SOIL & HYDROLOGY OF ALBION BASIN WETLANDS

LOCATED IN THE TOWN OF ALTA
LITTLE COTTONWOOD CANYON, UTAH

THE BOARD OF SALT LAKE COUNTY COMMISSIONERS
SALT LAKE COUNTY COMMISSION STAFF OFFICE

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Performed for Region VIII
Environmental Protection Agency
and
The Town of Alta

by

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Funded by Region VIII Environmental Protection Agency
Denver, Colorado
and
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Alta, Utah

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INTRODUCTION

The Town of Alta has been pursuing the update and refinement of the Town master plan for the last two years, and last year requested technical assistance from Salt Lake County in developing a wetland conservation ordinance. This measure would not only increase the ability of the Town to prevent development of valuable sub-alpine wetland resources, but would help maintain important functions provided by wetlands, such as flood storage, groundwater recharge, pollution control, sediment trapping, fish & wildlife habitat, and recreation.

Alta enjoys a unique reputation for world renowned alpine skiing. It is the home of "The Greatest Snow On Earth." The slopes of Alta provide premier and unmatched light powder skiing which draws a richly mixed crowd of American and European skiers and tourists. It is a very popular summer recreation area, hosting a wide density and diversity of seasonal wildflower displays, to be enjoyed while hiking several excellent trails such as Cecret Lake, Devils Castle, Catherines Pass, Superior Peak, Sunset Peak, and others.

Alta Lift Company and the Town of Alta have always and continue to emphasize a quality skiing experience, and are dedicated to maintaining a "quality" ethic above the typical "quantity" ethic which develops maximum natural terrain with the resultant over-crowded ski slopes.

The Lift Company has also been a leader in maintenance and enhancement of environmental conditions in the Albion Basin, and was one of the earliest demonstrators of "nonpoint source" pollution control measures along the Wasatch Front. They have successfully tried and monitored various local grass species for its effectiveness in revegetation of disturbed areas, initiated a tree replanting/transplanting program in conjunction with a modest nursery, and assisted the county in researching the effects of parking lot paving on the water quality of Little Cottonwood Creek.

In summary, The Town of Alta enthusiastically embraced the opportunity to begin the process of identifying important lower montane & subalpine wetlands to properly administer development controls within its jurisdiction. The Friends of Alta, a private nonprofit group of interested individuals, provided matching funds for the project in cooperation with the Town.

A grant for the project was awarded Region VIII EPA in Denver, and with local matching funds, the project began in July, 1992. Field work was conducted for approximately two months, with research assistance provided by the Town. The dedication and enthusiasm of officials and employees of Alta underscore the commitment for quality recreation within one of Utah's most important watersheds, while maintaining and enhancing the beautiful and very sensitive alpine environment.

o Background: Institutional & Regulatory Framework

The project involves an identification of wetlands within geographical areas--or rangesites--in advance of future development proposals, in order to systematically plan for land acquisition or compensatory mitigation. The project supports the wetland permit program administered by the U.S. Army Corps of Engineers, which has regulatory responsibility for protecting the nation's wetlands under section 404 of the Federal Clean Water Act.

The majority of land ownership and control within the project area rests with the federal government, namely the U.S. Department of Agriculture. It is administered by the Forest Service Salt Lake Ranger District, which maintains interlocal agreements with the Town of Alta, Salt Lake County, Salt Lake City, and the State of Utah for protection of water quality & water supply. Since Little Cottonwood Creek is designated as an "Anti-degradation" segment, no new point sources of pollution--treated or otherwise--are allowed in the watershed. Best Management Practices (BMP'S) to control other "nonpoint" pollution are required to the maximum extent feasible.

The Alta Lift Company, formed in 1936, has purchased many acres from private land holdings in the upper basin, and works closely with the Forest Service in protection and maintenance of the land/water interface during construction activities.

Salt Lake City Corporation, which possesses extra-territorial authority over water supply in Little Cottonwood Canyon, relies on the canyon for providing up to 15% of total culinary water demand in Salt Lake valley. The City works closely with the City-County Health Department in monitoring water quality and cooperatively enforcing provisions of local, state, and federal clean water regulations.

o Lead Agency and Technical Support

The grant for the project was awarded to the Salt Lake County Commission which recently received designation by the Governor of the State of Utah and EPA as the Area-Wide Water Quality Planning Agency for the Salt Lake Sub-Basin.

The County was supported by the Town of Alta and Friends of Alta through provision of a research assistant with extensive expertise in botany. In view of the unusual diversity of plant species in the basin, this particular assistance proved invaluable. The project director received training & certification from EPA in jurisdictional delineation techniques, and is certified by the Corps of Engineers to perform local delineation investigations.

PROJECT SCOPE AND OBJECTIVES

The scope for the Albion Basin wetland inventory is limited to specific wetland communities--or rangesites--in the lower and upper Basin area. It is estimated that these areas comprise approximately 485 total acres, with about 237 acres potentially meeting technical wetland criteria. The total sub-watershed contains approximately 2,340 acres.

The objectives of this technical report are to describe the soil hydrology in the basin which creates seasonal saturation, and typify basin soils from samples collected within numerous sample sites and rangesite transects. Specifically, soil identification for purposes of determining "hydric" saturated anerobic conditions must be made as one of three conditions used to define wetlands.

o Definitions

The Environmental Protection Agency and Corps of Engineers define wetlands for purposes of administering section 404 as:

> "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." (EPA, 1989)[1]

The U.S. Fish & Wildlife Service defines wetlands as those:

> "transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominanatly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year." (Cowardin, 1979)[2]

o "Normal Circumstances"

The Corps/EPA definition requires that "under normal circumstances," only lands having hydrophytic vegetation, hydric soils, and hydrologic saturation can be classified as wetlands. The Wasatch Range has been in a drought condition for the past six years, and this year snowpack accumulations were measured at only 50% of normal. Areas "normally" saturated were only partially wet or even damp. Stressed conditions of some hydrophytic plant communities occurred very shortly after snowpack runoff. Normal hydrologic circumstances were not present during this study.

STUDY METHODOLOGY

Due to the expanse of the study area, two levels of analysis were employed. The first analytical phase used both false-color and full-color remote sensing data compiled from the USDA Aerial Survey Center. The second analytical phase employed site-specific sampling methods described in the "Federal Manual for Identifying and Delineating Jurisdictional Wetlands." Additional sources of literature used extensively in the project were "An Ecological Characterization of Rocky Mountain Montane and Subalpine Wetlands"[3] by the U.S. Fish & Wildlife Service in cooperation with Region VIII EPA, and "Jurisdictional Delineation of Riparian Wetland Ecosystems in Southwestern United States."[4]

o Aerial Interpretation

Large scale false-color infrared aerial photography was used mainly for hydrologic interpretation. The properties of this type of remote sensing are quite useful for determining location of both ground and surface water hydrology due to changes in patterns and color hue. Only very large scale photography was available, however, which made interpretation difficult. Field notes were more reliable.

Full color aerial photography was used for mapping vegetative communities and hydrology. The resolution quality and clarity of this photography made interpretation quite accurate. Field data was collected on larger scale photo overlays and transferred to smaller scale prints for final mapping.

o Field Data Collection

Priorities for field data collection were determined through consultation with the Town of Alta. Field study began July 7, 1992, and continued through September 10, 1992. A modified comprehensive on-site method, described in the federal delineation manual was used, which involved point-intercept sample plots along transects extending through specific plant community types.

The determination of whether soils along a sample transect should be characterized was made using hydrologic condition field indicators, including visual observations of inundation, drift lines, rilling, water marks, gullying and other drainage patterns, and plant morphology (hydrophytic species).

Potential soil sample areas were probed with an 8" steel tube, and estimation of saturation made, i.e. dry, semi-damp, damp, wet, saturated. Damp sites were most often excavated with an 18" steel spade, and soil plugs removed in order of horizon. The plugs were laid out and analyzed using the standard guide for textural classification in soil families, the Munsell Soil Color charts, visual examination of presence of mottles, inclusions, concretions, etc., and divided most often into two distinct horizon levels.

All information was logged onto sample site data sheets, including any particular observations which may provide clues about the existence or characteristic of wetland type. These data are included in Appendix A, Soil/Hydrology Profile Data. The transects and sample sites were also recorded on maps developed for the Alta Town Master Plan. These were photo-enlarged to increase scale, and later transferred to Alta General Plan base map (Figures 1 & 2).

Due to the distinct variation of wetland communities within the Basin, representative photographs were taken of each rangesite and usually each transect. Most of the photographic documentation is shown as representative plant community types which were also logged at the time of field data collection.

ESTIMATED ACREAGE OF ALBION BASIN STUDY RANGESITES/WETLANDS

Acreage of each rangesite study area is estimated using 1"=250' scale full color aerial photographs obtained from the USDA aerial service center. A grid with 1" squares representing 1.43 acres was overlayed on each mapping area and estimates made. The acreages are approximate. Within each rangesite, transects ranging in length from 750-1500' and 1-6 samples sites within each transect recorded vegetation, hydrology and soil characteristics.

RANGESITE MAPPING UNIT	TOTAL ACRES	TRANSECTS	TEST SITES	WETLAND ACRES
Patsy Marley Hill	81	8	27	40
West Albion Basin	109	6	14	63
Albion Meadows	30	3	8	9
Albion Loop	29	2	9	11
East Albion Basin	26	2	6	17
Greely Bowl	34	1	3	6
Lower Greely	36	1	4	34
North Rustler	29	1	5	9
Creek Townsite	33	2	9	20
Upper Patsy Marley Hill	29	2	10	16
Emma Hill	49	3	12	12
TOTALS	485	31	107	237

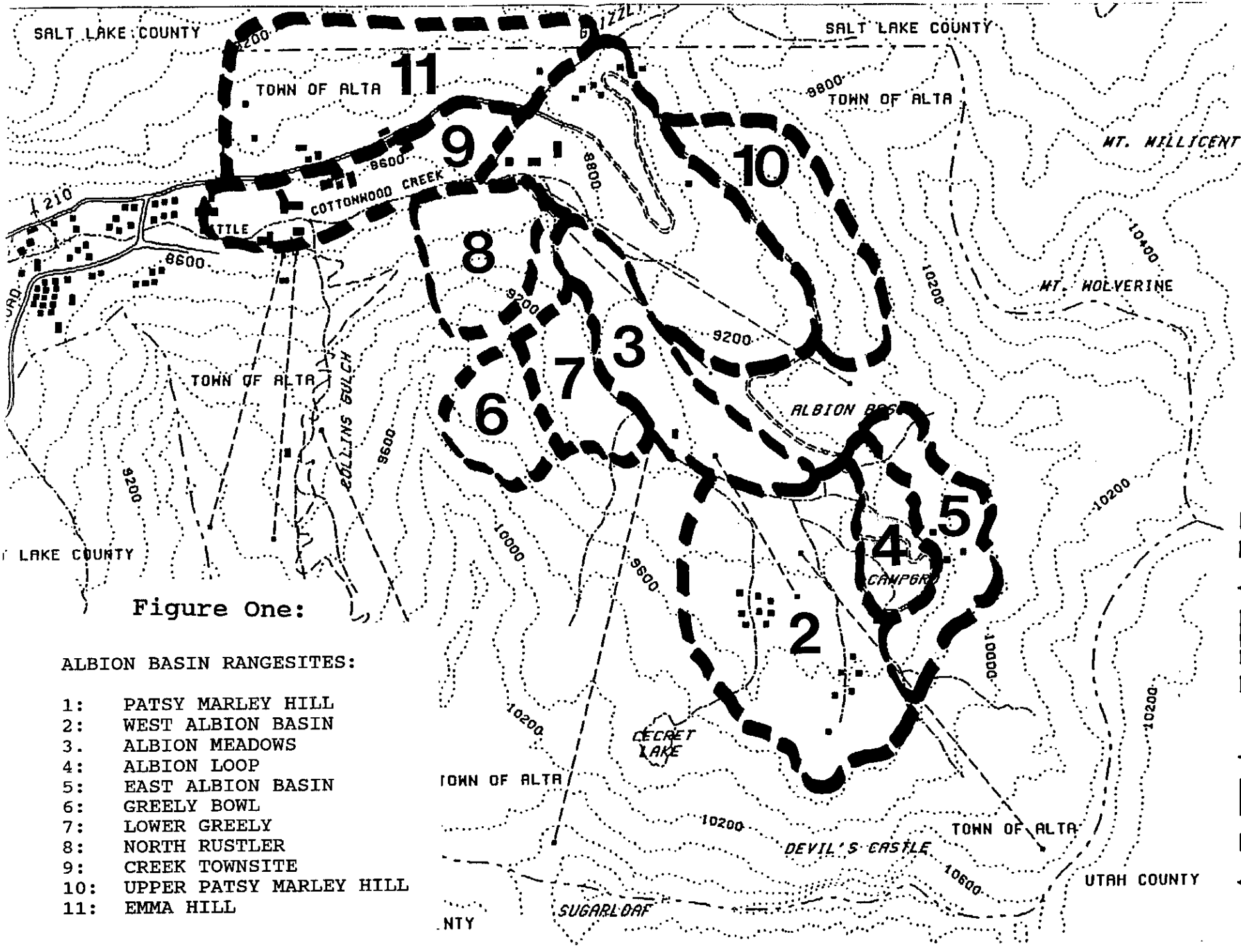


Figure One:

ALBION BASIN RANGESITES:

1: PATSY MARLEY HILL
2: WEST ALBION BASIN
3. ALBION MEADOWS
4: ALBION LOOP
5: EAST ALBION BASIN
6: GREELY BOWL
7: LOWER GREELY
8: NORTH RUSTLER
9: CREEK TOWNSITE
10: UPPER PATSY MARLEY HILL
11: EMMA HILL

