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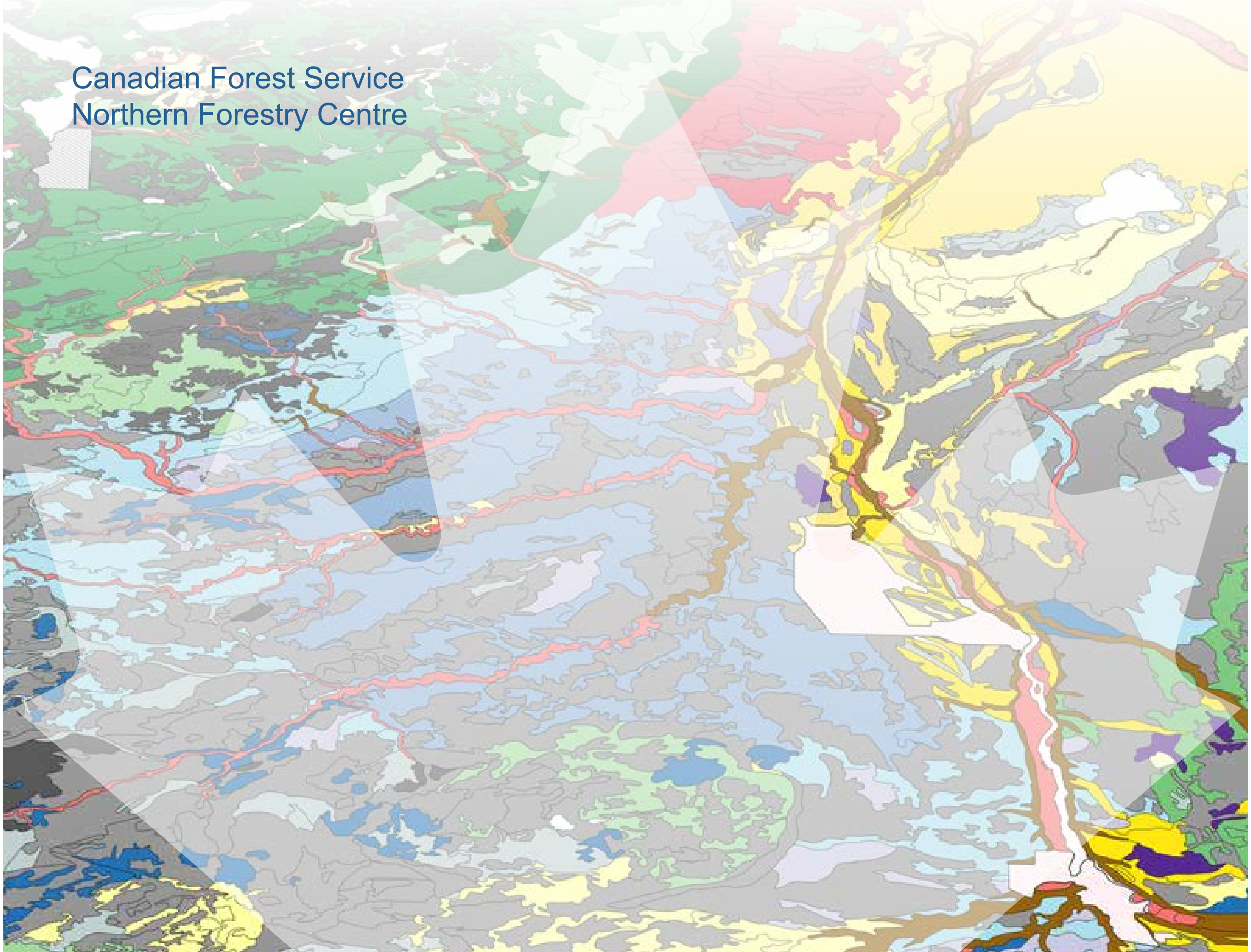
A DIGITAL INVENTORY OF THE SOILS IN THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA

G. Soundarapandian, B. Lu, E.H.Y. Li, B.D. Pinno, and D.T. Price

Canadian Forest Service
Northern Forestry Centre



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A digital inventory of the soils in the Alberta Oil Sands Environmental Research Program study area

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Cover image: A digital map based on the dominant soil units occurring in the mineable oil sands of Alberta, as reported by Turchenek and Lindsay (1982).

