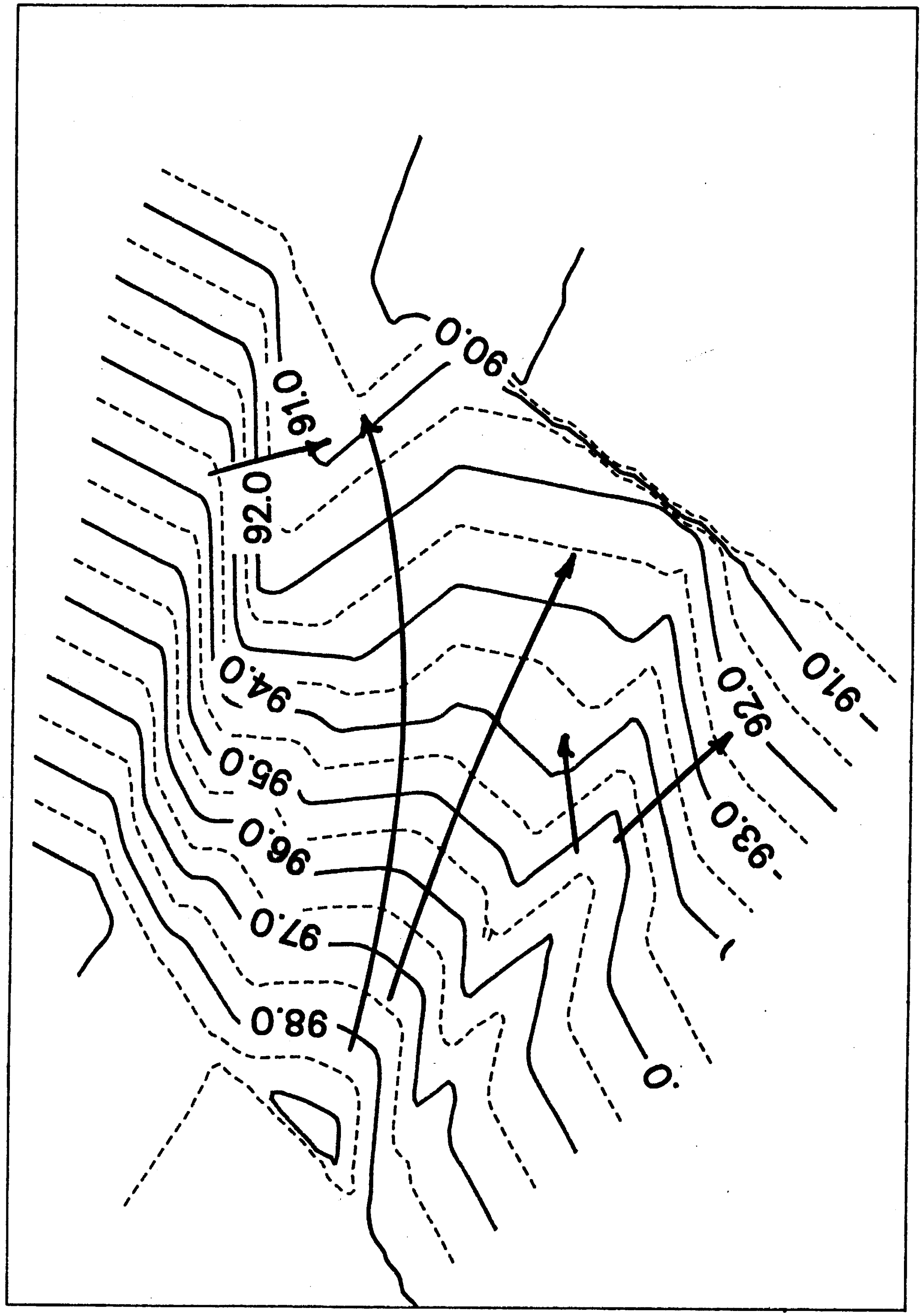
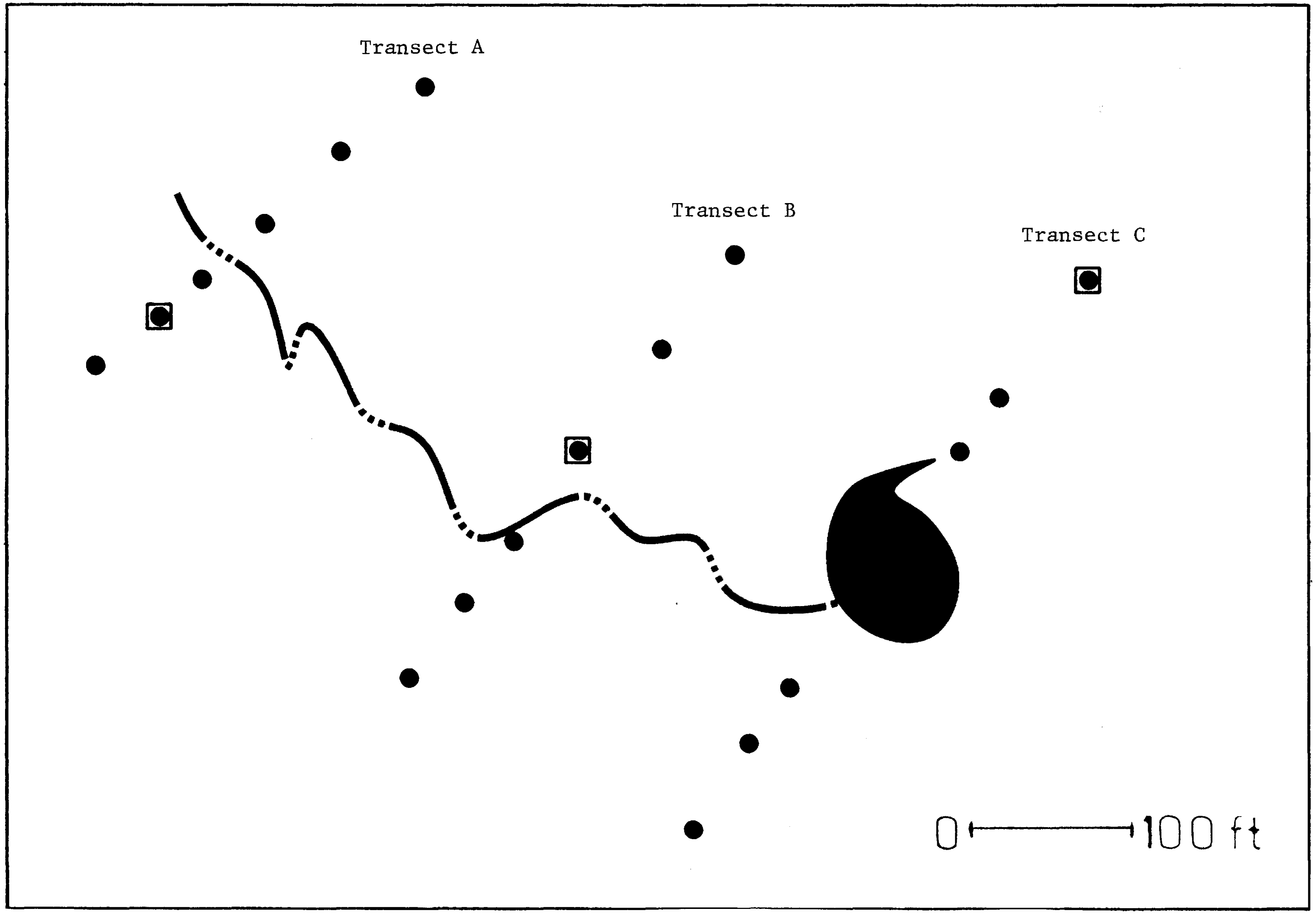

Transect A
Transect B
Transect C
0
100 ft

Figure 10. Surface Water, Stream Channel and Well Grid, Towner Lk. Road Intermittent Study Reach.
Overlay: Piezometric Head, August 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.



90.0
91.0
92.0
94.0
95.0
96.0
97.0
98.0
91.0
92.0
93.0


Transect A
Transect B
Transect C
0 100 ft

season (Figures 8,9,10). Early in the growing season, the stream gains from the surrounding meadow, while late in the season, the hydraulic gradient reverses and the stream loses flow to the meadow.

Streamflow in the intermittent reach ceased on July 23rd, 1991. Flow was measured on June 23rd in the poorly incised channel at 0.4 cfs. Hydric sedges invaded the channel after the cessation of flow.

One small ponded area exists near the 'A' well transect. This pond does not seem to be affected by overland flow, except during early season snowmelt. Nevertheless, it persisted throughout the summer without a visible source of inflow. This ponded area apparently represents the water level in the unconfined aquifer, although no attempt was made to gage its water depth in this study. While it is small in area (less than 50 sq. ft of surface area), it is over 2 ft deep.

The large pond at the downstream end of the study reach is affected by topography as well as surface water. While the intermittent stream flows, it is an inflow source into the pond. The pond is located in a depression, thus collecting surface runoff. The large pond also apparently reflects the phreatic surface of the unconfined aquifer in the intermittent meadow after stream flow ceases. Outflow from the pond again channelizes, and flows into Nash Fork Creek just upstream from the Nash Fork perennial study reach.

Snow depths in the area range from extensive coverages at significant depths for areas that are topographically lower or sheltered, to exposed wind blown ridges that remain effectively bare in all but the most severe winters. Snow removal in the spring to uncover wells showed a snowpack that was deeper and more extensive on the sides of the meadow, less extensive in the center. Snow depths during removal ranged from 9 ft near the outside well on the 'C' transect to scant cover near the center of the meadow in the most exposed areas.

Other water inflow sources for the intermittent reach include a small groundwater seep that is up valley of the study area. During early spring runoff this seep contributes water that initially channelizes, and is tributary to the intermittent channel. The flow from the seep slows to a trickle after runoff ceases. These minimal flows become unchannelized in less than 100 ft, then move as diffused surface water into the lower study area where they infiltrate.

<u>NASH FORK PERENNIAL REACH</u>. The Nash Fork perennial study reach is also an intermediate sized reach, 650 ft on the long axis and 500 ft on the short axis. Nash Fork Creek flows along the southern side of the meadow. Average land slope of the reach is the steepest of any of the study reaches, 18 ft in 538 ft or 3.7%. Approximately 1/4 mile

upstream of the study reach, Nash Fork Creek flows from Little Brooklyn Lake through a concrete weir. Outflow is controlled only by lake elevation.

Contributing area determined from the Wyoming Water Resource Center data base is 2.1 mi^2. Vegetation exhibits the stratified pattern of the intermittent reach where land slopes are minimal, becoming more xeric with movement away from the surface water source. This generally reflects movement up the topographic gradient. As the stream channel gradient increases in the middle section of the reach, a tree community bisects the meadow. Unlike the other reaches, a wetland sedge community was not observed (Figure 11).

Nash Fork Creek changes from a gaining to a losing stream within the study reach early in the season. Groundwater elevation is closest to the land surface in the upper portion of the reach, and Nash Fork Creek is effluent between the 'A' and 'B' transect early in the season (Figures 12, 13, 14). Groundwater levels drop noticeably in this area by late July.

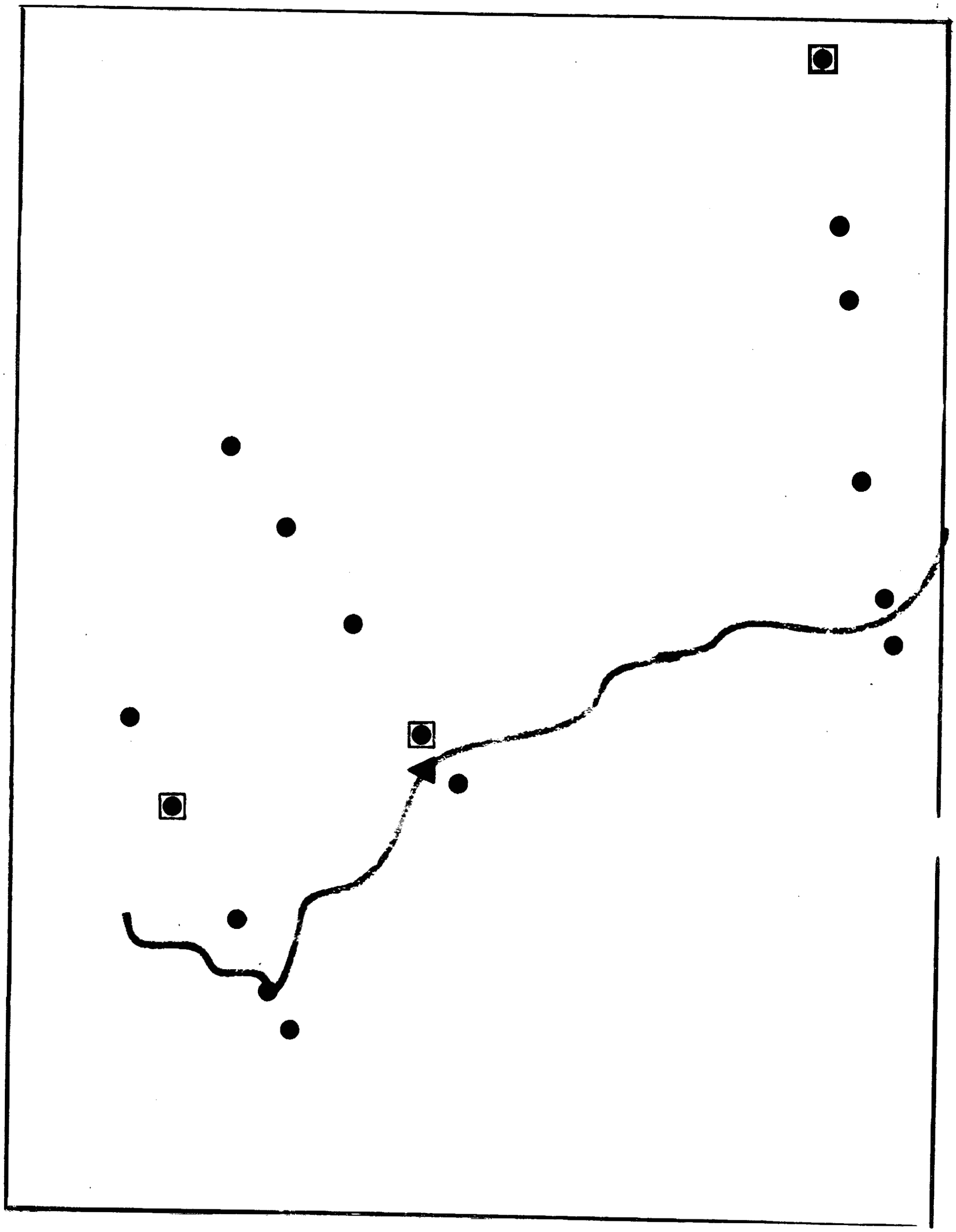
Near the 'B' transect, Nash Fork Creek becomes influent and loses through the topographically steep portion of the channel reach. This also corresponds closely to the vegetative shift from closed canopy willow to tree communities shown in Figure 11. In the center of the meadow, upstream of the trees bisecting the reach, water

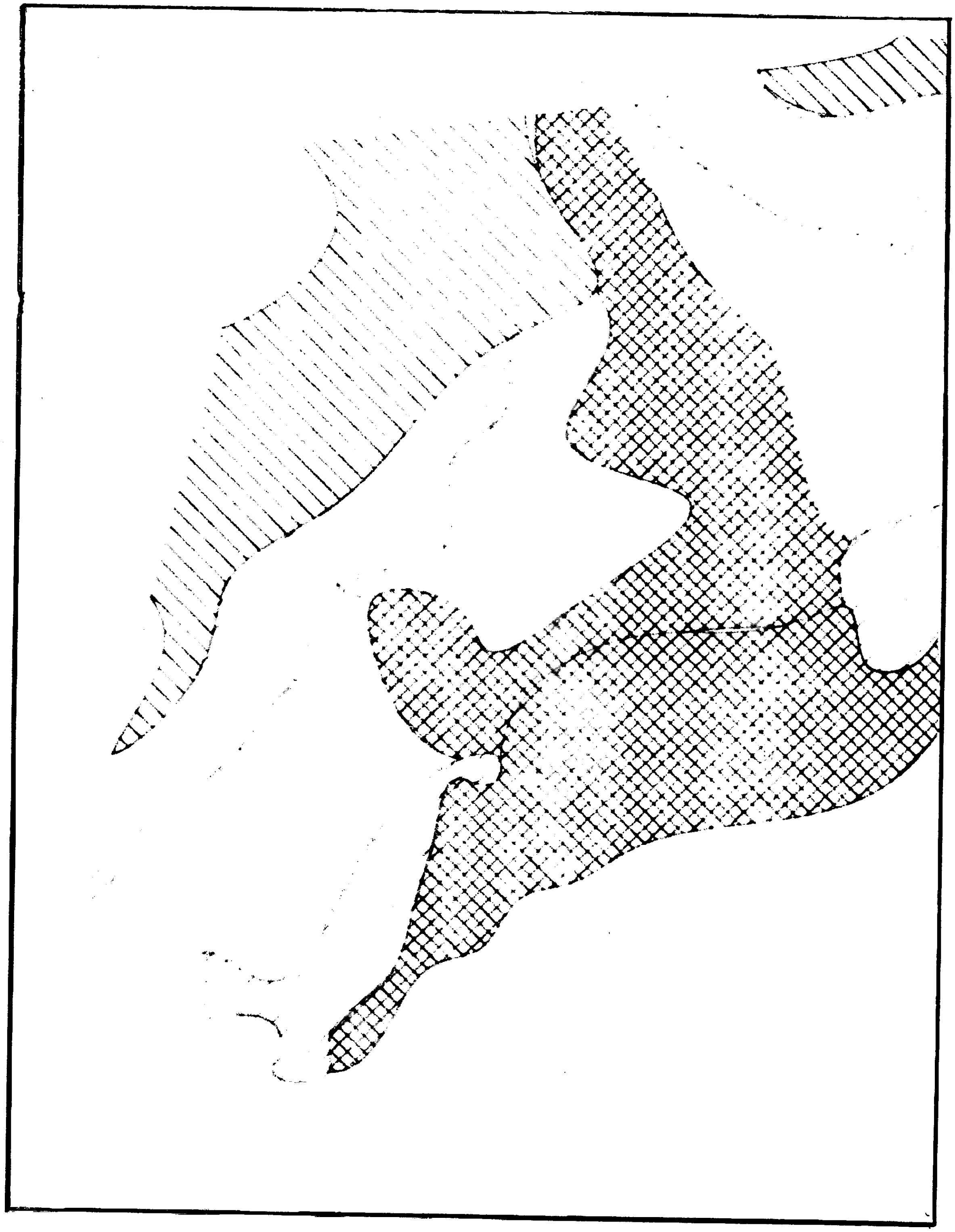
Figure 11. Topography of Nash Fork Perennial Meadow

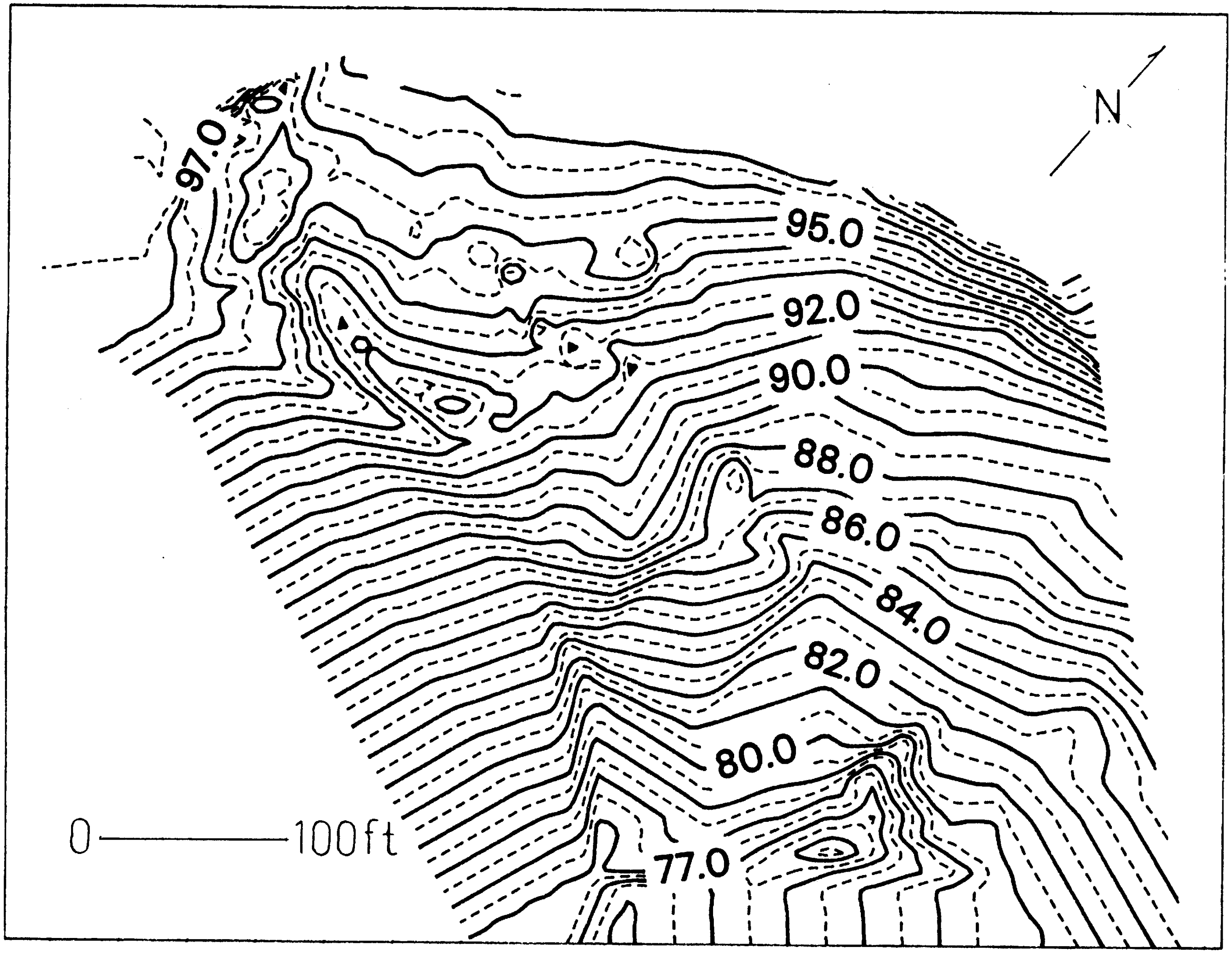
First Overlay. Ponded Areas, Stream Channel, Well Grid

Second Overlay. Vegetative Communities

1.) Green: Open Canopy Willow
2.) Red Shading: Upland Grass/Forb
3.) Yellow Shading: Closed Canopy Tall Willow
4.) Yellow Double Shading: Closed Canopy Short Willow
5.) Red Cross-Hatch: Tree







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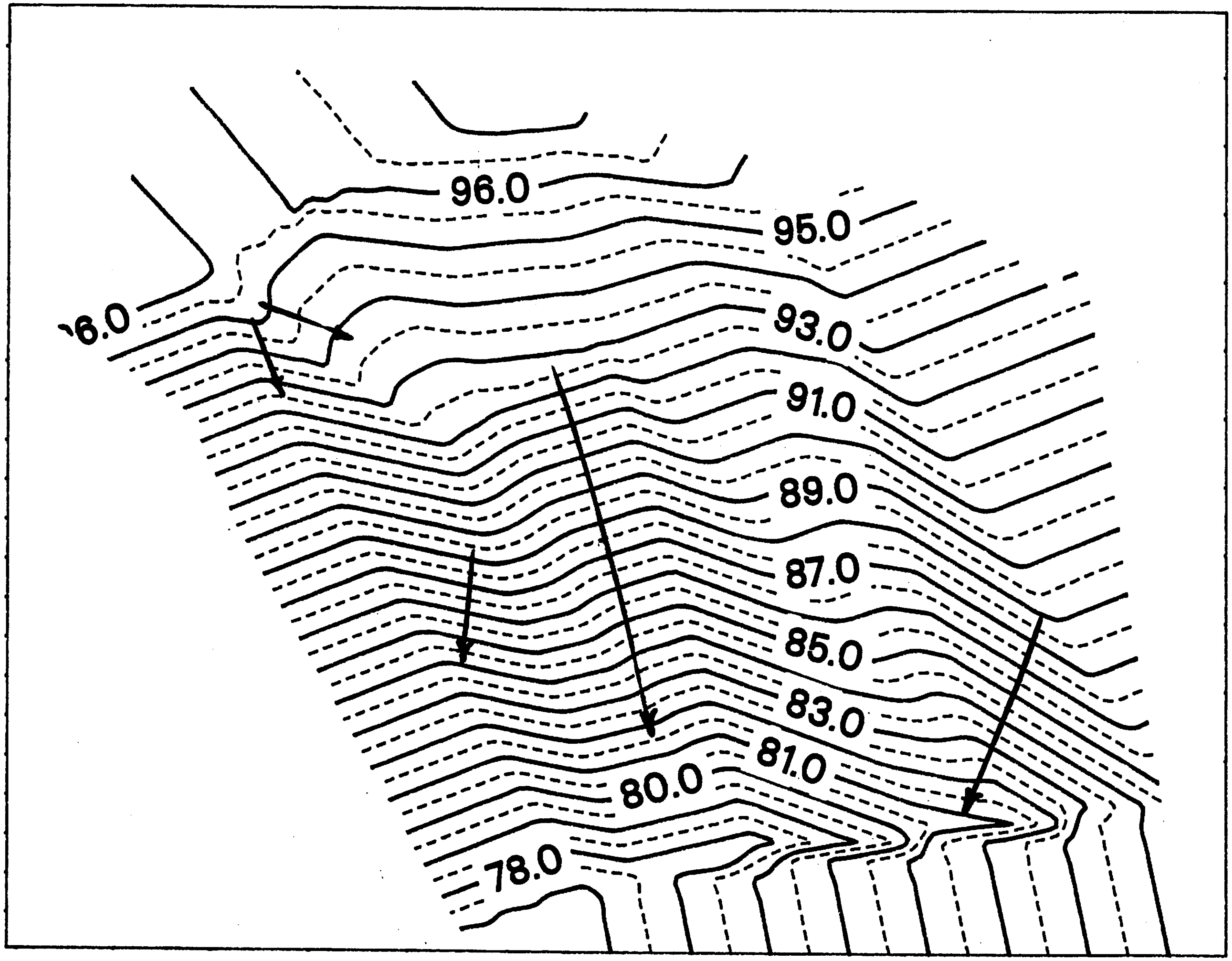
84.0
82.0
80.0
77.0
0 100ft

Figure 12. Surface Water, Stream Channel and Well Grid at the Nash Fork Perennial Study Reach.
Overlay: Piezometric Head, June 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.


96.0
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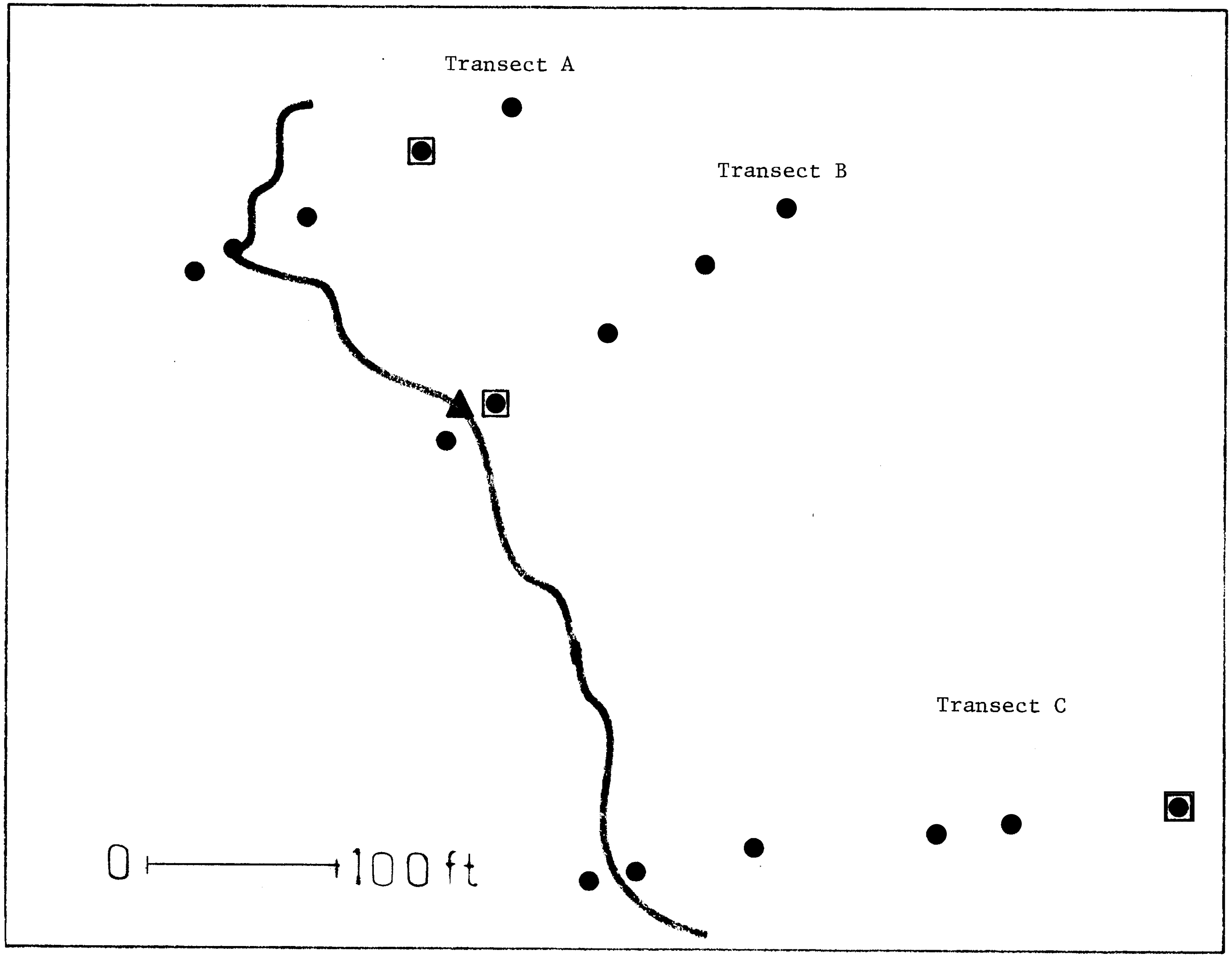
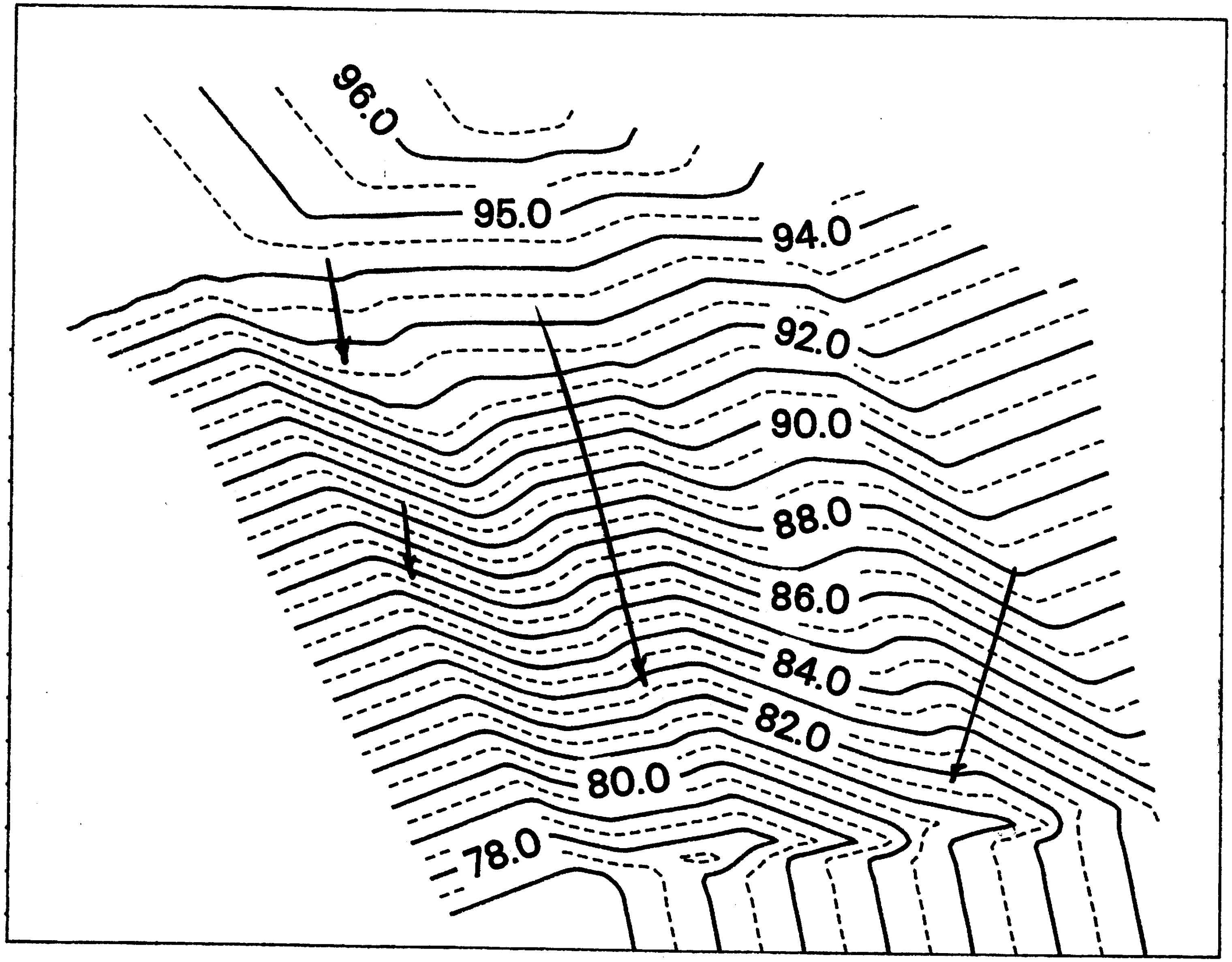

Transect A
Transect B
Transect C
0
100 ft

Figure 13. Surface Water, Stream Channel and Well Grid at the Nash Fork Perennial Study Reach.
Overlay: Piezometric Head, July 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.