ALTA, UTAH

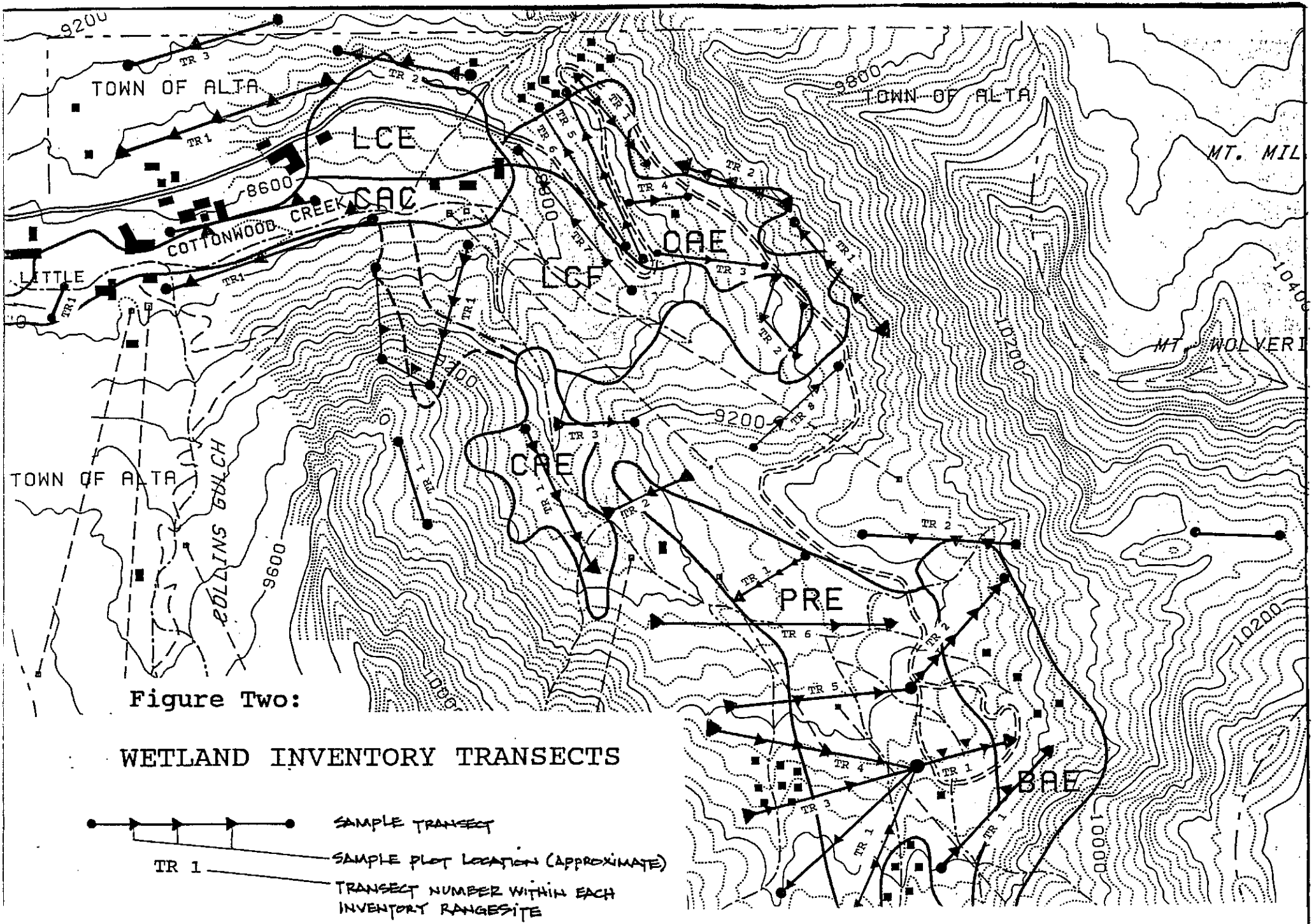


Figure Two:

WETLAND INVENTORY TRANSECTS

GEOLOGIC, SOIL, AND HYDROLOGIC SETTING OF LOWER MONTANE AND SUBALPINE WETLANDS IN ALBION BASIN

Prior to describing conditions encountered within each individual study rangesite, it is important to review some basic information which clarifies how wetlands in Albion Basin are created and naturally maintained. Therefore, a description of landform and soil processes in the basin is given with discussions of the geologic setting, resultant soil setting, hydrologic setting and various ecologic interactions.

I. GEOLOGIC SETTING

The geologic setting of the basin includes descriptions of elevation & physiography and a review of major geologic formations which directly affect snow storage, snowmelt and rainfall runoff, groundwater discharge, vegetative life zones and soils composition.

o Elevation and Physiography

Study areas in the Albion Basin range from 8,600 ft. to 10,200 ft. above sea level. The Basin sub-watershed is approximately two miles long from Devil's Castle Peak at the south end, to Little Cottonwood Creek near the Northern central townsite, and two miles wide from Catherine Pass to Cecret Lake, with a total drainage area of about 2,340 acres.

From the townsite near Grizzly Gulch, the southward Basin appears rather incised and divided in half from creek downcutting on the west and glaciation from the east, with a major granitic rock outcrop "finger" separating the two landforms. But near the top of the Albion Lift, at about 9,400 feet, the basin opens into a magnificent, broad expanse flanked by Cecret Lake pass to the west, Catherine Pass to the east, and the towering Devil's Castle to the South. The upper basin is heavily littered with conifers up to about 9,800 feet.

Residential development is limited to about 20 seasonal cabins, and the upper basin is dissected by three ski lifts; Supreme, Cecret, and Sugarloaf. The basin is also occupied by a Forest Service campground which is heavily used during the summer visitor season.[5]

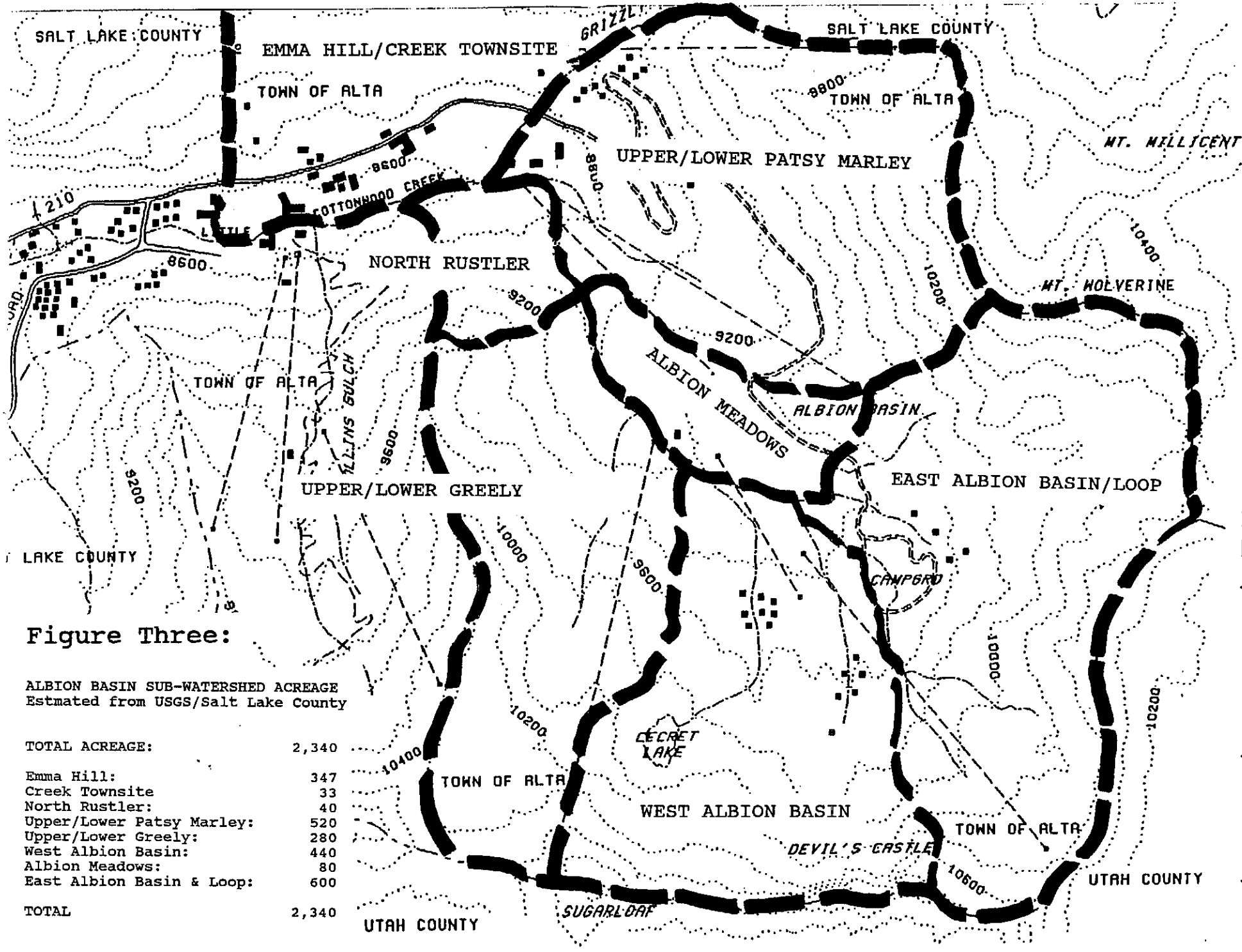


Figure Three:

ALBION BASIN SUB-WATERSHED ACREAGE
Estmated from USGS/Salt Lake County

TOTAL ACREAGE:	2,340
Emma Hill:	347
Creek Townsite	33
North Rustler:	40
Upper/Lower Patsy Marley:	520
Upper/Lower Greely:	280
West Albion Basin:	440
Albion Meadows:	80
East Albion Basin & Loop:	600
TOTAL	2,340

o Major Geologic Formations & Features[6]

Lower Albion Basin is characterized by a steeply incised canyon downcut by Little Cottonwood creek, flanked by on both sides by spectacular granitic formations of the Alta Stock, with the canyon floor and sides mainly Wisconsin Glacial Till **(Figure 4)**.

Upper Albion Basin is more complicated. Eastern canyon flanks (9,600-10,000 ft.) are mainly sedimentary, while western flanks are a combination of sedimentary strata intruded with quartzite.

Eastern flanks are composed of interbedded basal Mississippian limestone and Deseret-Madison undifferentiated limestone, while the western flanks are Maxfield limestone interbedded with Tintic Quartzite. The upper basin floor is principally earlier Cambrian Ophir Shale, with lateral glacial till along the east.

Both the Mississippian limestone and cambrian shales are heavily fossilized and interlaced with random quartzite veins.

o Glaciation

Late Pleistocene glaciation has played a significant role in the development of the Basin:

> "As glaciers retreat, large ice chunks break off at the toe and are buried in glacial outwash deposits on the valley floor. When the ice melts, a depression forms that fills with water and becomes a glacial kettle. These kettle lakes are usually less than 50 m deep, and often correspond in shape to the orginial ice block (Wetzel, 1983). Kettle lakes, like other lakes, pass through wetland seral stages."[7]

There are several examples of these phenomena in the upper Albion Basin province: Cecret Lake, Pittsburgh Lake in upper American Fork, Cloud Rim Lake near Guardsman Pass, Catherine, Twin, Blanche, Florence, and Lillian Lakes in the Big Cottonwood drainage. Some have been dammed to increase storage capacity.

o Cirques, Nivation Depressions, and Solifluction Terraces

Glacial action also forms large cirque basins below the upper peaks "resembling amphitheaters in which snow collects and remains, sometimes into late summer." Channels of melting snow & ice may "disappear under porous boulder and talus fields, re-emerging at the toe of slopes as trickling seeps or gushing springs."

Shallow pockets are often formed on upper cirque slopes that have since filled in with eroded material. As the snow and ice melt, these "nivation depressions" form pools of subterranean water slowly discharged during the summer season **(Figure 5)**.