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ABSTRACT

The Alberta Oil Sands Environmental Research Program (AOSERP), established in 1975, funded the creation of a soils inventory of the mineable Alberta oil sands, which was published as a set of eight soil map sheets with an accompanying report in 1982. These formed arguably the most comprehensive soils data set ever collected in the region and are of considerable value for environmental studies and reclamation efforts. This report describes the creation of a digital product containing these data, which was derived directly from the 1982 AOSERP map sheets and report and is freely available as a set of shapefiles and accompanying attribute databases for geographic information systems. The product includes a colored map showing soils classified by soil group, a coverage of soil polygons classified by dominant soil unit, soil unit characteristics derived from multiple tables, and a point coverage of soil-profile descriptions, with physical data, for specific locations in the study region.

RÉSUMÉ

Le programme de recherche environnementale sur les sables bitumineux de l'Alberta (Alberta Oil Sands Environmental Research Program, AOSERP), créé en 1975, a financé la création d'un inventaire des sols des sables bitumineux exploitables de l'Alberta. L'inventaire a été publié en 1982, sous la forme d'un ensemble de huit cartes des sols avec un rapport d'accompagnement. Celles-ci constituent, avec peu de doute, l'ensemble de données sur les sols les plus complètes jamais recueillies dans la région, et sont d'une valeur considérable dans la réalisation d'études environnementales et de remise en état. Ce rapport décrit la méthode de création d'un produit numérique contenant ces données, directement dérivé des cartes et du rapport AOSERP de 1982. Le rapport, disponible gratuitement, se présente sous la forme d'un ensemble de fichiers vectoriels associé à une base de données d'attributs, configurés pour les systèmes d'information géographique. Le produit comprend une carte de groupes de sols définis à l'aide de couleurs, une couverture de polygones de sol classés par unité de sol dominant, les caractéristiques des unités de sol dérivées de plusieurs tables, et une couverture de points géographiques des descriptions des profils du sol, avec leurs propriétés physiques, à des endroits spécifiques dans la région d'étude.

CONTENTS

INTRODUCTION

The Alberta Oil Sands Environmental Research Program (AOSERP) was established through an agreement between the governments of Alberta and Canada in 1975 to "direct and coordinate research projects concerned with the environmental effects of development of the Athabasca Oil Sands in Alberta" (AOSERP 1978). In the late 1970s, AOSERP funded the creation of a soils inventory for the AOSERP study area, which was based on field surveys and aerial photo-interpretation (Turchenek and Lindsay 1982). Survey information was initially mapped at a scale of 1:50 000 and then transferred to eight 1:126 720 map sheets, which were accompanied by a report. Figure 1 shows the location of the study region and the area covered by the AOSERP soils inventory.

Since 1975 more than US$150 billion have been invested in developing the Alberta oil sands (Burt et al. 2012; Alberta Government 2017). Landscape reclamation is a major concern, and information about soils is often crucial to developing successful and ecologically acceptable restoration plans. Detailed,