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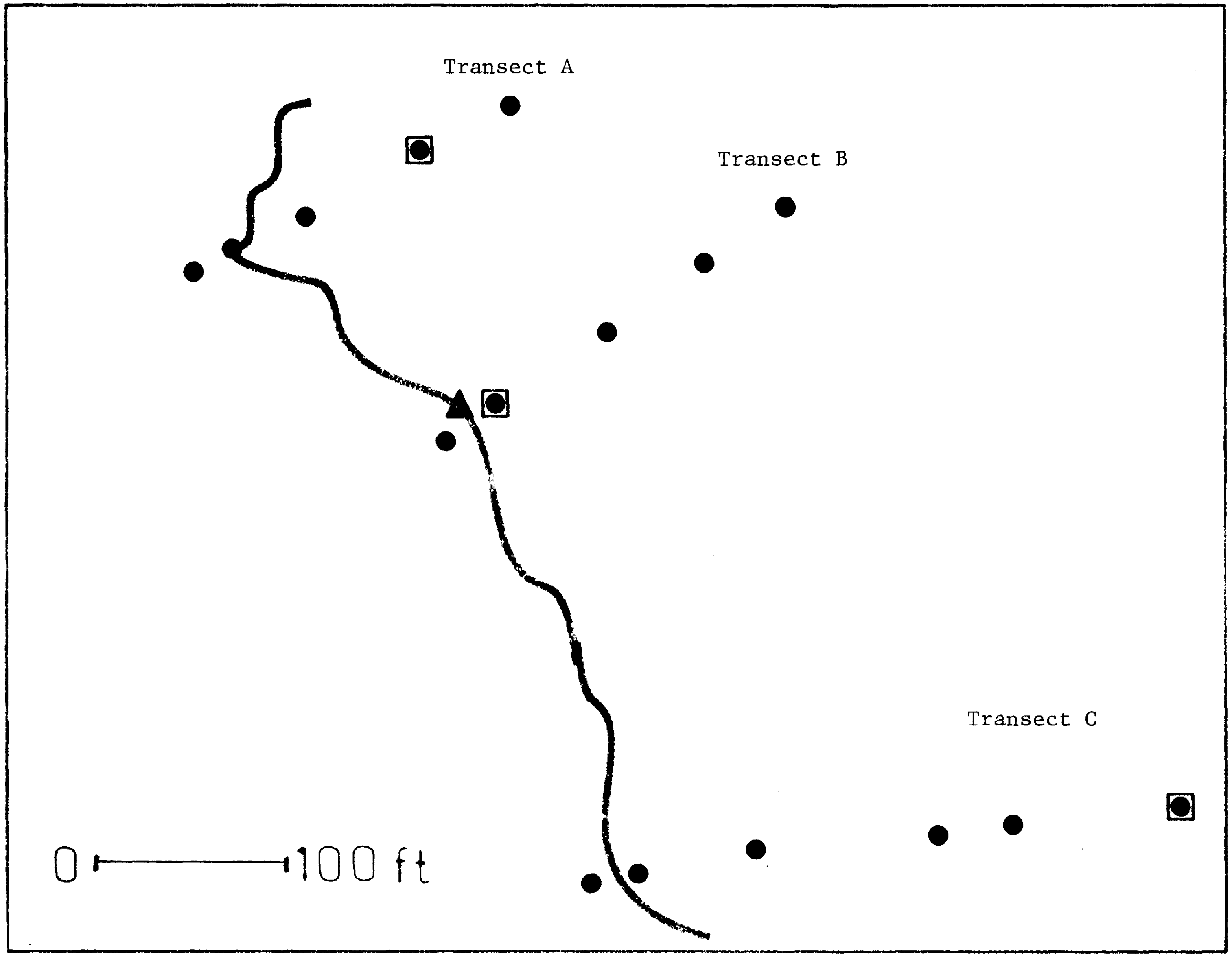
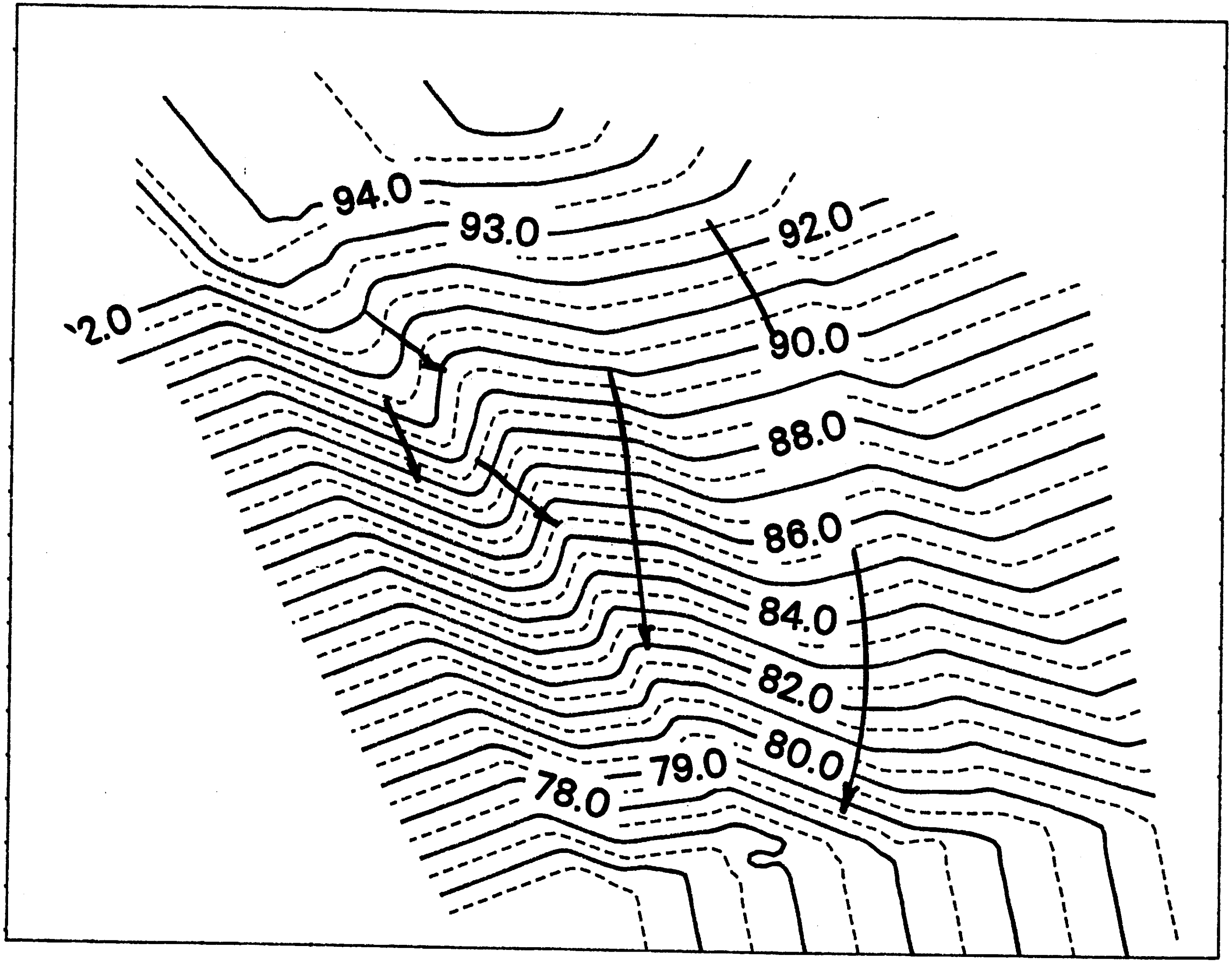

Transect A
Transect B
Transect C
0 100 ft

Figure 14. Surface Water, Stream Channel and Well Grid at the Nash Fork Perennial Study Reach.
Overlay: Piezometric Head, August 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.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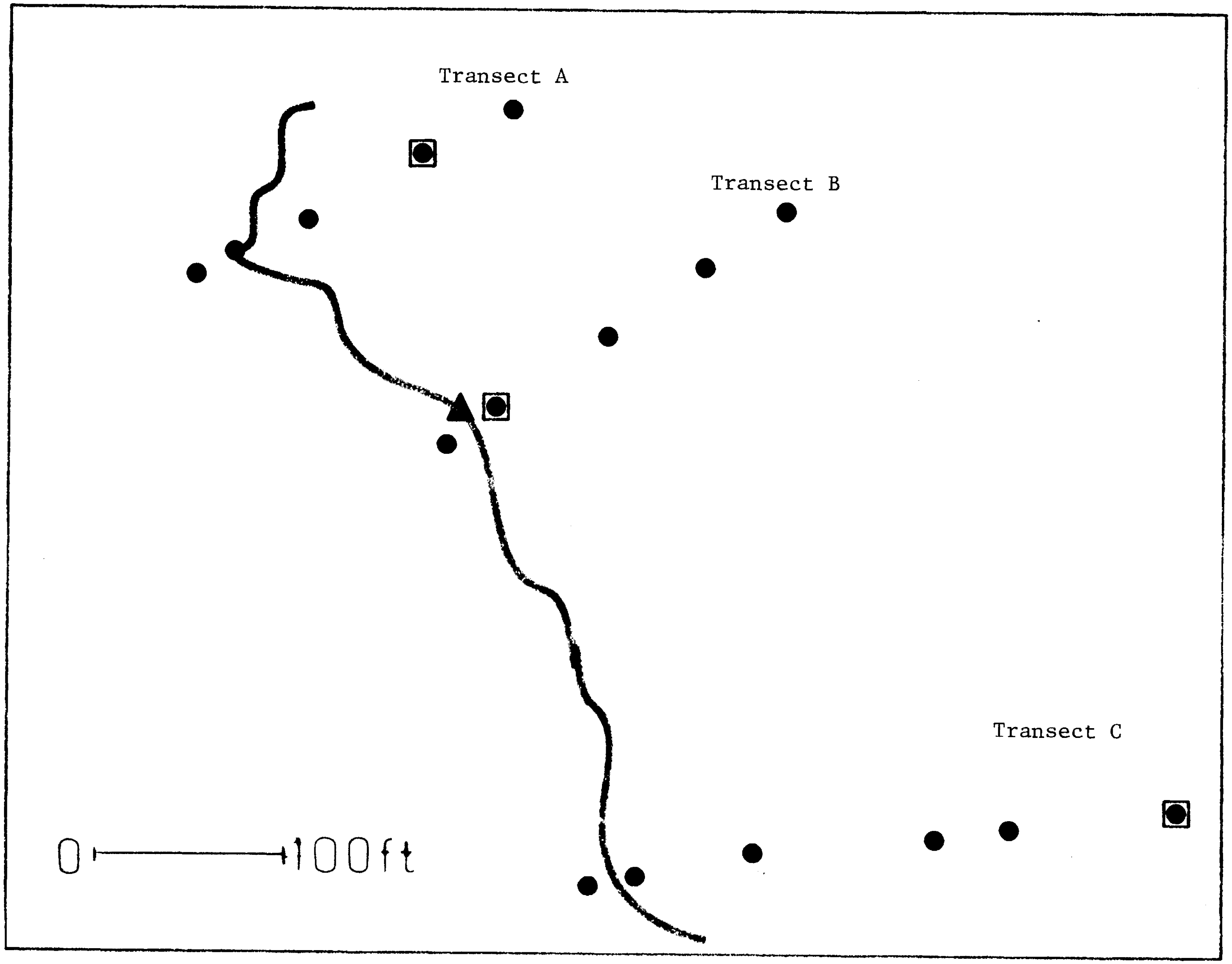

Transect A
Transect B
Transect C
0
100ft

table elevation rises, corresponding closely to the interior closed-canopy willow community. Downstream of the trees bisecting the reach, the topography flattens, a closed canopy willow community reappears, and the water table shows a corresponding rise. After mid-July, the groundwater pattern changes in the upper portion of the stream reach, and the creek is influent throughout the reach, although the hydraulic gradient remains steepest where channel gradient is steepest.

Flow in Nash Fork Creek peaked on June 10th 1991 at 34 cfs, as measured at the 'Nash Fork below Intermittent' streamgage. From the period of record at the downstream gage, #0111, the Q_2PF for Nash Fork Creek is 51.7 cfs. The two year peak flow (Q_2PF) is the flow that has a statistical return period of two years. The 34 cfs recorded on June 10th represents slightly greater than the 1.25 year flow (Table 3, page 80).

A seep between the 'B' and 'C' transects is the only other inflow source in the Nash Fork reach. Flow from the seep decreases rapidly after snowmelt. The outflow of the small seep flows overland for a short distance, where it infiltrates. A small pond with about 50 ft^2 of surface area lies between the 'A' and 'B' transect on the north side of the creek. This represents the water table at that location. Water levels were not measured in either the pond or spring during the 1991 field season.

Snow pack in the meadow, as observed from early spring snow removal work in the reach, was evenly distributed across the area. Snow depths were greatest near the stream, in excess of 6 ft, slowly tapering to 3 ft near the outside wells. Orientation of the meadow is nearly east-west but is sheltered by surrounding trees and surface contours. This allows more snow deposition in the meadow.

MILL POND PERENNIAL REACH. The Mill Pond study reach is the largest of the four reaches, over 1200 ft long and 450 ft wide. Average meadow slope for Mill Pond is 18 ft in 1350 ft or 1.3% (Figure 15). This is somewhat misleading since the land slopes more steeply at the upper end, with the majority of the topographic relief being in the upstream 500 ft of the study reach. Channel gradients follow a similar pattern, resulting in a C channel at the lower end of the meadow, and a B channel at the upper end. The lower channel gradient is 3 ft in 700 ft (0.4%) while the upper channel gradient is 15 ft in 500 (3%).

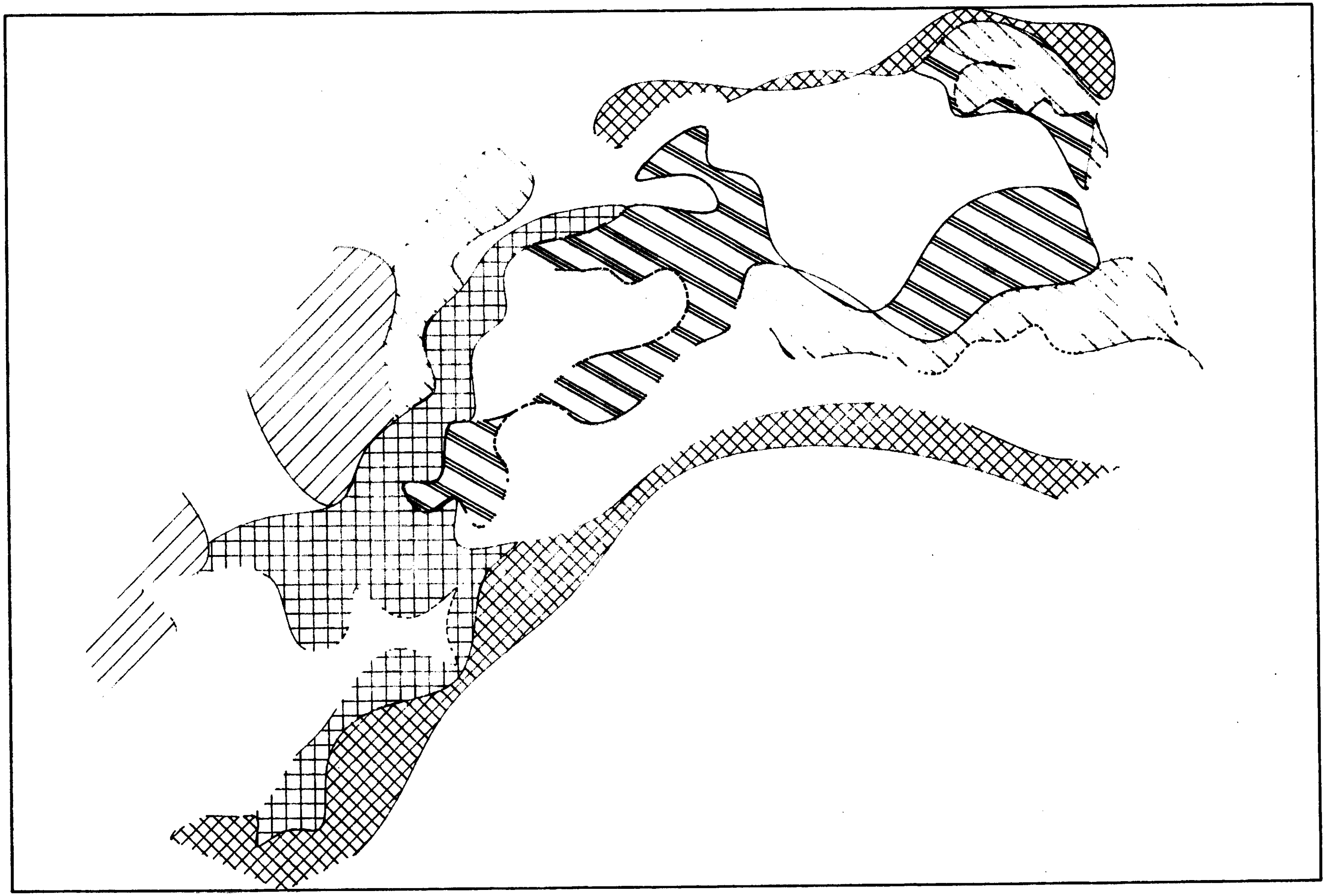
Vegetative communities are similar to the Nash Fork reach in the upper, steeper portion of the reach, and are more similar to the Towner Lake Road intermittent reach in the lower gradient sections (Figure 15). The tree community dominates south of Telephone Creek in the upstream 500 ft of the reach. North of Telephone Creek, the topographic gradient is much less steep, and a closed canopy willow community is present. The downstream, low gradient

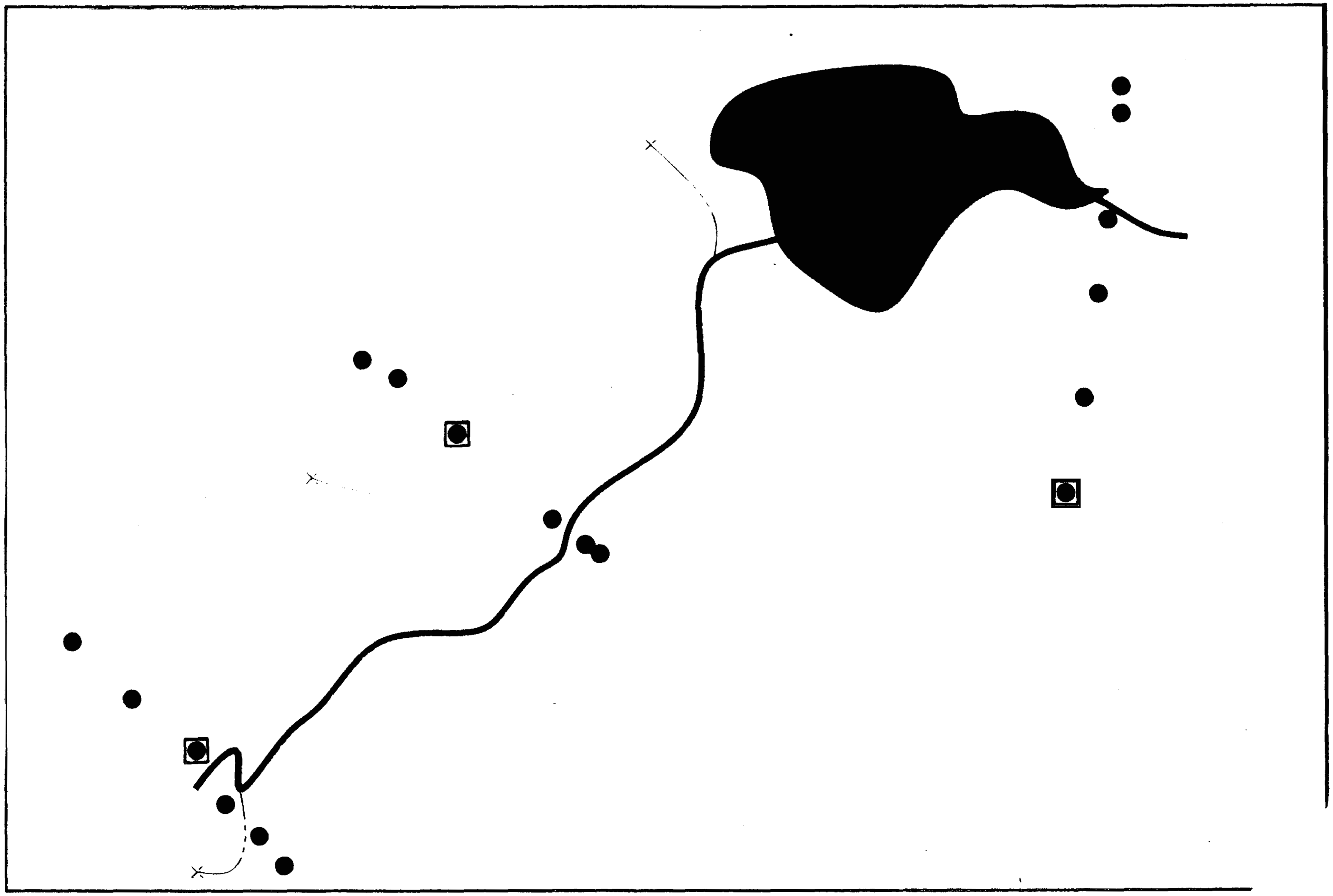
Figure 15. Topography of Mill Pond Perennial Meadow

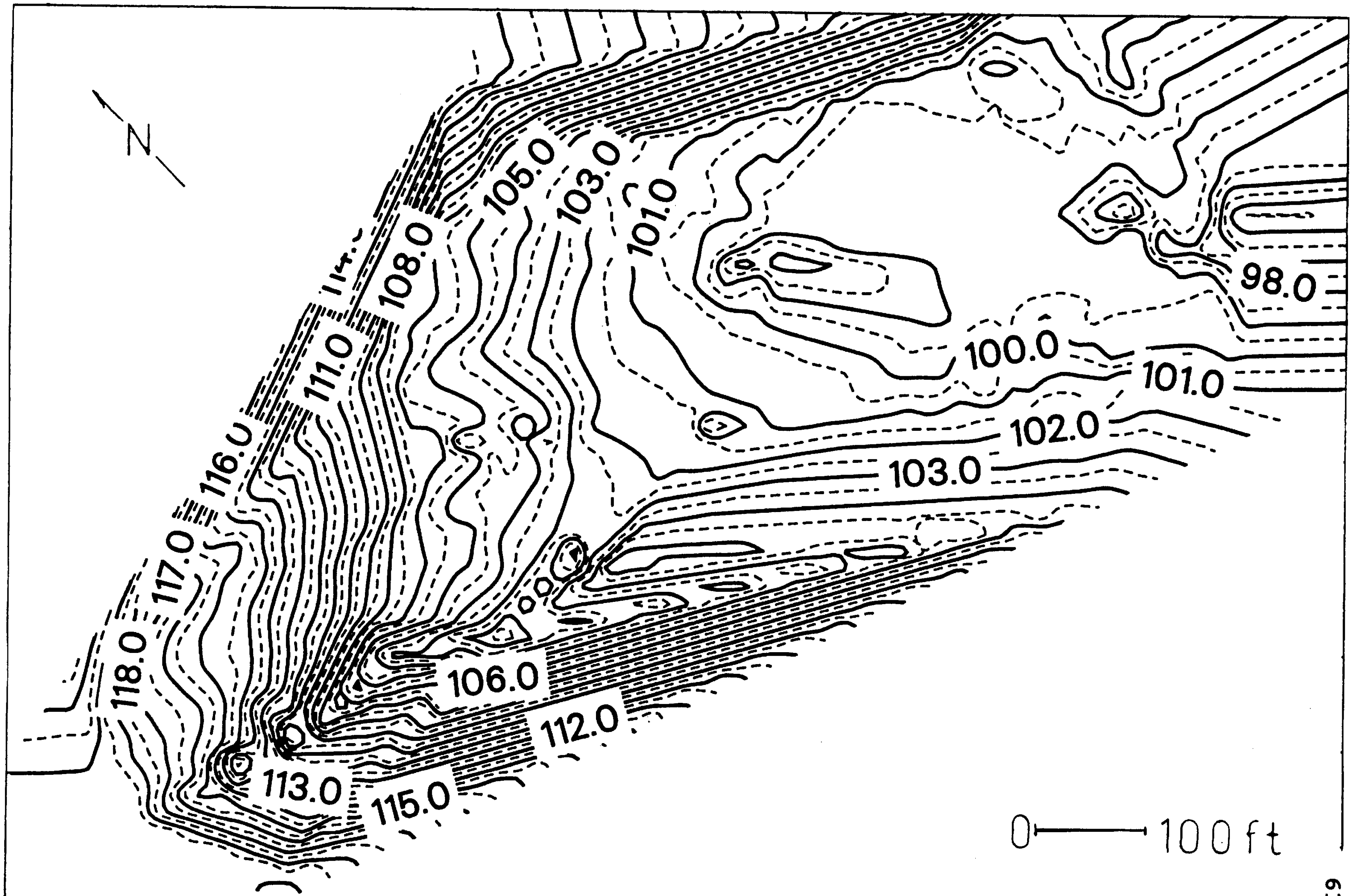
First Overlay. Ponded Areas, Stream Channel, Well Grid

Second Overlay. Vegetative Communities

1.) Green: Open Canopy Willow
2.) Red Shading: Upland Grass/Forb
3.) Yellow: Closed Canopy Willow
4.) Blue: Sedge
5.) Red Cross-Hatch: Tree
6.) Red Large Cross Hatch: Encroaching Spruce



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113.0
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112.0
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102.0
101.0
100.0
98.0
0
100 ft

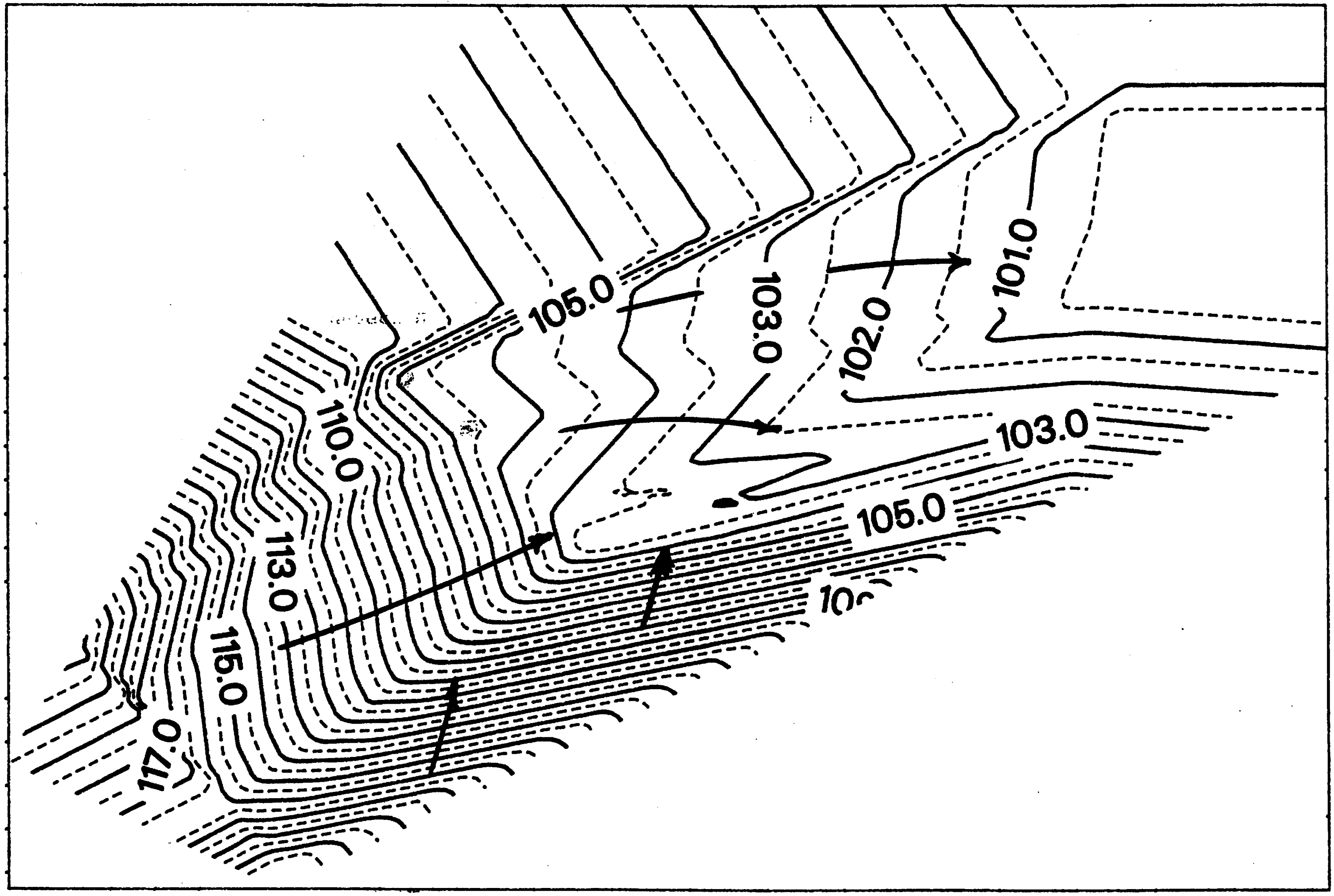
section of the study reach has a sedge community around the lake and in the topographic low areas, similar to the Towner Lake Road study reach. Moving away from the topographic low area in the center of the study reach results in gradual change to more mesic vegetative communities.

Telephone Creek is an effluent stream throughout the study reach, gaining strongly from the south throughout the study reach. The south side of the meadow has a north aspect, and holds snow late into the year. Groundwater flow is essentially down-valley north of Telephone Creek in the higher gradient portion of the study reach, (Figures 16, 17, 18). The sedge community at the east end of Middle Pond occupies the topographic low area around the lake as well as receiving groundwater flow from the north.

Like the intermittent study reach, the Mill Pond reach is oriented nearly east-west and is relatively exposed, thus having a less significant snow accumulation pattern. Observed spring snow accumulations were greatest near the meadow margins, 6 to 10 ft, tapering to 1 to 3 ft in the more exposed areas near the center of the meadow. This is consistent with the prevailing winter wind being essentially down the long axis of the meadow, thus reducing snow accumulation in the exposed areas.

Middle Pond forms at the downstream end of the meadow. Surface area of the pond is slightly less than 50,000 ft^2. Telephone Creek enters the pond at the west end, and flows

Figure 16. Surface Water, Stream Channel and Well Grid, Mill Pond Perennial Study Reach.
Overlay: Piezometric Head, June 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.