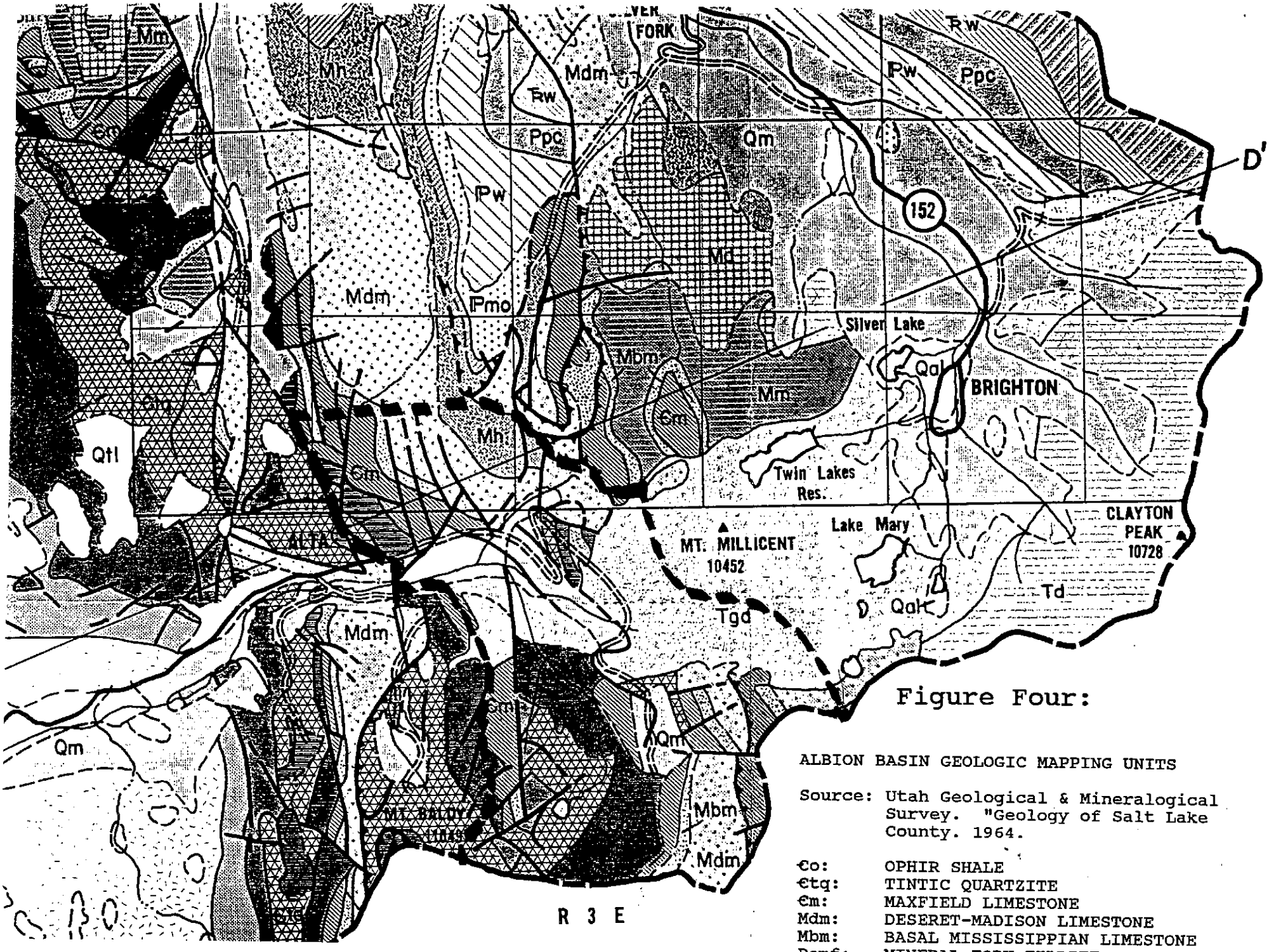


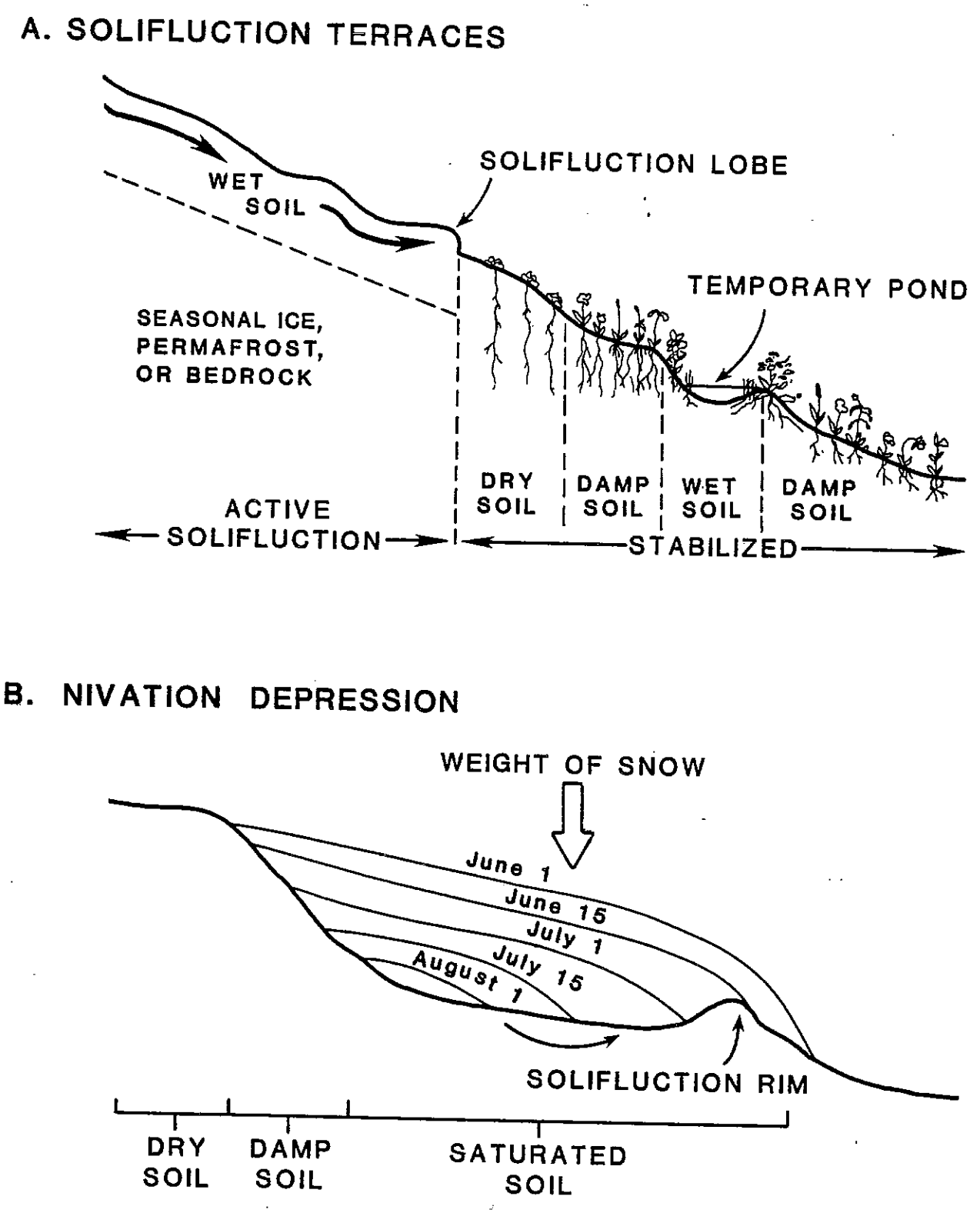
Figure Four:

ALBION BASIN GEOLOGIC MAPPING UNITS

Source: Utah Geological & Mineralogical Survey. "Geology of Salt Lake County. 1964.

€o:	OPHIR SHALE
€tq:	TINTIC QUARTZITE
€m:	MAXFIELD LIMESTONE
Mdm:	DESERET-MADISON LIMESTONE
Mbm:	BASAL MISSISSIPPIAN LIMESTONE
Pemf:	MINERAL FORK TILLITE
Qm:	WISCONSIN GLACIAL TILL
Tgd:	ALTA STOCK-GRANDIORITE

Figure Five:



Small pools may form near treelimit: (A) behind solifluction terraces formed by downhill movement of wet soil overlaying permafrost or bedrock; and (B) in shallow pockets (nivation depressions) as a heavy snowbed presses down on saturated soils and permafrost maintains a high water table. (Adapted from Zwinger and Willard 1972.)

On slopes of gentler grade, soils setting on bedrock become super-saturated, causing slight movement downslope which creates solifluction lobes with subterranean ponds. These areas, called solifluction terraces, may store large quantities of water providing steady sources of springs and soil saturation **(Figure 5)**.

Numerous cirques and depressions remain which have since drained and left relic wetlands, supported by snowmelt within porous rockfall and numerous springs and groundwater discharges through the summer season. Examples in Albion Basin are: Catherine Pass wetland (fen), Glory Hole cirques, springs below the Devil's Castle cirque, and Greely Bowl.

An excellent example of a solifluction terrace can be seen below Greely Bowl (the lower Greely Rangesite), and to a lesser extent, the saturated slopes of both upper and lower Patsy Marley Hill.

Glacial till plays an important role in the structure of basin side slopes and soil composition. Generally the formations created by lateral moraine deposition are very well drained and devoid of high concentrations of organic material.

II. SOIL SETTING

Soil characteristics in Albion Basin were surprising in view of the unexpected diversity encountered. Soil traits follow a definite pattern, however, depending on the location and aspect, and most importantly, level of saturation.

o Basic Characteristics of Rocky Mountain Soils[8]

The primary factors influencing soils development include geology, erosion, topography, climate and growing season, and vegetation Most soils in the Rocky Mountain cordillera are categorized into five principal orders: Entisols, Mollisols, Inceptisols, Histosols, and Spodosols. The Soil Conservation Service identifies the most often occurring pattern in the Rockies as "Xeric" Mollisols, or "Xerolls."

1. **Entisols** are generally undeveloped soils, occurring on unconsolidated talus or bedrock, recent glacial moraines and sandbars.
2. **Mollisols** and **Inceptisols** may occur in subalpine meadows displaying a relatively deep, tight organic root zone.
3. **Histosols** are bog/peat soils forming in poorly drained, poorly oxygenated areas.
4. **Spodosols** are moderately deep, well drained types which may occur in subapline zones where organic input and accumulation is high.

o General Categorization of Albion Basin Soils

The Soil Conservation Service mapped the soils in this area in 1975 (Summit Soil Survey Area)[9]. Approximately six test pits at a typical depth of five feet were excavated to discern soil mapping unit characteristics. The following summary describes the soils occuring throughout the Basin (Figure Six):

SOIL MAPPING UNITS IN THE ALBION BASIN, UTAH

FHD: Gravelly Loam, 15-25% slopes
FZE: Steep Rock Outcrop Association; very stony loam 25-40% slopes
FJG: Very Stony Loam, 40-70% slopes
FZG: Very steep Rock Outcrop Association; very stony loam 40-70% slopes
LcE: Cobbly Sandy Loam, 15-25% slopes
LcF: Cobbly Sandy Loam, 25-40% slopes
MD: Mine Dump
CaC: Gravelly Loam, 8-15% slopes
CaE: Gravelly Loam, 15-40% slopes
RX: Rock Land
PUH: Very Steep Rock Outcrop Association; stony loam 40-80% slopes
PUE: Rock Outcrops Association, steep; stony loam, 40-70% slopes
BaE: Silt Loam, 15-25% slopes
PRE: Cobbly Loam, 25-40% slopes
DRH: Very Steep Rock Outcrop Association; Lc cobbly sandy loam, 40-70% slopes
BWH: Very Steep Rock Outcrop Association; Ba silt loam, 25-70% slopes

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o Mapping Unit Correllation with Soil Samples

Of the sixteen soil mapping units described in the SCS survey, seven occurred within potential wetland rangesites. Of the seven which occurred in these sites, only one consistently exhibited characteristics consistent with descriptions of the "A" horizon in the SCS manual, which was the BaE silt loam.

One of the dominant mapping units, PRE cobbly loam, did not appear cobbly within a shallow 12" horizon. It is a uniform, fine silty to sandy clay loam. Formed in glacial till from mixed sedimentary rocks (mainly Ophir shale), gravelly loam was encountered mostly in dry areas between drainages.

These soils were interpreted previously by SCS as "Pachic Cryoborolls," a loamy-skeletal mixed soil (Carley, 1976). Samples taken during the study also characterize them as Aquolls or Borolls, a Mollisol suborder. However, they exhibit anerobic clay layers at relatively shallow depths when occurring in drainages.

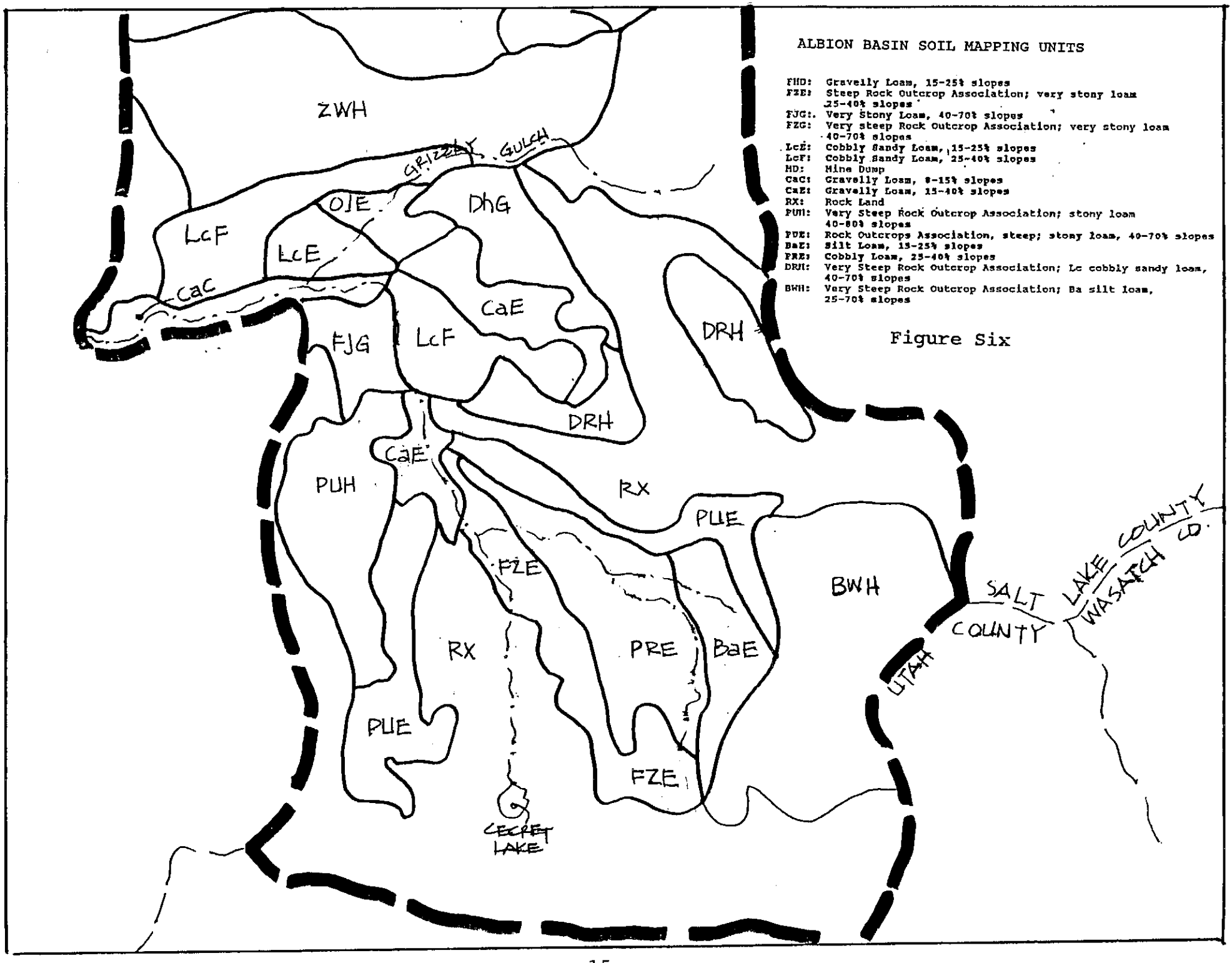
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Figure Six
ZWH
GRIZZLY GULCH
OJE
DhG
LcF
LcE
CaC
CaE
FJG
LcF
DRH
DRH
CaE
PUH
RX
PUE
FZE
BWH
RX
PRE
BaE
PUE
FZE
SECRET LAKE
SALT LAKE COUNTY
UTAH COUNTY
WASATCH CO.

The CaE gravelly loams, found on Patsy Marley Hill and at the base of Greely bowl, are alluvium/colluvium formed soils which are deep and poorly drained. The water table is between 10-20" until mid-summer and mottled to depths of 18." The upper elevation rangesite soils are consistently more gravelly, while lower units are more silty to sandy clay loams. These soils seemed to fit this general description, except that hue value & chromas in the samples were slightly darker than those described by SCS.

The LcE soil unit is described by SCS as a cobbly sandy loam. Samples taken to 24" indicate they are more predominantly sandy loams. Hue values and chromas were darker than in the SCS manual, and exhibited values & chromas consistently at 2/2-2/1 which could qualify them as hydric. The location of these soils is closer to floodplain/deposition features than lateral moraines. These soils bear little resemblance to those described by SCS.

o Classification of Albion Basin Soils by Order/Suborder[10]

Based on the collection of over 100 soil samples ranging from shallow bedrock-overlain depths of 12" to 24" in deeper areas, the following orders & suborders characterize soils found in potential wetlands throughout Albion Basin:

1. **Entisols**...Soils without pedogenic horizons:
   E1: Aquents (Seasonally saturated)
   E2: Orthents (Loamy-clayey textures)
   E4: Psamments (Sand or loamy sand textures)
   Most often found along glacial moraines and sideslopes throughout the Basin

2. **Histosols**...Organic Soils
   H1: Fibrists (fibrous or woody peats, largely undecomposed) or woody or idle peats.
   H2: Saprists (decomposed mucks)
   Limited to broad, wet meadow bottom lands in the upper Basin, beneath the Cecret Lift

3. **Mollisols**...Soils with nearly black, organic-rich surface horizons
   M1: Aquolls (Seasonally saturated with water)
   M2: Borolls (Cool or cold soils)
   Occurs in spring/stream channels throughout the Basin

4. **Spodosols**...Soils with accumulations of amorphous materials in subsurface horizons, often associated with coniferous forests
   S1: Aquods (Seasonally saturated with water)
   S2: Orthods (with subsurface accumulation of iron, aluminum, and organic matter)

III. HYROLOGIC SETTING

Hydrologic discharge in the Albion Basin province is influenced principally by snowfall accumulation, and rainfall to a lesser extent. The discharge of Little Cottonwood Creek near the guaging station at the Sunnyside Lift base, and all of the first and second order upper Basin tributaries, is created by storage of snowmelt runoff in geologic structures modifified by glaciation.

o Average Annual Snowpack in Albion Basin

The largest hydrologic contribution to spring and stream flow in the Albion Basin is snowpack. Mean annual total precipitation in the Rocky Mountain region in comparison to the United States ranges between 64-100 inches (Baldwin, 1973)[11]. Alta snowfall data is shown in **Figures Seven and Eight.**[12]

Discharge of the snowmelt to Little Cottonwood Creek begins in Mid-March (spring skiing conditions) and is well under way by April 1st. Second-order tributaries to Little Cottonwood Creek are Gunsite & Greely Bowl, Glory Hole, Cecret Lake, Devil's Castle cirque, Supreme Bowl, Catherine Pass, and Patsy Marley complex stream segments. These streams confluence into two main tributaries just east of the Sunnyside Lift base **(Figure Nine).**

The average annual discharge of Little Cottonwood Creek at the Sunnyside rating station is shown in **Figure Ten.** During a normal water year, the average peak discharge is about 12 cubic feet per second (c.f.s.). The majority of the discharge volume for the year occurs between April 1st and August 1st, when base flows range from 2-3 c.f.s. respectively.[13]

