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SOIL SURVEY
HANFORD PROJECT IN BENTON COUNTY WASHINGTO

B. F. HAJEK

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SOIL SURVEY
HANFORD PROJECT IN BENTON COUNTY WASHINGTON

By

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INTRODUCTION

This report presents a soil map and a descriptive report of Hanford Project soils grouped according to a scheme. The scheme is a soil classification contrived to group soils found on the Benton County portion of the Hanford Project in such a manner that general statements can be made about their properties.

The classification scheme chosen for Hanford soils is based mainly on morphologic and genetic characteristics. The need for other classifications may arise as our knowledge of soils increases and the intensity of land use at the Hanford Project increases. In such an event, it would be possible to use the system presented here to help in the formation of engineering, geologic, agronomic, and land use classes and to correlate with other current soil surveys.

The concept of soil differs among disciplines; thus, it is necessary that a definition of soil be included as used in this report. The concept of soil on which this classification is based is the unconsolidated mineral matter on the surface of the earth. This matter has been subjected to and influenced by genetic and environmental factors of parent material, climate, organisms and topography. All of these factors have acted over a period of time and produced a soil which is different from the parent material in many physical, biological, morphological, and chemical properties[(1)]. The upper limit of soil is air; and at its lateral margins, soil grades to deep water, barren rock, or active sand dunes. The lower limit of soil, in some instances, is difficult to set. In Hanford soils the lower soil limit is the lower limit of rooting of the native perennial plants. This limit is shallow in soil over bedrock and deep in areas of soil formed from unconsolidated sediments.

In general a geologist's definition corresponds to the one given above, however, an engineering definition usually includes all unconsolidated material above bedrock. The latter definition corresponds to the pedologist's and geologist's definition of regolith[1].

METHODS

The soil map published by the United States Department of Agriculture in 1919 was used as a base map[2]. Correlations from which the initial survey mapping units were converted to present concepts were supplied by soil scientists of the Soil Conservation Service - USDA. The present classification schemes are outlined in the Seventh Approximation[1], Soils and Men - 1938 Yearbook of Agriculture[3], and the Soil Survey Manual[4].

The accuracy of soil boundaries in the Hanford Project was spot checked by field study. Initial soil descriptions were supplemented with soil color designations by the use of Munsell color charts[5]. All colors reported are for moist soil material.

DESCRIPTION AND CLASSIFICATION OF HANFORD PROJECT SOILS

Soils which are alike in all characteristics except texture are grouped into soil series. If the texture class is added to the series, the soil unit is called a soil type. The soil type was the unit mapped in the initial survey; however, many small areas of other soil types were included in the delineation when the 1919 survey was made and others were included in the current revision.

For these reasons the soil type, indicated on the map (Figure 1) and described below, represents the predominate type of soil in the delineation. In some uniform areas the type indicated is representative of the entire area enclosed; in others, many inclusions of other soils occur. In addition, seldom do soil boundaries change abruptly, thus transitional areas also are included.