105.0
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101.0
110.0
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105.0
113.0
115.0
117.0

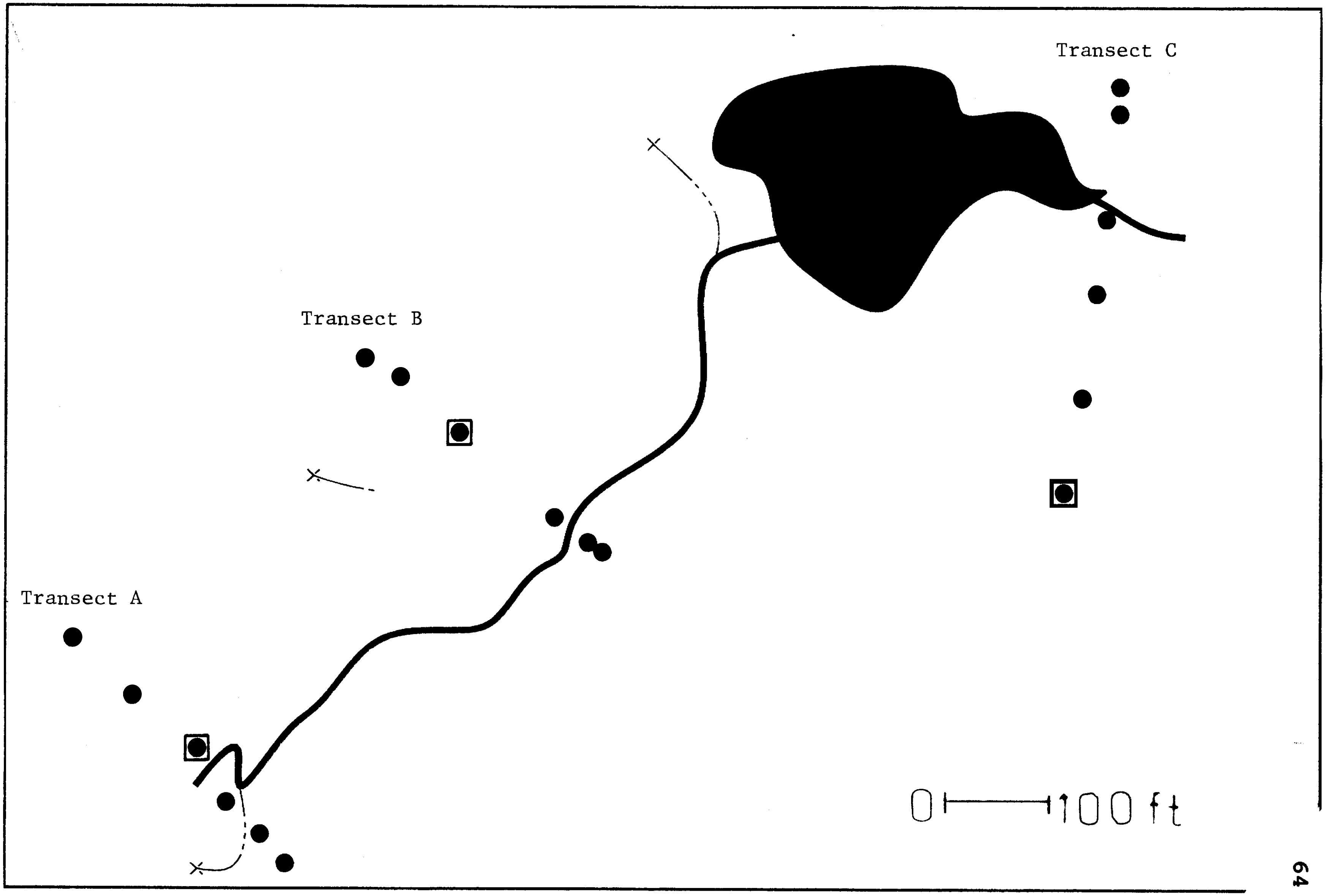
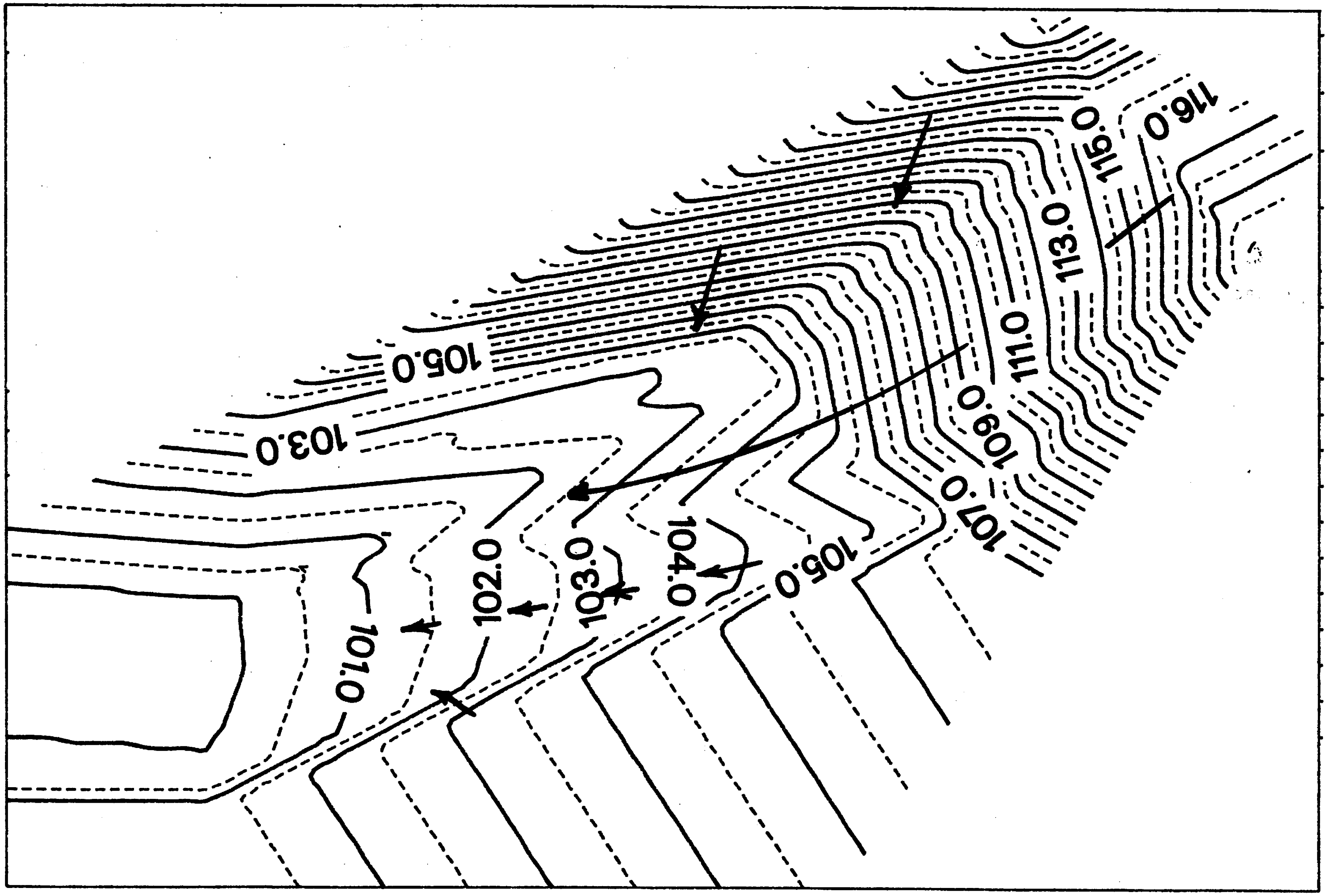

Transect C
Transect B
Transect A
0 100 ft

Figure 17. Surface Water, Stream Channel and Well Grid, Mill Pond Perennial Study Reach.
Overlay: Piezometric Head, July 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.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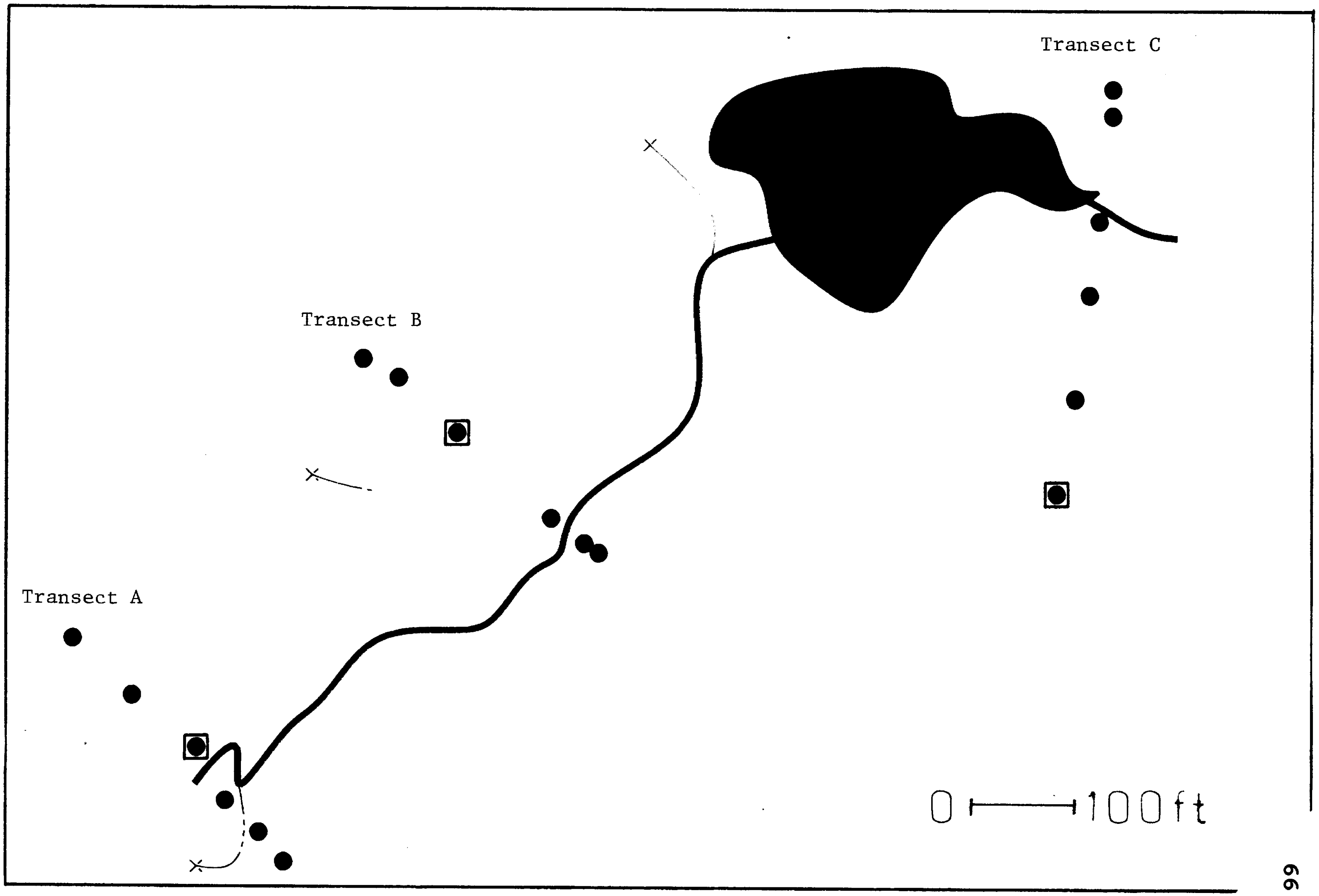
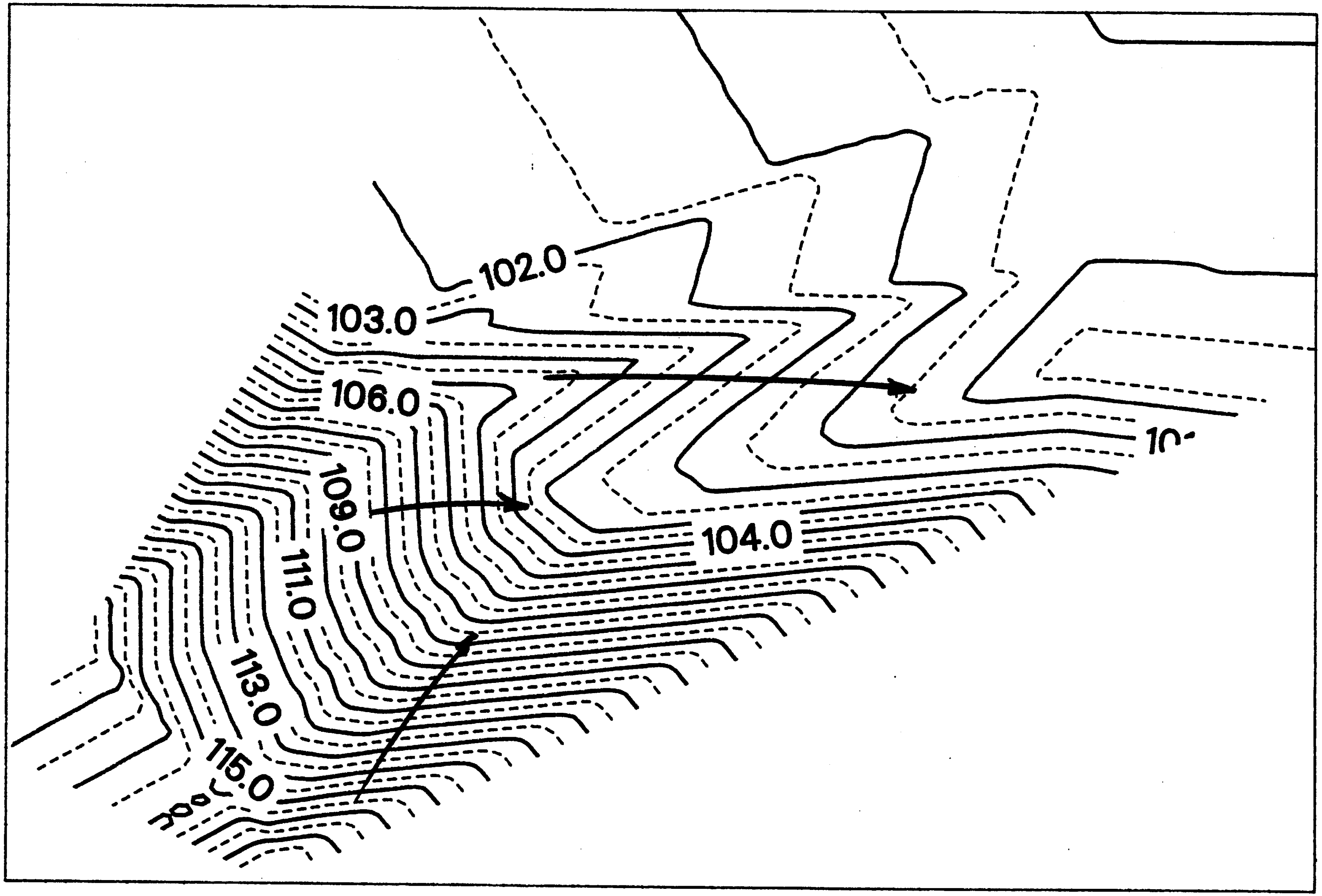

Transect C
Transect B
Transect A
0 100ft

Figure 18. Surface Water, Stream Channel and Well Grid, Mill Pond Perennial Study Reach.
Overlay: Piezometric Head, August 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.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103.0
106.0
109.0
111.0
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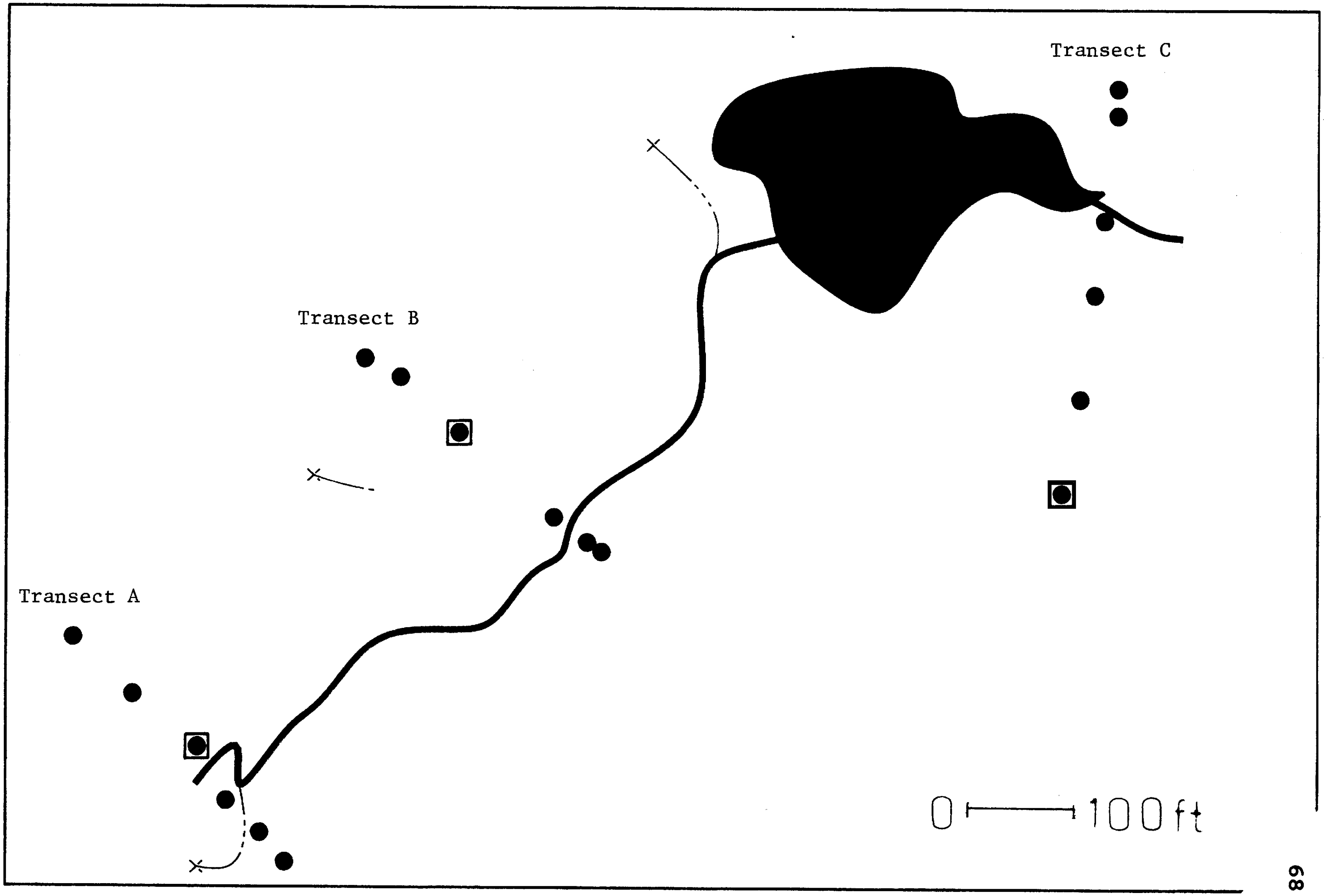
115.0
104.0


Transect C
Transect B
Transect A
0 100ft

over beaver dams into its channel at the east end of the pond. It lies topographically in the lowest area of the meadow, where channel gradients are the least. Beaver activity at the lower end of the reach has formed the ponded area. Analysis of aerial photographs indicate that the pond has been in existence for more than twenty years. Elevated groundwater levels and some low area flooding results from increased fall beaver activity.

As is typical of all of the study reaches, small springs exist around the outer edge of the meadow, contributing groundwater to the riparian ecosystem. As with all the study reaches, flows decrease from these seeps and springs as the summer progresses, diminishing or ceasing entirely after snowmelt. The upper and lower springs in the Mill Pond reach have incised channels that reach to the meanders of Telephone Creek, and had flow throughout the summer of 1991. The amount of water these springs contribute to the system is small, ranging from a trickle to nearly undetectable. The middle seep produces water that rapidly diffuses and infiltrates.

Well B298 is the northernmost B transect well, and appears to be completed in the aquifer that supplies water to the wells and seeps. This well is located near the meadow edge where geologic parent material is exposed, and has artesian flow until mid-July. At that point, the artesian flow ceases and the water level begins to drop rapidly, until late in the season when the water level in the well has dropped to over five feet below the ground surface.

UPPER TELEPHONE PERENNIAL REACH. The Upper Telephone study reach is the smallest of the four reaches in this study, having dimensions of 500 ft on its long axis and 450 ft at the widest point on the short axis. Land slopes at <1% from east to west through the reach. Channel gradients in the reach are typical of type C channels, 6 ft in 600 or 1%. It is also at the highest elevation of the four study reaches, 10,700 ft above msl.

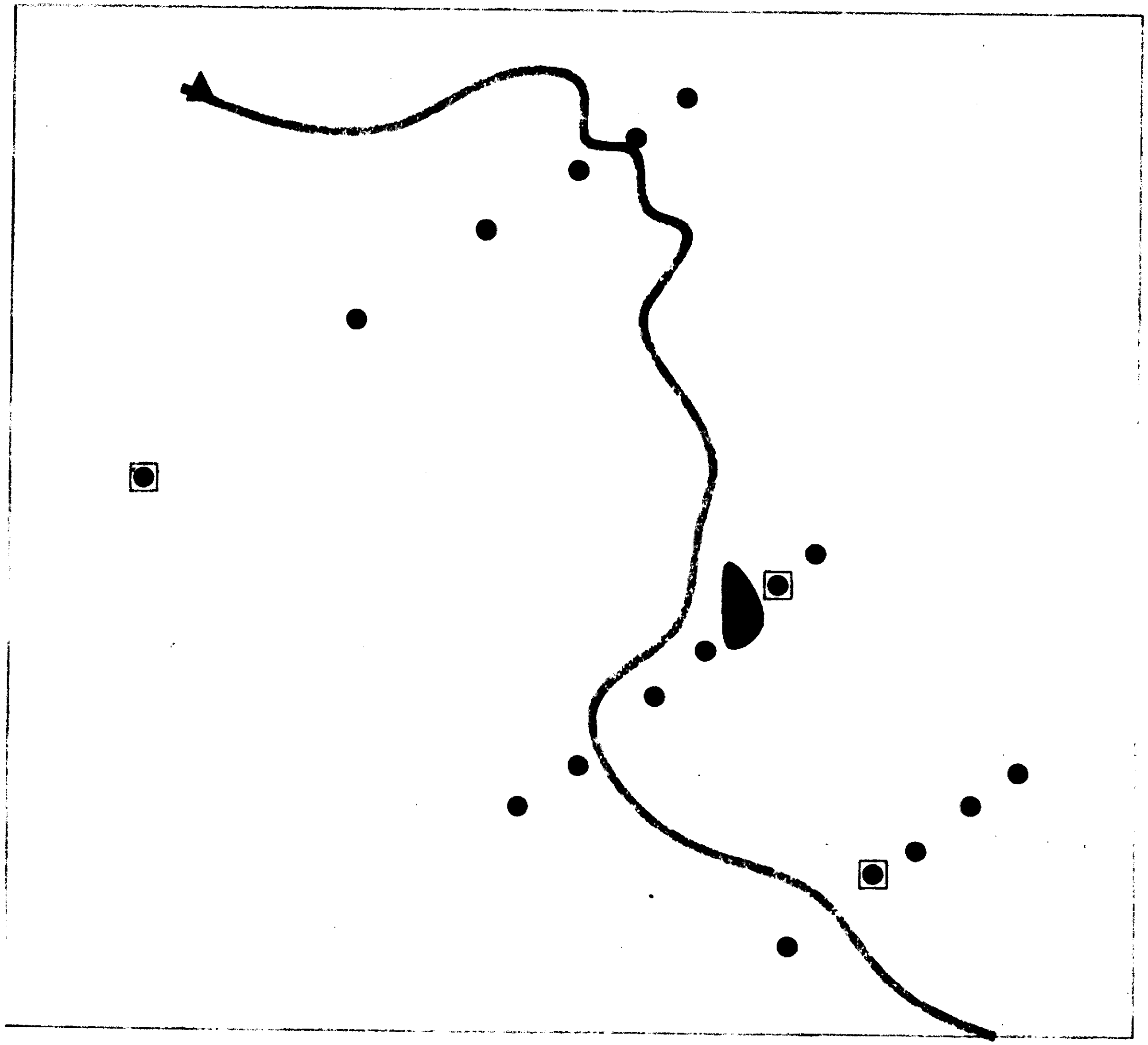
The meadow is oriented in a east-west direction, similar to the Nash Fork study reach. The orientation and the open nature of the terrain allows swirling winds to deposit snow in the meadow. As a result of this, and the increased elevation, this meadow receives and accumulates more winter snowfall than any of the other study reaches. Early spring snow removal to expose groundwater wells required excavation of 19 feet of snow to expose the C12 well. The B8 well in this meadow also had spring snow accumulations in late May of over 15 ft. Snow had not melted from the lower west side of the meadow until June 15th, and the west side wells were still inundated until July 1st from runoff from an upslope snowfield. Because of the inability to isolate the wells on the west side of the

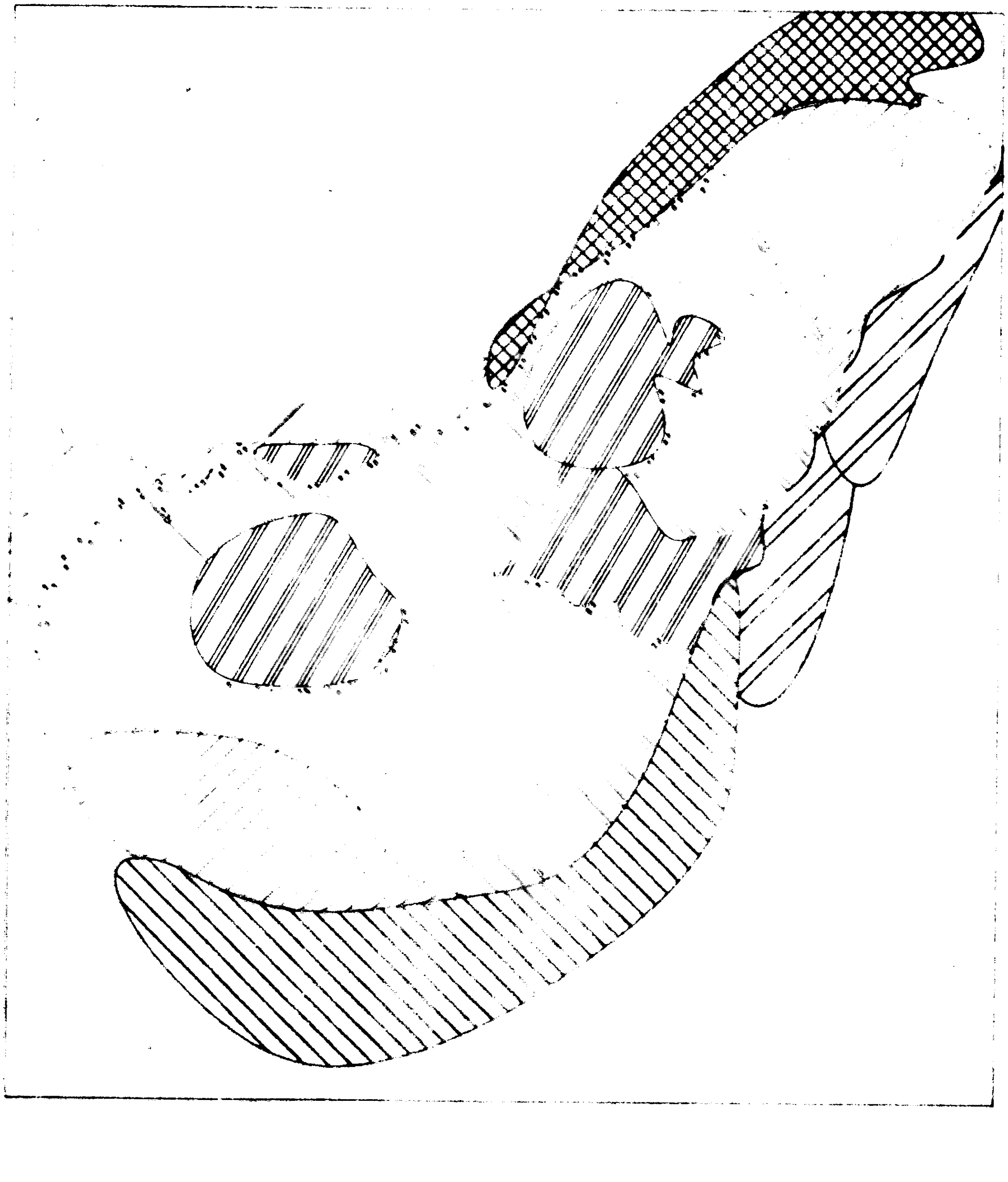
Figure 19. Topography of Upper Telephone Perennial Meadow

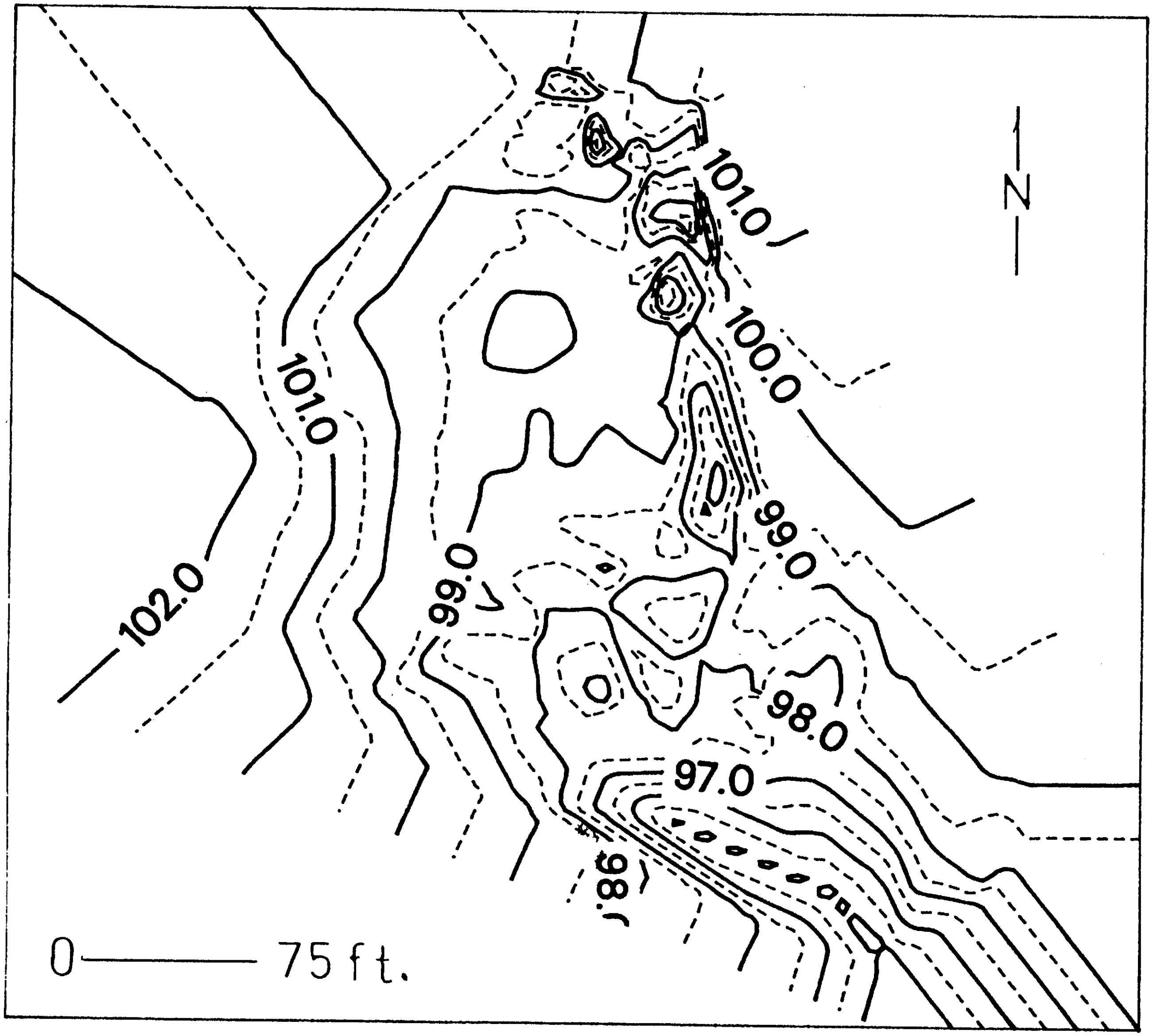
First Overlay. Ponded Areas, Stream Channel, Well Grid

Second Overlay. Vegetative Communities

1.) Green: Open Canopy Willow
2.) Red Shading: Upland Grass/Forb
3.) Yellow: Closed Canopy Willow
4.) Blue: Sedge
5.) Red Cross-Hatch: Tree
6.) Magenta: Forb






N
102.0
101.0
101.0
100.0
99.0
99.0
98.0
98.0
97.0
0 —— 75 ft.