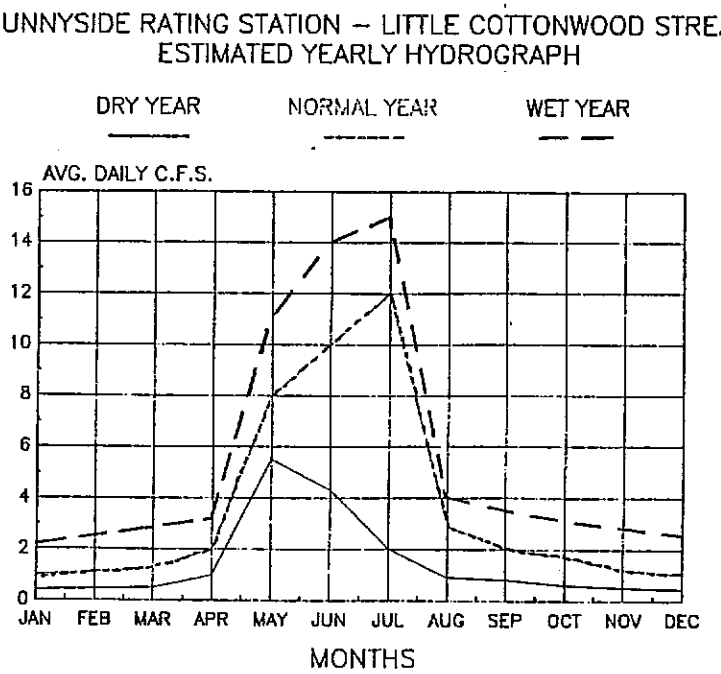
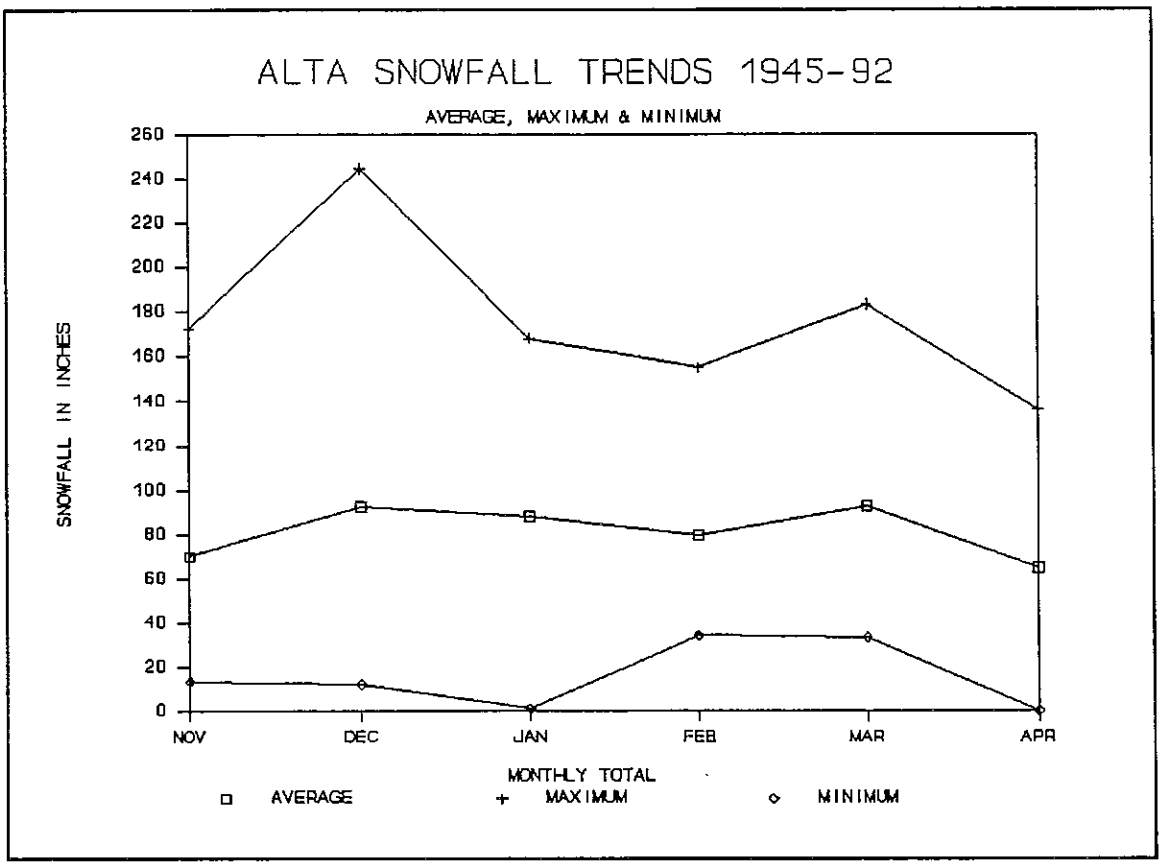


Figure Ten

Figure Seven



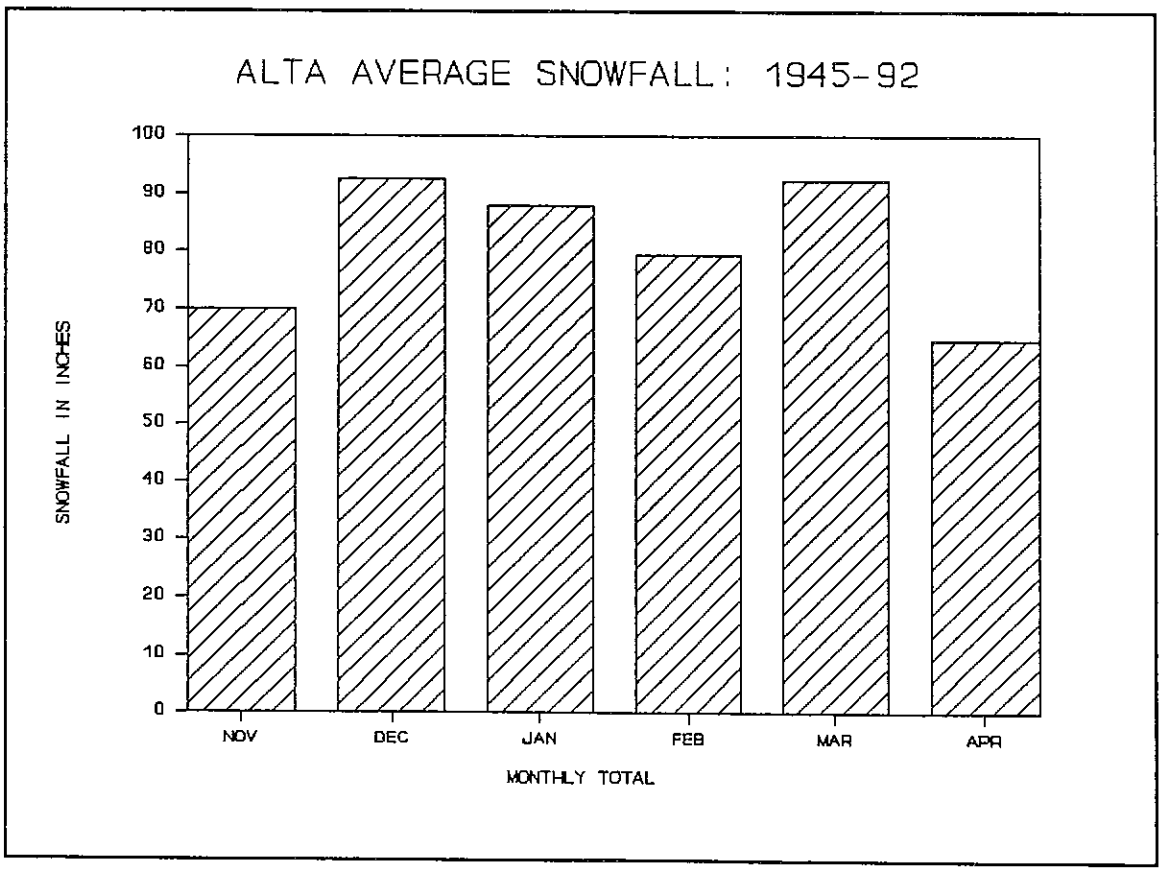
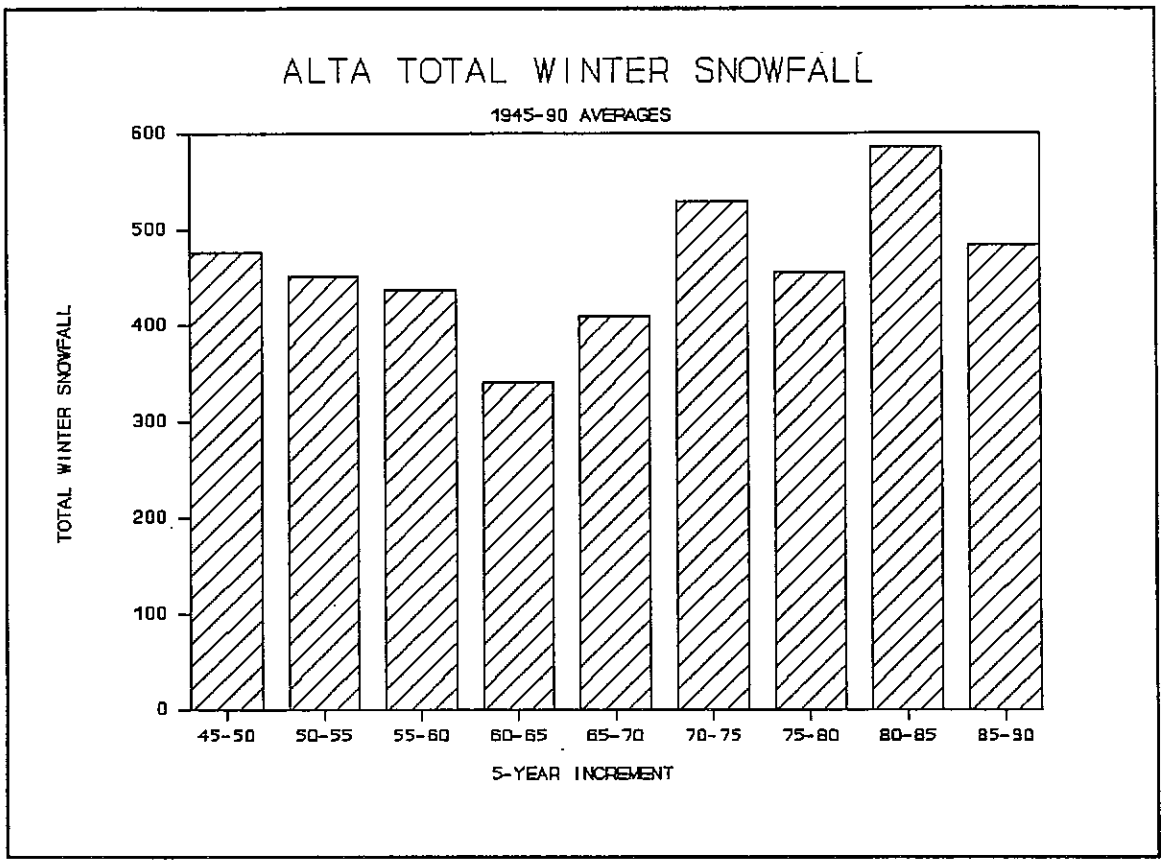
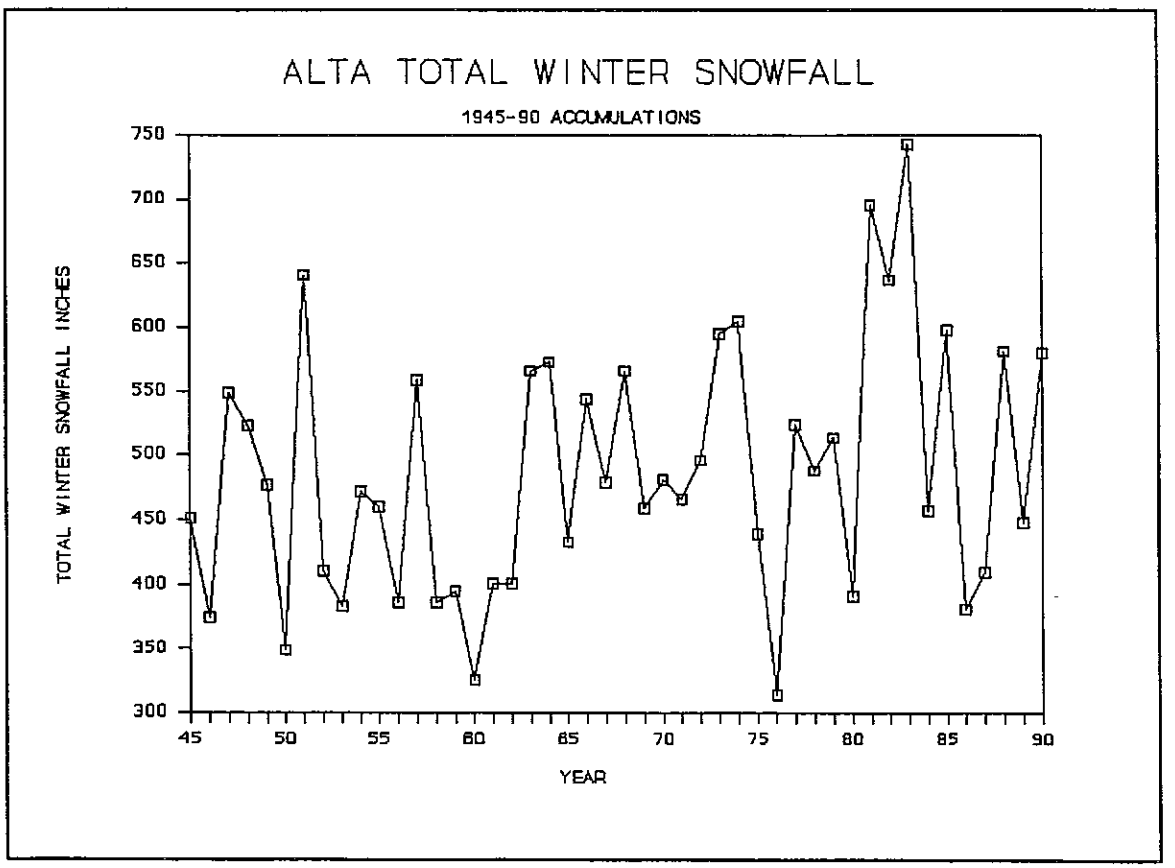