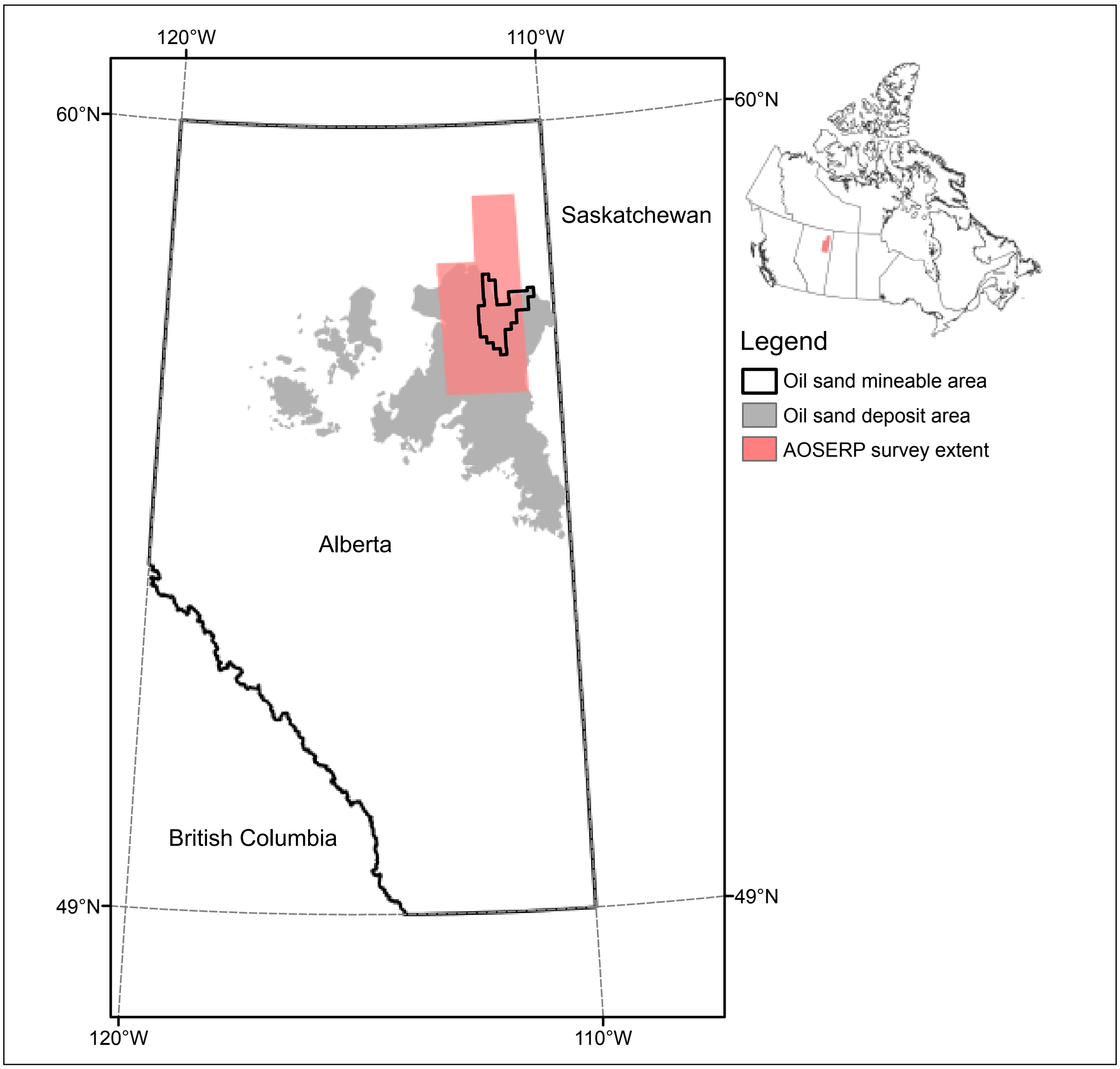

Figure 1. Location of the study area for the soils inventory produced for the Alberta Oil Sands Environmental Research Program (AOSERP). Oil sands information was collected by the Government of Alberta, Oil Sands Information Portal (Government of Alberta 2019). This soils map is based on information collected by Soils Department, Alberta Research Council (Turchenek and Lindsay 1982).

spatial data about soils are also extremely valuable for modeling vegetation dynamics and other processes, including simulating possible future outcomes if oil sands had not been mined. However, the AOSERP maps have been underused as a source of such information because, somewhat surprisingly, they were unavailable in digital format until now.