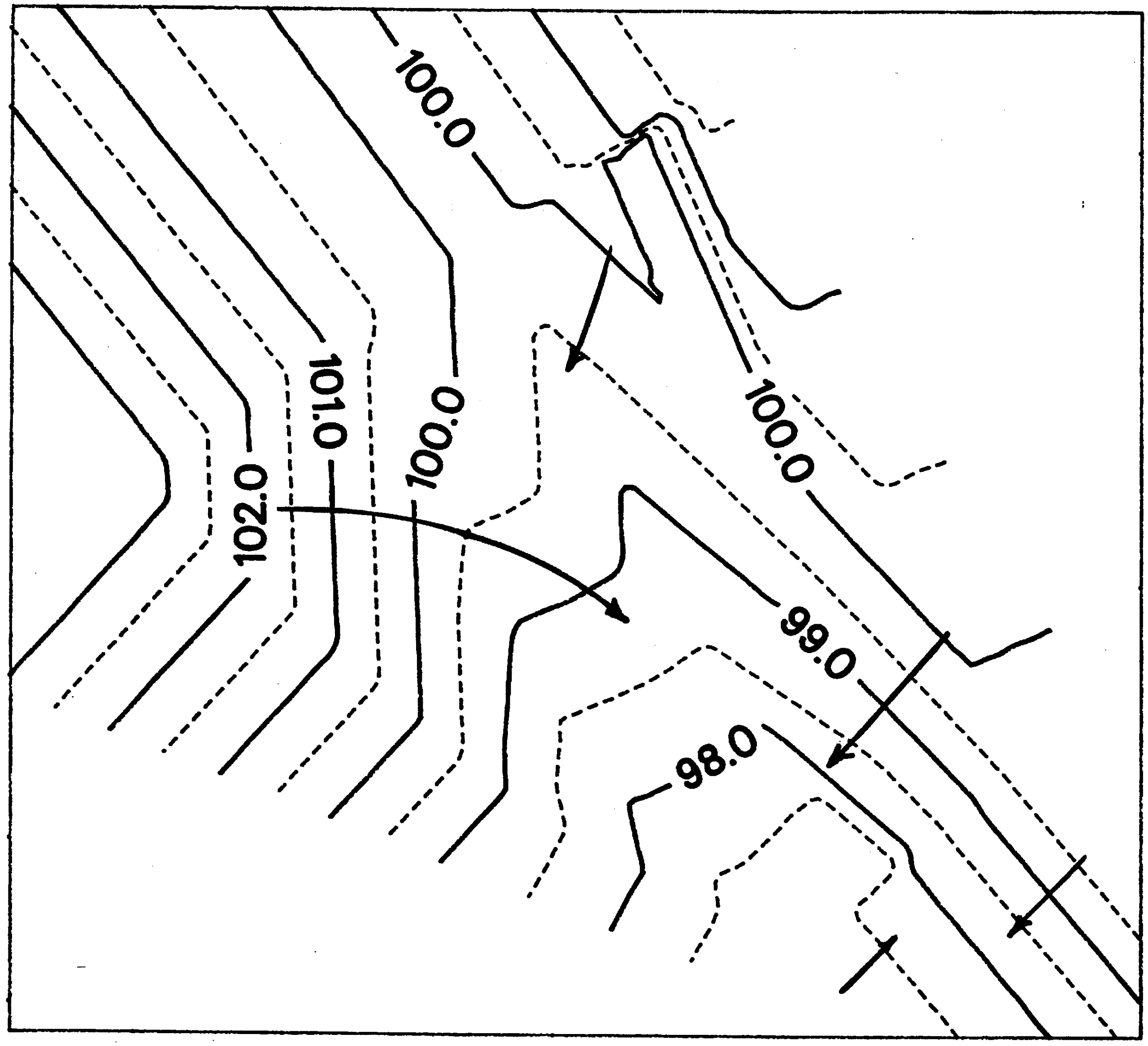
meadow from overland flow, groundwater measurements in these wells were not reliable.

Vegetation follows a pattern similar to the other study reaches. Topographic low areas tend to support the hydrophytic sedge communities, while upslope areas after 4-to-6 ft. of elevation gain will gradually tend to more mesic species dominated by the grasses and forbs (Figure 19). Groundwater elevations near the land surface are positively correlated with the sedge communities.

Early season groundwater flows form a hydraulic gradient essentially downslope, mirroring snowmelt. The lower end of the reach is geologically constricted, and hydraulic gradients move water down these side slopes into the meadow bottom from the northeast and southwest. A second groundwater gradient exists throughout the season from the northwest down the center of the meadow. Late in the season, this becomes the dominant groundwater flow pattern (Figures 20, 21, 22). Telephone Creek through this reach is not greatly affected by groundwater mid-to-late season. Early in the season the lower 300 ft of the stream is a strong gaining segment. This trend lessens after snowmelt.

There is a single spring that contributes channelized flow to the meadow. The spring discharges 200 yards north and upslope of the meadow, following a deeply incised and narrow channel into a topographic depression where it

Figure 20. Surface Water, Stream Channel and Well Grid, Upper Telephone Perennial Study Reach.
Overlay: Piezometric Head, June 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.



100.0
101.0
100.0
102.0
100.0
99.0
98.0

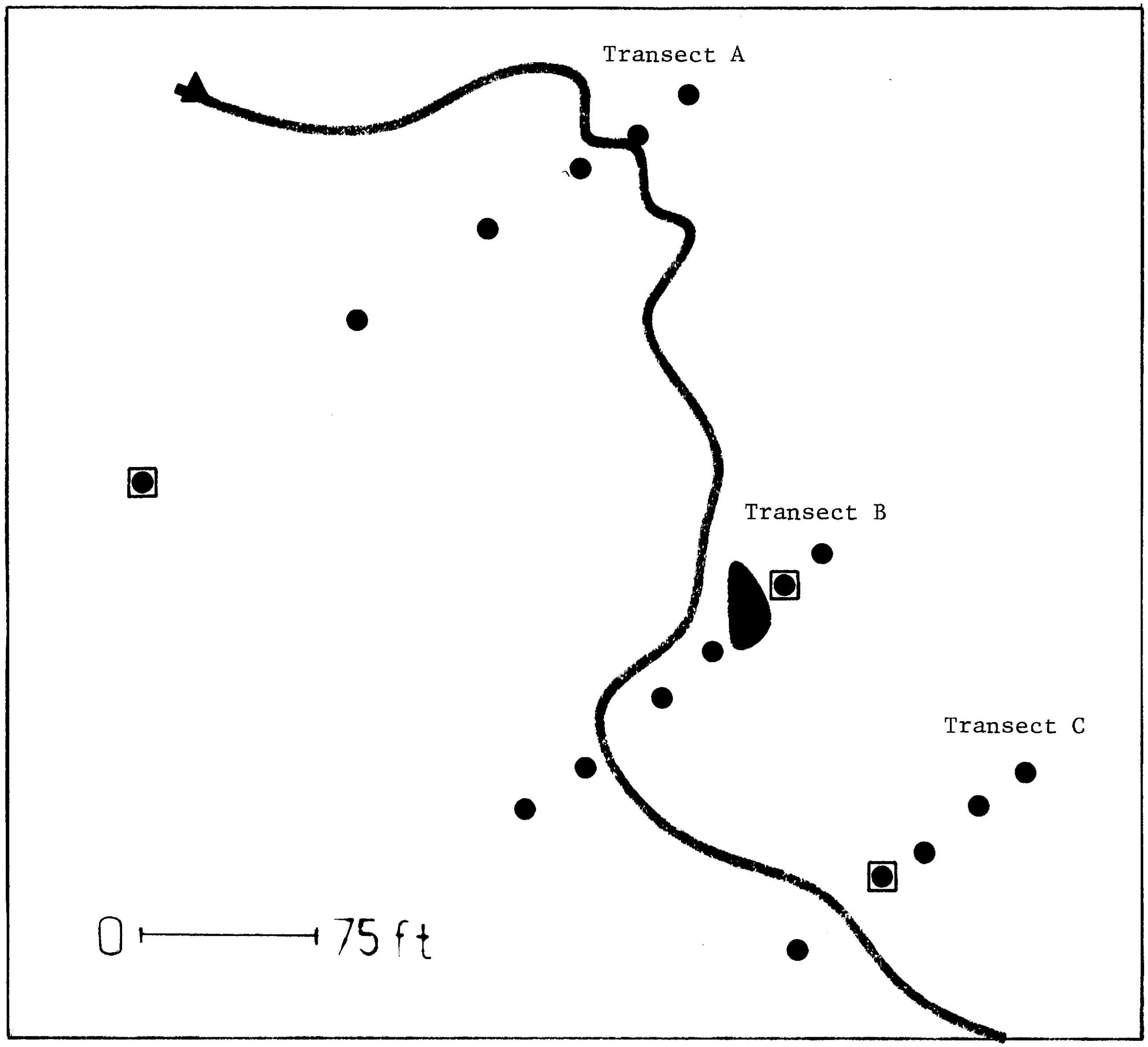
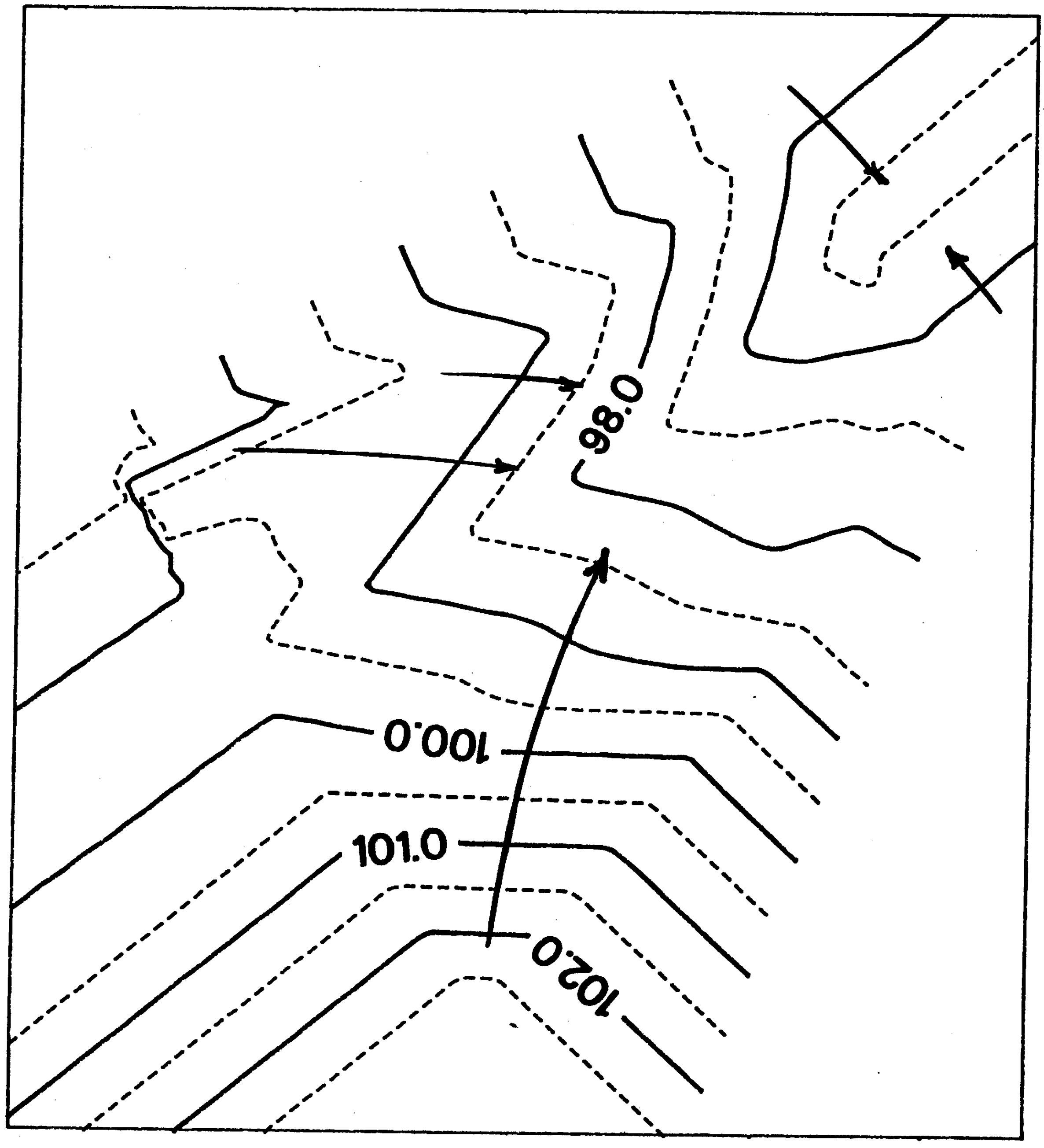

Transect A
Transect B
Transect C
0 75 ft

Figure 21. Surface Water, Stream Channel and Well Grid, Upper Telephone Perennial Study Reach.
Overlay: Piezometric Head, July 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.



98.0
100.0
101.0
102.0

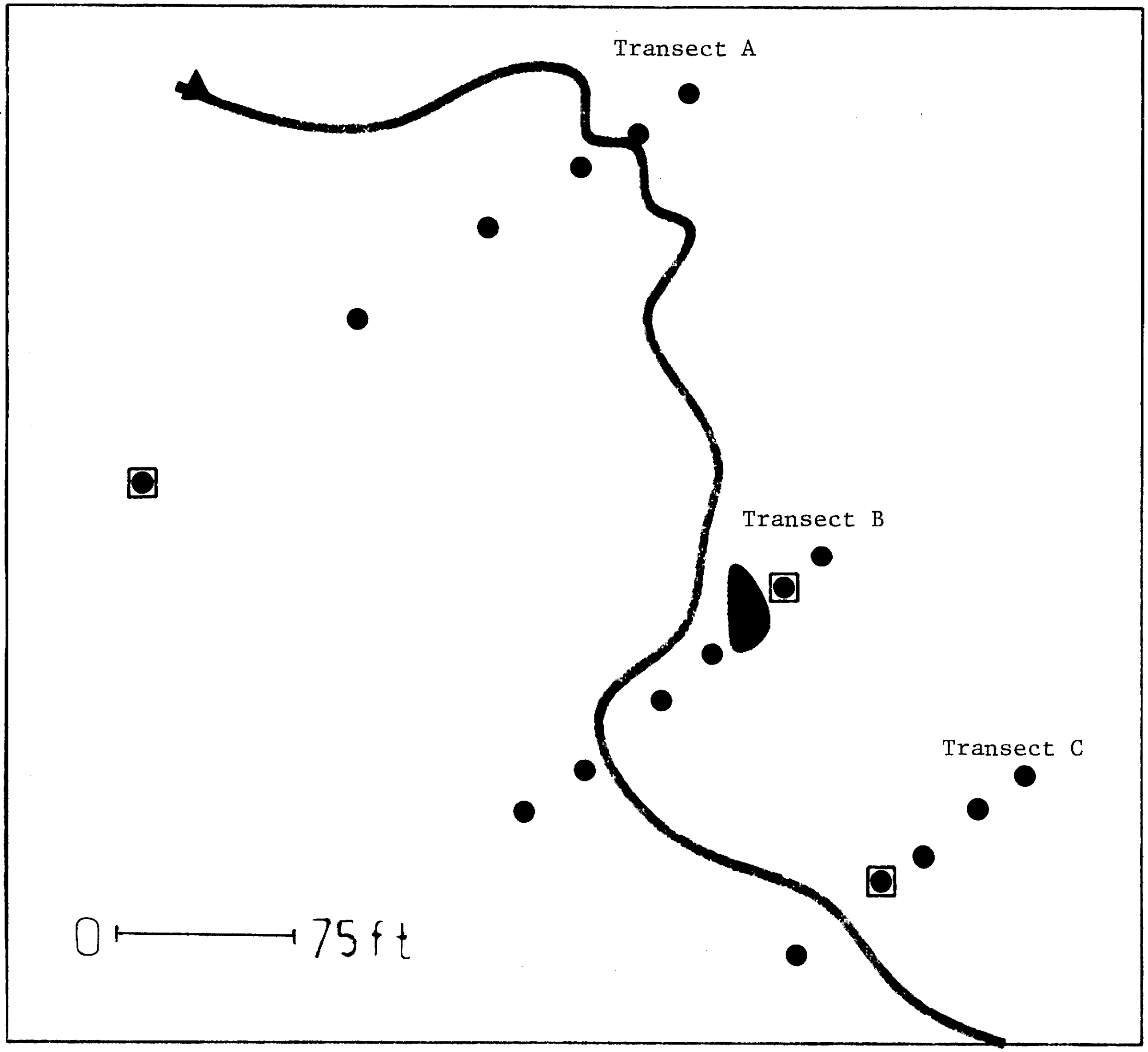
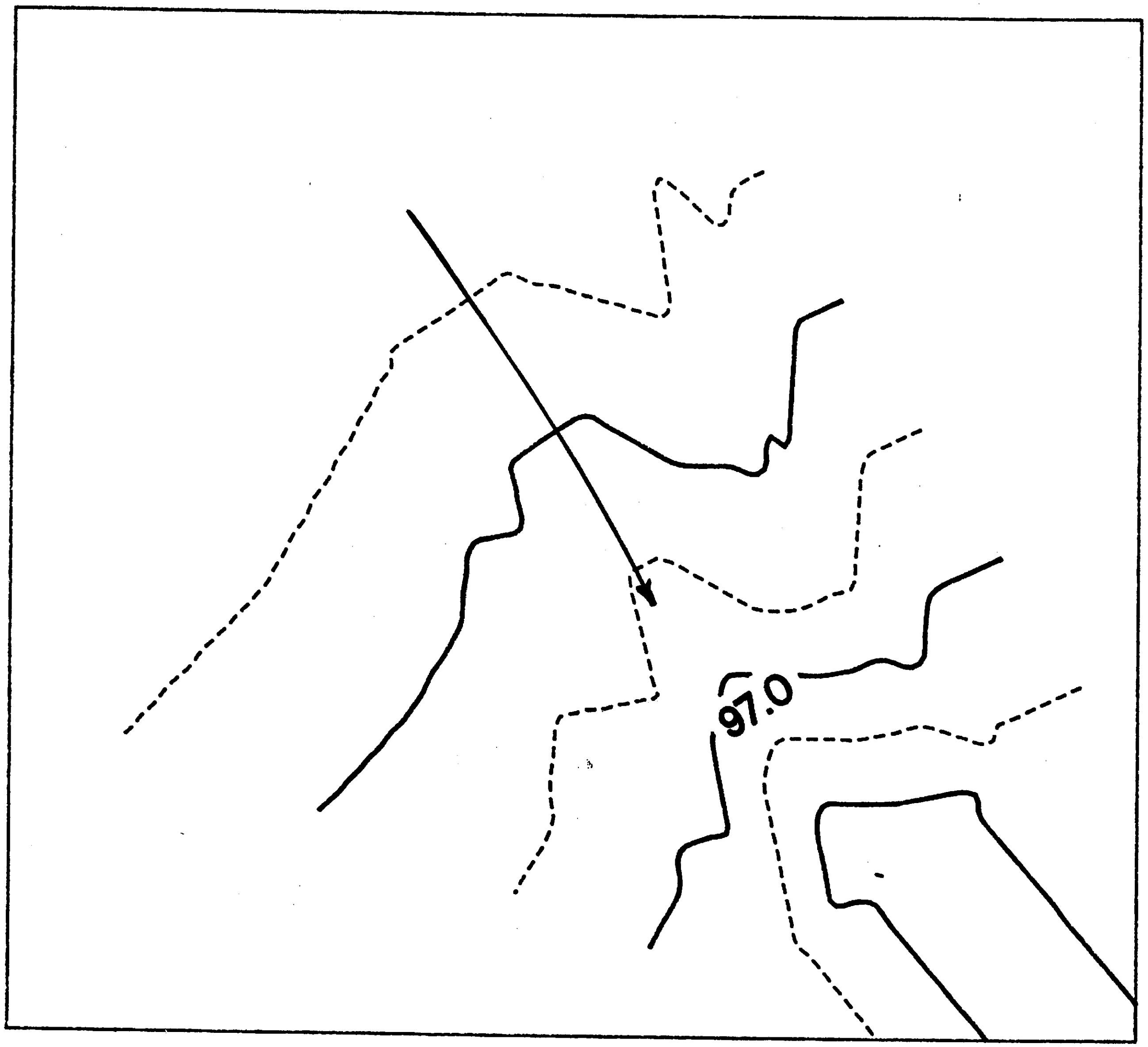
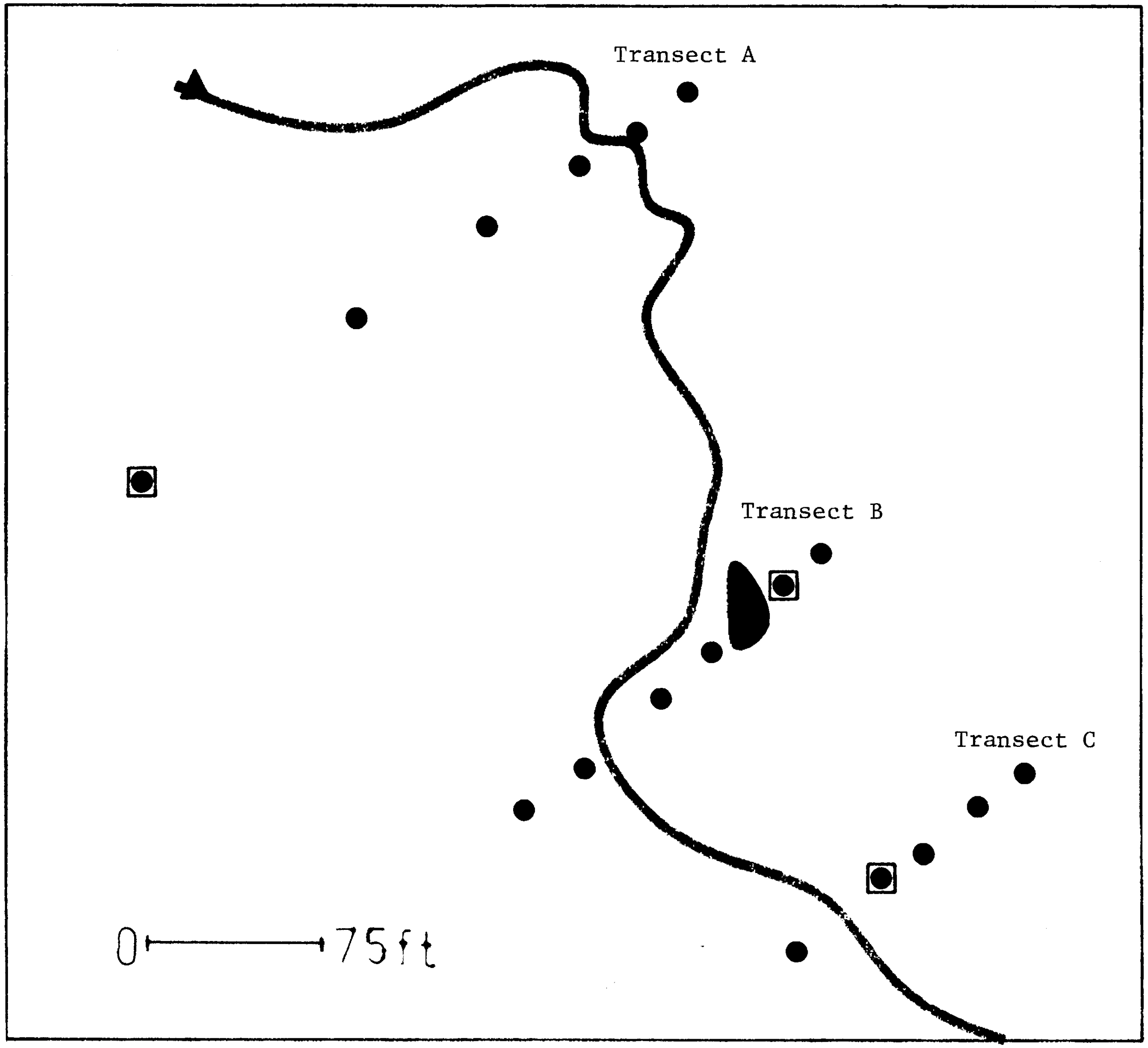

Transect A
Transect B
Transect C
0
75ft

Figure 22. Surface Water, Stream Channel and Well Grid, Upper Telephone Perennial Study Reach.
Overlay: Piezometric Head, August 25th, 1991. Arrows Indicate Direction of Isotropic Groundwater Movement.


97.0


Transect A
Transect B
Transect C
0
75ft

changes to diffused surface flow. This spring, unlike those in the other study reaches, contributes about 0.75 cfs of surface flow until mid-July. The flow in this channel was estimated twice in the field season by the float method. This was not difficult since the channel was nearly rectangular. After July 15th, the spring ceases to flow, and the channel dries.

HYDROLOGY

<u>SURFACE WATER</u>. Streamflow records from the Wyoming Water Resources Center gages 0111, 0112, and 0113 (Figure 2)

Table 3. Flood Flow Frequency, Log Pearson III Analysis, Nash Fork Creek, Station #0111.

Q (CFS)	RETURN PERIOD (YRS)
24.61	1.01
29.65	1.05
33.08	1.11
38.15	1.25
51.73	2.00
73.23	5.00
89.45	10.0
112.25	25.0
131.01	50.0
151.37	100.0
173.53	200.0
206.88	500.0

Table 4. Flood Flow Frequency, Log Pearson III Analysis, Telephone Creek, Station #0112

Q (CFS)	RETURN PERIOD (YRS)
18.16	1.01
22.16	1.05
24.83	1.11
28.70	1.25
38.77	2.00
54.01	5.00
65.06	10.0
80.14	25.0
92.19	50.0
104.98	100.0
118.60	200.0
138.46	500.0

were examined. Flood flow frequency analyses (Tables 3 and 4) were done for two of the three gages and flow duration analyses were done for all three gages. Data were compared to calculated bankfull flows (Table 5) to determine the amount and frequency of overbank flooding in these riparian ecosystems.

There is considerable variability in the flood return period for the study reaches. Bankfull flow (Q_{BF}) is estimated to be 75.1, 34.3 and 23.4 cfs for the Mill Pond, Nash Fork and Upper Telephone reaches and 0.18 cfs for the

Towner Lake Road Intermittent Reach. Q_{BF} for the Nash Fork Creek study reach has a return period near 1.25 years, similar to the Upper Telephone study reach. The Mill Pond Study reach has overbank events closer to the 20 year flow.

Analysis of the flow duration curves for each of the perennial study reaches shows that bankfull flow is equalled or exceeded in the Upper Telephone reach 6% of the time, in the Nash Fork reach 4% of the time and in the Mill Pond reach less than .02% of the time (Appendix D).

Table 5. Bankfull Flow (Q_{bf}) Calculations From Slope-Area Method. Q_{bf} is Presented for Two Cross-Sections (X/S) per Reach, Upper (U) and Lower (L). Reach Q_{bf} is the Geometric Mean of the Two Cross-Sectional Values. A = Cross Sectional Area; R = Hydraulic Radius = A/WP; S = Approximation of Energy Slope, Water Surface Slope; WP = Wetted Perimeter; n = Manning's 'n', a channel roughness coefficient.

Reach	X/S	A (ft^2)	R (ft)	S (ft/ft)	WP (ft)	$Q_{(bf)}$ (cfs)	n
Mill Pond	U	22.01	1.27	.0082	17.32	66.78	.035
	L	27.26	1.31	.0082	20.80	84.44	.035
Nash Fork	U	24.91	1.43	.0027	17.45	46.94	.035
	L	20.28	.76	.0027	26.66	25.07	.035
Upper Telephone	U	12.39	1.31	.0017	9.48	20.38	.030
	L	15.33	1.45	.0017	10.54	26.99	.030
Towner Lake Road	U	.29	.28*	.0015	6.88	.16	.030
	L	.37	.30*	.0015	7.12	.21	.030

* these values of 'R' are mean channel depths; appropriate for conditions where channel width-to-depth ratio is greater than 10.

GROUNDWATER

A cumulative frequency analysis was performed on the mean daily depths-to-groundwater for the continuously monitored wells to determine the requisite depth-to-groundwater duration data (Figures 23, 24, 25, 26). Signature depth-to-groundwater durations were chosen. The 40, 50, 75, and 90 percentile depth durations were selected, representing the depth-to-groundwater equalled or exceeded 40, 50, 75 and 90 percent of the time. Selection of these signature depth duration values was based on the similarity of all groundwater measurements during the early part of the subalpine summer. As noted above, saturated conditions predominated in all study reaches until after snowmelt (Table 6, page 87).

To enable use of the point-sampled (non continuously monitored) wells in the depth duration analysis, it was necessary to expand the data set associated with these wells using correlation techniques. Since each point-sampled well was measured 28 times during the 1991 field season, the data set for each point-sampled well was statistically correlated against the data from the continuously monitored wells for the same dates. Since statistical comparisons were only attempted between wells associated with different plant communities, point-sampled wells were only correlated to continuously monitored wells of like community. Where this involved comparisons with multiple continuously

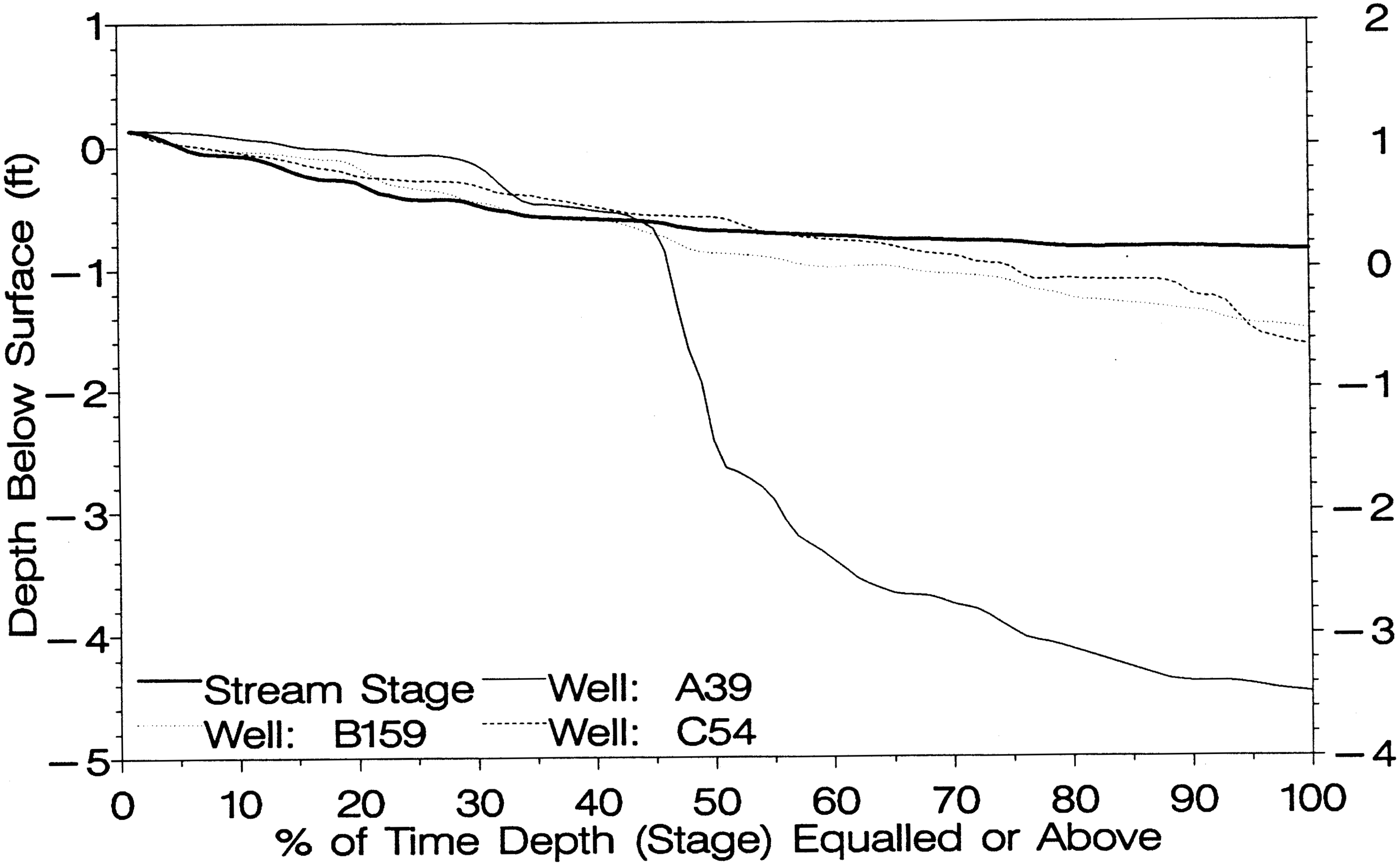


Figure 23. 1991 Stream Stage and Depth-to-Groundwater Duration Curves, Upper Telephone Reach. Well A39 is Located in a Grass/Forb Community, B159 in a Sedge Community, and C54 in an Open Canopy Willow Community. NOTE: Read Stream Stage from Right Vertical Axis.