Figure Eight





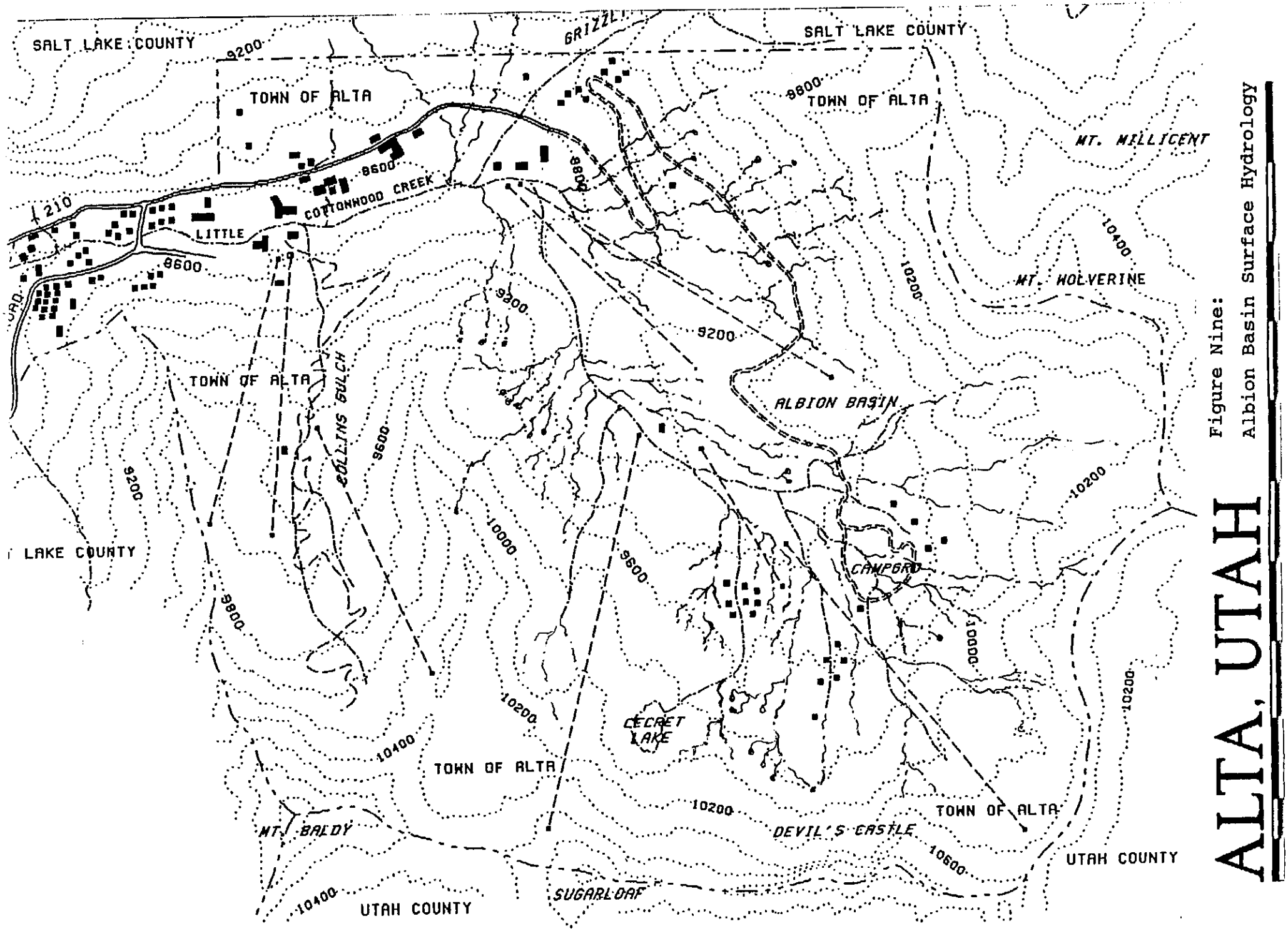


Figure Nine:
Albion Basin Surface Hydrology

ALTA, UTAH

o Seasonal Soil Saturation in Albion Basin

The Soil Conservation Service estimates soil properties in the Summit Soil Survey area which includes Albion Basin.[14] The table below summarizes some of the mapping unit data which provides only clues to seasonal soil saturation:

SOIL TYPE	AV. ANNUAL PRECIP	FROST FREE SEASON	PERMEAB.	AVAIL.WATER CAPACITY	WATER SUP. CAPACITY
BaE Silt Loam	35-45"	50-70 Days	Mod.Slow	8.5-9.5"	18-22"
CaE Grav Loam	35-45"	50-70 Days	Mod.Rapid	3.5-4.5"	10-20" WT
CaC Grav Loam	35-45"	50-70 Days	Mod.Rapid	3.5-4.5"	10-20" WT
LcF Cobbly Sandy Loam	35-45"	50-70 Days	Moderate	4-5"	16-22"
LcE " " "	35-45"	50-70 Days	Moderate	4-5"	16-22"
PRE cob. Loam	30-45"	50-70 Days	Moderate	5.5-6.5"	17-19"

The frost free period in the Basin begins in May and extends into early September, almost double the amount of time estimated by SCS. The average annual precipitation is also higher than that estimated in the soil survey. Soil samples taken in the PRE, BaE, and CaE mapping units also exhibited characteristics of slower, rather than moderate or rapid permeability.

Saturation of soils was encountered at most elevations in each soil mapping unit even during the late summer and in one of the driest climatic regimes in 50 years. Particularly in drainage swales on steep side slopes, wetness and saturation was common. The period of soil saturation in this basin approaches 4-5 months or 120-150 days during late spring to early autumn.

o Saturated conditions on Glacial Till

The following quoted narrative is taken from the Federal Manual for Identifying and Delineating Jurisdictional Wetlands:

> "Sloping wetlands occur in glaciated areas where thin soils cover relatively impermeable glacial till or where layers of glacial till have different hydraulic conditions that permit groundwater seepage. Such areas are seldeom, if ever, flooded, but downslope groundwater movement keeps the soils saturated for a sufficient portion of the growing season to produce anerobic and reducing soil conditions. This promotes development of hydric soils and hydrophytic vegetation. Indicators of wetland hydrology may be lacking during the drier portion of the growing season. Hydric soil indicators also may be lacking because certain areas are so rocky that it is difficult to examine soil characteristics within 18 inches."[15]

- **Wetland Hydrology Criterion**

In fact, most of the soil samples taken in areas dominated by facultative, facultative wet, or obligate vegetation, exhibit mineral characteristics and were either wet or saturated. Permeability may be moderate, but the soils appear poorly drained unless located along slopes composed of glacial till. Even for these sites, the duration of snowpack and snowmelt runoff may inundate or elevate groundwater to the extent that it meets wetland hydrology criteria. This saturation period encompasses mid-April to mid-July on lower slopes (8,600-9,600 ft.) or about two to three months depending on elevation.

The Corps of Engineers wetland hydrology criterion appear to be met at most soil transect sites.[16] These require saturation for only 2-3 weeks or 5% of the growing season.

SOIL AND HYDROLOGY OF ALBION BASIN RANGESITE TRANSECTS

The following descriptions of soil and hydrologic rangesite characteristics include a brief summary of the sub-watershed or drainage basin size, general slope, type, number, and source of hydrologic features, and influence of geology on soil/hydrology.

- **PATSY MARLEY HILL**

The total sub-watershed drainage area of both upper and lower Patsy Marley Hill rangesites contains approximately 520 acres. This rangesite contains approximately 81 acres. Elevations range from 10,700 ft. at Mt. Wolverine to 8,700 ft. near the confluence with Little Cottonwood Creek. Upper slopes are steep, ranging from 50-100%, with lower slopes between 10-40%.

Five seasonally intermittent drainages traverse the rangesite, beginning as snowmelt runoff at 9,000-10,000 ft. in early March, concluding discharge in late July to early August. At least five perennial springs discharge on mid-lower slopes of the site, which originate from groundwater storage in glacial till and talus deposited along the eastern flanks of the sub-watershed.

Groundwater saturation occurs along the full length of the rangesite for much of the growing season, due to storage of water in solifluction terraces formed from snowmelt on mid-upper slopes. By mid-summer, the more well drained soils begin to dry, leaving the drainages and adjacent areas wet to saturated.

- **Transect 1**

This northwest to southeast line includes three data points which exhibit well drained sandy-gravelly loams within the 16-18" profile. These are very dark gray aquent entisols with chromas ranging from dark brown to dark yellowish brown. The soils are damp. The transect crosses a small Salix Drummondiana community supported by seasonal snowmelt runoff originating at about 10,000 ft. It ends in a granite outcrop area composed of large rockfall, glacial talus and till averaging from 1-6' in diameter size.

- **Transect 2**

This line is box-shaped, surrounding a small snowmelt nivation depression (aquatic bed) inhabited by a Salix Drummondiana/Veratrum community at 9,200 ft. In includes four data points with a variety of soil profiles ranging from fine organic loams to silty clay loams. The organic loams are redder 5YR hues with very dark gray, dark red-brown, to black profiles. These mollic aquolls are hydric and saturated with iron oxide mottling present in the lower horizon. The organic silty clay loams are similar but with very dark gray to black values and very dark brown chromas. They also exhibit iron oxide mottling but with black concretions and gold flecks of mica distributed throughout the lower horizon.

- **Transect 3**

This line extends from the upper road westerly downhill to the first S-turn, just south of the octagon-shaped cabin. It flanks a salix drummondiana community inhabiting a mostly perrenial flowing channel between 9,000-9,200 ft. Three data points display hydric mollic aquolls consistently wet to saturated. They are mostly 10YR hues, very dark gray to black fine gravelly-organic clay loams with black to very dark brown chromas, exhibiting peaty characteristics. Some fine gravelly loams are more reddish 5YR hues.

- **Transect 4**

Beginning north of the octagon cabin, extending downhill westerly, this short transect flanks a salix community supported by perennial springs and snowmelt. It is characterized by shallow, uniform 10" profiles composed of very dark gray sandy clay loams, ranging from damp to saturated. The saturated areas occur on the lower transect level where black mottling occurs. Although saturation is variable across the transect, soils display largely hydric characteristics.

- **Transect 5**

This long line begins at the upper S-turn cabins extending downhill in a southerly direction, intersecting several salix communities between 9,000-9,200 ft. which are supported by both perennial springs and intermittent snowmelt runoff.

Upper site soils are principally entisols with aquent/psamment traits and 10YR values ranging from dark gray to very dark gray, with very dark brown to dark yellowish brown chromas. Histic epipedons are present in upper horizons, and are most likely saturated for at least 60 days during the growing season.

The lower soils are a different story. These are organic histosols ranging from fibrist to saprist, (saturated peaty loams and mucky peats). They also tend to be shallow 8-10" uniform profiles.

- **Transect 6**

This line is located just below Transect 5, proceeding uphill and northerly to the cabins, and possesses characteristics almost identical to those of Transect 5, except that it has large communities of juncus articus and other obligate wetland species.

- **Transect 7**

Beginning west of the lower S-turn and extending downhill in a northwest orientation to the Alta Lift equipment shops, this saturated composite transect intercepts various plant community types. 10YR hues with upper black and lower dark gray horizons are principally hydric sandy to sandy clay loams.

- **Transect 8**

This line extends across the ski slopes just below the Albion loop road in a southwesterly direction at an elevation of 9,200 ft. It intersects an intermittent snowmelt drainage, together with a perennial spring flow. The sandy to sandy clay loams are orthent to aquent-textured entisols, originating from relic glacial till, possessing very dark gray values with dark brown chromas. Iron oxide mottling and gold mica flecks are common in the saturated clay loams, indicating reduced, anaerobic conditions typical of long term saturation between early April and late July.

- **WEST ALBION BASIN**

Containing about 440 acres, the subwatershed is a gently sloping network of perennial and intermittent drainages beginning at 9,200 ft. at the base of the Sugarloaf ski lift rising drastically to 11,000 ft. at Devils Castle and Sugarloaf Peak. Slopes average between 5-20%. This is the largest rangesite, containing about 109 acres.

The area is hydrologically complicated. It is traversed by four major first-order intermittent/perennial tributaries, and numerous groundwater discharges in the form of perennial springs. The origin of both streams and springs is storage from glacial talus and till formations located in alpine and subalpine cirques, nivation depressions, and solifluction terraces.

- **Devils Castle Cirque**

The principal geologic structure which influences hydrology in this rangesite is the Devils Castle cirque, a steeply glaciated formation at the southern end of Albion Basin. This feature is deeply carved at its base, forming a broad, deep nivation depression composed of glacial till and talus. The parent material is mainly shale from the Ophir formation (cambrian), with alternating strata of Maxfield limestone, basal mississipian limestone, Deseret-Madison undifferentiated limestone, and Tintic quartzite.

Deep snowmelt accumulations are stored in this depression and discharge to the West Albion rangesite as springs located at the base of the cirque. At least 12 large springs have this stored groundwater as the main source.

- **Cecret Lake**

Another dominant hydrologic feature in the rangesite is Cecret Lake, a glacial kettle, cirque lake or tarn. Cecret Lake (pronounced "secret" lake) has approximately a 2 1/2 acre surface area, and collects large alpine snowmelt accumulations from Sugarloaf Peak. It discharges a perennial stream down its drainage course into the western boundary of the West Albion rangesite, and confluences with the Glory Hole tributary before reaching Little Cottonwood Creek.

- **Transect 1**

Beginning at the southwest corner of the campground loop, this line extends southwesterly past the western edge of the Albion Alps subdivision (9,700 ft.), to the base of the Devils Castle cirque. The soils lie between two predominant rock outcrops and are generally shallow, fine silty loams with a uniform profile. These are very dark gray entisols with orthent, aquent, or psamment sub-order traits. An intermittent spring discharges near the base of the cirque, providing the principal source of seasonal soil saturation.

- **Transect 2**

Two data points comprise this transect which extends from the same campground loop beginning point (about 9,500 ft.) to the base of the Cecret Lake drainage (9,800 ft.). The wetland communities in this reach are supported by at least seven different springs which originate from the base of the Devils Castle cirque. These saturated, very fine silty clay loams are shallow, uniformly profiled, aquents. They display a 5YR hue with black values and chromas. These hydric soils support a variety of obligate, facultative wet, and facultative plant communities.

- **Transect 3**

Variable conditions characterize this line which extends from the southern edge of Cecret Lake subdivision to the campground loop. The line intersects three major intermittent to perennial tributaries at elevations ranging from 9,500-9,800 ft. The topography is "hill and dell" rocky outcrop to streamside drainage, changing drastically from upland plant communities to predominantly hydrophytic. Soil conditions range from: sandy-gravelly loam to being too rocky to dig; dark gray values with yellowish-brown chromas, to black values with very dark brown chromas; mostly damp to dry conditions.

Only those soils displaying values & chromas of 2/2 could be considered hydric within this transect.

Soils in this transect bear little resemblance to those which have shale parent material. The mixed gravel/cobble texture at the bottom of a drainage basin such as this suggests past drastic modification of the landscape by man-made or natural phenomena. Sites in the transect have either been filled or deposited by landslide or other erosional processes.

The characteristic deep, incised tributary courses suggest down-cutting through newly deposited, unstable material, depositing fines below the eroded channels. A separate soil survey conducted for the Alta-Little Cottonwood Study area (1975)[17] suggests that the upper basin may have been subjected to an ancient landslide, perhaps of post-pleistocene age.

- **Transect 4**

This transect extends from the campground loop west, below the Cecret subidivision to Tintic Quartzite outcrops flanking the western rangesite boundary. Grades are slightly flatter on this transect than those adjoining to the south, giving way to a more uniformly-sloped, deposition type fluvial system.

Soil conditions are wide ranging from gravelly loams to fine sandy loams to fine silty clay loams. They display characteristics of both aquent entisols and aquic mollisols. Bright inclusions of iron oxide mottling is common in the lower saturated horizons, and 4-6" histic epipedons are common in the upper horizons. The silty clays in the lower 8" horizon appear almost gleyed, with values & chromas ranging from 10YR 2/1 to 4/1.