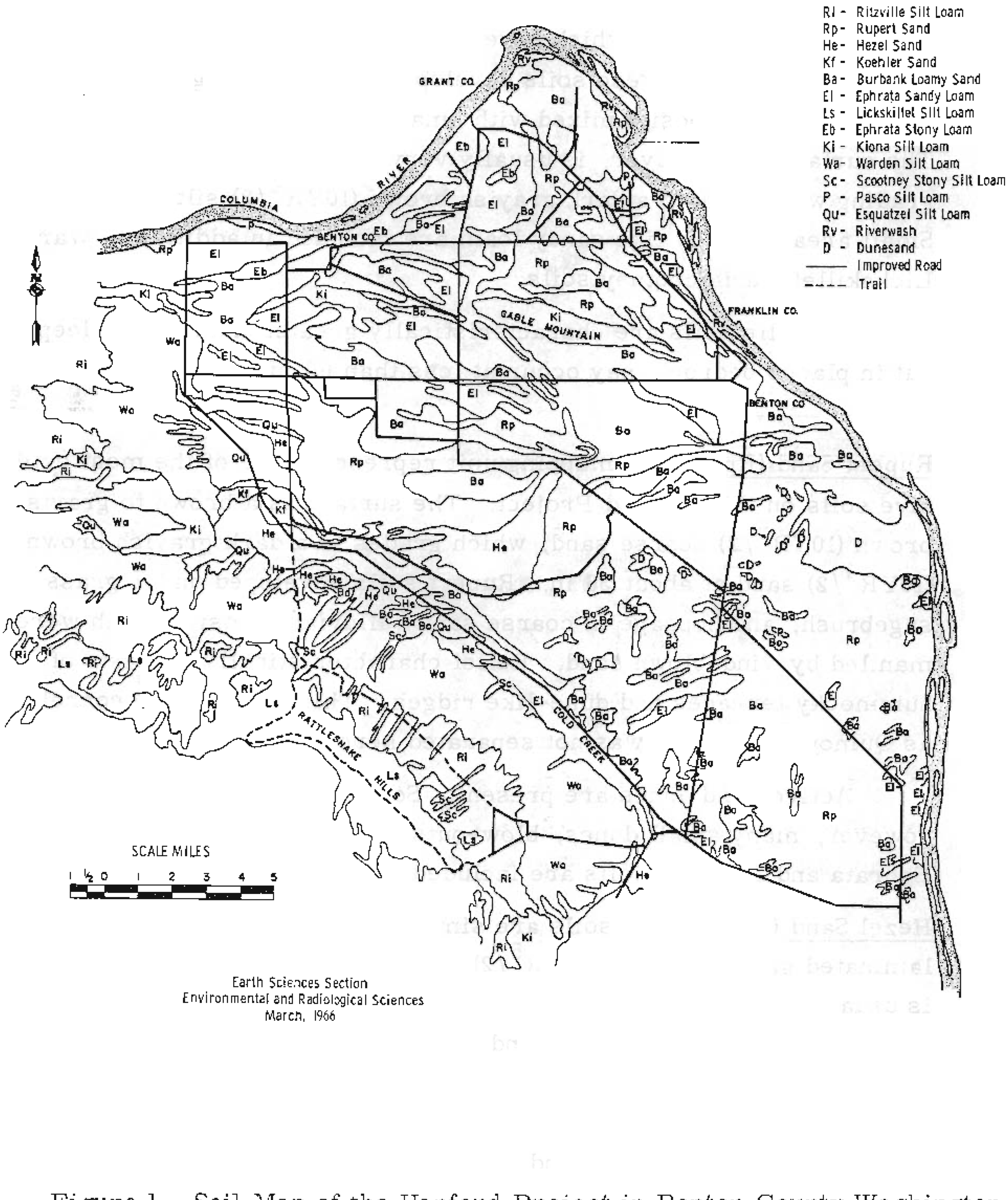

Figure 1. Soil Map of the Hanford Project in Benton County Washington

SOIL DESCRIPTIONS

Ritzville Silt Loam (Ri). This mapping unit consists chiefly of dark colored silt loam soils which have developed midway up the slopes of Rattlesnake Hills. These soils developed under bunch grass from silty wind-laid deposits mixed with small amounts of volcanic ash. The surface, 8 in. layer, is usually very dark grayish brown ($10YR^3/2$)* grading with depth to a dark grayish brown ($10YR^4/2$) silt loam subsoil. Small areas of very fine sandy loam are included in addition to Warden, Lickskillet, and Scootney soils.

Ritzville soils are characteristically greater than 60 in. deep but in places bedrock may occur at less than 60 in. but greater than 30 in.