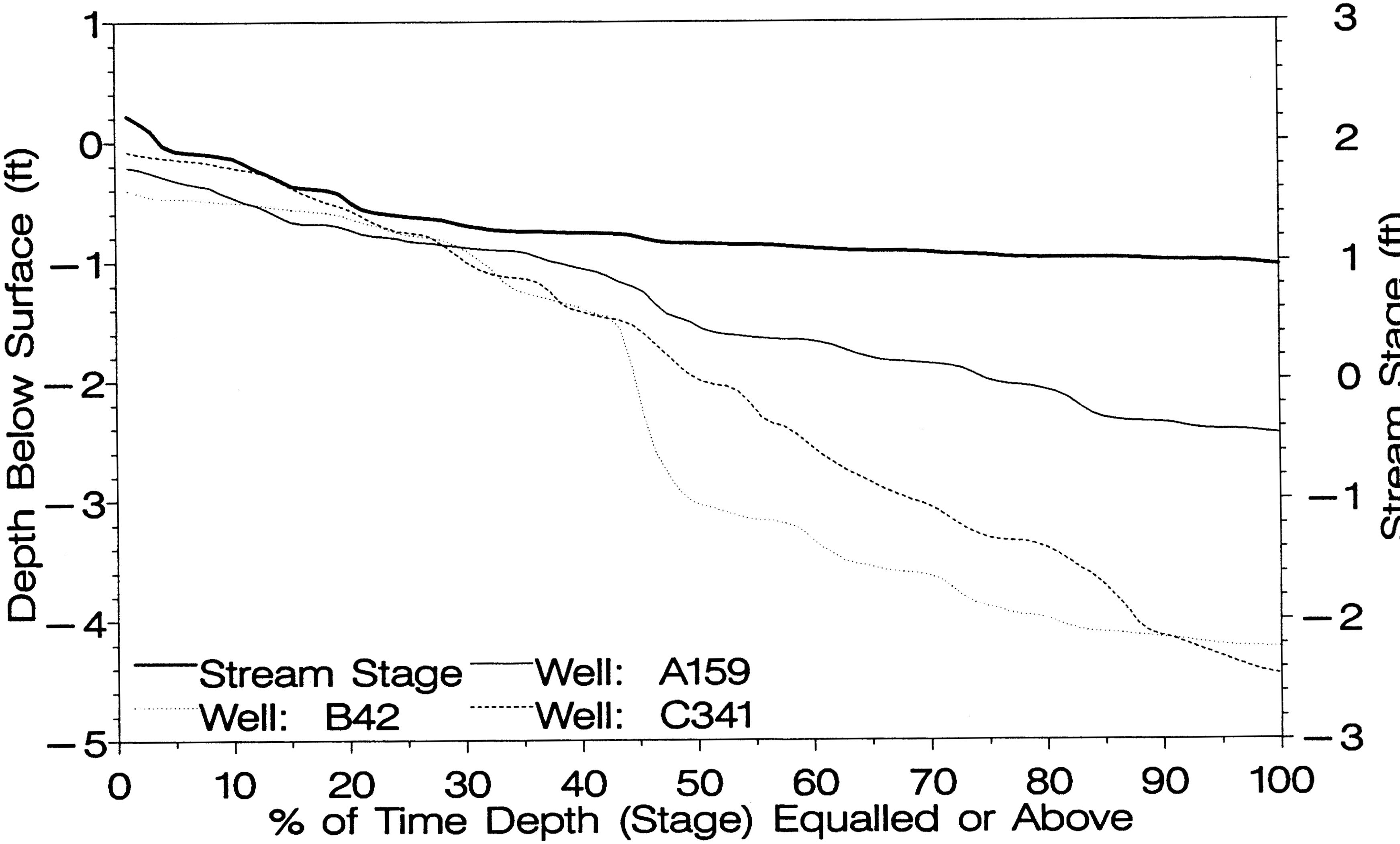


Figure 24. 1991 Stream Stage and Depth-to-Groundwater Duration Curves, Nash Fork Reach. Wells B42 and C341 are Located in a Tree Community, and Well A159 is in an Open Canopy Willow Community. NOTE: Read Stream Stage from the Right Vertical Axis.

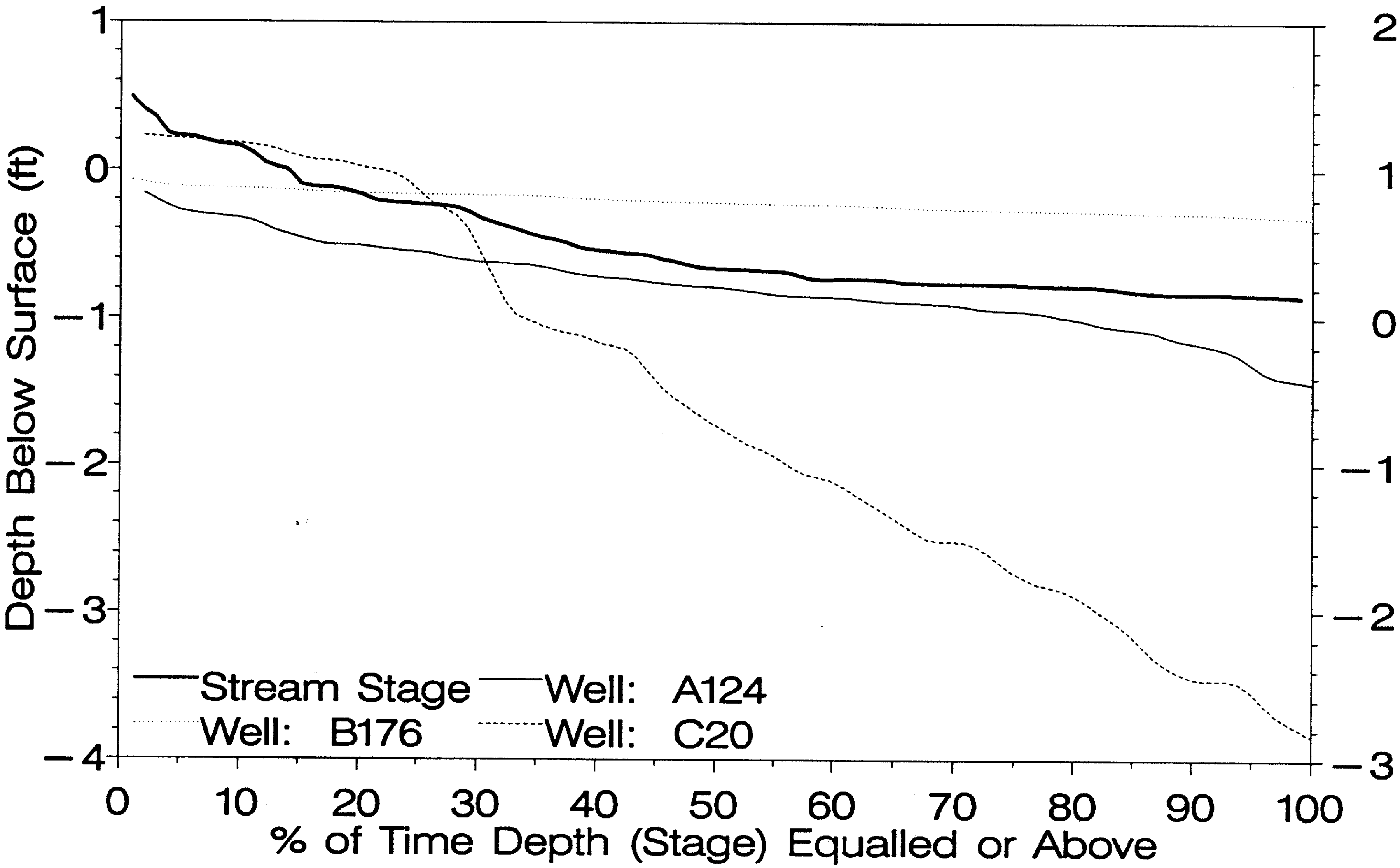


Figure 25. 1991 Stream Stage and Depth-to-Groundwater Duration Curves, Mill Pond Reach. Well A124 is Located in a Closed Canopy Willow Community, Well B176 in a Sedge Community and Well C20 in a Tree Community. NOTE: Read Stream Stage From Right Vertical Axis.

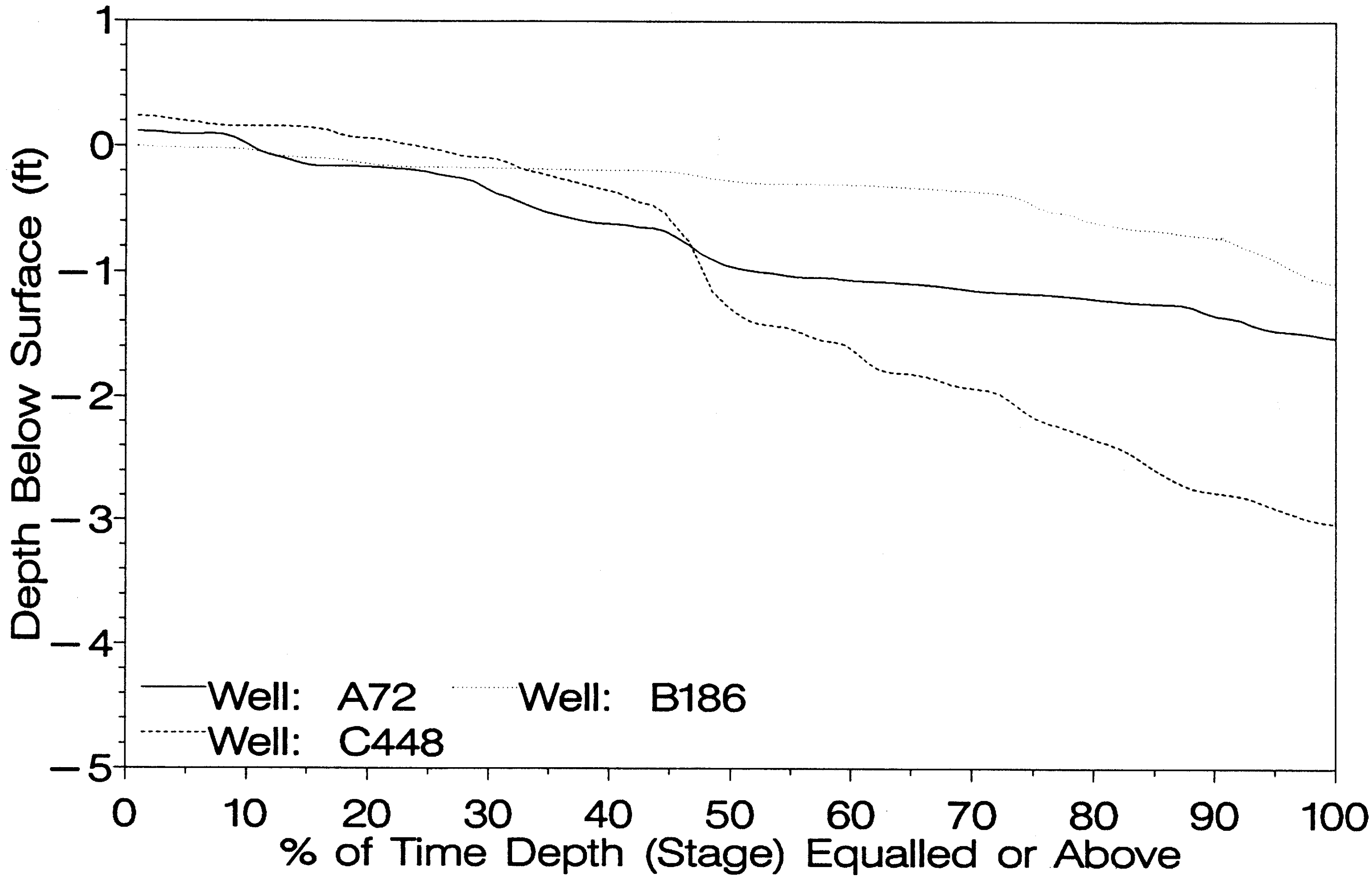


Figure 26. 1991 Depth-to-Groundwater Duration Curves, Towner Lk. Road Intermittent Flow Reach. Well A72 is Located in a Closed Canopy Willow Community, Well B186 in a Sedge Community and Well C448 in a Grass/Forb Community.

monitored wells, the highest coefficient of determination determined the continuously monitored well used in the procedure.

Using the selected continuously monitored well and the derived correlation equations, a full 99 date data set was developed for each point sampled well. The corresponding depth duration analysis for each of the signature depth durations was performed. This technique greatly expanded the data set for statistical analysis (Appendix C).

Table 6. Signature Depth-to-Groundwater Durations for Continuously Monitored Wells. Wells are Identified by Well Number, Transect, and Meadow. Meadows are Upper Telephone, 'TC', Nash Fork, 'NF', Mill Pond, 'MP" and Towner Lake Road, 'TLR'. Communities are the Plant Communities Surrounding Each Well (Carex, Grass/Forb 'GR/FB', Open Canopy Willow 'OCW', Closed Canopy Willow 'CCW', Tree). Depth-to-Groundwater (ft) Equalled or Exceeded 40, 50, 75, and 90 Percent of the Time are Presented.

MEADOW	TRANSECT	WELL NO	COMMUNITY	D_{40}	D_{50}	D_{75}	D_{90}
TC	A	39	GR/FB	.52	2.54	3.97	4.38
TC	B	159	CAREX	.61	.87	1.11	1.36
TC	C	54	OCW	.49	.59	.98	1.24
MP	A	124	CCW	.72	.79	.95	1.17
MP	B	176	CAREX	.20	.22	.26	.29
MP	C	20	TREE	1.18	1.75	2.76	3.46
TLR	A	72	CCW	.62	.95	1.18	1.33
TLR	B	186	CAREX	.20	.27	.42	.72
TLR	C	448	GR/FB	.35	1.23	2.12	2.76
NF	A	159	OCW	1.07	1.58	2.02	2.37
NF	B	42	TREE	1.4	3.04	3.90	4.16
NF	C	341	TREE	1.42	2.01	3.33	4.16

VEGETATION

Plant communities were defined during the initial surveying of each study reach as open canopy willow, closed canopy willow, sedge, upland grass/forb, tree, and encroaching spruce. These community boundaries have been presented as overlays to the topographical base maps of each study reach (Figures 7, 11, 15, 19). Specific data derived from the frequency sampling around each well is included in Appendix B.

Normalized frequency indices were plotted against the signature depth-to-ground water durations for Salix planifolia, Carex aquatilus, and Deschampsia cespitosa. These types of plots, originally developed from fisheries habitat research, are called 'suitability curves' (Bovee, 1986). The optimal suitability levels for each important species were determined for D_{40}, D_{50}, D_{75}, and D_{90} depth-to-groundwater. The D_{90} depth duration provided the most statistically significant differences (Figures 27, 28, 29).

STATISTICAL ANALYSES

D_{90} depths-to-groundwater for continuously monitored wells were tested in a single factor analysis of variance (ANOVA) and were found not significantly different between stream reaches (P=.83>alpha=.10). The null hypothesis of equality of D_{90} depths-to-groundwater between perennial and intermittent stream reaches is statistically valid.

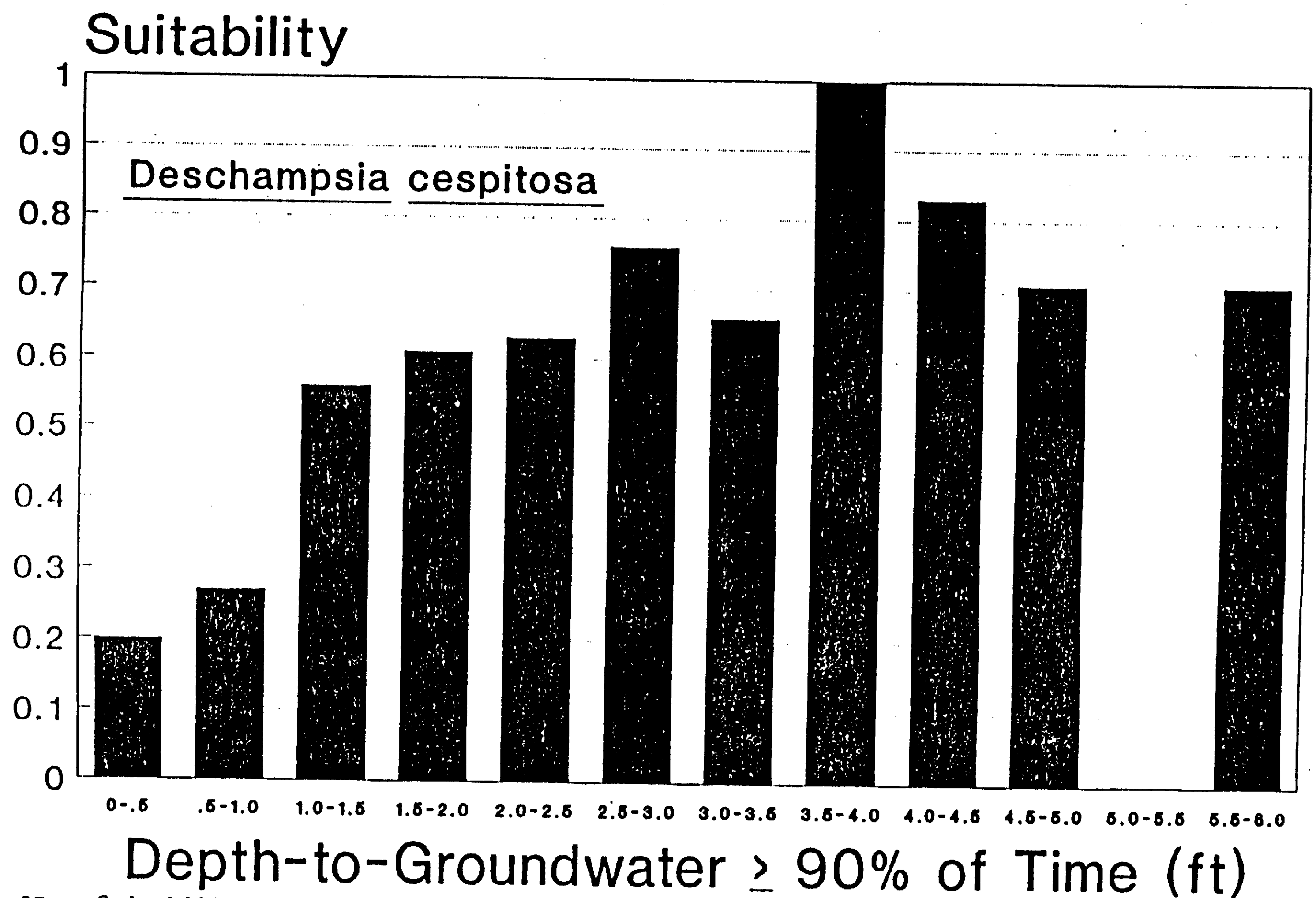


Figure 27. Suitability Curve for *D. cespitosa* at D_{90} Depth Duration. Suitability is a Measure of Species Response. D_{90} is discretized in one half foot intervals.

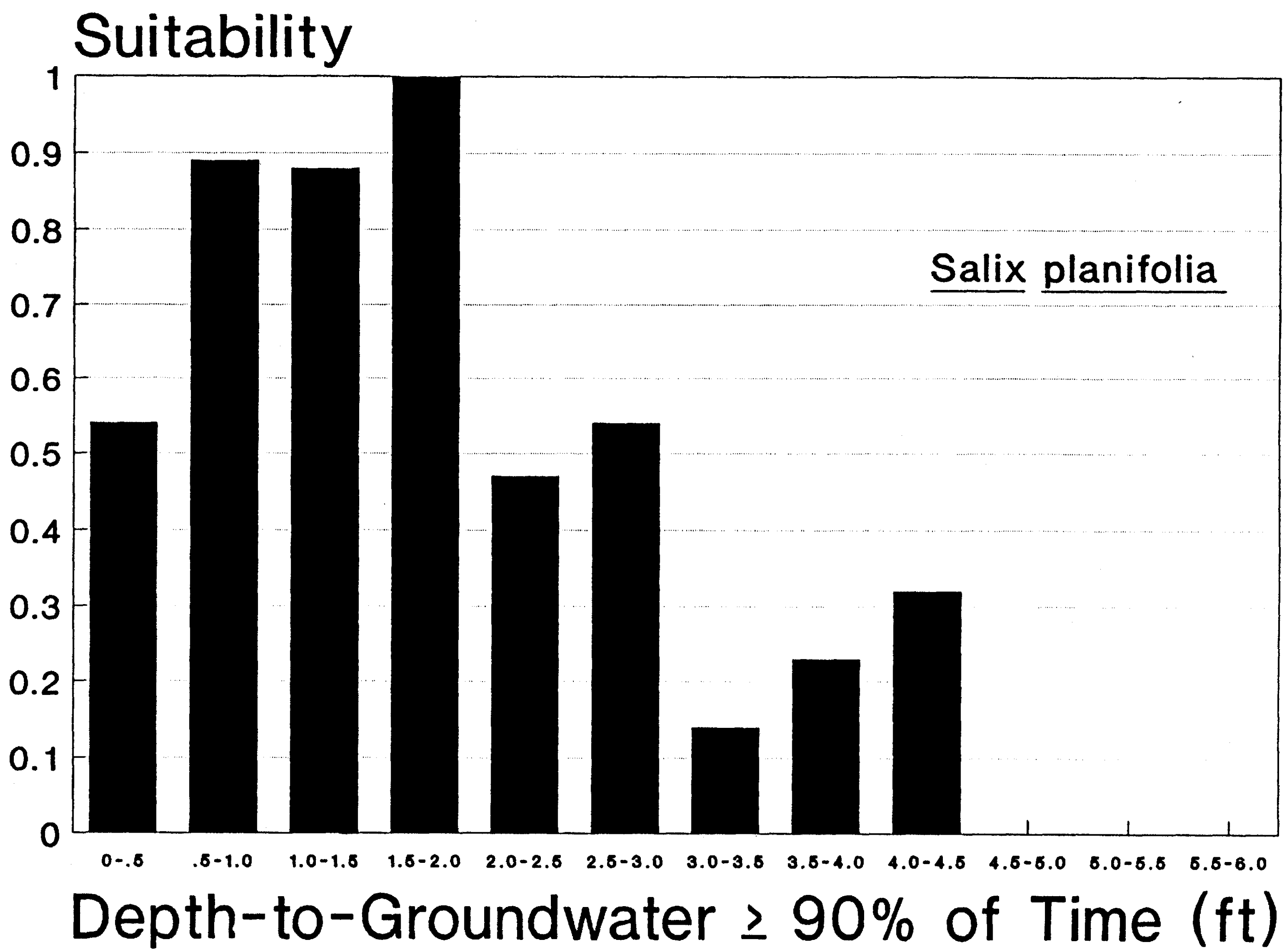


Figure 28. Suitability Curve for S. planifolia at D_{90} Depth Duration. Suitability is a Measure of Species Response. D_{90} Depths are Discretized in one half Foot Intervals.

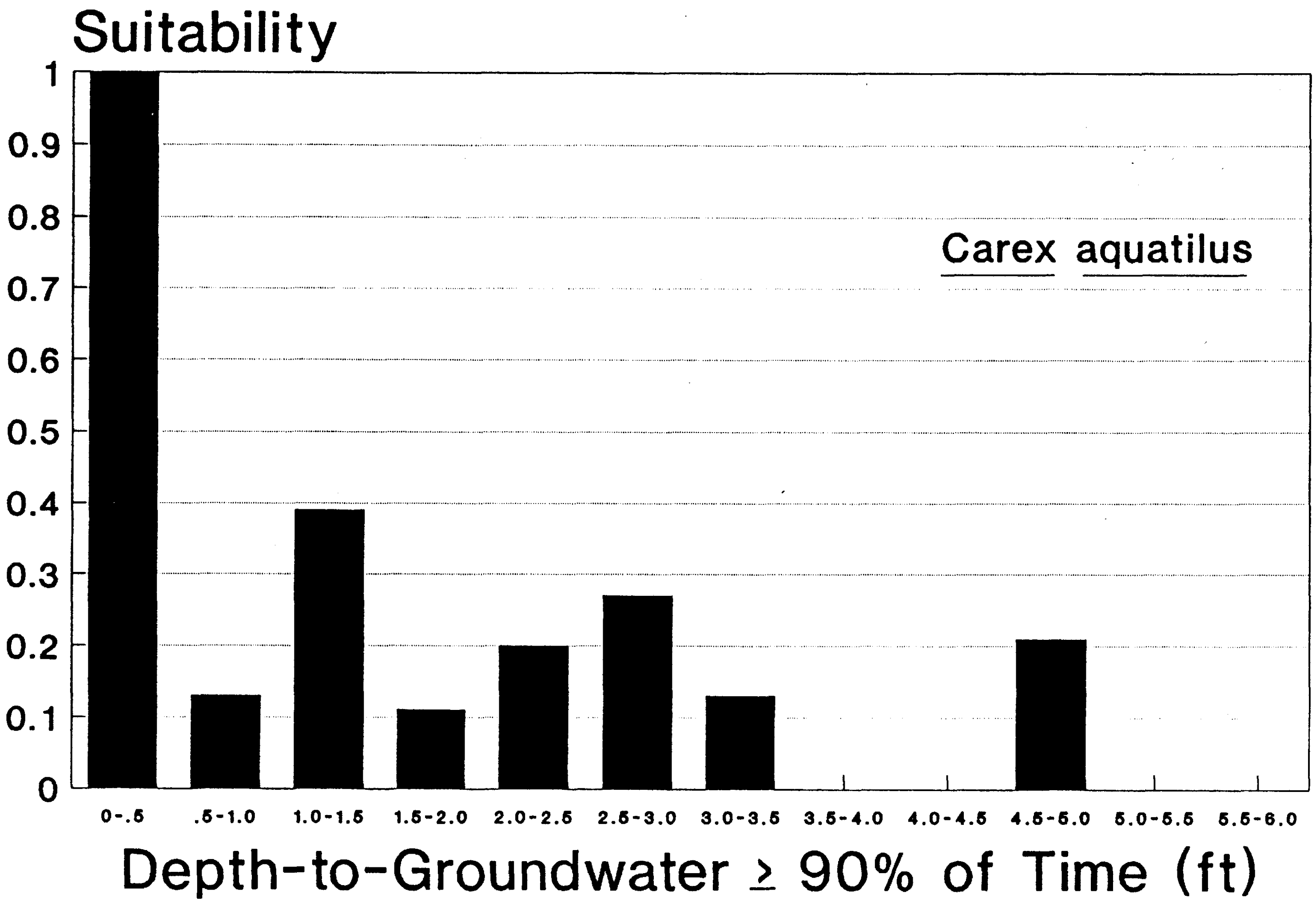


Figure 29. Suitability Curve for C. aquatilus at D_{90} Depth Duration. Suitability is a Measure of Species Response. D_{90} Depths are Discretized in one half Foot Intervals.

Single factor ANOVA testing the equality of the D_{90} signature groundwater depths (alpha=.10) for each plant community using all available wells in the analysis rejected the null hypothesis of equality (P<.0001<alpha=.10) (Table 7). Specific multiple comparisons were then run using Bonferroni's multiple comparison procedure to determine differences between the D_{90} depths-to-groundwater for the various plant communities.

Communities indistinguishable at D_{90} were upland grass/forb (GR/FB) and the tree community. These communities were distinguishable, however, at D_{40}. Closed canopy willow (CCW) was also indistinguishable from the carex communities at D_{90}, and at all other tested signature depth durations. Bonferroni's multiple comparisons yielded a positive separation of all other communities, as expressed below:

OCW   CAREX   CCW   GR/FB   TREE

Table 7. Single Factor Analysis of Variance Table for Null Hypothesis of Equality of D_{90} Depths-to-Groundwater by Community.

Source	Degrees of freedom	Sum of Squares	Mean Square	F Statistic	P value
Model	4	54.85	13.71	22.77	<.0001
Error	53	31.91	.60		
Total	57	86.76			

A two-factor ANOVA was run to test the significance of D_{90} depth-to-groundwater and important species by normalized score. This resulted in an ANOVA equally replicated by rows and columns. Species and interaction were significantly different at P<.0001<alpha=.10 (Table 8). Bonferroni's multiple comparison test indicates that Carex aquatilus and Salix planifolia suitability scores statistically separate between species at D_{90} depths of 1.0-1.5, 1.5-2.0, and 2.0-2.5 ft. Deschampsia cespitosa does not have statistically separable normalized suitability scores between species or within species at any D_{90} groundwater depth. Salix planifolia showed within species separation between D_{90} depths 1.5-3.5, 1.0-3.5, and 2.0-3.5 ft.

Table 8. Two Factor Analysis of Variance Table for Carex aquatilus, Deschampsia cespitosa, and Salix planifolia and D_{90} by Normalized Score.

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Statistic	P Value
Species	2	3.96	1.98	27.01	<.0001
D_{90}	10	1.11	.11	1.51	.14
Interact	20	4.41	.22	3.01	<.0001

CHAPTER VI

DISCUSSION

OVERVIEW

Water is critical to riparian areas. Boelman (1989) documented the increased amount of stored water in riparian areas in good condition, and Henszey (1988) noted that augmented surface water flows resulted in changes in groundwater elevation as well as changes in vegetation communities. Cooper (1990) stated that the hydrologic gradient was the most important factor controlling wetlands in the Big Meadows region of Rocky Mountain National Park.

Subalpine wetlands in the Snowy Range are complex. Surface water, groundwater, springs and seeps, precipitation and snowmelt all contribute inflows to the systems. Snowmelt dominates the surface water hydrograph and provides a large early season inflow source to the unconfined riparian aquifers.

Groundwater gradients are steepest in the early summer, gradually flattening after snowmelt. This was particularly noticeable in the Upper Telephone and Mill Pond study reaches. As the groundwater gradient resulting from downslope recharge lessened, overall gradients flattened. Surface water flow regimes changed from effluent to influent systems in the Nash Fork and Towner Lake Road intermittent meadows as well as in the lower portions of the Upper Telephone study reach. Mill Pond gradients flattened, but remained essentially unchanged in direction. Cooper (1990) stated that the center of Big Meadows appears to be a groundwater discharge area, while the margin of the meadow was a groundwater recharge area. In general, I concur, especially early in the season.

Groundwater seeps are present in all of the study reaches, but decrease greatly in flow after snowmelt ceases. Because of this I speculate that these groundwater sources are indicative of hydraulic connections with upslope basins, rather than of significant confined aquifers. Nevertheless, these seeps and springs are locally important in the Mill Pond meadow where they persist throughout the summer and provide diffused surface flow.

Surface water flows appear to be secondary in importance in these meadows. As the season progresses, their importance may increase as portions of all the streams become influent systems. Overbank flows in the subalpine appear to be even less significant, since they occur infrequently. When such events do occur, they encounter saturated conditions, and most probably runoff. With regard to the health of the riparian area, they are at best neutral.

Stage-discharge relationships indicate long-term channel stability. Lack of aggradation or degradation in these channels indicates hydrologic equilibrium.

Data layering allowed the development of specific plant-water relationships. Groundwater D_{90} depths were not significantly different between intermittent and perennial study reaches, but D_{90} depths were positively correlated to riparian plant communities. In addition, suitability curves for Salix planifolia, Carex aquatilus, and Deschampsia cespitosa show strong trends associated with depth-to-groundwater. Statistical separation between species supports the hypothesis that a hydrologic gradient similar to that below does exist between the species:

Carex------------------>Salix------------------>Deschampsia

Hydric--->Mesic

Within species separation by depth-to-groundwater duration was apparent primarily in Salix planifolia and Carex aquatilus. Deschampsia cespitosa clearly favored a specific depth-to-groundwater, but data scatter and insufficient number of samples made statistical separation impossible using a conservative multiple comparison test. A liberal test such as Fischer's Least Significant Difference (LSD) with an increased comparisonwise error rate (unacceptable here), produces a large increase in the within and between species separation. Data scatter occurs in a study such as this because of natural variability. Statistically, I set alpha equal to .10, attempting to accommodate some of this variability while still maintaining a conservative approach.

Further research using biomass as the measure of vegetative response is in order. Biomass may reduce the amount of scatter associated with the vegetative data. The frequency technique I used measures presence or absence of a species, failing to completely answer quantitative questions of species abundance. Biomass is the best statistic for addressing these questions.

RESEARCH UTILITY

Kusler and Kentula (1990) stressed the need for further basic research into hydro-period requirements of specific wetland species. This research addresses that need in the subalpine zone. Further work is needed to extend the level of inference of this research, but it does not seem illogical that wetland species representative of the genera studied in this research may respond in a similar manner at varying elevations. This question needs to be investigated further.

The 'suitability' curve technique appears quite applicable to vegetation. This is particularly true with respect to groundwater. Grootjans and Ten Klooster (1980) hypothesized the importance of groundwater duration analysis with respect to wetland species. This research supports that hypothesis. Henszey (1988) noted the effects of flow augmentation on groundwater and vegetative composition. The present research supports the importance of groundwater to wetland species composition.

The concept of 'site' encompasses all factors that contribute to the ability of a plant to occupy a particular ecological niche. Soils, competition or other parameters may be more important than hydro-period in many ecosystems. This would not necessarily preclude the use of suitability techniques but could change the independent variable measured. A particular location would not be completely described in terms of suitability until all limiting factors are considered.

In situations where hydro-period is the dominant factor acting to maintain the system, the suitability technique appears particularly useful. It is not hard to imagine utility in a technique that quantifies the level and duration of application of the limiting factor.

CHAPTER VII

CONCLUSIONS

Based upon the results of this research presented and discussed, I conclude the following:

- In this elevation zone, groundwater appears to predict vegetative community distribution.

- Depth-duration analysis for groundwater is a useful tool for developing plant/groundwater relationships.

- Surface water flow regime is only marginally important for riparian ecosystem maintenance in this elevation zone.