Here, we report on the creation and documentation of a digital soils data inventory for the AOSERP study region, derived directly from the map sheets of the AOSERP soils inventory and from the accompanying report (AOSERP Report 122, Turchenek and Lindsay 1982), which should be considered the ultimate reference for the digital data product. The entire digital data set and a soils map in PDF format are now available in the public domain: https://cfs.nrcan.gc.ca/pubwarehouse/supplemental/AOSERP_supplemental_information.zip.

Scanning and vectorization

To create the Alberta Oil Sands Digital Soils Inventory, we digitized scanned images (in JPEG format, Fig. 2) of the original eight paper map sheets to create approximately 4 600 soil polygons in a geographic information system (GIS) layer covering approximately 3.3 million ha (Table 1). In detail, each scanned map sheet was georeferenced using four corner control points, converted to EPSG: 3401 projection (MyGeodata Cloud date unknown), and saved in TIFF format. Individual TIFF files were reclassified using the ESRI Spatial Analyst Reclassify tool to values of 0, 1, or NoData, and stored as eight-bit unsigned integers. Values of 1 were assigned a bright fill color, whereas values of 0 were assigned no color. The reclassified layer was scanned using ESRI ArcScan to generate a polyline coverage[1]. Descriptive text and other scanning errors were removed manually, a process requiring several weeks to complete. The cleaned-up polyline layers for each of the eight maps were converted to polygons and exported as separate files.

The eight polygon files were then merged, and the edges of polygons that crossed map edges were joined or deleted, as necessary, using the ESRI ArcMap line/polygon editing tool. The fully merged map was then saved as a shapefile. Fields for soil group and dominant soil unit were created in the attribute table. Following Turchenek and Lindsay (1982), each polygon represents the physical location and extent of a soil unit within a soil group, as classified on the basis of the Canadian system of soil classification (Canada Soil Survey Committee 1998). The term "soil group" refers to closely related soils sharing the same parent materials and developed under similar climatic conditions, following a definition adapted from Twardy and Corns (1980). Soil groups were named after the predominant soil in each group, and names were taken from local geographic features. Different names were used for soils in different soil orders (e.g., Brunisol, Luvisol, Organic), even when these soils were developed on the same parent materials. (The names of the soil groups Heart, Kenzie, and Eaglesham were adopted from previous soil survey projects.) Each soil group can contain several soils, although the full range might not be found everywhere in a given landscape. The soil groups were therefore subdivided into "soil units"—smaller groups that are found in predictable geographic associations but that have distinct profile morphologies and drainage regimes.

According to Twardy and Corns (1980), "soil units are areal subdivisions of soil groups such that, within a given soil unit, they identify both the group and the proportions of the soils within the unit, along with the relative landscape and consequent drainage conditions." The individual soil polygons define the extent of "dominant soil units," the soil units that occupy more than 40% of the area of the polygon. In most cases, only one soil is dominant. In certain cases, however, two or more soils are listed as "dominant," meaning these soils together make up more than 40% of the soil unit, or "significant," meaning they make up 15% to 40% of the soil unit. For the digital soils database, a maximum of three soil units were recognized within a single soil group.

The georeferenced TIFF files were then added individually into the background layer, below the layer containing the merged polygons. Polygons could then be selected individually, and information added to the polygon attribute fields by reading them manually from the background layer. Once this work

1 A coverage is a data model for storing geographic features, which stores a set of thematically associated data considered to be a unit. It usually represents a single layer, such as soils, streams, roads, or land use. In a coverage, features are stored as both primary features (points, arcs, polygons) and secondary features (tics, links, annotations). Feature attributes are described and stored independently in feature attribute tables.

was completed, the entire coverage was checked for errors: for the 4 847 polygons, a total of 41 errors in the assignment of soil group and soil unit were discovered and corrected.