Rupert Sand (Rp). This mapping unit represents one of the most extensive soils on the Hanford Project. The surface is a brown to grayish brown ($10YR^5/2$) coarse sand, which grades to a dark grayish brown ($10YR^4/2$) sand at about 36 in. Rupert soils developed under grass, sagebrush, and hopsage in coarse sandy alluvial deposits which were mantled by wind-blown sand. Relief characteristically consists of hummocky terraces and dune-like ridges. This soil may be correlated as Quincy sand which was not separated here.

Active sand dunes are present. Some dune areas are separated; however, many small dunes, blow-outs, and associated small areas of Ephrata and Burbank soils are included.

Hezel Sand (He). Hezel soils are similar to Rupert sands; however, a laminated grayish brown ($10YR^5/2$) strongly calcareous silt loam subsoil is usually encountered within 40 in. of the surface. The surface soil is very dark brown ($10YR^3/3$) and was formed in wind-blown sands which mantled lake-laid sediments. Areas of Rupert, Burbank, and blow-outs are included.

*Munsell color designation indicating hue chroma and value

<u>Koehler Sand (Kf)</u>. Koehler soils are similar to the other sandy soils found on the Hanford Project. They developed in a wind-blown sand mantle. This soil differs from the other sands in that the sand mantles a lime-silica cemented layer "hardpan". The very dark grayish brown ($10YR^3/2$) color of the surface layer is somewhat darker than Rupert. The calcareous subsoil is usually dark grayish brown ($10YR^4/2$) at about 18 in. Inclusions are of the Rupert and Burbank series.

<u>Burbank Loamy Sand (Ba)</u>. This is a dark-colored [surface is very dark grayish brown ($10YR^3/2$); subsoil is dark grayish brown ($10YR^4/2$)], coarse-textured soil which is underlain by gravel. The surface soil is usually about 16 in. thick but can be 30 in. thick. The gravel content of the subsoil may range from 20 to 80 volume percent. Areas of Ephrata and Rupert are included.

<u>Kiona Silt Loam (Ki)</u>. This soil occupies steep slopes and ridges. The surface soil is very dark grayish brown ($10YR^3/2$) and about 4 in. thick. The dark brown ($10YR^4/3$) subsoil contains basalt fragments 12 in. and larger in diameter. Many basalt fragments also are found in the surface layer. Many basalt rock outcrops are present. Normally this shallow stony soil occurs in association with Ritzville and Warden soils. Many areas of stony silt loam and very shallow Lithosols are included.

<u>Warden Silt Loam (Wa)</u>. This is a dark grayish brown soil ($10YR^4/2$). The surface layer is usually 9 in. thick. The silt loam subsoil becomes strongly calcareous at about 20 in. and becomes lighter colored (grayish brown $10YR^5/2$). Granitic boulders are found in many areas. Usually this soil is greater than 60 in. deep. Associated soils and inclusions are of the Ritzville, Kiona, Esquatzel and Scootney series. At higher elevations (1200 ft.), Warden soils grade to Ritzville silt loam.

Ephrata Sandy Loam (El). This is a dark colored [surface is very dark grayish brown (10YR^3/2)]; subsoil is dark grayish brown (10YR ^{4}/2) medium-textured soil which is underlain by gravelly material which may continue for many feet. This soil is associated with the Burbank soil and many small areas were included in delineations of this soil type. The topography is generally level.

Ephrata Stony Loam (Eb). This soil is similar to Ephrata sandy loam. It differs in that many large hummocky ridges are present which are made up of debris released from the melting ice of glaciers. Areas between hummocks contain many boulders several feet in diameter. Ephrata sandy loam and Burbank loamy sand are associated and included.

Scootney Stony Silt Loam (Sc). This soil has developed along the north slope of the Rattlesnake Hills, usually confined to floors of narrow draws or small fan-shape areas where draws open onto plains. The soils are often severely eroded with numerous basaltic boulders and fragments being exposed. The surface soil is usually dark grayish brown (10YR^4/2) grading to grayish brown in the subsoil. Many small areas of Warden and Ritzville are included.