- Suitability analysis indicates *Deschampsia cespitosa*, *Salix planifolia* and *Carex aquatilus* are highly correlated to depth-to-groundwater.

- Statistical separation of plant communities and species in the subalpine zone of the central Rocky Mountains is likely using D_{90} depth-to-groundwater as the independent variable.

APPENDIX A

Appendix A. Plant species list of the riparian study reaches, Snowy Range Observatory.

Scientific Name	Common Name
Abies concolor	white fir
Achillea millefolium	western yarrow
Aconitum columbianum	monkshood
Agoseris glauca	false dandelion
Agropyron smithii	western wheatgrass
Agropyron trachycaulum	slender wheatgrass
Agrostis alba	bentgrass
Allium schoenoprasum	siberian chive
Antennaria rosii	pussy-toes
Arenaria obtusiloba	sandwort
Betula glandulosa	bog birch
Brassicaceae	mustard family
Bromus marginata	mountain brome
Caltha leptosepala	marsh marigold
Carex aquatilus	water sedge
Carex ebenea	ebony sedge
Carex gynocrates	bog sedge
Carex lenticularis	Kellogg's sedge
Carex rostrata	beaked sedge
Carex scopulorum	mountain sedge
Castilleja sulphurea	paintbrush
Catabrosa aquatica	brookgrass
Circuta douglassii	water hemlock
Danthonia intermedia	timber oatgrass
Delphinium barbeyi	larkspur
Deschampsia atropurpurea	mountain hairgrass
Deschampsia cespitosa	tufted hairgrass
Epilobium cileodum	willow-herb
Equisetum arvense	horsetail
Erigeron pinnatisectus	pinnate daisy
Erigeron simplex	alpine daisy
Erigeron ursinous	fleabane
Eriogonum umbellatum	sulfurflower
Erythronium grandiflorum	glacier lily
Festuca ovina	sheep fescue
Frageria virginiana	strawberry
Gentianella barbellota	fringed gentian
Gentianella detonsa	mountain fringed gentian
Geranium	geranium
Geum macrophyllum	large-leafed avens
Hieracium gracille	slender hawkweed
Juncus balticus	baltic rush
Luzula parviflora	woodrush
Mertensia ciliata	chiming bells
Pedicularis groenlandica	elephants' head
Pentaphylloides floribunda	shrubby cinquefoil

Scientific Name	Common Name
Phleum alpinum	alpine timothy
Picea englemannii	Englemann spruce
Plantago tweedii	Tweedy's plantago
Poa alpina	alpine bluegrass
Poa nervosa	Wheeler's bluegrass
Poa leptocoma	bog bluegrass
Polygonium bistortoides	bistort
Potentilla diversifolia	blue cinquefoil
Potentilla spp.	cinquefoil
Pseudotsuga menzesii	douglas-fir
Ranunculus alismaefolius	plantain-leaved buttercup
Ranunculus eschscholtzii	alpine buttercup
Ranunculus spp.	buttercup
Ribes montigenum	mountain gooseberry
Rumex densiflorous	dock
Salix brachiacarpa	short-fruited willow
Salix monticola	mountain willow
Salix planifolia	planeleaf willow
Salix wolfii	Wolf's willow
Saxifrage odontolomin	brook saxifrage
Sedum rodanthum	stonecrop
Senicio serra	groundsel
Senicio triangularis	groundsel
Sibbaldia procumbens	sibbaldia
Solidago spathulata	goldenrod
Stellaria umbellata	starwort
Swertia parenis	star gentian
Taraxacum officinal	dandelion
Thlaspi montanum	candytuft
Trifolium parryii	Parry's clover
Trisetum spicatum	spike trisetum
Trollius laxus	globeflower
Vaccinium scoparina	grouseberry
Veronica wormskjoldii	speedwell
Viola canadensis	Canada violet
Viola spp.	violet
Zigadenus elegans	death camas

APPENDIX B

Appendix B. Vegetation Frequency Sampling, by Individual Well. "TC" is Upper Telphone Meadow, "MP" is Mill Pond, "NF" is Nash Fork and "TLR" is Towner Lake Road. "TRN" is Transect. "#" is Distance in Feet from Right Transect Stake to Individual Well. Class is Grass (G), Forb (F), Shrub (S), Tree (T). Raw Score is Frequency Score out of Possible 40 Using Nested Quadrat.

MDW	TRN	#	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	A	39	G	Deschampsia cespitosa	36
TC	A	39	G	Phleum alpinum	26
TC	A	39	G	Agrostis alba	7
TC	A	39	G	Poa alpina	4
TC	A	39	G	Carex spp.	32
TC	A	39	G	Carex aquatilus	26
TC	A	39	G	Carex lenticularis	4
TC	A	39	G	Juncus balticus	11
TC	A	39	F	Gentiana spp.	3
TC	A	39	F	Caltha leptosepala	37
TC	A	39	F	Epilobium cileodum	12
TC	A	39	F	Veronica wormskjoldii	11
TC	A	39	F	Polygonium bistortoides	9
TC	A	39	F	Senicio triangularis	9
TC	A	39	F	Swertia parenis	14
TC	A	39	F	Rumex densiflorous	1
TC	A	39	F	Ranunculus spp.	14
TC	A	156	G	Deschampsia cespitosa	16
TC	A	156	G	Catabrosa aquatica	4
TC	A	156	G	Festuca ovina	3
TC	A	156	G	Carex aquatilus	26
TC	A	156	G	Carex rostrata	17
TC	A	156	G	Carex lenticularis	13
TC	A	156	G	Poa spp.	27
TC	A	156	S	Salix planifolia	34
TC	A	156	F	Gentiana spp.	2
TC	A	156	F	Caltha leptosepala	32
TC	A	156	F	Epilobium cileodum	7
TC	A	156	F	Veronica wormskjoldii	7
TC	A	156	F	Senicio triangularis	1
TC	A	156	F	Swertia parenis	5
TC	A	156	F	Stellaria umbellata	4
TC	A	156	F	Sedum rodanthum	19
TC	A	226	G	Deschampsia cespitosa	12
TC	A	226	G	Poa spp.	7
TC	A	226	G	Catabrosa aquatica	7
TC	A	226	G	Trisetum spicatum	3
TC	A	226	G	Carex aquatilus	21
TC	A	226	G	Carex lenticularis	23
TC	A	226	S	Salix planifolia	28

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	A 226	F	Veronica wormskjoldii	7
TC	A 226	F	Achillea millefolium	11
TC	A 226	F	Stellaria umbellata	18
TC	A 226	F	Ranunculus spp.	4
TC	A 226	F	Geum macrophyllum	4
TC	A 276	G	Deschampsia cespitosa	14
TC	A 276	G	Agrostis alba	2
TC	A 276	G	Carex lenticularis	13
TC	A 276	S	Salix planifolia	40
TC	A 276	F	Aster/Erigeron	6
TC	A 276	F	Caltha leptosepala	3
TC	A 276	F	Epilobium cileodum	9
TC	A 276	F	Veronica wormskjoldii	12
TC	A 276	F	Achillea millefolium	17
TC	A 276	F	Senicio triangularis	23
TC	A 276	F	Swertia parenis	5
TC	A 276	F	Rumex densiflorous	14
TC	A 276	F	Stellaria umbellata	16
TC	A 276	F	Sedum rodanthum	3
TC	A 276	F	Plantago tweedii	4
TC	A 276	F	Ranunculus spp.	13
TC	A 276	F	Saxifrage odontolomin	9
TC	A 276	F	Pedicularis groenlandica	2
TC	A 276	F	Mertensia ciliata	10
TC	A 308	G	Deschampsia cespitosa	15
TC	A 308	G	Phleum alpinum	13
TC	A 308	G	Agrostis alba	18
TC	A 308	G	Poa spp.	3
TC	A 308	G	Poa alpina	7
TC	A 308	G	Deschampsia atropurpurea	2
TC	A 308	G	Festuca ovina	16
TC	A 308	G	Carex aquatilus	32
TC	A 308	G	Juncus balticus	11
TC	A 308	S	Salix planifolia	36
TC	A 308	F	Potentilla spp.	2
TC	A 308	F	Caltha leptosepala	13
TC	A 308	F	Veronica wormskjoldii	32
TC	A 308	F	Achillea millefolium	4
TC	A 308	F	Senicio triangularis	8
TC	A 308	F	Swertia parenis	6
TC	A 308	F	Stellaria umbellata	7
TC	A 308	F	Sedum rodanthum	1
TC	A 308	F	Ranunculus spp.	14
TC	A 308	F	Geum macrophyllum	2
TC	A 308	F	Saxifrage odontolomin	13
TC	A 308	F	Pedicularis groenlandica	3
TC	A 308	F	Taraxacum officinal	4
TC	A 308	F	Trifolium parryii	5
TC	A 308	T	Picea englemannii	3

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	A 337	G	Deschampsia cespitosa	34
TC	A 337	G	Phleum alpinum	22
TC	A 337	G	Agrostis alba	1
TC	A 337	G	Poa alpina	21
TC	A 337	G	Elymus trachycaulum	5
TC	A 337	G	Festuca ovina	24
TC	A 337	G	Carex spp.	11
TC	A 337	G	Carex aquatilus	33
TC	A 337	G	Juncus balticus	29
TC	A 337	S	Salix planifolia	24
TC	A 337	F	Aster/Erigeron	14
TC	A 337	F	Potentilla spp.	6
TC	A 337	F	Caltha leptosepala	31
TC	A 337	F	Epilobium cileodum	27
TC	A 337	F	Veronica wormskjoldii	19
TC	A 337	F	Polygonium bistortoides	3
TC	A 337	F	Achillea millefolium	8
TC	A 337	F	Swertia parenis	16
TC	A 337	F	Stellaria umbellata	16
TC	A 337	F	Plantago tweedii	3
TC	A 337	F	Ranunculus spp.	20
TC	A 337	F	Pedicularis groenlandica	14
TC	A 337	F	Taraxacum officinal	9
TC	A 337	F	Trifolium parryii	7
TC	A 337	F	Arenaria obtusiloba	15
TC	A 337	F	Viola spp.	11
TC	A 337	F	Brassicaceae	4
TC	B 8	G	Deschampsia cespitosa	36
TC	B 8	G	Phleum alpinum	32
TC	B 8	G	Poa alpina	24
TC	B 8	G	Festuca ovina	14
TC	B 8	G	Carex spp.	13
TC	B 8	G	Carex gynocrates	17
TC	B 8	G	Juncus balticus	10
TC	B 8	G	Equisetum arvense	10
TC	B 8	S	Salix planifolia	8
TC	B 8	F	Aster/Erigeron	15
TC	B 8	F	Gentiana spp.	2
TC	B 8	F	Potentilla spp.	16
TC	B 8	F	Caltha leptosepala	23
TC	B 8	F	Epilobium cileodum	3
TC	B 8	F	Veronica wormskjoldii	11
TC	B 8	F	Polygonium bistortoides	19
TC	B 8	F	Achillea millefolium	22
TC	B 8	F	Senicio triangularis	19
TC	B 8	F	Swertia parenis	4
TC	B 8	F	Stellaria umbellata	8
TC	B 8	F	Sedum rodanthum	3
TC	B 8	F	Plantago tweedii	6
TC	B 8	F	Ranunculus spp.	29
TC	B 8	F	Trollius laxus	7

MDW	TCT #		CLASS	SCIENTIFIC NAME	RAW SCORE
TC	B	8	F	Saxifrage odontolomin	10
TC	B	8	F	Pedicularis groenlandica	9
TC	B	8	F	Taraxacum officinal	6
TC	B	8	F	Trifolium parryii	17
TC	B	38	G	Deschampsia cespitosa	17
TC	B	38	G	Poa alpina	11
TC	B	38	G	Carex aquatilus	21
TC	B	38	G	Carex lenticularis	32
TC	B	38	G	Equisetum arvense	1
TC	B	38	S	Salix planifolia	35
TC	B	38	F	Caltha leptosepala	15
TC	B	38	F	Epilobium cileodum	7
TC	B	38	F	Veronica wormskjoldii	9
TC	B	38	F	Stellaria umbellata	21
TC	B	38	F	Sedum rodanthum	7
TC	B	38	F	Plantago tweedii	1
TC	B	38	F	Ranunculus spp.	21
TC	B	38	F	Saxifrage odontolomin	6
TC	B	85	G	Deschampsia cespitosa	16
TC	B	85	G	Danthonia intermedia	2
TC	B	85	G	Poa alpina	3
TC	B	85	G	Bromus marginata	8
TC	B	85	G	Poa spp.	11
TC	B	85	G	Festuca ovina	7
TC	B	85	G	Carex spp.	4
TC	B	85	G	Carex rostrata	26
TC	B	85	G	Juncus balticus	2
TC	B	85	G	Equisetum arvense	10
TC	B	85	S	Salix planifolia	39
TC	B	85	F	Aster/Erigeron	20
TC	B	85	F	Epilobium cileodum	25
TC	B	85	F	Veronica wormskjoldii	13
TC	B	85	F	Achillea millefolium	13
TC	B	85	F	Stellaria umbellata	16
TC	B	85	F	Ranunculus spp.	10
TC	B	85	F	Geum macrophyllum	1
TC	B	85	F	Saxifrage odontolomin	9
TC	B	85	F	Mertensia ciliata	1
TC	B	85	F	Veraginaceae	5
TC	B	114	G	Deschampsia cespitosa	17
TC	B	114	G	Phleum alpinum	7
TC	B	114	G	Carex aquatilus	13
TC	B	114	G	Carex lenticularis	29
TC	B	114	G	Carex rostrata	22
TC	B	114	G	Juncus balticus	5
TC	B	114	S	Salix planifolia	2
TC	B	114	F	Castilleja sulphurea	2
TC	B	114	F	Aster/Erigeron	8
TC	B	114	F	Caltha leptosepala	6

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	B 114	F	Epilobium cileodum	10
TC	B 114	F	Veronica wormskjoldii	16
TC	B 114	F	Achillea millefolium	7
TC	B 114	F	Rumex densiflorous	6
TC	B 114	F	Stellaria umbellata	17
TC	B 114	F	Ranunculus spp.	18
TC	B 114	F	Geum macrophyllum	3
TC	B 114	F	Saxifrage odontolomin	3
TC	B 114	F	Taraxacum officinal	2
TC	B 114	F	Thlaspi montanum	3
TC	B 114	F	Mertensia ciliata	2
TC	B 114	F	Agoseris glauca	6
TC	B 159	G	Deschampsia cespitosa	24
TC	B 159	G	Phleum alpinum	17
TC	B 159	G	Agrostis alba	3
TC	B 159	G	Poa alpina	1
TC	B 159	G	Festuca ovina	8
TC	B 159	G	Elymus trachycaulum	3
TC	B 159	G	Deschampsia atropurpurea	5
TC	B 159	G	Equisetum arvense	3
TC	B 159	G	Carex spp.	9
TC	B 159	G	Carex aquatilus	38
TC	B 159	S	Salix wolfii	4
TC	B 159	S	Salix planifolia	25
TC	B 159	F	Aster/Erigeron	2
TC	B 159	F	Potentilla spp.	2
TC	B 159	F	Epilobium cileodum	8
TC	B 159	F	Veronica wormskjoldii	22
TC	B 159	F	Polygonium bistortoides	3
TC	B 159	F	Achillea millefolium	26
TC	B 159	F	Rumex densiflorous	3
TC	B 159	F	Ranunculus spp.	3
TC	B 159	F	Geum macrophyllum	7
TC	B 159	F	Taraxacum officinal	10
TC	B 159	F	Trifolium parryii	5
TC	B 180	G	Deschampsia cespitosa	27
TC	B 180	G	Phleum alpinum	10
TC	B 180	G	Poa alpina	4
TC	B 180	G	Festuca ovina	9
TC	B 180	G	Carex spp.	13
TC	B 180	G	Carex aquatilus	13
TC	B 180	G	Carex lenticularis	20
TC	B 180	G	Juncus balticus	12
TC	B 180	S	Salix wolfii	20
TC	B 180	S	Salix planifolia	34
TC	B 180	S	Salix brachiacarpa	20
TC	B 180	F	Castilleja sulphurea	1
TC	B 180	F	Aster/Erigeron	1
TC	B 180	F	Caltha leptosepala	18
TC	B 180	F	Epilobium cileodum	4

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	B 180	F	Veronica wormskjoldii	19
TC	B 180	F	Achillea millefolium	1
TC	B 180	F	Swertia parenis	7
TC	B 180	F	Stellaria umbellata	4
TC	B 180	F	Plantago tweedii	12
TC	B 180	F	Ranunculus spp.	24
TC	B 180	F	Pedicularis groenlandica	20
TC	B 180	F	Taraxacum officinal	18
TC	B 180	F	Agoseris glauca	4
TC	C 12	G	Deschampsia cespitosa	24
TC	C 12	G	Phleum alpinum	20
TC	C 12	G	Poa alpina	18
TC	C 12	G	Festuca ovina	4
TC	C 12	G	Carex spp.	22
TC	C 12	G	Carex aquatilus	22
TC	C 12	G	Juncus balticus	16
TC	C 12	G	Equisetum arvense	2
TC	C 12	S	Salix planifolia	14
TC	C 12	F	Aster/Erigeron	8
TC	C 12	F	Potentilla spp.	10
TC	C 12	F	Caltha leptosepala	28
TC	C 12	F	Epilobium cileodum	21
TC	C 12	F	Veronica wormskjoldii	3
TC	C 12	F	Achillea millefolium	5
TC	C 12	F	Stellaria umbellata	13
TC	C 12	F	Sedum rodanthum	1
TC	C 12	F	Ranunculus spp.	15
TC	C 12	F	Saxifrage odontolomin	3
TC	C 12	F	Pedicularis groenlandica	2
TC	C 12	F	Taraxacum officinal	4
TC	C 12	F	Arenaria obtusiloba	3
TC	C 12	F	Antennaria rossi	5
TC	C 12	F	Trifolium parryii	10
TC	C 54	G	Deschampsia cespitosa	32
TC	C 54	G	Phleum alpinum	13
TC	C 54	G	Agrostis alba	17
TC	C 54	G	Poa alpina	8
TC	C 54	G	Festuca ovina	11
TC	C 54	G	Carex aquatilus	30
TC	C 54	G	Carex lenticularis	10
TC	C 54	G	Equisetum arvense	16
TC	C 54	S	Salix planifolia	15
TC	C 54	F	Potentilla spp.	12
TC	C 54	F	Caltha leptosepala	1
TC	C 54	F	Epilobium cileodum	1
TC	C 54	F	Veronica wormskjoldii	19
TC	C 54	F	Achillea millefolium	9
TC	C 54	F	Senicio triangularis	3
TC	C 54	F	Swertia parenis	9
TC	C 54	F	Stellaria umbellata	11

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	C 54	F	Sedum rodanthum	3
TC	C 54	F	Plantago tweedii	5
TC	C 54	F	Ranunculus spp.	3
TC	C 54	F	Pedicularis groenlandica	5
TC	C 54	F	Taraxacum officinal	6
TC	C 54	F	Allium schoenoprasum	1
TC	C 54	F	Agoseris glauca	3
TC	C 82	G	Deschampsia cespitosa	19
TC	C 82	G	Deschampsia atropurpurea	3
TC	C 82	G	Phleum alpinum	12
TC	C 82	G	Poa alpina	24
TC	C 82	G	Festuca ovina	30
TC	C 82	G	Carex spp.	22
TC	C 82	S	Salix planifolia	32
TC	C 82	S	Salix wolfii	29
TC	C 82	S	Salix brachiacarpa	7
TC	C 82	F	Potentilla spp.	19
TC	C 82	F	Aster/Erigeron	16
TC	C 82	F	Gentiana spp.	9
TC	C 82	F	Caltha leptosepala	33
TC	C 82	F	Veronica wormskjoldii	20
TC	C 82	F	Achillea millefolium	10
TC	C 82	F	Senicio triangularis	13
TC	C 82	F	Swertia parenis	10
TC	C 82	F	Stellaria umbellata	17
TC	C 82	F	Sedum rodanthum	5
TC	C 82	F	Ranunculus spp.	29
TC	C 82	F	Pedicularis groenlandica	28
TC	C 82	F	Taraxacum officinal	4
TC	C 82	F	Solidago spathulata	3
TC	C 82	F	Antennaria rosii	1
TC	C 82	T	Picea englemannii	3
TC	C 114	G	Deschampsia cespitosa	23
TC	C 114	G	Deschampsia atropurpurea	3
TC	C 114	G	Phleum alpinum	24
TC	C 114	G	Poa alpina	29
TC	C 114	G	Festuca ovina	27
TC	C 114	G	Carex spp.	17
TC	C 114	S	Salix wolfii	14
TC	C 114	S	Salix planifolia	11
TC	C 114	S	Salix brachiacarpa	22
TC	C 114	F	Castilleja sulphurea	9
TC	C 114	F	Aster/Erigeron	10
TC	C 114	F	Potentilla spp.	35
TC	C 114	F	Caltha leptosepala	15
TC	C 114	F	Epilobium cileodum	1
TC	C 114	F	Veronica wormskjoldii	26
TC	C 114	F	Achillea millefolium	6
TC	C 114	F	Senicio triangularis	17
TC	C 114	F	Swertia parenis	24

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TC	C 114	F	Plantago tweedii	20
TC	C 114	F	Ranunculus spp.	22
TC	C 114	F	Pedicularis groenlandica	25
TC	C 114	F	Taraxacum officinal	3
TC	C 114	F	Trifolium parryii	4
TC	C 114	F	Thlaspi montanum	7
TC	C 114	F	Antennaria rosii	1
TC	C 114	F	Arenaria obtusiloba	5
TC	C 141	G	Deschampsia cespitosa	33
TC	C 141	G	Phleum alpinum	4
TC	C 141	G	Poa alpina	29
TC	C 141	G	Bromus marginata	1
TC	C 141	G	Festuca ovina	11
TC	C 141	G	Elymus trachycaulum	5
TC	C 141	G	Carex spp.	6
TC	C 141	G	Juncus balticus	1
TC	C 141	S	Salix planifolia	7
TC	C 141	S	Salix brachiacarpa	3
TC	C 141	F	Castilleja sulphurea	11
TC	C 141	F	Aster/Erigeron	34
TC	C 141	F	Potentilla spp.	34
TC	C 141	F	Caltha leptosepala	10
TC	C 141	F	Epilobium cileodum	3
TC	C 141	F	Veronica wormskjoldii	6
TC	C 141	F	Polygonium bistortoides	5
TC	C 141	F	Achillea millefolium	11
TC	C 141	F	Senicio triangularis	5
TC	C 141	F	Sedum rodanthum	3
TC	C 141	F	Plantago tweedii	16
TC	C 141	F	Zigadenus elegans	11
TC	C 141	F	Ranunculus spp.	16
TC	C 141	F	Pedicularis groenlandica	7
TC	C 141	F	Taraxacum officinal	30
TC	C 141	F	Trifolium parryii	25
TC	C 141	F	Thlaspi montanum	11
TC	C 141	F	Antennaria rosii	2
TC	C 141	F	Eriogonum	2
TC	C 141	F	Brassicaceae	10
TC	C 141	F	Viola spp.	6
MP	A 5	G	Deschampsia cespitosa	26
MP	A 5	G	Phleum alpinum	8
MP	A 5	G	Poa alpina	11
MP	A 5	G	Festuca ovina	4
MP	A 5	G	Carex spp.	8
MP	A 5	G	Juncus balticus	8
MP	A 5	F	Castilleja sulphurea	20
MP	A 5	F	Aster/Erigeron	20
MP	A 5	F	Potentilla spp.	1
MP	A 5	F	Caltha leptosepala	19
MP	A 5	F	Veronica wormskjoldii	8

MDW	TCT #		CLASS	SCIENTIFIC NAME	RAW SCORE
MP	A	5	F	Polygonium bistortoides	13
MP	A	5	F	Achillea millefolium	4
MP	A	5	F	Swertia parenis	14
MP	A	5	F	Stellaria umbellata	6
MP	A	5	F	Zigadenus elegans	6
MP	A	5	F	Ranunculus spp.	13
MP	A	5	F	Trollius laxus	6
MP	A	5	F	Saxifrage odontolomin	6
MP	A	5	F	Trifolium parryii	13
MP	A	5	F	Equisetum arvense	2
MP	A	39	G	Deschampsia cespitosa	31
MP	A	39	G	Phleum alpinum	27
MP	A	39	G	Agrostis alba	27
MP	A	39	G	Danthonia intermedia	2
MP	A	39	G	Festuca ovina	23
MP	A	39	G	Carex spp.	21
MP	A	39	G	Carex aquatilus	7
MP	A	39	G	Carex lenticularis	4
MP	A	39	G	Equisetum arvense	4
MP	A	39	S	Salix wolfii	24
MP	A	39	S	Salix planifolia	32
MP	A	39	S	Salix brachiacarpa	3
MP	A	39	F	Aster/Erigeron	22
MP	A	39	F	Gentiana spp.	13
MP	A	39	F	Potentilla spp.	33
MP	A	39	F	Caltha leptosepala	28
MP	A	39	F	Veronica wormskjoldii	30
MP	A	39	F	Polygonium bistortoides	7
MP	A	39	F	Senicio triangularis	6
MP	A	39	F	Swertia parenis	29
MP	A	39	F	Stellaria umbellata	7
MP	A	39	F	Sedum rodanthum	16
MP	A	39	F	Plantago tweedii	14
MP	A	39	F	Ranunculus spp.	32
MP	A	39	F	Trollius laxus	17
MP	A	39	F	Pedicularis groenlandica	24
MP	A	39	F	Taraxacum officinal	9
MP	A	39	F	Agoseris glauca	2
MP	A	39	F	Antennaria rosii	7
MP	A	39	F	Trifolium parryii	3
MP	A	85	G	Deschampsia cespitosa	30
MP	A	85	G	Phleum alpinum	3
MP	A	85	G	Agrostis alba	5
MP	A	85	G	Poa spp.	3
MP	A	85	G	Festuca ovina	8
MP	A	85	G	Carex spp.	5
MP	A	85	G	Carex aquatilus	13
MP	A	85	G	Carex lenticularis	25
MP	A	85	G	Carex rostrata	3
MP	A	85	G	Juncus balticus	3

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
MP	A 85	G	Luzula parviflora	2
MP	A 85	G	Equisetum arvense	7
MP	A 85	S	Salix wolfii	29
MP	A 85	S	Salix planifolia	34
MP	A 85	F	Castilleja sulphurea	1
MP	A 85	F	Aster/Erigeron	29
MP	A 85	F	Ranunculus spp.	27
MP	A 85	F	Veronica wormskjoldii	16
MP	A 85	F	Senicio triangularis	4
MP	A 85	F	Swertia parenis	18
MP	A 85	F	Circuta douglassii	8
MP	A 85	F	Trollius laxus	28
MP	A 85	F	Saxifrage odontolomin	19
MP	A 85	F	Pedicularis groenlandica	13
MP	A 85	F	Taraxacum officinal	2
MP	A 85	F	Sedum rodanthum	9
MP	A 85	F	Stellaria umbellata	9
MP	A 85	F	Trifolium parryii	15
MP	A 85	F	Agoseris glauca	3
MP	A 124	G	Deschampsia cespitosa	23
MP	A 124	G	Phleum alpinum	8
MP	A 124	G	Poa alpina	4
MP	A 124	G	Carex spp.	2
MP	A 124	G	Carex aquatilus	4
MP	A 124	G	Carex lenticularis	30
MP	A 124	G	Luzula parviflora	5
MP	A 124	G	Catabrosa aquatica	2
MP	A 124	S	Salix wolfii	19
MP	A 124	S	Salix planifolia	39
MP	A 124	F	Aster/Erigeron	26
MP	A 124	F	Ranunculus spp	30
MP	A 124	F	Caltha leptosepala	15
MP	A 124	F	Aconitum columbianum	25
MP	A 124	F	Epilobium cileodum	8
MP	A 124	F	Veronica wormskjoldii	10
MP	A 124	F	Senicio triangularis	15
MP	A 124	F	Swertia parenis	20
MP	A 124	F	Rumex densiflorous	1
MP	A 124	F	Stellaria umbellata	18
MP	A 124	F	Sedum rodanthum	3
MP	A 124	F	Plantago tweedii	2
MP	A 124	F	Circuta douglassii	3
MP	A 124	F	Trollius laxus	8
MP	A 124	F	Saxifrage odontolomin	6
MP	A 124	F	Mertensia ciliata	5
MP	A 124	F	Allium schoenoprasum	5
MP	A 124	F	Trifolium parryii	25
MP	A 211	G	Deschampsia cespitosa	18
MP	A 211	G	Phleum alpinum	6
MP	A 211	G	Poa spp.	18

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
MP	A 211	G	Carex spp.	5
MP	A 211	G	Carex aquatilus	18
MP	A 211	G	Carex lenticularis	31
MP	A 211	G	Carex rostrata	18
MP	A 211	G	Equisetum arvense	3
MP	A 211	S	Salix planifolia	37
MP	A 211	F	Aster/Erigeron	3
MP	A 211	F	Gentiana spp.	4
MP	A 211	F	Ranunculus spp	6
MP	A 211	F	Caltha leptosepala	28
MP	A 211	F	Epilobium cileodum	17
MP	A 211	F	Veronica wormskjoldii	14
MP	A 211	F	Achillea millefolium	4
MP	A 211	F	Swertia parenis	18
MP	A 211	F	Stellaria umbellata	1
MP	A 211	F	Sedum rodanthum	13
MP	A 211	F	Pedicularis groenlandica	6
MP	A 211	F	Taraxacum officinal	9
MP	A 286	G	Deschampsia cespitosa	33
MP	A 286	G	Deschampsia atropurpurea	3
MP	A 286	G	Phleum alpinum	29
MP	A 286	G	Agrostis alba	3
MP	A 286	G	Danthonia intermedia	10
MP	A 286	G	Poa spp.	7
MP	A 286	G	Festuca ovina	2
MP	A 286	G	Poa alpina	14
MP	A 286	G	Carex spp.	18
MP	A 286	G	Agropyron smithii	3
MP	A 286	G	Juncus balticus	10
MP	A 286	F	Aster/Erigeron	39
MP	A 286	F	Gentiana spp.	2
MP	A 286	F	Potentilla spp.	15
MP	A 286	F	Caltha leptosepala	5
MP	A 286	F	Epilobium cileodum	19
MP	A 286	F	Veronica wormskjoldii	16
MP	A 286	F	Polygonium bistortoides	1
MP	A 286	F	Achillea millefolium	17
MP	A 286	F	Senicio triangularis	6
MP	A 286	F	Stellaria umbellata	3
MP	A 286	F	Plantago tweedii	28
MP	A 286	F	Ranunculus spp.	20
MP	A 286	F	Pedicularis groenlandica	4
MP	A 286	F	Taraxacum officinal	18
MP	A 286	F	Trifolium parryii	9
MP	A 286	F	Erythronium grandiflorum	13
MP	A 286	F	Aconitum columbianum	1
MP	A 286	F	Viola spp.	3
MP	B 4	G	Deschampsia cespitosa	18
MP	B 4	G	Poa alpina	18
MP	B 4	G	Poa spp.	13

MDW	TCT	#	CLASS	SCIENTIFIC NAME	RAW SCORE
MP	B	4	G	Bromus marginata	1
MP	B	4	G	Festuca ovina	9
MP	B	4	G	Carex spp.	8
MP	B	4	F	Aster/Erigeron	6
MP	B	4	F	Potentilla spp.	13
MP	B	4	F	Epilobium cileodum	3
MP	B	4	F	Achillea millefolium	12
MP	B	4	F	Senicio triangularis	3
MP	B	4	F	Sedum rodanthum	7
MP	B	4	F	Trifolium parryii	26
MP	B	4	F	Arenaria obtusiloba	9
MP	B	4	T	Picea englemannii	20
MP	B	19	G	Deschampsia cespitosa	10
MP	B	19	G	Poa alpina	5
MP	B	19	G	Carex rostrata	33
MP	B	19	S	Salix planifolia	34
MP	B	19	F	Caltha leptosepala	1
MP	B	19	F	Veronica wormskjoldii	1
MP	B	19	F	Senicio triangularis	8
MP	B	19	F	Swertia parenis	1
MP	B	19	F	Stellaria umbellata	23
MP	B	19	F	Ranunculus spp.	9
MP	B	19	F	Trollius laxus	3
MP	B	19	F	Geum macrophyllum	16
MP	B	19	F	Geranium	9
MP	B	19	F	Mertensia ciliata	3
MP	B	58	G	Deschampsia cespitosa	17
MP	B	58	G	Poa alpina	11
MP	B	58	G	Carex aquatilus	21
MP	B	58	G	Carex lenticularis	32
MP	B	58	G	Equisetum arvense	1
MP	B	58	S	Salix planifolia	35
MP	B	58	F	Caltha leptosepala	15
MP	B	58	F	Epilobium cileodum	7
MP	B	58	F	Veronica wormskjoldii	9
MP	B	58	F	Sedum rodanthum	7
MP	B	58	F	Ranunculus spp.	21
MP	B	58	F	Plantago tweedii	1
MP	B	58	F	Saxifrage odontolomin	6
MP	B	176	G	Carex aquatilus	21
MP	B	176	G	Carex lenticularis	39
MP	B	176	G	Carex scopulorum	8
MP	B	176	G	Juncus balticus	7
MP	B	176	S	Salix wolfii	20
MP	B	176	S	Salix planifolia	6
MP	B	176	S	Salix brachiacarpa	3
MP	B	176	S	Betula glandulosa	13
MP	B	176	F	Potentilla spp.	1
MP	B	176	F	Swertia parenis	6