Attribute data were then assigned to each soil polygon based on representative soil profiles and other data from several tables in AOSERP Report 122. In detail, text and numerical information presented in Tables 9 to 13 were scanned using the optical character recognition tool in Adobe Acrobat Pro. Data values from the scanned tables were copied into Microsoft Excel worksheets. Numerous errors in the optical character recognition were corrected to produce accurate digital versions of the original tables. Additional information was extracted from the legends on the scanned map sheets. These data were then combined to create a master attribute table (containing information from AOSERP Report 122, Tables 9, 11, 12, and 13). Duplicate data were deleted, and any discrepancies (e.g., between map legends and the report tables) were resolved. The contents of the master attribute table were then linked to the individual soil polygons, with soil group and dominant soil unit as the linking keys. Comprehensive metadata for the map polygons and attribute data were compiled (Appendix 1).

Table 10 of the AOSERP report presented engineering test data for the B and C horizons of individual soil profiles, representing most of the major soil groups, mapped to the Alberta Township System legal subdivisions in which they are located. The precise latitude/longitude coordinates of the soil profiles are unknown, so we assumed they were at the centroids of each legal subdivision, meaning they are generally within 250 m of the exact sampling sites. A separate

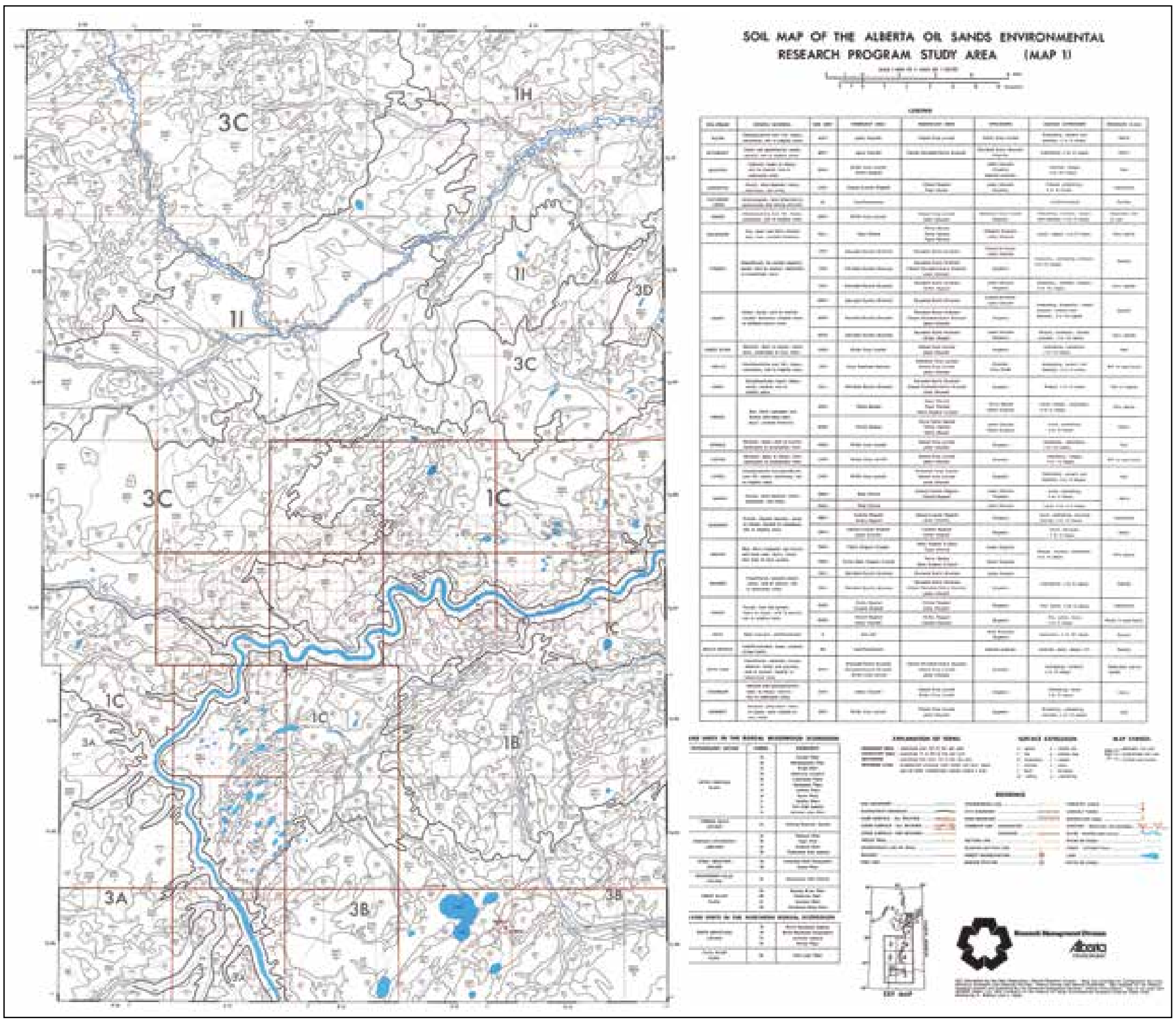

Figure 2. Example of a soils map sheet created for Alberta Oil Sands Environmental Research Program Report 122 (Turchenek and Lindsay 1982).