Pasco Silt Loam (P). This is a poorly drained very dark grayish brown (10YR^3/2) soil formed in recent alluvial material. The subsoil is variable, consisting of stratified layers. Only small areas of this soil are found on the Hanford Project and they are located in low areas adjacent to the Columbia River. Areas of Riverwash may be included.

Esquatzel Silt Loam (Qu). This is a deep dark brown (10YR^3/3) soil formed in recent alluvium derived from loess and lake sediments. The subsoil grades to dark grayish brown (10YR^4/2) in many areas but color and texture of the subsoil is variable due to the stratified nature of the alluvial deposits. Esquatzel soils are associated with Ritzville and Warden and often seem to have developed from sediments eroded from these two series.

Riverwash (Rv). These are wet, periodically flooded areas of sand gravel, and boulder deposits which make up overflowed islands in the Columbia River and adjacent to the river.

Dune Sand (D). This unit represents a miscellaneous land type which consists of hills or ridges of sand-sized particles drifted and piled up by wind and are either actively shifting or so recently fixed or stabilized that no soil horizons have developed. In places, recently blown-out land and areas of Rupert sand are included. Many small active dunes and accompanying blown-out areas are included with other soils, mostly Rupert, Hezel and less frequently Burbank.

Lickskillet Silt Loan (Ls). This soil occupies the ridge tops of Rattlesnake Hills and slopes above the 2500 ft. elevation. The soil is similar to the Kiona series except that the surface soils are darker [very dark brown (10YR $^2/2$ to $^3/2$)]. Lickskillet soils are shallow over basalt bedrock. Numerous basalt fragments are present throughout the profile. Many areas of very stony silt loam and Ritzville soils are included.

SOIL CLASSIFICATION

The correlation from the initial survey into the present system appears in Table I. Most names have changed and some soil series were combined. In addition to the correlations shown, many small areas of soil were included with surrounding or adjacent large bodies of soils.

Table II lists the approximate higher category and engineering classification of soil types on the Hanford Project. The classification proposed in the 1938 Yearbook of Agriculture - Soils and Men has been widely used in soil studies. The two orders in this system which occur here are outlined in Table III.

TABLE I

Correlation Table

Current Classification		1919 Soil Survey	
Symbol	Soil Type	Symbol	Soil Type
Ri	Ritzville silt loam	Rs, R, R1	Ritzville sand, very fine sand and loam
Rp	Rupert sand	Ws Wf	Winchester sand, fine sand
Kf	Koehler sand	Kf	Koehler fine sand
Ba	Burbank loamy sand	Es, Bs, Bf Ef	Ephrata sand, Beverly fine sand, very fine sand
He	Hezel sand	Qf Qs, Qt	Quincy sand
E1	Ephrata sandy loam	Ef	Ephrata sandy loam, fine sandy loam
Ls	Lickskillet silt loam	S	Scabland; elevation, 2000 ft.
Eb	Ephrata stony loam	S	Scabland, glacial deposits near Columbia River
Ki	Kiona silt loam	S	Scabland; elevation, 2000 ft.
Wa	Warden silt loam	So, S1, Ss	Sagemoor, fine sand, very fine sand, silt loam
Sc	Scootney stony silt loam	Sf	Stacy stony silt loam
P	Pasco silt loam	P, Pc	Pasco fine sandy loam, clay
Qu	Esquatzel silt loam	Ey, Eo	Esquatzel fine sandy loam, silt loam
Rv	Riverwash	Rv	Riverwash
D	Dune sand	D	Dune sand