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE 118
MP	B 176	F	Pedicularis groenlandica	7
MP	B 176	T	Picea englemannii	4
MP	B 245	G	Deschampsia cespitosa	22
MP	B 245	G	Poa spp	14
MP	B 245	G	Festuca ovina	6
MP	B 245	G	Carex spp.	2
MP	B 245	G	Carex aquatilus	26
MP	B 245	G	Carex lenticularis	31
MP	B 245	G	Carex rostrata	17
MP	B 245	G	Equisetum arvense	3
MP	B 245	S	Salix wolfii	6
MP	B 245	S	Salix planifolia	28
MP	B 245	F	Aster/Erigeron	10
MP	B 245	F	Potentilla spp.	7
MP	B 245	F	Caltha leptosepala	23
MP	B 245	F	Epilobium cileodum	10
MP	B 245	F	Veronica wormskjoldii	11
MP	B 245	F	Polygonium bistortoides	10
MP	B 245	F	Swertia parenis	7
MP	B 245	F	Sedum rodanthum	16
MP	B 245	F	Ranunculus spp.	22
MP	B 245	F	Trollius laxus	10
MP	B 245	F	Pedicularis groenlandica	6
MP	B 245	F	Viola spp.	3
MP	B 245	F	Trifolium parryii	4
MP	B 298	G	Deschampsia cespitosa	23
MP	B 298	G	Phleum alpinum	6
MP	B 298	G	Agropyron smithii	10
MP	B 298	G	Trisetum spicatum	3
MP	B 298	G	Carex spp.	7
MP	B 298	G	Carex aquatilus	2
MP	B 298	G	Carex lenticularis	11
MP	B 298	F	Aster/Erigeron	27
MP	B 298	F	Gentiana spp.	13
MP	B 298	F	Potentilla spp.	24
MP	B 298	F	Caltha leptosepala	17
MP	B 298	F	Epilobium cileodum	4
MP	B 298	F	Veronica wormskjoldii	
MP	B 298	F	Polygonium bistortoides	16
MP	B 298	F	Achillea millefolium	6
MP	B 298	F	Senicio triangularis	7
MP	B 298	F	Swertia parenis	23
MP	B 298	F	Plantago tweedii	13
MP	B 298	F	Zigadenus elegans	17
MP	B 298	F	Ranunculus spp.	24
MP	B 298	F	Trollius laxus	6
MP	B 298	F	Taraxacum officinal	18
MP	B 298	F	Agoseris glauca	3
MP	B 298	F	Solidago spathulata	2
MP	B 298	F	Allium schoenoprasum	2

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
MP	B 298	F	Equisetum arvense	2
MP	C 20	G	Deschampsia cespitosa	16
MP	C 20	G	Poa spp	7
MP	C 20	G	Trisetum spicatum	9
MP	C 20	G	Carex spp.	10
MP	C 20	G	Equisetum arvense	11
MP	C 20	S	Ribes montigenum	8
MP	C 20	F	Aster/Erigeron	17
MP	C 20	F	Caltha leptosepala	32
MP	C 20	F	Epilobium cileodum	9
MP	C 20	F	Polygonium bistortoides	10
MP	C 20	F	Achillea millefolium	16
MP	C 20	F	Swertia parenis	1
MP	C 20	F	Stellaria umbellata	6
MP	C 20	F	Plantago tweedii	2
MP	C 20	F	Circuta douglassii	7
MP	C 20	F	Erythronium grandiflorum	3
MP	C 20	F	Trollius laxus	24
MP	C 20	F	Taraxacum officinal	11
MP	C 20	F	Trifolium parryii	14
MP	C 20	T	Picea englemannii	31
MP	C 20	T	Abies concolor	10
MP	C 108	G	Deschampsia cespitosa	22
MP	C 108	G	Carex spp.	28
MP	C 108	G	Carex aquatilus	27
MP	C 108	G	Carex lenticularis	18
MP	C 108	G	Luzula parviflora	3
MP	C 108	S	Salix wolfii	17
MP	C 108	S	Salix planifolia	25
MP	C 108	S	Salix brachiacarpa	36
MP	C 108	S	Betula glandulosa	4
MP	C 108	F	Castilleja sulphurea	3
MP	C 108	F	Aster/Erigeron	22
MP	C 108	F	Gentiana barbellota	10
MP	C 108	F	Potentilla spp.	4
MP	C 108	F	Caltha leptosepala	9
MP	C 108	F	Veronica wormskjoldii	3
MP	C 108	F	Polygonium bistortoides	3
MP	C 108	F	Achillea millefolium	1
MP	C 108	F	Swertia parenis	23
MP	C 108	F	Stellaria umbellata	11
MP	C 108	F	Plantago tweedii	30
MP	C 108	F	Ranunculus spp.	7
MP	C 108	F	Pedicularis groenlandica	14
MP	C 108	F	Taraxacum officinal	8
MP	C 108	F	Agoseris glauca	6
MP	C 108	F	Solidago spathulata	6
MP	C 108	T	Picea englemannii	25
MP	C 203	G	Deschampsia cespitosa	23

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
MP	C 203	G	Phleum alpinum	3
MP	C 203	G	Poa spp	12
MP	C 203	G	Bromus marginata	3
MP	C 203	G	Carex aquatilus	14
MP	C 203	G	Carex lenticularis	30
MP	C 203	G	Carex scopulorum	22
MP	C 203	S	Salix wolfii	28
MP	C 203	S	Salix planifolia	26
MP	C 203	F	Aster/Erigeron	10
MP	C 203	F	Gentiana barbellota	3
MP	C 203	F	Potentilla spp.	13
MP	C 203	F	Epilobium cileodum	2
MP	C 203	F	Veronica wormskjoldii	2
MP	C 203	F	Swertia parenis	22
MP	C 203	F	Stellaria umbellata	26
MP	C 203	F	Sedum rodanthum	6
MP	C 203	F	Ranunculus spp.	9
MP	C 203	F	Geum macrophyllum	1
MP	C 203	F	Saxifrage odontolomin	7
MP	C 203	F	Pedicularis groenlandica	34
MP	C 203	F	Taraxacum officinal	4
MP	C 203	T	Picea englemannii	10
MP	C 273	G	Deschampsia cespitosa	5
MP	C 273	G	Catabrosa aquatica	10
MP	C 273	G	Carex aquatilus	3
MP	C 273	G	Carex lenticularis	12
MP	C 273	G	Carex rostrata	31
MP	C 273	S	Salix planifolia	20
MP	C 273	F	Caltha leptosepala	6
MP	C 273	F	Stellaria umbellata	7
MP	C 273	F	Sedum rodanthum	4
MP	C 273	F	Circuta douglassii	5
MP	C 273	F	Ranunculus spp.	20
MP	C 273	F	Trollius laxus	3
MP	C 273	F	Pedicularis groenlandica	4
MP	C 273	F	Mertensia ciliata	10
MP	C 371	G	Deschampsia cespitosa	6
MP	C 371	G	Deschampsia atropurpurea	10
MP	C 371	G	Trisetum spicatum	6
MP	C 371	G	Poa spp	18
MP	C 371	G	Carex spp.	32
MP	C 371	G	Carex scopulorum	32
MP	C 371	G	Equisetum arvense	10
MP	C 371	G	Luzula parviflora	4
MP	C 371	S	Salix monticola	38
MP	C 371	F	Gentiana spp.	2
MP	C 371	F	Caltha leptosepala	13
MP	C 371	F	Achillea millefolium	1
MP	C 371	F	Swertia parenis	11
MP	C 371	F	Stellaria umbellata	26

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
MP	C 371	F	Trollius laxus	7
MP	C 371	F	Geum macrophyllum	1
MP	C 371	F	Pedicularis groenlandica	7
MP	C 371	F	Taraxacum officinal	3
MP	C 371	F	Trifolium parryii	1
MP	C 371	T	Picea englemannii	4
MP	C 371	T	Abies concolor	5
MP	C 371	T	Pseudotsuga menzesii	3
MP	C 396	G	Deschampsia cespitosa	4
MP	C 396	G	Danthonia intermedia	8
MP	C 396	G	Trisetum spicatum	6
MP	C 396	G	Poa alpina	9
MP	C 396	G	Poa spp	5
MP	C 396	G	Festuca ovina	5
MP	C 396	G	Carex spp.	12
MP	C 396	G	Juncus balticus	3
MP	C 396	S	Vaccinium scoparina	15
MP	C 396	S	Ribes montigenum	19
MP	C 396	F	Aster/Erigeron	14
MP	C 396	F	Gentiana spp.	2
MP	C 396	F	Potentilla spp.	11
MP	C 396	F	Caltha leptosepala	4
MP	C 396	F	Achillea millefolium	16
MP	C 396	F	Stellaria umbellata	3
MP	C 396	F	Circuta douglassii	2
MP	C 396	F	Zigadenus elegans	6
MP	C 396	F	Ranunculus spp.	3
MP	C 396	F	Trollius laxus	3
MP	C 396	F	Taraxacum officinal	1
MP	C 396	F	Trifolium parryii	17
MP	C 396	F	Equisetum arvense	1
MP	C 396	T	Picea englemannii	33
TLR	A 23	G	Deschampsia cespitosa	21
TLR	A 23	G	Deschampsia atropurpurea	19
TLR	A 23	G	Phleum alpinum	37
TLR	A 23	G	Danthonia intermedia	1
TLR	A 23	G	Poa alpina	6
TLR	A 23	G	Agropyron smithii	2
TLR	A 23	G	Carex spp.	22
TLR	A 23	G	Carex lenticularis	35
TLR	A 23	S	Salix wolfii	7
TLR	A 23	F	Aster/Erigeron	6
TLR	A 23	F	Potentilla spp.	9
TLR	A 23	F	Caltha leptosepala	8
TLR	A 23	F	Veronica wormskjoldii	1
TLR	A 23	F	Achillea millefolium	4
TLR	A 23	F	Swertia parenis	6
TLR	A 23	F	Stellaria umbellata	5
TLR	A 23	F	Plantago tweedii	6
TLR	A 23	F	Ranunculus spp.	7

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR A 23	F	Taraxacum officinal	5
TLR A 23	F	Solidago spathulata	13
TLR A 72	G	Carex aquatilus	12
TLR A 72	G	Carex lenticularis	34
TLR A 72	G	Luzula parviflora	8
TLR A 72	S	Salix wolfii	26
TLR A 72	S	Salix planifolia	32
TLR A 72	F	Aster/Erigeron	3
TLR A 72	F	Potentilla spp.	1
TLR A 72	F	Veronica wormskjoldii	2
TLR A 72	F	Swertia parenis	26
TLR A 72	F	Plantago tweedii	2
TLR A 72	F	Ranunculus spp.	16
TLR A 72	F	Saxifrage odontolomin	4
TLR A 72	F	Pedicularis groenlandica	7
TLR A 72	F	Agoseris glauca	3
TLR A 72	F	Aconitum columbianum	3
TLR A 106	G	Deschampsia cespitosa	12
TLR A 106	G	Poa spp	3
TLR A 106	G	Carex aquatilus	2
TLR A 106	G	Carex lenticularis	29
TLR A 106	G	Carex scopulorum	33
TLR A 106	G	Juncus balticus	13
TLR A 106	G	Luzula parviflora	25
TLR A 106	S	Salix wolfii	23
TLR A 106	S	Salix planifolia	24
TLR A 106	F	Gentiana barbellota	7
TLR A 106	F	Potentilla spp.	21
TLR A 106	F	Achillea millefolium	2
TLR A 106	F	Swertia parenis	25
TLR A 106	F	Stellaria umbellata	9
TLR A 106	F	Sedum rodanthum	8
TLR A 106	F	Plantago tweedii	30
TLR A 106	F	Ranunculus spp.	17
TLR A 106	F	Pedicularis groenlandica	28
TLR A 106	F	Taraxacum officinal	1
TLR A 156	G	Deschampsia cespitosa	9
TLR A 156	G	Poa spp	10
TLR A 156	G	Festuca ovina	5
TLR A 156	G	Carex spp.	25
TLR A 156	G	Carex aquatilus	8
TLR A 156	G	Carex scopulorum	2
TLR A 156	G	Juncus balticus	11
TLR A 156	G	Luzula parviflora	28
TLR A 156	S	Salix wolfii	32
TLR A 156	S	Salix planifolia	35
TLR A 156	F	Aster/Erigeron	15
TLR A 156	F	Gentiana barbellota	5
TLR A 156	F	Potentilla spp.	24

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR A 156	F	Achillea millefolium	1
TLR A 156	F	Swertia parenis	9
TLR A 156	F	Sedum rodanthum	1
TLR A 156	F	Plantago tweedii	24
TLR A 156	F	Pedicularis groenlandica	30
TLR A 156	F	Trifolium parryii	7
TLR A 156	F	Antennaria rosii	2
TLR A 156	T	Picea englemannii	4
TLR A 220	G	Deschampsia cespitosa	10
TLR A 220	G	Poa spp	34
TLR A 220	G	Festuca ovina	6
TLR A 220	G	Carex spp.	37
TLR A 220	S	Salix wolfii	24
TLR A 220	S	Salix planifolia	5
TLR A 220	S	Pentaphylloides floribunda	18
TLR A 220	F	Aster/Erigeron	6
TLR A 220	F	Potentilla spp.	13
TLR A 220	F	Veronica wormskjoldii	1
TLR A 220	F	Achillea millefolium	9
TLR A 220	F	Swertia parenis	25
TLR A 220	F	Stellaria umbellata	23
TLR A 220	F	Plantago tweedii	8
TLR A 220	F	Ranunculus spp.	6
TLR A 220	F	Geum macrophyllum	17
TLR A 220	F	Taraxacum officinal	4
TLR A 220	F	Frageria virginiana	2
TLR A 220	F	Solidago spathulata	12
TLR A 310	G	Deschampsia cespitosa	18
TLR A 310	G	Deschampsia atropurpurea	16
TLR A 310	G	Phleum alpinum	25
TLR A 310	G	Agrostis alba	3
TLR A 310	G	Danthonia intermedia	22
TLR A 310	G	Poa alpina	19
TLR A 310	G	Festuca ovina	15
TLR A 310	G	Agropyron smithii	6
TLR A 310	G	Trisetum spicatum	16
TLR A 310	G	Carex spp.	25
TLR A 310	G	Carex aquatilus	17
TLR A 310	G	Juncus balticus	18
TLR A 310	G	Luzula parviflora	4
TLR A 310	S	Salix wolfii	31
TLR A 310	S	Salix planifolia	12
TLR A 310	F	Castilleja sulphurea	2
TLR A 310	F	Aster/Erigeron	34
TLR A 310	F	Gentiana barbellota	17
TLR A 310	F	Potentilla spp.	31
TLR A 310	F	Caltha leptosepala	21
TLR A 310	F	Epilobium cileodum	10
TLR A 310	F	Veronica wormskjoldii	25
TLR A 310	F	Achillea millefolium	27

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE 124
TLR A 310	F	Senicio triangularis	3
TLR A 310	F	Swertia parenis	28
TLR A 310	F	Stellaria umbellata	22
TLR A 310	F	Plantago tweedii	20
TLR A 310	F	Circuta douglassii	2
TLR A 310	F	Erythronium grandiflorum	3
TLR A 310	F	Ranunculus spp.	33
TLR A 310	F	Trollius laxus	18
TLR A 310	F	Pedicularis groenlandica	11
TLR A 310	F	Solidago spathulata	13
TLR A 310	F	Agoseris glauca	4
TLR A 310	F	Antennaria rosii	3
TLR A 310	F	Trifolium parryii	17
TLR A 310	T	Picea englemannii	3
TLR B 11	G	Deschampsia cespitosa	23
TLR B 11	G	Phleum alpinum	1
TLR B 11	G	Agrostis alba	19
TLR B 11	G	Danthonia intermedia	13
TLR B 11	G	Poa alpina	16
TLR B 11	G	Agropyron smithii	8
TLR B 11	G	Festuca ovina	7
TLR B 11	G	Carex spp.	37
TLR B 11	G	Carex aquatilus	6
TLR B 11	G	Juncus balticus	6
TLR B 11	G	Luzula parviflora	3
TLR B 11	S	Pentaphylloides floribunda	10
TLR B 11	F	Aster/Erigeron	12
TLR B 11	F	Gentiana spp.	10
TLR B 11	F	Potentilla spp.	34
TLR B 11	F	Caltha leptosepala	12
TLR B 11	F	Epilobium cileodum	12
TLR B 11	F	Achillea millefolium	3
TLR B 11	F	Swertia parenis	15
TLR B 11	F	Stellaria umbellata	12
TLR B 11	F	Plantago tweedii	9
TLR B 11	F	Trollius laxus	2
TLR B 11	F	Taraxacum officinal	3
TLR B 11	F	Allium schoenoprasum	3
TLR B 11	F	Sibbaldia procumbens	31
TLR B 11	F	Trifolium parryii	5
TLR B 69	G	Deschampsia cespitosa	19
TLR B 69	G	Poa spp	9
TLR B 69	G	Carex lenticularis	34
TLR B 69	G	Carex scopulorum	13
TLR B 69	G	Equisetum arvense	3
TLR B 69	S	Salix wolfii	25
TLR B 69	S	Salix planifolia	27
TLR B 69	S	Salix brachiacarpa	15
TLR B 69	S	Betula glandulosa	3
TLR B 69	F	Potentilla spp.	1

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR B 69	F	Swertia parenis	14
TLR B 69	F	Stellaria umbellata	25
TLR B 69	F	Plantago tweedii	11
TLR B 69	F	Ranunculus spp.	2
TLR B 69	F	Pedicularis groenlandica	4
TLR B 69	F	Solidago spathulata	18
TLR B 115	G	Deschampsia cespitosa	5
TLR B 115	G	Poa spp	6
TLR B 115	G	Carex spp.	13
TLR B 115	G	Carex aquatilus	1
TLR B 115	G	Carex lenticularis	30
TLR B 115	G	Luzula parviflora	2
TLR B 115	S	Salix wolfii	30
TLR B 115	S	Salix planifolia	26
TLR B 115	F	Aster/Erigeron	2
TLR B 115	F	Gentiana barbellota	6
TLR B 115	F	Achillea millefolium	3
TLR B 115	F	Swertia parenis	13
TLR B 115	F	Stellaria umbellata	1
TLR B 115	F	Sedum rodanthum	7
TLR B 115	F	Plantago tweedii	7
TLR B 115	F	Ranunculus spp.	1
TLR B 115	F	Pedicularis groenlandica	13
TLR B 115	F	Solidago spathulata	9
TLR B 186	G	Deschampsia cespitosa	17
TLR B 186	G	Carex spp.	1
TLR B 186	G	Carex aquatilus	38
TLR B 186	G	Carex scopulorum	9
TLR B 186	G	Juncus balticus	6
TLR B 186	S	Salix wolfii	24
TLR B 186	S	Salix planifolia	30
TLR B 186	S	Salix brachiacarpa	2
TLR B 186	S	Pentaphylloides floribunda	5
TLR B 186	S	Betula glandulosa	7
TLR B 186	F	Aster/Erigeron	1
TLR B 186	F	Potentilla spp.	1
TLR B 186	F	Swertia parenis	20
TLR B 186	F	Plantago tweedii	27
TLR B 186	F	Ranunculus spp.	6
TLR B 186	F	Pedicularis groenlandica	15
TLR B 186	F	Taraxacum officinal	5
TLR B 186	F	Solidago spathulata	3
TLR B 269	G	Deschampsia cespitosa	4
TLR B 269	G	Deschampsia atropurpurea	3
TLR B 269	G	Agrostis alba	3
TLR B 269	G	Poa spp	4
TLR B 269	G	Agropyron smithii	6
TLR B 269	G	Carex lenticularis	36
TLR B 269	S	Salix wolfii	22

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR B 269	S	Salix planifolia	32
TLR B 269	S	Betula glandulosa	11
TLR B 269	F	Aster/Erigeron	4
TLR B 269	F	Caltha leptosepala	17
TLR B 269	F	Epilobium cileodum	3
TLR B 269	F	Veronica wormskjoldii	4
TLR B 269	F	Swertia parenis	8
TLR B 269	F	Stellaria umbellata	14
TLR B 269	F	Sedum rodanthum	24
TLR B 269	F	Ranunculus spp.	15
TLR B 269	F	Trollius laxus	9
TLR B 269	F	Geum macrophyllum	4
TLR B 269	F	Saxifrage odontolomin	8
TLR B 269	F	Taraxacum officinal	3
TLR B 269	F	Aconitum columbianum	7
TLR B 269	F	Mertensia ciliata	7
TLR B 269	T	Picea englemannii	
TLR B 359	G	Deschampsia cespitosa	18
TLR B 359	G	Deschampsia atropurpurea	11
TLR B 359	G	Phleum alpinum	33
TLR B 359	G	Agrostis alba	4
TLR B 359	G	Poa spp	5
TLR B 359	G	Festuca ovina	4
TLR B 359	G	Carex spp.	14
TLR B 359	G	Juncus balticus	26
TLR B 359	S	Salix planifolia	21
TLR B 359	F	Aster/Erigeron	24
TLR B 359	F	Gentiana barbellota	13
TLR B 359	F	Potentilla spp.	19
TLR B 359	F	Caltha leptosepala	29
TLR B 359	F	Epilobium cileodum	17
TLR B 359	F	Veronica wormskjoldii	16
TLR B 359	F	Achillea millefolium	10
TLR B 359	F	Swertia parenis	13
TLR B 359	F	Stellaria umbellata	1
TLR B 359	F	Sedum rodanthum	10
TLR B 359	F	Ranunculus spp.	13
TLR B 359	F	Trollius laxus	4
TLR B 359	F	Solidago spathulata	4
TLR B 359	F	Trifolium parryii	6
TLR B 359	F	Geranium	2
TLR C 26	G	Deschampsia cespitosa	28
TLR C 26	G	Phleum alpinum	3
TLR C 26	G	Agrostis alba	25
TLR C 26	G	Poa alpina	15
TLR C 26	G	Poa spp	13
TLR C 26	G	Festuca ovina	3
TLR C 26	G	Carex spp.	35
TLR C 26	G	Juncus balticus	21
TLR C 26	G	Luzula parviflora	6

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR C 26	S	Pentaphylloides floribunda	7
TLR C 26	F	Aster/Erigeron	2
TLR C 26	F	Gentiana barbellota	21
TLR C 26	F	Potentilla spp.	32
TLR C 26	F	Caltha leptosepala	15
TLR C 26	F	Veronica wormskjoldii	2
TLR C 26	F	Polygonium bistortoides	6
TLR C 26	F	Swertia parenis	1
TLR C 26	F	Stellaria umbellata	14
TLR C 26	F	Plantago tweedii	29
TLR C 26	F	Ranunculus spp.	1
TLR C 26	F	Geum macrophyllum	2
TLR C 26	F	Pedicularis groenlandica	5
TLR C 26	F	Allium schoenoprasum	31
TLR C 26	F	Trifolium parryii	6
TLR C 90	G	Deschampsia cespitosa	27
TLR C 90	G	Deschampsia atropurpurea	3
TLR C 90	G	Phleum alpinum	6
TLR C 90	G	Poa alpina	1
TLR C 90	G	Poa spp	19
TLR C 90	G	Festuca ovina	4
TLR C 90	G	Carex spp.	25
TLR C 90	G	Carex aquatilus	2
TLR C 90	G	Carex lenticularis	31
TLR C 90	G	Juncus balticus	4
TLR C 90	S	Salix wolfii	8
TLR C 90	S	Salix planifolia	20
TLR C 90	S	Salix brachiacarpa	8
TLR C 90	F	Aster/Erigeron	11
TLR C 90	F	Gentiana spp.	3
TLR C 90	F	Potentilla spp.	17
TLR C 90	F	Caltha leptosepala	19
TLR C 90	F	Epilobium cileodum	1
TLR C 90	F	Veronica wormskjoldii	2
TLR C 90	F	Achillea millefolium	4
TLR C 90	F	Swertia parenis	31
TLR C 90	F	Stellaria umbellata	22
TLR C 90	F	Sedum rodanthum	24
TLR C 90	F	Plantago tweedii	21
TLR C 90	F	Geum macrophyllum	5
TLR C 90	F	Saxifrage odontolomin	2
TLR C 90	F	Pedicularis groenlandica	16
TLR C 90	F	Solidago spathulata	7
TLR C 132	G	Deschampsia cespitosa	2
TLR C 132	G	Poa alpina	3
TLR C 132	G	Carex spp.	10
TLR C 132	G	Carex aquatilus	13
TLR C 132	G	Carex lenticularis	29
TLR C 132	S	Salix wolfii	26
TLR C 132	S	Salix planifolia	18

MDW TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR C 132	F	Aster/Erigeron	12
TLR C 132	F	Gentiana spp.	2
TLR C 132	F	Potentilla spp.	7
TLR C 132	F	Achillea millefolium	1
TLR C 132	F	Swertia parenis	11
TLR C 132	F	Sedum rodanthum	5
TLR C 132	F	Plantago tweedii	15
TLR C 132	F	Ranunculus spp.	2
TLR C 132	F	Pedicularis groenlandica	20
TLR C 132	F	Taraxacum officinal	3
TLR C 132	T	Picea englemannii	7
TLR C 316	G	Deschampsia cespitosa	6
TLR C 316	G	Carex spp.	3
TLR C 316	G	Carex lenticularis	38
TLR C 316	G	Carex rostrata	2
TLR C 316	S	Salix planifolia	24
TLR C 316	S	Salix brachiacarpa	30
TLR C 316	F	Betula glandulosa	7
TLR C 316	F	Swertia parenis	14
TLR C 316	F	Sedum rodanthum	21
TLR C 356	G	Deschampsia cespitosa	14
TLR C 356	G	Poa spp	16
TLR C 356	G	Carex lenticularis	34
TLR C 356	G	Carex rostrata	21
TLR C 356	S	Salix planifolia	38
TLR C 356	F	Caltha leptosepala	21
TLR C 356	F	Swertia parenis	3
TLR C 356	F	Stellaria umbellata	9
TLR C 356	F	Aconitum columbianum	3
TLR C 448	G	Phleum alpinum	12
TLR C 448	G	Deschampsia cespitosa	35
TLR C 448	G	Deschampsia atropurpurea	24
TLR C 448	G	Poa alpina	3
TLR C 448	G	Poa spp	9
TLR C 448	G	Festuca ovina	2
TLR C 448	G	Carex spp.	26
TLR C 448	G	Carex lenticularis	33
TLR C 448	G	Juncus balticus	12
TLR C 448	S	Salix wolfii	13
TLR C 448	F	Aster/Erigeron	27
TLR C 448	F	Gentiana spp.	18
TLR C 448	F	Potentilla spp.	16
TLR C 448	F	Caltha leptosepala	32
TLR C 448	F	Epilobium cileodum	14
TLR C 448	F	Veronica wormskjoldii	5
TLR C 448	F	Polygonium bistortoides	2
TLR C 448	F	Senicio triangularis	16
TLR C 448	F	Swertia parenis	10
TLR C 448	F	Stellaria umbellata	21

MDW	TCT	#	CLASS	SCIENTIFIC NAME	RAW SCORE
TLR	C	448	F	Plantago tweedii	16
TLR	C	448	F	Ranunculus spp.	34
TLR	C	448	F	Taraxacum officinal	8
NF	A	21	G	Deschampsia cespitosa	29
NF	A	21	G	Deschampsia atropurpurea	3
NF	A	21	G	Phleum alpinum	21
NF	A	21	G	Danthonia intermedia	15
NF	A	21	G	Poa alpina	29
NF	A	21	G	Poa spp	6
NF	A	21	G	Carex spp.	32
NF	A	21	G	Juncus balticus	21
NF	A	21	G	Equisetum arvense	11
NF	A	21	S	Salix wolfii	17
NF	A	21	S	Salix planifolia	14
NF	A	21	S	Pentaphylloides floribunda	16
NF	A	21	F	Castilleja sulphurea	6
NF	A	21	F	Aster/Erigeron	26
NF	A	21	F	Gentiana spp.	17
NF	A	21	F	Potentilla spp.	17
NF	A	21	F	Veronica wormskjoldii	24
NF	A	21	F	Achillea millefolium	6
NF	A	21	F	Swertia parenis	9
NF	A	21	F	Stellaria umbellata	21
NF	A	21	F	Plantago tweedii	23
NF	A	21	F	Zigadenus elegans	3
NF	A	21	F	Ranunculus spp.	14
NF	A	21	F	Pedicularis groenlandica	25
NF	A	21	F	Taraxacum officinal	21
NF	A	21	F	Solidago spathulata	9
NF	A	21	F	Antennaria rossi	5
NF	A	21	F	Epilobium cileodum	4
NF	A	21	T	Picea englemannii	11
NF	A	47	G	Deschampsia cespitosa	38
NF	A	47	G	Deschampsia atropurpurea	13
NF	A	47	G	Phleum alpinum	26
NF	A	47	G	Agrostis alba	18
NF	A	47	G	Poa alpina	13
NF	A	47	G	Poa spp	23
NF	A	47	G	Carex spp.	35
NF	A	47	G	Juncus balticus	3
NF	A	47	G	Equisetum arvense	1
NF	A	47	S	Salix wolfii	13
NF	A	47	S	Salix planifolia	29
NF	A	47	S	Betula glandulosa	1
NF	A	47	F	Castilleja sulphurea	15
NF	A	47	F	Aster/Erigeron	14
NF	A	47	F	Gentiana spp.	14
NF	A	47	F	Potentilla spp.	2
NF	A	47	F	Caltha leptosepala	23
NF	A	47	F	Veronica wormskjoldii	9

MDW	TCT	#	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	A	47	F	Achillea millefolium	1
NF	A	47	F	Senicio triangularis	3
NF	A	47	F	Swertia parenis	28
NF	A	47	F	Stellaria umbellata	7
NF	A	47	F	Sedum rodanthum	1
NF	A	47	F	Plantago tweedii	6
NF	A	47	F	Zigadenus elegans	3
NF	A	47	F	Erythronium grandiflorum	3
NF	A	47	F	Ranunculus spp.	2
NF	A	47	F	Pedicularis groenlandica	27
NF	A	47	F	Taraxacum officinal	13
NF	A	47	F	Frageria virginiana	9
NF	A	47	F	Trifolium parryii	7
NF	A	47	F	Gentiana barbellota	11
NF	A	47	T	Picea englemannii	2
NF	A	89	G	Deschampsia cespitosa	33
NF	A	89	G	Deschampsia atropurpurea	15
NF	A	89	G	Phleum alpinum	10
NF	A	89	G	Poa alpina	9
NF	A	89	G	Poa spp	16
NF	A	89	G	Carex spp.	29
NF	A	89	G	Luzula parviflora	4
NF	A	89	G	Equisetum arvense	4
NF	A	89	S	Salix wolfii	9
NF	A	89	S	Salix planifolia	24
NF	A	89	S	Salix brachiacarpa	19
NF	A	89	F	Castilleja sulphurea	19
NF	A	89	F	Aster/Erigeron	19
NF	A	89	F	Gentiana spp.	3
NF	A	89	F	Caltha leptosepala	31
NF	A	89	F	Veronica wormskjoldii	3
NF	A	89	F	Achillea millefolium	5
NF	A	89	F	Senicio triangularis	22
NF	A	89	F	Swertia parenis	25
NF	A	89	F	Rumex densiflorous	3
NF	A	89	F	Stellaria umbellata	19
NF	A	89	F	Sedum rodanthum	4
NF	A	89	F	Plantago tweedii	5
NF	A	89	F	Circuta douglassii	1
NF	A	89	F	Erythronium grandiflorum	9
NF	A	89	F	Ranunculus spp.	11
NF	A	89	F	Saxifrage odontolomin	14
NF	A	89	F	Taraxacum officinal	11
NF	A	89	F	Agoseris glauca	8
NF	A	89	F	Trifolium parryii	26
NF	A	89	F	Aconitum columbianum	10
NF	A	89	F	Frageria virginiana	4
NF	A	159	G	Deschampsia cespitosa	9
NF	A	159	G	Deschampsia atropurpurea	11
NF	A	159	G	Phleum alpinum	31