Saturation of varying degree is common in these soils. The transect is generally wet and influenced by numerous springs which appear to have no discrete source. The upper soil horizons are often covered by mosses and are squishy and spongy when stepped on. The majority of the soils along this transect most likely meet hydric criteria.

- **Transect 5**

This is among the most interesting areas in the Basin, due to the unique hydrology, plant and soil conditions encountered.

The transect begins near the entrance to the campground loop and extends westward toward the Quartzite outcrops. The terrain is gently rolling depositional sandy clay loams until standing water is encountered in obligate vegetative communities comprised of Carex Aquatilis and Pedicularis groenlandica (Elephants Head). Saturated Histosols (black sandy clay loams and peaty loams) are common. Histic epipedons are evident with most soils, and iron oxide mottling is common in the sandy clay loams. The majority of the transect is saturated and hydric.

- **"The Cecret Fen"**

The hydrology of this transect is most interesting. It intersects at least eight live intermittent streams, half of which are groundwater discharges of one sort or another. Some of the springs appear to have no origin, and in fact may be a phenomenon of sheet flow across saturated plant communities which becomes braided, strewn, and separated across the rangesite:

> "Peat composition greatly affects horizontal and vertical water movement and water retention...surface peat samples released water more readily than deeper samples... water movement in surface peat can be as much as 1000 times greater than water movement in deeper parts."[18]

This is the only area within Albion Basin which consistently exhibits peat soils (excluding Catherines Pass), dominated by Carex aquatilis, mertensia, pedicularis, parnassia, mimulus and other wetland obligates. The section of this transect directly below the lower Cecret lift is a distinct wetland usually denoted as a "fen" or "bog." Bogs, however, usually depend on direct precipitation, while fens have groundwater as the principal source of saturation.

- **Transect 6**

The lower elevations and last of the West Albion transects are represented here. The line extends from the campgound loop entrance west to a point just south of the Sugarloaf lift base station. The elevations range from 9,200-9,300 ft. This transect is very similar to transect 5, except that peaty loams are not as prevalent. Soils are mostly saturated aquolls with histic epipedons. Many are classic gleyed clays and clay loams, with hues of 5BG and values/chromas of 5/1 to 6/1, but Saprist Histosols (Mucky peat soils) occur with some regularity.

A unique aspect of the bluish gleyed soils is the presence of bright red and yellow mottling, iron oxide-sulfide traces, which could denote the existence of remnant mine tailings in the area. These were found within about 20 meters south of the Sugarloaf base station.

The transect is threaded through a maze of quartzite rock outcrops, where numerous springs discharge forming fascinating little moss-lined streamlets cascading through chains of 1-3' high waterfalls.

- **ALBION MEADOWS**

The rangesite designated as the "Albion Meadows" contains approximately 30 acres and is a rather long, broad, gently sloping meadow between 8,800 and 9,300 ft. elevation. Slopes average between 10-40% and are decorated with striking arrangements of colorful faculative, facultative wet, and obligate plants. The total subwatershed contains about 80 acres.

The hydrology of this site is difficult to assess, due mainly to the structure of the well-drained cobbly, gravelly, sandy loams. These are aquent entisols, remnants of lateral glacial till deposits underlain by Maxfield Limestone and Ophir Shale. Head-rilling is evident on this rangesite, indicating saturation with snowmelt or groundwater during the early part of the growing season. The rilling progresses to minor gullying on the downslopes toward Little Cottonwood Creek, which are well vegetated and non-eroding.

The very curious condition occurring on this site is the presence of a 2-3 acre plant community dominated by Veratrum Californicum, an obligate usually found in conjunction with Salix along the borders of intermittent drainages. The plants were beginning to stress in mid-July, indicating a very early and drastic drop in soil saturation. Saturation was more evident on the lower reaches of the site, closer to the creek.

- **Transect 1**

Fine sandy loams characterize this transect, with dark gray values and dark yellowish brown chromas. Soils are generally uniform, lacking definite pedogenic horizons, and are mostly dry to damp during July. It is likely that the site is saturated April, May, and most of June, when snowmelt runoff occurs.

Compared to many other sites in the Basin, this area probably receives very little snowmelt runoff because the zone of deepest accumulation is small and upper elevation snowmelt is intercepted by the Albion loop road. The soils are fairly well drained and fit the psamment subgroup of the entisol order.

The Veratrum Californicum community present at this transect is emergent very early, and retires very early. The site most likely becomes saturated enough to support obligates, but drains rapidly enough to stress the plants by mid-summer.

- **Transect 2**

Conditions here are very close to those in Transect 1, except that soils possess lower horizons of fine sandy clay loam. They are still dry to damp. Veratrum become widely dispersed.

- **Transect 3**

The lower sample site changes markedly from upper sites, where thick, 8" histic epipedons appear in the upper soil horizon, lower horizons are wet, and 10YR value/chromas are black/very dark brown. Widely distributed Salix groups are found here, indicating higher moisture concentration than on up-gradient transects.

These soils fall closer to the aquents, and most likely meet hydric criteria.

There is a very narrow margin between these deep, sandy loams and the shallower gravelly soils of fluvial origin near Little Cottonwood Creek.

- **ALBION BASIN LOOP**

This rangesite, like Albion Meadows, is located at the base of a larger drainage comprised of Catherines Pass and Supreme sub-basins. It encompasses approximately 30 acres, of which only about 11 acres are potentially wetland. It is a very gently sloping area with average grades between 5-20%. The loop includes a publicly owned Forest Service campground and part of a privately owned subdivision. The subwatershed is very large, encompassing about 600 acres, draining most of the Supreme area upper and lower slopes.

Geology of the area is Ophir Shale and various limestones. Soils are both alluvial and glacial till outwash from upper base formations, ranging from sandy loams to silty clay loams.

Seven first order intermittent tributaries cross the site, severely downcutting 6-10' in some instances. Snowpack accumulations on the upper sub-watershed are impressive, and the seasonal discharge of these streams extends into mid-August. Several springs originate and discharge within the upper loop, their origins upgradient in deeply drained glacial till and talus slopes.

As a result of this geology-soil-hydrology combination, a wide variety of plant communities occur, mostly facultative to facultative wet. The soil development is quite different than the adjacent West Albion rangesite: less organic, less saturated, more rapidly drained.

- **Transect 1**

A west-east line extends across the southern end of the campground inside the loop road, beginning at the southwest corner. Four data points exhibited a variety of soil conditions, all the same 10YR hue, but ranging from black/very dark brown value/chromas to gleyed. Many of the soils have damp to wet histic epipedons. These soils generally display pedogenic horizons, with the upper 6-8" having substantially higher organic content than the lower 8-12" horizon.

It is difficult to group soils here in any one order or suborder. Types range from alfisols of the aqualf/boralf suborder; Aquept or Andept Inceptisols; or mollic fluvaquents & borolls. Test sites vary greatly as to whether they meet hydric criteria, but in view of the fact that the transect crosses at least four intermittent drainages, it is likely that soils are seasonally saturated for at least three months during the growing season.

- **Transect 2**

Beginning at the northwestern loop road entrance and proceeding northeasterly to the base of the Catherine Pass trailhead, this transect crosses private ground, part of which has been subdivided. The elevation is at 9,400 ft. At least three seasonal intermittent-but dry-drains were crossed. This transect appears more well drained than the campground, and the soil profiles were consistently dry-damp fine silty loam or silty gravelly loam, with very dark gray "A" horizons. Plant communities are mostly facultative.

- **EAST ALBION BASIN**

This rangesite flanks the eastern boundary of the Albion loop, and extends from the southerly Supreme basin drainage north to the salix communities located just below 9,600 ft. near Catherines Pass trailhead. It includes about 26 acres, of which 17 are potential wetlands. Slopes range from 5-50%, which intersect 12-13 intermittent snowmelt drainages. Springs discharge just above the loop road, creating unique plant communities dominated by mosses, Parnassia, juncus, and other obligates.

The basic geology and soil structure is similar to the interior loop, but the soils around the springs are predominantly silt loams which are black, gleyed, mottled, and definitely hydric.

- **Transect 1**

This inventory line begins east of Albion Alps subdivision and extends northeasterly to the southern end of the Albion Basin subdivision at about 9,600 ft. elevation. It crosses 4-5 intermittent snowmelt drainages originating from the Supreme bowl area. All of these feed into the Albion Basin Loop rangesite.

The soil profiles are generally black to very dark brown fine silty loam in the upper horizon (10YR 2/2), and fine silty clay loam in the lower horizon (10YR 3/2). It is dominated by damp to wet conditions supporting salix, veratrum, carex, assorted mosses, lupine and coneflower. Most of the transect contains soils which meet hydric criteria, both in terms of saturation period and texture.

- **Transect 2**

This short line crosses numerous little springs characterized by spongy, moss-lined channels, and decorated with dispersed Pernassus, Elephant Head, and Mertensia. It extends northward along the outside of the loop road, and intercepts 3-4 intermittent drainages occupied by Salix. Soils range from damp-saturated uniform aquents composed of fine sand and fine sandy clay loam, to very wet, brightly mottled silty clay loam aquolls.

- **GREELY BOWL, LOWER GREELY, AND NORTH RUSTLER**

These rangesites are some of the most interesting in the basin, due to the unique hydrology and related geomorphology. They are systems which support saturated, facultative-wet plant communities distributed downslope from points of spring discharge at upper elevations. The total sub-watershed area contains approximately 320 acres. Together, this rangesite complex totals about 100 acres, among the largest communities in the Basin. Almost half (49 acres) of the combined area is potentially wetland.

o Solifluction Terraces & Nivation Depressions

The rangesite is the steepest in the Basin, averaging between 15-70% slopes. The hydrology is complex, fed by at least 15 intermittent (many perennial) springs, and two major first order tributaries, Glory Hole and Gunsite. The springs discharge at a critical grade where groundwater saturation can no longer be stored in the soil or geologic substrate, and drains generously out of the hillsides forming dense thickets of salix drummondiana. These phenomena are termed "solifluction terraces," or "nivation depressions."

This condition can be observed near the summits of many alpine cirques in both Little and Big Cottonwood canyon, and is probably responsible for most overstory vegetation on steep canyon slopes.

Active solifluction appears to occur on these rangesites at elevations above 9,400 ft. Conditions become stable at lower slopes below the point of discharge where deep rooted salix keep soil creeping, sliding, and mass-wasting in check. The weight of the alpine & subalpine snow-pack is collected and stored in the glacial till and talus of the filled-in Greely Bowl cirque, where snowmelt collects and is slowly released as groundwater discharge to Little Cottonwood Creek.

o Faultlines

Another major influence on the discharge of geologic/soil saturation is the south-north running fault line which bisects the grandiorite of the Alta Stock formation, creating mid to upper elevation exposures of Maxfield Limestone and Ophir Shale. This fault line appears to run laterally to the 9,200 ft. elevation level occupied by Salix communities, and forms the basic configuration of sub-basin drainage for the upper Gunsite and Glory Hole tributaries.

Soil development along the western flanks of Albion Basin is influenced by a combination of upper formation colluvium and alluvium eroded downslope, and laterally deposited glacial till and talus. These have formed loose associations of gravelly loam and cobbly sandy loams, with water tables between 10-20" until mid-summer. Permeability is moderately rapid.

o Greely Bowl Composite Transect

A composite transect was taken south-north across the upper Greely cirque at an elevation of approximately 9,500 ft. Vegetation is mainly mixed facultative to facultative wet species, with isolated pockets of juncus, veratrum, and other obligates.

Surface hydrology across the transect was not obvious, and all four soil sampling sites were dry to a depth of 18" with traits most closely resembling orthent entisols, since pedogenic horizons were not evident. They may possess aquent characteristics earlier in the snowmelt runoff season, but it is very difficult to determine whether or not long-term saturation occurs. These are 10YR very dark gray/dark brown fine sandy loams.

- **Lower Greely Transect**

This transect was the most difficult to assess, due to the thickness and density of the salix community that calls it home. It extends 1500' northward from the Glory Hole tributary to the edge of the northernmost salix group. The elevation is about 9,200 ft. and is very steep. The transect intercepts about 12 intermittent and possibly perennial streams and springs which keep the site either wet or saturated.

Soil samples collected were mostly fine sandy to silty clay loams ranging in value from dark gray to black. They resemble aquolls (a mollisol suborder) with values & chromas usually between 3/1 and 2/1, with histic epipedons and mottling present. Some of the lower horizons are gleyed with bright yellowish brown mottles.

- **North Rustler Transect**

This box-shaped transect begins just above the Sunnyside Lift base and extends 1000' straight up to 9,400 ft., laterally across the slope, and down about 750 ft. It surrounds the salix community extending down these slopes, which easily exceed 60% near the top.

There are three principal springs which support the willows, and have formed uniform 12" thick saturated soil horizons of mucky, sandy, clay loam with 10YR values/chromas of 2/1. These soils are on the border of being classified as saprist histosols, and often heavily mottled in lower horizons with brownish-yellow inclusions. Some of the soils could be aquent entisols when uniform. The "control" sites along borders of salix drummondiana are dry, fine sandy clay loams, but most likely saturated for two to three months during the growning season. The majority of these soils appear hydric.

- **CREEK TOWNSITE**

The rangesite designated as the Creek Townsite lies at the foot of the Albion Basin drainage. It contains approximately 33 acres, and extends from the Alta day lodge to the end of the Goldminers Daughter parking area. The hydrology of the potential 20 acre wetland community here is supported mainly by Little Cottonwood Creek, and to a lesser extent several discharges from six first order tributaries (including Grizzly Gulch), and mine tunnels from the Emma Hill area.

The geology of this study area is influenced by fluvial deposition and erosion of the stream channel. Parent material is glacial till and talus scoured from the upper Basin formations. The creek forms a broad, lower montane braided flood channel which fluctuates widely during spring runoff. The creek has been channelized and constricted by ski area development over the years which has slightly increased bank erosion and head-cutting.

Soil development is a product of stream fluvial dynamics. The Soil Conservation Service data designate the soils as gravelly loams with 8-15% slopes, but data collected during this study were mostly fine sandy loams, except near Goldminer's Daughter, where peaty to clay soils were found. Vegetation is primarily Salix Drummondiana and forbs related to that community.

o Goldminer's Daughter Transect

The salix community south of the Goldminer's Daughter parking area has historically been used for snow storage. As a result, soils stripped from the parking area during snow plowing operations have been deposited into the adjacent wetland. This transect was selected to survey soil conditions influenced by this specific land use.

A short transect extends from Little Cottonwood Creek northward through the salix community to the edge of the parking area, at an elevation of just under 8,600 ft. This site is seasonally inundated by spring floods (either directly by flooding or indirectly from groundwater saturation) and also saturated by deep accumulations of snow. Snowmelt ends by late June.

Soils are varied. Closest to the creek, they are sandy clay loams underlain with gravelly sand, ranging in chroma from dark gray to dark brown. Significant concentrations of histosols occur toward the middle of the transect, both saprist and fibrist types. Thick histic epipedons of peaty loam and peaty clay loam overlay heavily mottled lower horizons of sandy clay loams and coarse sandy loams. Values & chromas of these were most often black, resembling aquolls. Mottling tended to be yellowish brown. All of these soil horizons were either wet or saturated, and support extensive hydrophytes including carex, juncus, and salix. The majority of the soils meet hydric criteria.

o Creek Townsite Transect

This transect extends eastward from the Alta Ticket Office building to the old Gelandespruung ski jump ramp, crosses the creek, and extends westward to Alta Lodge. Soil samples were damp and represented by fine sandy loams. Dark brown to black histic epipedons occur in the upper horizons, and seasonal saturation of these soils categorize them as hydric, even though lower horizons are predominantly sand. They could be classified as mollic fluvaquents, due to the thick, dark surface layer.