To access the original report and see this map in greater detail, please go to the following link: https://www.agric.gov.ab.ca/soil/survey-reports/zip/ab42.zip.

metadata document was compiled for the contents of Table 10 (Appendix 2).

A map was created from the shapefile showing polygons colored to indicate soil group, based on legend information compiled from the scanned JPEGs. Horizontal scale and a north arrow symbol were added, and latitude and longitude tick marks were inserted along the inner edges of the neat line (Fig. 2). The map file was then exported to Adobe Illustrator for final cartographic formatting, with the final map available in PDF format.

Data product release

The new Alberta Oil Sands Digital Soils Inventory covers the AOSERP study area (Fig. 3), providing GIS users with spatially explicit data on soil attributes at the polygon level. The number of polygons and total area for each

Table 1. Number of polygons and total area for each soil group in the Alberta Oil Sands Digital Soils Inventory

Soil group	Number of polygons	Total area (ha)
Algar	62	36 303.57
Bitumount	18	9860.30
Buckton	69	50 248.77
Chipewyan	29	10 231.72
Dover	139	95 416.49
Eaglesham	452	170 157.04
Firebag	209	92 881.98
Heart	321	229 751.09
Horse River	39	30 252.41
Joslyn	46	89 776.37
Kearl	6	1142.31
Kenzie	1 082	792 978.50
Kinosis	97	69 390.18
Legend	327	176 105.65
Livock	168	64 617.83
Mamawi	163	42 162.89
Mcmurray	156	86 966.59
Mikkwa	675	286 702.52
Mildred	197	151 120.51
Namure	68	61 507.69
Rock	65	21 210.98
Rough Broken	100	97 508.16
Ruth Lake	62	27 256.31
Steepbank	47	27 485.05
Surmount	44	33 590.59
Total soil groups	4 641	2 754 625.50
Other land		
Active sand	3	1336.51
Disturbed	2	10 137.85
Hydro	191	46 519.59
Reserve	8	7405.00
Settlement	1	4062.82
Not surveyed	1	455 234.38
Total other land	206	524 696.15
Total all polygons	4 847	3 279 321.65