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	A 159	G	Agrostis alba	6
NF	A 159	G	Danthonia intermedia	1
NF	A 159	G	Festuca ovina	22
NF	A 159	G	Carex spp.	33
NF	A 159	G	Juncus balticus	3
NF	A 159	G	Luzula parviflora	4
NF	A 159	S	Salix wolfii	5
NF	A 159	S	Salix planifolia	25
NF	A 159	S	Salix brachiacarpa	4
NF	A 159	F	Castilleja sulphurea	17
NF	A 159	F	Aster/Erigeron	22
NF	A 159	F	Gentiana spp.	22
NF	A 159	F	Potentilla spp.	10
NF	A 159	F	Caltha leptosepala	33
NF	A 159	F	Epilobium cileodum	8
NF	A 159	F	Veronica wormskjoldii	19
NF	A 159	F	Achillea millefolium	4
NF	A 159	F	Senicio triangularis	3
NF	A 159	F	Swertia parenis	34
NF	A 159	F	Stellaria umbellata	16
NF	A 159	F	Sedum rodanthum	10
NF	A 159	F	Plantago tweedii	8
NF	A 159	F	Zigadenus elegans	10
NF	A 159	F	Ranunculus spp.	30
NF	A 159	F	Trollius laxus	20
NF	A 159	F	Pedicularis groenlandica	25
NF	A 159	F	Taraxacum officinal	2
NF	A 159	F	Agoseris glauca	6
NF	A 159	F	Antennaria rosii	11
NF	A 159	F	Trifolium parryii	19
NF	A 213	G	Deschampsia cespitosa	10
NF	A 213	G	Deschampsia atropurpurea	17
NF	A 213	G	Phleum alpinum	22
NF	A 213	G	Agrostis alba	29
NF	A 213	G	Danthonia intermedia	18
NF	A 213	G	Poa alpina	6
NF	A 213	G	Festuca ovina	4
NF	A 213	G	Agropyron smithii	2
NF	A 213	G	Carex spp.	28
NF	A 213	G	Carex lenticularis	2
NF	A 213	S	Salix planifolia	3
NF	A 213	F	Aster/Erigeron	24
NF	A 213	F	Gentiana spp.	4
NF	A 213	F	Potentilla spp.	29
NF	A 213	F	Caltha leptosepala	30
NF	A 213	F	Epilobium cileodum	8
NF	A 213	F	Veronica wormskjoldii	28
NF	A 213	F	Senicio triangularis	6
NF	A 213	F	Swertia parenis	38
NF	A 213	F	Stellaria umbellata	1
NF	A 213	F	Plantago tweedii	5

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	A 213	F	Erythronium grandiflorum	3
NF	A 213	F	Ranunculus spp.	28
NF	A 213	F	Trollius laxus	4
NF	A 213	F	Pedicularis groenlandica	6
NF	A 213	F	Antennaria rosii	2
NF	A 213	F	Agoseris glauca	2
NF	A 213	F	Trifolium parryii	11
NF	A 213	F	Equisetum arvense	9
NF	A 213	T	Picea englemannii	5
NF	B 8	G	Deschampsia cespitosa	28
NF	B 8	G	Phleum alpinum	11
NF	B 8	G	Agrostis alba	1
NF	B 8	G	Poa alpina	17
NF	B 8	G	Poa spp	2
NF	B 8	G	Festuca ovina	2
NF	B 8	G	Carex aquatilus	25
NF	B 8	G	Juncus balticus	6
NF	B 8	G	Luzula parviflora	7
NF	B 8	S	Salix planifolia	5
NF	B 8	S	Ribes montigenum	2
NF	B 8	F	Aster/Erigeron	4
NF	B 8	F	Gentiana barbellota	3
NF	B 8	F	Potentilla spp.	7
NF	B 8	F	Caltha leptosepala	5
NF	B 8	F	Veronica wormskjoldii	10
NF	B 8	F	Achillea millefolium	2
NF	B 8	F	Rumex densiflorous	4
NF	B 8	F	Stellaria umbellata	4
NF	B 8	F	Plantago tweedii	15
NF	B 8	F	Circuta douglassii	12
NF	B 8	F	Ranunculus spp.	1
NF	B 8	F	Pedicularis groenlandica	5
NF	B 8	F	Taraxacum officinal	17
NF	B 8	F	Trifolium parryii	11
NF	B 8	T	Picea englemannii	13
NF	B 42	G	Deschampsia atropurpurea	10
NF	B 42	G	Deschampsia cespitosa	25
NF	B 42	G	Phleum alpinum	6
NF	B 42	G	Poa alpina	13
NF	B 42	G	Poa spp	12
NF	B 42	G	Carex spp.	20
NF	B 42	G	Carex lenticularis	13
NF	B 42	G	Juncus balticus	4
NF	B 42	G	Luzula parviflora	3
NF	B 42	G	Equisetum arvense	8
NF	B 42	S	Salix planifolia	28
NF	B 42	F	Castilleja sulphurea	8
NF	B 42	F	Aster/Erigeron	11
NF	B 42	F	Gentiana barbellota	7
NF	B 42	F	Caltha leptosepala	14

MDW	TCT #		CLASS	SCIENTIFIC NAME	RAW SCORE
NF	B	42	F	Veronica wormskjoldii	7
NF	B	42	F	Senicio triangularis	8
NF	B	42	F	Swertia parenis	3
NF	B	42	F	Rumex densiflorous	2
NF	B	42	F	Stellaria umbellata	10
NF	B	42	F	Sedum rodanthum	3
NF	B	42	F	Plantago tweedii	3
NF	B	42	F	Circuta douglassii	5
NF	B	42	F	Zigadenus elegans	3
NF	B	42	F	Erythronium grandiflorum	2
NF	B	42	F	Ranunculus spp.	12
NF	B	42	F	Trollius laxus	2
NF	B	42	F	Saxifrage odontolomin	7
NF	B	42	F	Pedicularis groenlandica	20
NF	B	42	F	Taraxacum officinal	10
NF	B	42	F	Trifolium parryii	12
NF	B	42	F	Epilobium cileodum	12
NF	B	42	F	Aconitum columbianum	3
NF	B	42	F	Frageria virginiana	3
NF	B	42	T	Picea englemannii	5
NF	B	113	G	Deschampsia cespitosa	25
NF	B	113	G	Phleum alpinum	12
NF	B	113	G	Poa alpina	32
NF	B	113	G	Poa spp	16
NF	B	113	G	Festuca ovina	26
NF	B	113	G	Carex spp.	34
NF	B	113	G	Juncus balticus	9
NF	B	113	G	Luzula parviflora	5
NF	B	113	S	Salix wolfii	3
NF	B	113	S	Salix planifolia	30
NF	B	113	F	Castilleja sulphurea	10
NF	B	113	F	Aster/Erigeron	20
NF	B	113	F	Gentiana barbellota	14
NF	B	113	F	Potentilla spp.	8
NF	B	113	F	Caltha leptosepala	34
NF	B	113	F	Epilobium cileodum	3
NF	B	113	F	Veronica wormskjoldii	20
NF	B	113	F	Swertia parenis	32
NF	B	113	F	Stellaria umbellata	7
NF	B	113	F	Sedum rodanthum	6
NF	B	113	F	Plantago tweedii	29
NF	B	113	F	Ranunculus spp.	36
NF	B	113	F	Trollius laxus	29
NF	B	113	F	Saxifrage odontolomin	14
NF	B	113	F	Pedicularis groenlandica	22
NF	B	113	F	Taraxacum officinal	4
NF	B	113	F	Agoseris glauca	3
NF	B	113	F	Trifolium parryii	23
NF	B	113	F	Frageria virginiana	2
NF	B	113	F	Allium schoenoprasum	4
NF	B	113	F	Solidago spathulata	3

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	B 113	F	Aconitum columbianum	2
NF	B 113	F	Equisetum arvense	5
NF	B 176	G	Deschampsia cespitosa	33
NF	B 176	G	Deschampsia atropurpurea	4
NF	B 176	G	Phleum alpinum	24
NF	B 176	G	Agrostis alba	11
NF	B 176	G	Poa alpina	17
NF	B 176	G	Poa spp	6
NF	B 176	G	Festuca ovina	7
NF	B 176	G	Carex spp.	37
NF	B 176	G	Juncus balticus	10
NF	B 176	G	Luzula parviflora	9
NF	B 176	G	Equisetum arvense	5
NF	B 176	S	Salix wolfii	2
NF	B 176	S	Salix planifolia	7
NF	B 176	F	Castilleja sulphurea	2
NF	B 176	F	Aster/Erigeron	30
NF	B 176	F	Gentiana spp.	1
NF	B 176	F	Gentiana barbellota	20
NF	B 176	F	Potentilla spp.	16
NF	B 176	F	Caltha leptosepala	30
NF	B 176	F	Epilobium cileodum	4
NF	B 176	F	Veronica wormskjoldii	10
NF	B 176	F	Polygonium bistortoides	2
NF	B 176	F	Senicio triangularis	8
NF	B 176	F	Senicio serra	9
NF	B 176	F	Swertia parenis	12
NF	B 176	F	Stellaria umbellata	14
NF	B 176	F	Plantago tweedii	18
NF	B 176	F	Ranunculus spp.	25
NF	B 176	F	Saxifrage odontolomin	3
NF	B 176	F	Pedicularis groenlandica	18
NF	B 176	F	Taraxacum officinal	14
NF	B 176	F	Agoseris glauca	4
NF	B 176	F	Trifolium parryii	10
NF	B 176	T	Picea englemannii	3
NF	B 229	G	Deschampsia cespitosa	34
NF	B 229	G	Deschampsia atropurpurea	6
NF	B 229	G	Phleum alpinum	30
NF	B 229	G	Agrostis alba	8
NF	B 229	G	Danthonia intermedia	23
NF	B 229	G	Poa alpina	7
NF	B 229	G	Poa spp	9
NF	B 229	G	Festuca ovina	5
NF	B 229	G	Carex spp.	34
NF	B 229	G	Juncus balticus	21
NF	B 229	F	Castilleja sulphurea	4
NF	B 229	F	Aster/Erigeron	38
NF	B 229	F	Gentiana barbellota	11
NF	B 229	F	Potentilla spp.	28

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	B 229	F	Caltha leptosepala	21
NF	B 229	F	Epilobium cileodum	16
NF	B 229	F	Veronica wormskjoldii	1
NF	B 229	F	Senicio triangularis	10
NF	B 229	F	Swertia parenis	14
NF	B 229	F	Stellaria umbellata	12
NF	B 229	F	Plantago tweedii	21
NF	B 229	F	Erythronium grandiflorum	1
NF	B 229	F	Ranunculus spp.	24
NF	B 229	F	Pedicularis groenlandica	4
NF	B 229	F	Taraxacum officinal	18
NF	B 229	F	Agoseris glauca	14
NF	C 19	G	Deschampsia cespitosa	22
NF	C 19	G	Deschampsia atropurpurea	3
NF	C 19	G	Phleum alpinum	3
NF	C 19	G	Agrostis alba	11
NF	C 19	G	Poa spp	18
NF	C 19	G	Carex spp.	37
NF	C 19	G	Juncus balticus	1
NF	C 19	S	Salix planifolia	38
NF	C 19	F	Aster/Erigeron	3
NF	C 19	F	Gentiana barbellota	9
NF	C 19	F	Caltha leptosepala	29
NF	C 19	F	Veronica wormskjoldii	12
NF	C 19	F	Achillea millefolium	5
NF	C 19	F	Senicio triangularis	4
NF	C 19	F	Swertia parenis	13
NF	C 19	F	Stellaria umbellata	5
NF	C 19	F	Sedum rodanthum	5
NF	C 19	F	Plantago tweedii	3
NF	C 19	F	Circuta douglassii	3
NF	C 19	F	Ranunculus spp.	6
NF	C 19	F	Trollius laxus	16
NF	C 19	F	Saxifrage odontolomin	4
NF	C 19	F	Pedicularis groenlandica	7
NF	C 19	F	Taraxacum officinal	5
NF	C 19	F	Solidago spathulata	7
NF	C 19	F	Trifolium parryii	6
NF	C 45	G	Deschampsia cespitosa	1
NF	C 45	G	Phleum alpinum	10
NF	C 45	G	Agrostis alba	22
NF	C 45	G	Poa spp	15
NF	C 45	G	Carex spp.	20
NF	C 45	G	Carex lenticularis	16
NF	C 45	G	Juncus balticus	23
NF	C 45	G	Equisetum arvense	6
NF	C 45	S	Salix planifolia	34
NF	C 45	F	Castilleja sulphurea	3
NF	C 45	F	Aster/Erigeron	14
NF	C 45	F	Gentiana barbellota	1

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	C 45	F	Caltha leptosepala	24
NF	C 45	F	Veronica wormskjoldii	11
NF	C 45	F	Senicio triangularis	2
NF	C 45	F	Swertia parenis	16
NF	C 45	F	Stellaria umbellata	10
NF	C 45	F	Sedum rodanthum	9
NF	C 45	F	Plantago tweedii	5
NF	C 45	F	Circuta douglassii	4
NF	C 45	F	Ranunculus spp.	2
NF	C 45	F	Trollius laxus	9
NF	C 45	F	Saxifrage odontolomin	1
NF	C 45	F	Pedicularis groenlandica	20
NF	C 110	G	Deschampsia cespitosa	18
NF	C 110	G	Phleum alpinum	3
NF	C 110	G	Carex spp.	21
NF	C 110	G	Carex rostrata	1
NF	C 110	G	Equisetum arvense	23
NF	C 110	S	Salix planifolia	38
NF	C 110	F	Aster/Erigeron	20
NF	C 110	F	Caltha leptosepala	24
NF	C 110	F	Epilobium cileodum	16
NF	C 110	F	Senicio triangularis	15
NF	C 110	F	Swertia parenis	4
NF	C 110	F	Stellaria umbellata	14
NF	C 110	F	Sedum rodanthum	4
NF	C 110	F	Ranunculus spp.	23
NF	C 110	F	Trollius laxus	19
NF	C 110	F	Saxifrage odontolomin	36
NF	C 209	G	Carex spp.	21
NF	C 209	G	Carex rostrata	16
NF	C 209	G	Equisetum arvense	25
NF	C 209	S	Salix planifolia	39
NF	C 209	F	Aster/Erigeron	7
NF	C 209	F	Caltha leptosepala	25
NF	C 209	F	Senicio triangularis	20
NF	C 209	F	Ranunculus spp.	16
NF	C 209	F	Saxifrage odontolomin	16
NF	C 209	F	Epilobium cileodum	19
NF	C 248	G	Deschampsia cespitosa	17
NF	C 248	G	Phleum alpinum	24
NF	C 248	G	Poa alpina	3
NF	C 248	G	Carex spp.	38
NF	C 248	G	Equisetum arvense	18
NF	C 248	S	Salix planifolia	30
NF	C 248	F	Aster/Erigeron	31
NF	C 248	F	Gentiana spp.	2
NF	C 248	F	Potentilla spp.	1
NF	C 248	F	Caltha leptosepala	33
NF	C 248	F	Veronica wormskjoldii	22

MDW	TCT #	CLASS	SCIENTIFIC NAME	RAW SCORE
NF	C 248	F	Senicio triangularis	1
NF	C 248	F	Swertia parenis	26
NF	C 248	F	Stellaria umbellata	24
NF	C 248	F	Sedum rodanthum	22
NF	C 248	F	Plantago tweedii	7
NF	C 248	F	Ranunculus spp.	29
NF	C 248	F	Trollius laxus	19
NF	C 248	F	Saxifrage odontolomin	9
NF	C 248	F	Pedicularis groenlandica	28
NF	C 248	F	Taraxacum officinal	7
NF	C 341	G	Deschampsia cespitosa	32
NF	C 341	G	Danthonia intermedia	4
NF	C 341	G	Trisetum spicatum	3
NF	C 341	G	Poa alpina	10
NF	C 341	G	Poa spp	11
NF	C 341	G	Festuca ovina	4
NF	C 341	G	Agropyron smithii	6
NF	C 341	G	Carex spp.	32
NF	C 341	G	Equisetum arvense	17
NF	C 341	S	Salix planifolia	8
NF	C 341	F	Aster/Erigeron	16
NF	C 341	F	Gentiana spp.	5
NF	C 341	F	Potentilla spp.	12
NF	C 341	F	Caltha leptosepala	7
NF	C 341	F	Veronica wormskjoldii	3
NF	C 341	F	Senicio triangularis	11
NF	C 341	F	Swertia parenis	11
NF	C 341	F	Stellaria umbellata	6
NF	C 341	F	Plantago tweedii	14
NF	C 341	F	Zigadenus elegans	16
NF	C 341	F	Ranunculus sp.	35
NF	C 341	F	Trollius laxus	21
NF	C 341	F	Pedicularis groenlandica	17
NF	C 341	F	Taraxacum officinal	18
NF	C 341	T	Picea englemannii	12

APPENDIX C

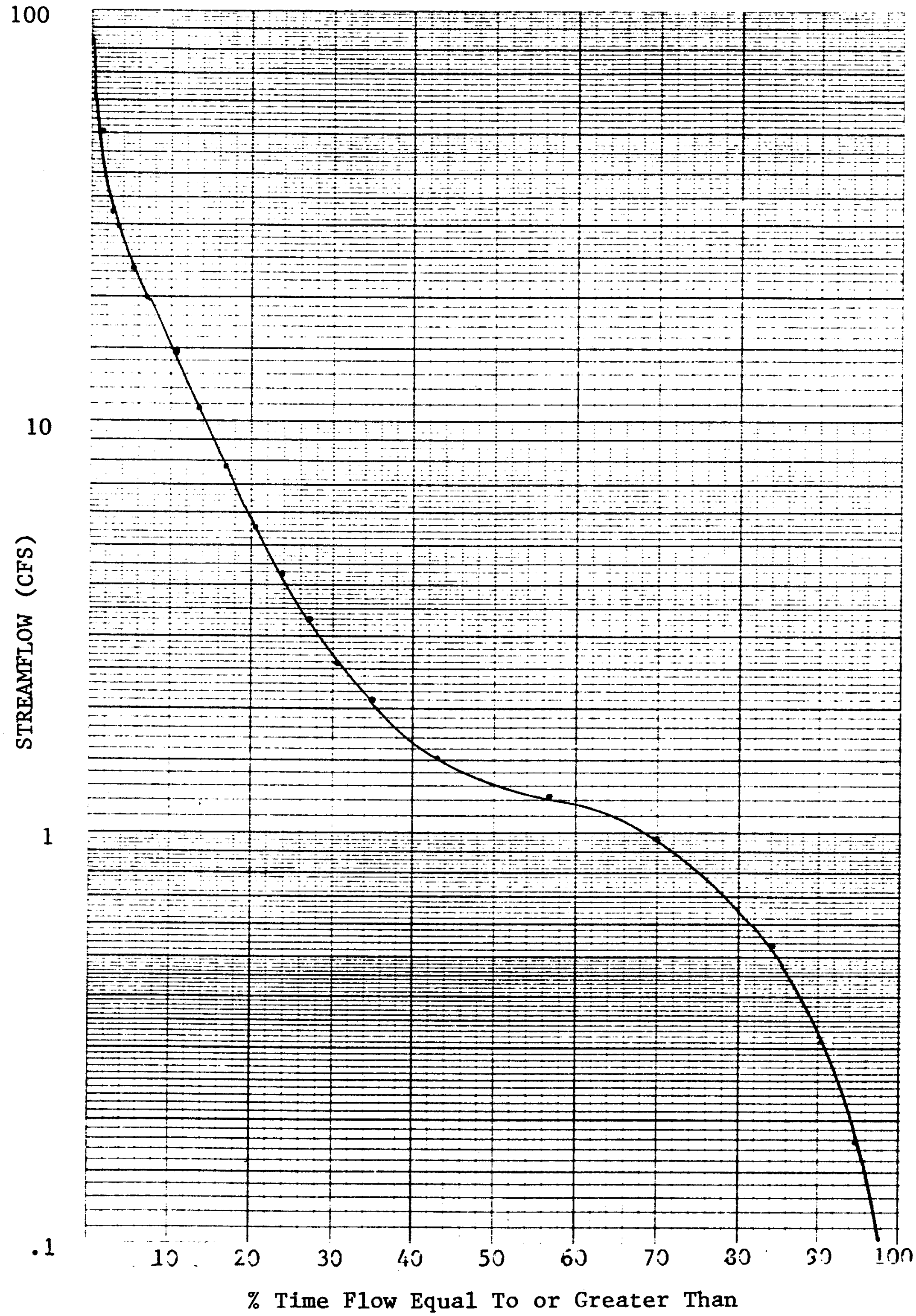
Appendix C. Correlated Signature Depth Durations for the Point Sampled Wells, and the Continuouly Monitored Well Correlated with. An * Indicates Well Was Not Used in Statistical Analysis. Community Is Carex, Open Canopy Willow (OCW), Closed Canopy Willow (CCW), Tree and Grass/Forb (GR/Forb). Well No. is the Well Number of the Point Sampled Well. The First Two or Three Letters Represent the Stream Reach ('TLR' is Towner Lake Road, The Intermittent Reach, 'TC' is The Upper Telephone Perennial Reach, 'NF' is the Nash Fork Perennial Reach and 'MP'is the Mill Pond Perennial Reach); The Final Letter Represents the Transect (A, B, or C) that the Well is On. The Number is the Distance in feet From the Right transect Stake. Regression Well No. Follows the Same Pattern, And Represents the Continuously Monitored well that Was Used to Expand The Point-Sampled Well's Data Set. D_{40}, D_{50}, D_{75}, and D_{90} Represent the Depth-to-Groundwater Equalled or Exceeded 40, 50, 75, and 90 percent of the Time, based on the Point sampled Well's Expanded Data Set.

COMMUNITY	WELL NO.	REGRESSION WELL NO.	D_{40} (FT)	D_{50} (FT)	D_{75} (FT)	D_{90} (FT)
CAREX	TLRC 316	TCB 159	.44	.56	.68	.81
	TCB 114	TCB 159	.66	.93	1.18	1.43
	TCA 226	TCB 159	.31	.52	.72	.92
OCW	TLRC 132	TCC 54	.12	.16	.30	.40
	TCC 82	TCC 54	1.51	1.66	2.28	2.69
	TLRA 157	TCC 54	.80	.85	1.05	1.18
	TLRA 310	NFA 159	1.55	2.32	2.98	3.51
	TLRB 220	NFA 159	.83	1.41	1.91	2.31
	TCA 156	NFA 159	.48	.97	1.39	1.72
	TLRB 269	NFA 159	.71	1.32	1.84	2.26
	TLRB 115	NFA 159	.32	.52	.69	.83
	TLRC 90	NFA 159	.63	1.14	1.58	1.92
	TCA 337	NFA 159	.96	1.62	2.19	2.65
	TCA 308	NFA 159	1.32	1.59	1.83	2.02
	NFA 47	NFA 159	1.57	1.97	2.32	2.60
	NFA 21	NFA 159	1.94	2.86	3.66	4.29
	NFC 248	NFA 159	.51	.88	1.21	1.47
	NFC 45	NFA 159	.55	.83	1.08	1.27

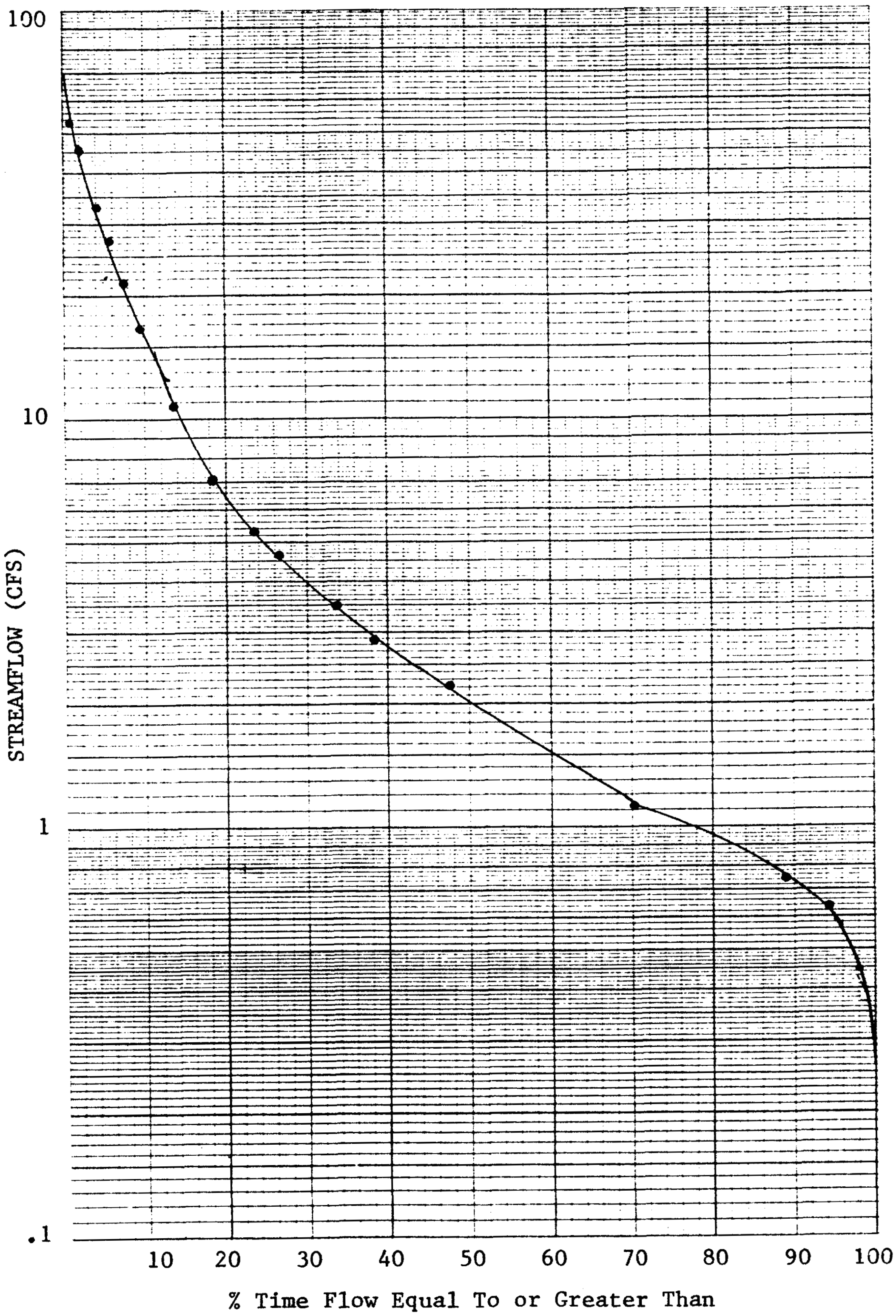
COMMUNITY	WELL NO.	REGRESSION WELL NO.	D_{40} (FT)	D_{50} (FT)	D_{75} (FT)	D_{90} (FT)
	NFC 19	NFA 159	.80	1.25	1.63	1.94
	MPB 245	NFA 159	.77	1.31	1.78	2.15
	TCC 114	NFA 159	1.66	2.34	2.92	3.38
	NFB 113	NFA 159	.73	1.25	1.70	2.06
	TLRA 106	NFA 159	.07	.36	.62	.81
	MPC 203	*				
CCW	TLRB 69	TLRA 72	.99	1.39	1.66	1.86
	TLRC 356	TLRA 72	.54	.78	.94	1.05
	TCB 85	TLRA 72	1.11	1.33	1.47	1.57
	NFA 89	TLRA 72	.71	1.01	1.21	1.35
	NFC 209	TLRA 72	.45	.70	.86	.98
	NFC 110	TLRA 72	.41	.62	.77	.87
CCW	MPA 86	TLRA 72	.73	.94	1.09	1.18
	TCA 276	TLRA 72	1.04	1.30	1.46	1.57
	TCB 180	TLRA 72	.61	1.02	1.29	1.49
	MPA 211	TLRA 72	.44	.71	.89	1.02
	MPC 371	*				
	MPC 273	*				
	MPC 108	*				
	MPB 58	*				
TREE	NFB 8	NFB 42	1.61	2.39	2.79	2.92
	TCC 141	MPC 20	1.94	2.38	3.14	3.70
	MPA 5	MPC 20	1.00	1.32	1.91	2.31
	MPB 4	NFB 42	2.88	3.18	3.33	3.38
	MPB 19	*				
	MPA 39	*				
	MPC 396	*				
GR/FORB	TLRA 23	TLRC 448	1.02	1.71	2.40	2.90

COMMUNITY	WELL NO.	REGRESSION WELL NO.	D_{40} (FT)	D_{50} (FT)	D_{75} (FT)	D_{90} (FT)
	TLRB 359	TLRC 448	.72	1.40	2.08	2.57
	NFA 213	TLRC 448	.83	1.36	1.90	2.29
	NFB 229	TLRC 448	.77	1.70	2.60	3.30
	NFB 176	TLRC 448	.66	1.22	1.79	2.20
	TLRB 11	TCA 39	1.19	3.13	4.50	4.89
	TLRC 26	TCA 39	.60	2.41	3.70	4.06
	MPA 286	TCA 39	.52	1.33	1.90	2.06
	MPB 298	TCA 39	.57	3.45	5.48	6.08
	TCC 12	*				
	TCB 38	*				
	TCB 8	*				

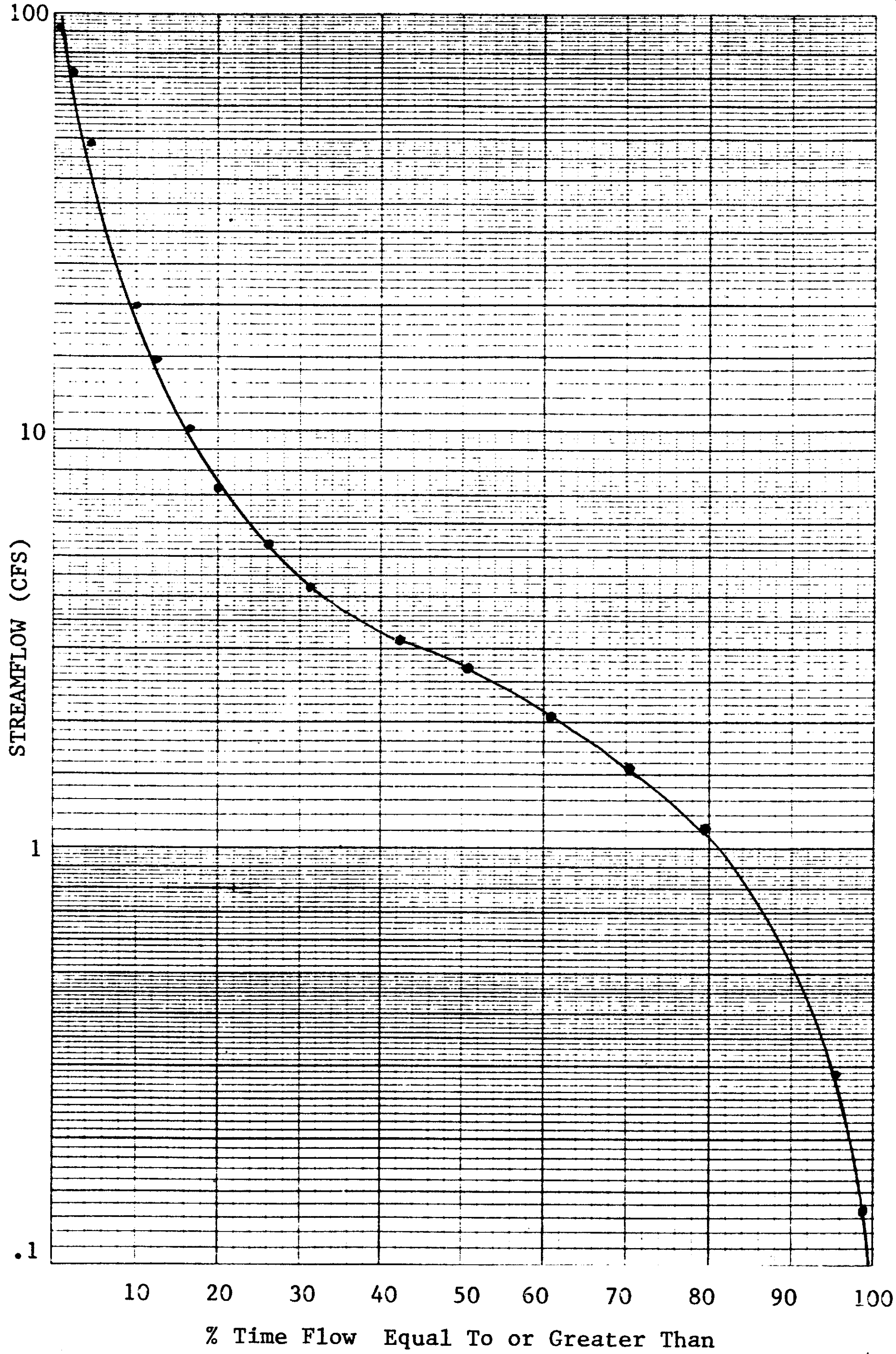
APPENDIX D



Flow Duration Curve, Telephone Creek Above Towner Lake Gage.
Compiled From 9 Complete Years Data, Using Mean Daily Values.



Flow Duration Curve, Telephone Creek Above Mill Pond Gage. Compiled From 12 Complete Years Data, Using Mean Daily Values.



Flow Duration Curve, Nash Fork Creek Below Brooklyn Lodge Gage.
Based on 11 Complete Years Data, Using Mean Daily Values.

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