The vegetation is mainly facultative wet, dominated by salix drummondiana and related community forbs. The extent of the community had been drastically modified at the time of the inventory, with removal of about one acre of the salix to accommodate construction activity.

o UPPER PATSY MARLEY HILL

Toward the end of the inventory, it was decided that two additional rangesites should be added. These included the upper contributing drainages of Patsy Marley Hill, and Emma Hill above the Alta Townsite.

Upper Patsy Marley Hill is included in the 520 acre Patsy Marley sub-watershed area. The study area is approximately 29 acres, 16 of which are potentially wetland. It is a rather steep area with average 30-60% slopes, and is influenced by four major intermittent snowmelt drainages. Water on these steep slopes is stored in rockfall concentrations and laterally deposited glacial talus & till, and gradually discharged as springs during the summer. These upper slopes resemble solifluction terraces, with minor nivation depressions scattered along the lower slope reaches.

Springs discharge below the major rock outcrops on the upper half of the hill, supplied by storage in the network of cracks and fissures in the upper rock formations.

Vegetation is mainly Salix Drummondiana, Populus Tremuloides, and conifers scattered along the drainages between 9,400-10,000 ft.

o Transect 1

This is a southeast-northwesterly line extending across the 9,600 ft. elevation, alternately running through seasonally flooded drainages, rockfall, rock outcrops, and little subalpine meadows. Soil depths are quite variable, ranging from 8-24" and dry to wet conditions; from gravelly loams to fine sandy loams to coarse peaty loams. They are usually uniform aquent entisols with very dark brown to black chromas, consistently classified at 10YR 2/1. They are moderately well drained and very likely saturated between the end of April through the end of June. Vegetation is mainly Aspen and willow.

o Transect 2

Beginning at 9,400 ft. extending west-northwestward diagonally downhill, this transect intersects three intermittent drainages which carry both snowmelt runoff until mid-June, and spring discharges from the base of the cliffs. The vegetation consists of dense thickets of salix drummondiana, coneflower, veratrum, and associated facultative species.

Soil conditions were variable, from dry to saturated. The fine-coarse sandy loams often possessed very dark brown to black histic epipedons, as did coarse peaty loams encountered. Near the drainages, saturated mucky peats and coarse, sandy-peaty loams displayed bright iron oxide mottling in lower horizons. Most of the soils sampled appear to meet hydric criteria.

o EMMA HILL

This large sub-basin drainage area includes about 350 acres of very steep terrain, drastically modified by past and present hardrock mining activity. Slopes average between 10-70%, with mid-slopes excavated for roads, tunnels, drains, buildings, sluices, rail lines, and dumps. The site is littered with mine tailings, and drainage channels have been directly impacted by excavated material from the mines.

Many of the drainages on Emma Hill are steeply downcut and incised from erosion caused by stripping away native vegetation during mining operations. There are six major first order tributaries flowing from elevations over 10,000 ft., which carry snowmelt runoff from mid-March to mid-June. This south-facing site is among the first to dry out during the growing season.

The principal geologic formations of this rangesite are the Deseret-Madison undifferentiated limestone, Maxfield limestone, Ophir shale, Tintic and Weber Quartzites, and Wisconsin Glacial Till. A half dozen faultlines run uphill from the main canyon road, forming the basis for much of the surface drainage and hydrology, which may also account for the deep, incised character of the stream courses.

The vegetation is mainly aspen, which has been shifted and moved over time with disturbance from mining activities. The soils are generally very well drained, but damp. Saturation occurs for at least two months during the growing season, and longer in the drainage bottoms, where most of the limited salix communities grow.

o Transect 1

Beginning just above Alta Central at 8,800 ft., this transect extends eastward for about 1200' along the contour. It crosses three intermittent tributary channels which are seasonally flooded for 2-3 months, and is occupied primarily by aspen trees.

Soils are dry-damp coarse-fine gravelly and sandy loams, often uniform in profile, with 10YR values and chromas ranging from 2/2-4/2, dark brown to very dark brown, most closely resembling aquent entisols. Dark upper profiles suggest histic epipedons.

o Transect 2

This one is an extension of TR 1, which begins where TR 1 leaves off, and extends to Grizzly Gulch at approximately 8,840 ft. Intersecting four intermittent tributaries, it possesses many soil, hydrologic, and vegetative characteristics similar to TR 1.

Most of the soils are fine sandy loams fitting the aquent entisol suborder, with very dark gray to grayish brown values & chromas. Of note, however, are fine gravelly silts and flaggy sandy to silty loams, dark yellowish brown or very pale brown, with bright iron oxide mottling. These occur in TR 2, sites III & IV and appear to be deposits from upslope mine tailings or excavated limestone.

Salix Drummondiana communities are basically "trapped" in the deep, incised intermittently flooded stream channels, where wet to saturated soil is more often found. While the other soil profiles were generally damp, they are likely saturated during at least one month during the growing season. Most of the soils do not meet hydric soil criteria.

o Transect 3

This short line extends along the 9,000 ft. elevation in proximity to the upper access road. It possesses very similar soil, hydrology and vegetation as TR 1 & 2. 10YR hues are 2/2 to 2/3 values & chromas, suggesting that even though they are fairly uniform fine sandy loams, they are saturated to the extent that they could support facultative, fac-wet, or obligate plants at least during part of the growing season.

SELECTED REFERENCES/BIBLIOGRAPHY

BIBLIOGRAPHY

1. Federal Interagency Committee for Wetland Delineation. "Federal Manual for Identifying and Delineating Jurisdictional Wetlands." U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish & Wildlife Service, and U.S.D.A. Soil Conservation Service. Cooperative Technical Publication, Washington, D.C. 1989.

2. Lewis M. Cowardin, et.al. "Classification of Wetlands and Deepwater Habitats of the United States." Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior. Washington, D.C. December, 1979.

3. John T. Windell, et.al. "An Ecological Characterization of Rocky Mountain Montane and Subalpine Wetlands." Fish & Wildlife Service, U.S. Department of the Interior. Washington, D.C. September, 1986.

4. U.S. Environmental Protection Agency. "Jurisdicational Delineation of Wetland and Riparian Ecosystems in the Southwestern United States." Training Course Proceedings. Tucson, Arizona. March, 1988.

5. Town of Alta. "General Plan for the Town of Alta, Utah." Draft. April, 1992.

6. Utah Geological & Mineralogical Survey. "Geology of Salt Lake County." College of Mines, University of Utah. Bulletin 69. November, 1964.

7. Wetzel, R.G. "Limnology." 1983. ("Ecological Characterization of Rocky Mountain and Subalpine Wetlands." op.cit.)

8. L.W. Price. "Mountains and Man: A Study of Processes and Environment." University of California Press, Los Angeles, CA. 1981. ("Ecological Characterization of Rocky Mountain and Subalpine Wetlands, op.cit.)

9. Soil Conservation Service. "Summit Soil Survey." U.S. Department of Agriculture. 1975.

10. W.B. Parker. "The Comprehensive Classification System." (U.S. EPA, Jurisdictional Delineation of Wetland and Riparian Ecosystems, op.cit)

11. Baldwin, J.L. "Climates of the United States." Dept. of Commerce. Washington, D.C. 1973. ("Ecological Characterization.....op.cit.)

12. Town of Alta. "Snowfall Accumulation Data for Alta Central, 1945-92." U.S. Forest Service/Alta Lift Company/Utah Department of Transportation. 1992.

13. Dan Schenck, Salt Lake City Hydrologist. "Sunnyside Rating Station--Little Cottonwood Stream Estimated Yearly Hydrograph" Salt Lake City Department of Public Utilities. November, 1992.

14. Soil Conservation Service. "Summit Soil Survey." op.cit.

15. Federal Interagency Committee. "Federal Manual.." op.cit.

16. Ibid. Wetland Hydrology Criterion. page 12.

SELECTED REFERENCES

Dr. S.A. Wilde, G.K. Voigt, et.al. University of Wisconsin. "Munsell Color Charts for Plant Tissues." Munsell Color, Macbeth Division of Kollmorgen Instruments Corporation. Baltimore, Maryland. Revised, 1977.

L. Arnow, B. Albee, and A. Wyckoff. "Flora of the Central Wasatch Front, Utah." University of Utah Printing. Salt Lake City, Utah. March, 1980.

U.S. Department of Agriculture, Soil Conservation Service. "Hydric Soils of the United States." Publication 1491. June, 1991.

U.S. Department of Agriculture, Soil Conservation Service. "Hydric Soils of Utah 1985." First Edition 1985.

U.S. Department of the Interior, Fish and Wildlife Service. "National List of Plant Species that Occur in Wetlands: Intermountain Region 8." Biological Report 88(26.8) May, 1988.

Porter B. Reed Jr. "1986 Wetland Plant List-Utah." National Wetlands Inventory, U.S. Fish & Wildlife Service. May, 1986.

David J. Cooper and David Gilbert. "An Ecological Characterization and functional Evaluation of Wetlands in the Telluride Region of Colorado." Region VIII, Environmental Protection Agency. October, 1990.

S.C. Colbeck and M.Ray. "Proceedings: Modeling of snow Cover Runoff." U.S. Army Corps of Engineers. Cold Regions Research and Engineering Laboratory. Hanover, New Hampshire. September, 1978.

U.S. Department of Agriculture. Aerial Photography Field Offices. "False Color Infrared Photography of the Alta & American Fork Drainage Province." #614190-480-174. 1984.

U.S. Department of Agriculture. Aerial Photography Field Offices. "Full Color Photography of the Alta/Albion Basin Drainage Province." # 480-175 and 480-188. September, 1980.

Thomas Dunne and Luna B. Leopold. "Water in Environmental Planning." W.H. Freeman and Company, New York. 1978.

W. Viessman, Jr., J.W. Knapp, G.L. Lewis, and T.E.Harbaugh. "Introduction to Hydrology." 1977.

Steven F. Jensen. "Jordan River Wetlands Advance Identification Study." Salt Lake County, Utah. October, 1987.

Steven F. Jensen. "Wasatch Watershed Monitoring Network: 1990-91 Season Summary." Salt Lake County. March 1991.

Society of Wetland Scientists. "Proceedings: Eleventh Annual Meeting. Breckenridge, Colorado. June, 1990.

Allen G. Hely, R.W. Mower, and C. Albert Harr. "Water Resources of Salt Lake County, Utah." U.S. Geological Survey, 1971.

U.S. Environmental Protection Agency. "Water Quality Standards for Wetlands: National Guidance." Office of Water Regulations & Standards. Washington, D.C. July, 1990.

APPENDIX A

SOIL AND HYDROLOGY DATA SHEETS

PATSY MARLEY HILL RANGESITE I.
SOIL/HYDROLOGY PROFILE DATA
July 9-14, 1992
Transects 1 & 2

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	6"Fine Grav.Loam	10YR 3/3	Damp
	10"Fine Sandy Loam	10YR 3/4	Damp
TR1/II	6"Fine Grav. Loam	10YR 3/2	Damp
	10"Fine Sandy Loam	10YR 3/4	Damp
TR1/III	6"Fine Grav. Loam	10YR 3/3	Wet
	10"Fine Sandy Loam	10YR 3/4	Wet
TR1/IV	8"Fine Grav. Loam	10YR 3/3	Damp
	8"Fine Sandy Loam	10YR 3/4	Damp
TR1/V	8"Fine Grav. Loam	10YR 3/3	Damp
	8"Fine Sandy Loam	10YR 3/4	Damp
TR2/I	8" Organic Loam	10YR 3/4	Damp
	8"Fine Grav. Loam	10YR 3/4	Damp
TR2/II	8"Fine Org. Loam	5YR 2.5/1	Wet
	8"Fine Org. Loam (Iron Oxide Mottling Present)	5YR 3/2	Saturated
TR2/III	16"Uniform Coarse Gravelly Loam	10YR 3/2	Saturated
TR2/IV	8" Organic Silty Clay Loam	10YR 2/2	Saturated
	8" Silty Clay Loam (Iron Oxide Mottling w/Black Concretions)	10YR 3/4	Saturated

Notes:

1. Both Transects generally damp
2. Two intermittent drainages cross the transects, recently saturated by snowmelt
3. No significant changes in soil type
4. Veratrum Californicum occurs near outside zones of Salix Drummondiana communities in areas consistently saturated

PATSY MARLEY HILL RANGESITE I.
SOIL/HYDROLOGY PROFILE DATA
July 14-17, 1992
Transects 3,4 & 5

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR3/I	10"Fine Grav.Loam Very shallow soil profile-uniform	5YR 3/2	Damp-Wet
TR3/II	10"Fine Grav.Clay Loam.Peaty.Hydric	10YR 2/1	Wet-Saturated
TR3/III	6"Fine Organic Loam 10"Fine Sandy Clay Loam	10YR 2/1 10YR 3/4	Wet Wet-Saturated
TR4/I	10"F Sndy Clay Loam Shallow soil profile	10YR 3/2	Wet
TR4/II	10"Fine Sandy Loam	10YR 3/2	Damp
TR4/III	10"F Sndy Clay Loam Black Mottling @ 2/1	10YR 3/2	Saturated
TR5/I	6"Coarse Sandy Loam Histic Epipedon 6"Coarse Sandy Loam	10YR 3/2 10YR 4/4	Wet Wet
TR5/II	16"Uniform Fine Sandy Loam.	10YR 3/4	Damp
TR5/III	4" Dark Peaty Loam 6" F Sndy Peaty Loam	10YR 2/1 10YR 3/4	Wet Saturated
TR5/IV	10"Dark Peaty Loam	5YR 2/1	Saturated
TR5/V	8"Mucky Peat-Uniform	5YR 2/1	Saturated

Notes:
1. 10" soil pit depths due to shallow rock
2. Profile is commonly uniform.
3. Veratrum commonly found in Sandy CLAY Loam within this range.
4. Very wet transects. Numerous seeps.
5. Site saturation rare in such a low water & snowpack year (60% of normal).
6. Gold mica flecks often found in Clays

PATSY MARLEY HILL RANGESITE I.
SOIL/HYDROLOGY PROFILE DATA
July 17-23, 1992
Transects 6,7 & 8

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR6/I	4"Peaty Clay Loam	10YR 2/1	Saturated
	6"Silty Clay Loam (Iron Oxide Mottling)	10YR 2/1	Saturated
	4"Coarse Sandy Clay	10YR 4/4	Saturated
TR6/II	10"Peaty Muck. Uniform	10YR 2/1	Saturated
TR6/III	4" Peaty Loam	10YR 2/2	Damp
	6" Sandy Loam	10YR 2/2	Damp
TR6/IV	4" Peaty Loam	10YR 2/1	Damp
	6" Sandy Loam	10YR 3/2	Damp
TR7/I	8" Sandy Loam	10YR 2/1	Saturated
	8" Sandy Clay Loam	10YR 4/3	Saturated
TR8/I	6"Fine Sandy Loam	10YR 3/3	Damp
	10"Fine Sandy Loam	10YR 3/3	Damp-Dry
TR8/II	12" Sandy Clay Loam Uniform. Iron Oxide Mottling	10YR 3/3	Saturated

Notes:

1. Gold mica flecks common in clays
2. Transect 6 Peaty muck represents riparian vegetation with Veratrum & large Juncus Articus communities
3. Transect 6 Peaty loam represents Aspen Grove communities.