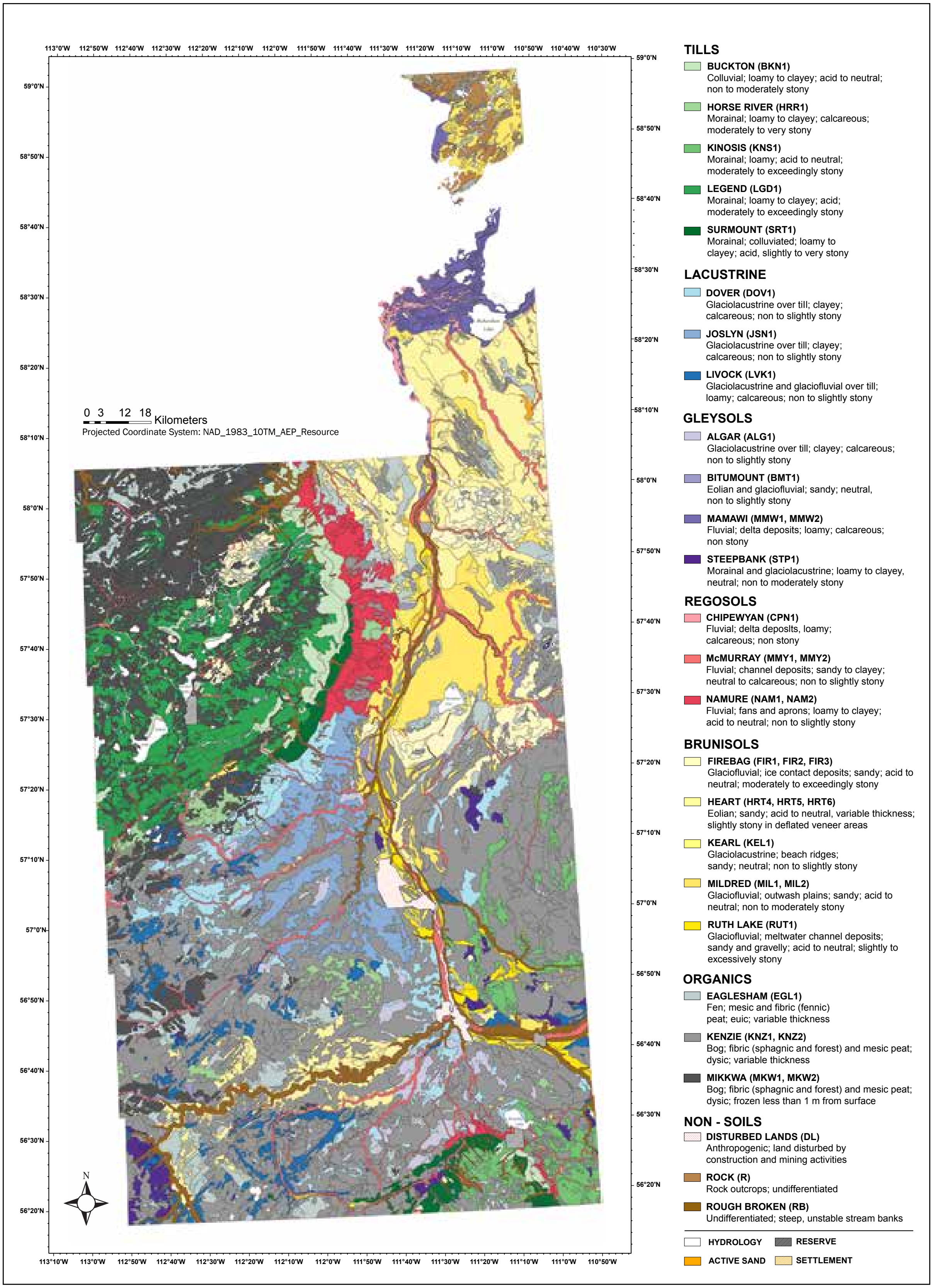

Figure 3. Digital soils map of the Alberta Oil Sands Environmental Research Program study area derived from Turchenek and Lindsay (1982).
To view this map in greater detail, please go to the following link: https://cfs.nrcan.gc.ca/pubwarehouse/supplemental/AOSERP_supplemental_information.zip.

soil group are summarized in Table 1. The data set can be used by resource managers, including reclamation specialists, to obtain basic soil attributes (e.g., depth, texture, and drainage class) for project planning, or by researchers and others to provide inputs for spatial models. The soil data could also be linked to other vector- or raster-based data, including topographic data, vegetation classes, regional climatology and hydrology, and resource development plans.