TABLE II

Approximate Classification of Hanford Soils

Engineering and Higher Categories

Soil Type	Classification			
	Soils and Men 1938	7th Approximation	Unified	A. A. S. H. O.
Ritzville silt loam	Brown integrade to Regosol	Andic Aridic Haplustoll	ML	A-4
Rupert sand	Regosol	Typic Torripsamment	Surface SM Subsoil SP to SM	A-4
Hezel sand	Regosol	Typic Torrifluvent	Surface SM Subsoil ML	A-2 A-4
Koehler sand	Regosol	Mollic Durorthid	SM	A-2
Burbank loamy sand	Regosol	Typic Torripsamment	Surface SM Subsoil GM to GP	A-2 A-2 to A-4
Ephrata sandy loam	Sierozem integrade to Regosol	Andic Mollic Camborthid	Surface SM to ML Subsoil ML	A-2 to A-4 A-4 to A-1
Lickskillet silt loam	Lithosol	Lithic Haplustoll	ML to GM	A-4 to A-1
Kiona silt loam	Sierozem integrade to Regosol	Andic Mollic Camborthid	GM	A-1
Warden silt loam	Sierozem integrade to Regosol	Andic Mollic Camborthid	SM to ML	A-2 to A-4
Scootney stony silt	Sierozem integrade to Regosol	Andic Mollic Camborthid	SM to ML	A-2 to A-4
Ephrata stony loam	Sierozem integrade to Regosol	Mollandeptic Camborthid	Surface SM-ML Subsoil ML	A-2 to A-4 A-4 to A-1
Pasco silt loam	Alluvial	Andic Cumulic Haplaquoll	SM to ML	A-4
Esquatzel silt loam	Alluvial	Andic Cumulic Haplustoll	SM to ML	A-4
Riverwash	Miscellaneous	Not soil	GP	A-1
Dune sand	Miscellaneous	Not soil	SP to SW	A-3

TABLE III

Classification Proposed in the 1938 Yearbook of Agriculture

Order	Suborder	Great Soil Group
Zonal soils	Light-colored soils of arid region	Sierozem Brown soils
Azonal soils	- - - -	Lithosols Regosols Alluvial Soils

The "Zonal Soils" order occurs over large areas or zones which are limited by geographical characteristics. This order includes those great soil groups which have developed soil characteristics that reflect the influence of climate and vegetation on soil genesis. In this order brown soils have a dark grayish brown surface and a light colored transitional subsurface horizon over calcium carbonate accumulations. Here at Hanford, the seirozems have grayish brown surface horizons, less than 1 ft. thick, grading into calcareous light colored material usually at less than 20 in. from the surface. Sierozens in the Hanford Project appear to be transitional soils between Browns and Regosols.

The "Azonal Soils" do not have well developed horizons either because of their youth or because parent material or relief have prevented development. In this order, alluvial soils are young recent deposits; lithosols are shallow soils on steep slopes and over bedrock; and regosols are developing in deep unconsolidated soft mineral deposits such as sands, loess, or glacial drift.

For further description of soils in the Seventh Approximation, reference is made to the publication "Soil Classification - A Comprehensive System" and later supplements. The units in this system have names which relate somewhat to soil properties. The formative elements in the names are mostly of Greek and Latin origin. Table IV shows those categories into which Hanford Project soils are grouped. The great group name includes an element of both the order and suborder. Terms preceding great group names, (Table II), such as -- Mollic, Typic, or Aridic --, indicate intergrades to orders, suborders, great groups, or aberrant soil properties which are not characteristic of any class.

TABLE IV

Names of Orders, Suborders, and Great Groups

Order	Suborder	Great Groups
Entisol	Psamment	Torripsamment
	Fluent	Torrifluent
Aridisol	Orthid	Camorthid
		Durorthid
Mollisol	Ustoll	Haplustoll
	Aquoll	Haplaquoll

The Unified and A.A.S.H.O. engineering classification systems are based on characteristics which influence engineering behavior of soil[6]. Both systems are based mostly on grain size, plasticity, and load limits. Brief description of the engineering categories are given in the following outline:

A. A. S. H. O. (American Association of State Highway Officials)

Group A-1. Typically this is a well-graded mixture of stone fragments or gravel, coarse sand, fine sand, and a nonplastic or pebble plastic soil binder. This group also includes stone fragments, gravel, coarse sand, etc., without soil binder.