WEST ALBION BASIN RANGESITE
SOIL/HYDROLOGY PROFILE DATA
July 27-29, 1992
Transects 1,2,3 & 4

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	12"Fine Silty Loam Uniform & Shallow	10YR 3/2	Damp-Dry
TR1/II	12"Fine Silty Loam	10YR 3/2	Wet
TR1/III	12" Fine Silty Loam Uniform & Shallow	10YR 2/2	Damp
TR2/I	12" Very Fine Silty Clay Loam, Uniform	5YR 2.5/1	Saturated
TR2/II	12" Very Fine Silty Clay Loam, Uniform	5YR 2.5/1	Saturated
TR3/I	12-18"Sandy-Gravelly Loam, Uniform	10YR 4/4	Dry
TR3/II	8" Gravelly Loam 10" Fine Sandy Loam	10YR 2/2 10YR 2/2	Damp Damp
TR3/III	Too Rocky to dig		
TR4/I	6" Fine Sandy Loam 6" Fine Sandy Clay Loam (Iron Oxide Mottling)	10YR 3/3 10YR 3/4	Damp Damp-Wet
TR4/II	6" Gravelly Loam 6" Sandy-Gravelly Loam	10YR 3/3 10YR 5/6	Dry Dry
TR4/III	4" Fine Sandy Loam Histic Epipedon 8" Silty Clay (Extensively Mottled Bright Fe Inclusions)	10YR 2/1 10YR 4/1	Wet Wet
TR4/IV	6" Fine Silty Clay Loam 6" Fine Silty Clay Loam (Fe Mottling. Black Incl) 4" Fine Sandy Clay Loam (Black Mottling)	10YR 2/2 10YR 4/3 10YR 4/3	Saturated Saturated Saturated

Note: Iron & Manganese Inclusions may indicate long periods of saturation

WEST ALBION BASIN RANGESITE
SOIL/HYDROLOGY PROFILE DATA
July 27-29, 1992
Transects 5 & 6

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR5/I	8" Sandy Clay Loam Histic Epipedon Present	10YR 2/1	Saturated
	4" Fine Silty Clay (Fe Mottling Present)	10YR 3/4-6	Saturated
TR5/II	6" Peaty Loam	5YR 2.5/1	Saturated
	10" Mucky Peat	5YR 2.5/1	Saturated
TR5/III	16" Sandy Loam. Uniform	10YR 3/2	Damp
TR6/I	8" Fine Sandy Clay Loam Histic Epipedon	10YR 2/2	Saturated
	8" Gleyed Clay (Bright Red/Yellow Mottling Present)	5BG 5/1	Saturated
TR6/II	6" Peaty Loam	5YR 2.5/1	Saturated
	10" Mucky Peat	5YR 2.5/2	Saturated
TR6/III	4" Sandy Loam	10YR 2/1	Damp-Dry
	12" Fine Sandy Loam	10YR 3/6	Damp

Notes:

1. Transect 5 encountered Peat Bog (Fen) beneath Cecret Lift. Standing Water present.
2. Transect 6 encountered Peat Bog (Fen) beneath Cecret Lift. Standing Water present. This fen encompasses approximately 5-6 acres, and is dominated by obligate species.
3. Transect 6 encountered major concentrations of true Bluish-gray gleyed soils.

ALBION BASIN MEADOW RANGESITE
SOIL/HYDROLOGY PROFILE DATA
July 30, 1992
Transects 1, 2, & 3

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	8" Fine Sandy Loam	10YR 4/6	Dry
	12" Fine Sandy Loam	10YR 4/6	Dry
TR1/II	6" Fine Sandy Loam	5YR 4/6	Dry
	12" Fine Sandy Loam	5YR 4/6	Dry-Damp
TR1/III	6" Sandy-Gravelly Loam.	10YR 2/2	Damp
	12" Sandy-Gravelly Loam	10YR 2/2	Damp
TR1/IV	6" Sandy-Gravelly Loam	10YR 2/2	Damp
	12" Sandy-Gravelly Loam	10YR 2/2	Damp
TR2/I	6" Sandy Loam	10YR 3/6	Damp
	6" Fine Sandy Clay Loam	10YR 3/6	Damp
TR2/II	6" Sandy Loam	10YR 3/6	Damp
	6" Fine Sandy Clay Loam	10YR 3/6	Damp
TR2/III	6" Fine Sandy Loam	10YR 4/6	Dry
	12" Fine Sandy Loam	10YR 4/6	Dry
TR3/I	8" Fine Sandy Loam Histic Epipedon	10YR 2/2	Dry
	10" Fine Sandy Loam	10YR 2/2	Wet

Notes:

1. Some areas of the meadow appear to have been recently modified by filling and revegetation of primarily bromus sp.
2. The soils within these transects appear to be problem types, i.e. entisols or spodosols with glacial till origins (well drained sandy soils)
3. The meadow most likely meets saturation requirements under Corps guidelines, but appears well drained.
4. The meadow most likely meets vegetation community requirements under Corps guidelines, but the obligate species are stressed from water shortage.

ALBION BASIN LOOP RANGESITE
SOIL/HYDROLOGY PROFILE DATA
July 30-31, 1992
Transects 1 & 2

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	8" Fine Sandy Loam Histic Epipedon	10YR 2/2	Damp-Wet
	8" Fine Sandy Loam	10YR 3/4	Damp
TR1/II	12" Silty Loam	10YR 2/2	Dry
	4" Silty Loam	10YR 4/6	Dry
TR1/III	2" Silty Clay Loam	10YR 5/1	Saturated
	16" Grav.Coarse Sand	10YR 3/6	Saturated
TR1/IV	6" Fine Sandy Loam	10YR 2/2	Damp
	12" FineSandy-Grav.Loam	10YR 3/4	Damp
TR2/I	6" Fine Silty Loam	10YR 3/3	Dry-Damp
	8" Fine Silty Clay Loam	10YR 3/6	Damp
TR2/II	6" Fine Silt Loam	10YR 3/3	Dry
	18" Fine Silt Loam	10YR 3/3	Dry
TR2/III	8" Fine Silty-Grav Loam	10YR 3/3	Dry
	8" Fine Silty-Grav Loam	10YR 3/3	Damp
TR2/IV	8" Fine Silty Loam	10YR 3/2	Dry
	10" Fine Silty Loam	10YR 3/2	Damp
TR2/V	6" Fine Silty Loam	10YR 3/2	Dry
	10" Fine Silty Loam	10YR 3/2	Dry

Notes:
1. Some areas of the loop appear to have been modified by filling and revegetation
2. The meadow most likely meets saturation requirements under Corps guidelines, with several springs originating and discharging in the upper loop campground.

EAST ALBION BASIN RANGESITE
SOIL/HYDROLOGY PROFILE DATA
August 7, 1992
Transects 1 & 2

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	12" Fine Silty Loam Uniform Profile	10YR 2/1	Damp
TR1/II	4" Fine Silty Loam 12"Fine Silty Clay Loam	10YR 2/2 10YR 3/2	Damp Damp
TR1/III	4" Fine Silty Loam 12"Fine Silty Clay Loam	10YR 2/2 10YR 3/2	Damp Damp
TR2/I	8"Organic Silt Clay Loam 10"Silty Clay Loam (Bright Iron Oxide Mottling Present)	10YR 2/2 10YR 2/1	Wet Wet
TR2/II	12" Uniform Fine Sand	10YR 3/2	Damp
TR2/III	18" Fine Sandy Clay Loam Uniform Soil Profile	10YR 2/1	Saturated

Notes:
1. Transect 1 dominated by Salix, Veratrum, Carex, Mosses, Lupine & Coneflower.
2. Transect 2 is a unique plant community which is dominated by spring discharges surrounded by Pernassus & Elephant Head with Veratrum, Mertensia, and other FACW species.

GREELY BOWL/LOWER GREELY/NORTH GREELY RANGESITES
SOIL/HYDROLOGY PROFILE DATA
August 12-14, 1992

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
Greely Bowl			
TR1/I	8" Fine Sandy Loam	10YR 3/3	Dry
	10" Fine Sandy Loam	10YR 2/2	Dry
	(Composite Sample across cirque)		
Lower Greely			
TR1/I	4"Fine Silty Clay Loam	10YR 2/1	Wet
	8"Fine Silty Clay	10YR 3/1-5/1	Saturated
	Mottling @ 5/8 Gleyed		
TR1/II	8" Grav-Sandy Clay Loam	10YR 4/4-4/1	Wet
	8" Fine Sandy Clay	10YR 4/1-4/3	Wet
	(Mottling Present)		
TR1/III	8" Fine Silty Clay	10YR 2/1	Wet
	Histic Epipedon		
	8" Fine Silty Clay Loam	10YR 2/1	Wet
	(Mottling Present)		
TR1/IV	16"Fine Silty Clay Loam	10YR 2/3	Damp
	Uniform Profile		
North Greely			
TR1/I	6" Fine Sandy Clay Loam	10YR 3/2	Dry
	6" Sandy Clay Loam	10YR 3/3	Dry
TR1/II	12"Fine Sandy Clay Loam	10YR 3/3	Dry
	Uniform Profile		
TR1/III	12"Fine Sandy Clay Loam	10YR 3/2	Dry
	Uniform Profile		
TR1/IV	12" Mucky Sandy Clay Loam	10YR 2/1	Saturated
	Uniform Profile		
	Heavily Mottled @ 6/8		
TR1/V	12" Mucky Clay Loam	10YR 2/1	Saturated

Notes:
1. Several springs originate and dicharge within the these transects
4. The rangesite slopes resemble solifluction terraces

CREEK TOWNSITE AND GOLDMINER'S DAUGHTER RANGESITES
SOIL/HYDROLOGY PROFILE DATA
August 18, 1992

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
Goldminers Daughter			
TR1/I	4" Sandy Clay Loam	10YR 4/1	Saturated
	8" Gravelly Sand	10YR 3/3	Saturated
TR1/II	8" Peaty-Org. Clay Loam (Heavily Mottled @ 5/8)	10YR 2/1	Saturated
	10" Sandy Clay Loam (Heavily Mottled)	10YR 5/2	Saturated
TR1/III	8" Grav-Sandy Loam	10YR 3/3	Wet
	8" Grav Clay Loam (Mottling Present)	10YR 2/1	Saturated
TR1/IV	8" Peaty Loam Histic Epipedon	10YR 2/1	Wet
	8" Coarse Sandy Loam	10YR 2/1	Wet
Creek Townsite			
TR1/I	6" Grav-Sandy Loam Histic Epipedon	10YR 2/1	Damp
	8" Gravelly Sand	10YR 4/2	Dry
TR1/II	8" Fine Sandy Loam	10YR 3/2	Damp
	8" Fine Sandy Loam	10YR 3/3	Damp
TR1/III	6" Fine Sandy Loam Histic Epipedon	10YR 2/1	Damp
	12" Fine Sandy Loam	10YR 2/2	Damp
TR1/IV	6" Fine Sandy Loam	10YR 2/1	Damp
	12" Fine Sandy Loam	10YR 2/2	Damp
TR1/V	6" Fine Sandy Loam	10YR 2/1	Dry
	6" Fine Sandy Loam	10YR 2/2	Damp

Notes:
1. These transects are characterized by seasonally flooded "streamlets" of Little Cottonwood Creek.
2. Further extensive investigation of Goldminer's Daughter transect is recommended, including full chemical analysis.

UPPER PATSY MARLEY HILL RANGESITE
SOIL/HYDROLOGY PROFILE DATA
August 27-28, 1992
Transects 1 & 2

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	12" Fine Sandy Loam Uniform Profile	10YR 2/1	Dry
TR1/II	4" Fine Sandy Loam Histic Epipedon	10YR 2/1	Damp
	12" Fine Sandy Loam	10YR 2/1	Damp
TR1/III	8" Fine Sandy Loam Very Shallow Profile	10YR 2/1	Damp
TR1/IV	9" Coarse Peaty Loam Histic Epipedon	10YR 2/1	Damp
	9" Coarse Sandy Loam	10YR 2/1	Wet
TR2/I	4" Fine Sandy Loam Histic Epipedon	10YR 2/2	Dry
	12" Coarse Sandy Loam	10YR 3/4	Dry
TR2/II	6" Fine Sandy Loam	10YR 2/1	Dry
	6" Coarse Sandy Loam	10YR 2/2	Dry
TR2/III	8" Coarse Peaty Loam Histic Epipedon	10YR 2/1	Wet
	10" Fine Sandy Loam	10YR 2/2	Wet
TR2/IV	8" Coarse Peaty Loam	10YR 2/1	Wet
	10" Fine Sandy Loam	10YR 2/2	Wet
TR2/V	8" Mucky Peat	10YR 2/1	Saturated
	10"CoarseSandyClay Loam (Iron Oxide Mottling Present)	10YR 2/1	Saturated
TR2/VI	10" Coarse Sandy Peaty Loam (Bright Mottles)	10YR 2/1	Saturated

Notes:
1. TR2 I & II are a composite Aspen/Willow site
2. TR2 V taken in stream channel above Cahill's Spring Box

EMMA HILL RANGESITE
SOIL/HYDROLOGY PROFILE DATA
August 31-September 10, 1992
Transects 1, 2 & 3

TRANSECT/SITE	SOIL TEXTURE HORIZON A HORIZON B	HUE/VALUE/CHROMA HORIZON A HORIZON B	HYDROLOGY
TR1/I	3" Coarse Gravelly Sand 12" Fine Sandy Loam	10YR 4/2 10YR 3/3	Dry Damp
TR1/II	3" Coarse Gravelly Sand 12" Fine Sandy Loam	10YR 4/2 10YR 3/3	Dry Damp
TR1/III	10"Fine Grav-Sandy Loam Uniform Profile	10YR 3/4	Damp
TR1/IV	4" Fine Sandy Loam 12" Fine Sandy Loam	10YR 2/2 10YR 2/2	Damp Damp
TR1/V	12" Fine Sandy Loam Uniform Profile	10YR 2/2	Damp
TR2/I	8" Fine Sandy Loam 12" Fine Sandy Loam	10YR 2/2 10YR 3/2	Damp Damp
TR2/II	8" Fine Sandy Loam 12" Fine Sandy Loam	10YR 2/2 10YR 3/2	Damp Damp
TR2/III	12"Flaggy Sand-Silt Loam Bright Iron Oxide Mottles Uniform Profile	10YR 4/4	Damp
TR2/IV	**8" Fine Gravelly Silt** 6" Fine Gravelly Sand	**10YR 6/3** 10YR 3/2	Damp Damp
TR2/V	8" Fine Silty Sand 8" Hard Peaty Loam	10YR 2/2 10YR 2/1	Damp Damp
TR2/VI	12" Fine Sandy/GravLoam Uniform Profile	10YR 2/2	Damp
TR3/I	6" Fine Sandy Loam 10" Fine Sany Loam	10YR 2/2 10YR 3/2	Dry Damp

Notes:
1. Entire Rangsite disturbed from historic and present mining activity
2. FACW communities limited to steep draws
3. Fine silts appear to originate from mines. (TR2/IV)