Group A-3. This soil group is a fine beach sand or fine desert blow sand without silty or clayey fines or with a very small amount of nonplastic silt.

Group A-2. This group comprises a wide variety of granular material which is at the border line between groups A-1 and A-3. It includes any material of which not more than 35 percent will pass through a No. 2 sieve and cannot be classified as A-1 or A-3 because of having fines, plasticity, or both in excess or limitation for these groups.

Group A-4. Typically Group A-4 is a nonplastic or moderately plastic silty soil with more than 36% of the material passing through a No. 200 sieve. The usual type of significant constituent material is silt.

Unified System

Group ML. Group ML is predominantly silty material and micaceous or diatomaceous soils. The soils usually are sandy silts, clayey silts, or inorganic silts with relatively low plasticity. Also included are loessial soils and rock flours.

Groups GM to SM. These groups include gravels or sands which contain more than 12% fines that have little or no plasticity. Both well graded and poorly graded materials are included. Some dry strength may be provided by cementation of calcareous materials or iron oxides.

Groups GP to SP. Poorly graded sands and gravels containing less than 5% of nonplastic fines constitute these groups. They may consist of uniform gravels, uniform sands, or nonuniform mixtures of very coarse material and very fine sand with intermediate sizes lacking.

Groups GW to SW. These groups comprise well-graded sandy and gravelly soils which contain less than 5% of nonplastic fines passing through the No. 200 sieve. Fines which are present must not noticeably interfere with the free draining characteristics of this group.

Table V gives the approximate land use capability classification of Hanford Project soils. This is a practical grouping of soils based on limitations of soils for cropland and pasture use and on the risk of damage when they are used. The classification shown is the broadest grouping; subclasses and units are lower groups within this system but were not included. Dryland and irrigated capability units are used because of the increased potential of the soil when irrigated. The capability units are the same when the same hazards exist in both cases.

The following are descriptions of capability classes[7].

Class I. These soils have few limitations and have wide latitude for use. Soils classed in this group are deep, productive, easily worked, and nearly level. No wind or water erosion hazard exists.

Class II. Soils in this group have moderate limitations in use and are subject to moderate risk of damage. These are good soils; however, some special conservation attention is necessary due to slopes, erosion, depth, drainage, or overflows.

Class III: These soils are subject to severe limitations in use for cropland because of moderately steep slopes, severe erosion hazards (wind or water), inherently low fertility. Intensive conservation practices are needed to farm this class of soil safely.

Class IV: This class consists of soils that have very severe permanent limitations or hazards for cropland use. These limitations may be caused by steep slopes, wind, or water erosion hazards, or a dry, arid climate.

Class V: Soils in this class should be kept in permanent vegetation used for pasture or forestry. Cultivation is not feasible because of wetness or stoniness.

Class VI: Class VI soils should be used for grazing and forestry and may have moderate hazards when in this use. These soils are steep, or shallow over bedrock and stony. Erosion susceptibility is high.

Class VII: These soils can be used for grazing or forestry; however, the steep, eroded rough stony or very dry sandy condition causes severe permanent limitations to use.

Class VIII: These soils are suitable only for wildlife, recreation, or watershed uses.

TABLE V

Capability Classification

Soil Type	Dryland	Irrigated
Ritzville silt loam	III-VII	I-IV
Rupert sand	VII	IV
Koehler sand	VII	IV
Hezel sand	VII	IV
Burbank loamy sand	VII	IV
Ephrata sandy loam	VI	II-IV
Lickskillet silt loam	VI & VII	---
Ephrata stony loam	VI	---
Kiona silt loam	VI	---
Warden silt loam	IV	I-IV
Scootney stony silty loam	VI	---
Pasco silt loam	IV	III
Esquatzel silt loam	III	I
Riverwash	VIII	---
Dunesand	VIII	---

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