Limitations of the digital product

After the analog map sheets were digitized, the positional accuracy of the polygons was assessed. The selection of the four corner positions as control points necessarily caused some spatial distortion, particularly in the central portions of each digitized map sheet. Firm evidence of this distortion came from comparing the positions of polygons representing lakes and other hydrologic features with independent (and presumably more accurate) digital coverages of hydrology (Canadian Base Map Transportation Web Mapping Service [CBMT WMS 2016]) and satellite imagery displayed in Google Maps (Google Maps 2018). We found that many of the digitized lake and river boundaries (mapped in the mid-1970s) had shifted, mainly east-west, by varying distances of up to 150 m compared with modern coverages. Some of the shifts in river boundaries are almost certainly due to fluvial processes, but, in general, shifts in the apparent positions of these water bodies imply that the digitization of the soil polygons introduced some errors.

We attempted to correct this problem by using the ArcGIS "rubbersheet" option to select multiple control points for lake polygons, which were referenced to the positions of larger lakes on the independent coverages. Using the CBMT layer as a base layer, we placed displacement links along the Athabasca River and lakes (e.g., Gregoire Lake, Namur Lake, and McClelland Lake). As much as possible, adjustment links were applied evenly across the eight map sheets to limit the amount of influence from an individual displacement link. If shifts were found after close inspection, minor lakes and rivers were used to correct them. After the adjustments were finalized, we inspected the soils map in Google Earth to verify that the spatial adjustments correlated well with aerial photos of the region.

Adjusting the positions of many of the soil polygons to align with the boundaries of water bodies derived from CBMT and Google Maps has subjectively improved the accuracy of the mapped soil polygons. However, even the lines marking polygon boundaries on the original map sheets are up to 30 m wide, so some uncertainty in the digitized polygons is inevitable.

Users of the digital soils product should be aware of this limitation. For very detailed assessment of soil polygon boundaries, users are encouraged to check the positions of our mapped lake polygons with independent hydrological data, such as CBMT, and adjust the positions as necessary. For example, small areas could be clipped from the AOSERP study area coverage, and the boundaries of water bodies could be used as control points to position the soil polygons more precisely.

ACKNOWLEDGMENTS

The Alberta Oil Sands Digital Soils Inventory owes its existence to the efforts of many soils researchers and technical support personnel working during the 1970s and 1980s. The original soils research project LS 2.1 was funded by the Alberta Oil Sands Environmental Research Program (AOSERP). The final AOSERP Report 122 was prepared by L. W. Turchenek and J. D. Lindsay, who recognized contributions from Debbie Ben-Oliel, Joe Beres, Bettina Chong, Jarka Dlask, Matt Fairbarns, Bill Grbavac, Pal Hooper, Judy Lorinczi, Dan McCarthy, Wayne McKean, Wayne Pettapiece, Alex Schwarzer, Darrell Skinner, Connie Smith, Graeme Spiers, Charles Tarnocai, and Haluk Yuksel, as well as Dirk Hadler and the staff of AOSERP.

Advice on the recognition and attribution of past work and suggestions for distribution were provided by David Spiess, Environmental Stewardship Branch, Alberta Forests, Edmonton, and by Dave Howlett and David Lee, Canadian Soil Information Service, Agriculture and Agri-Food Canada, Ottawa. Cindy Shaw, David Paré, and Nicolas Mansuy, all of Canadian Forest Service, provided helpful comments on the first draft of this report.

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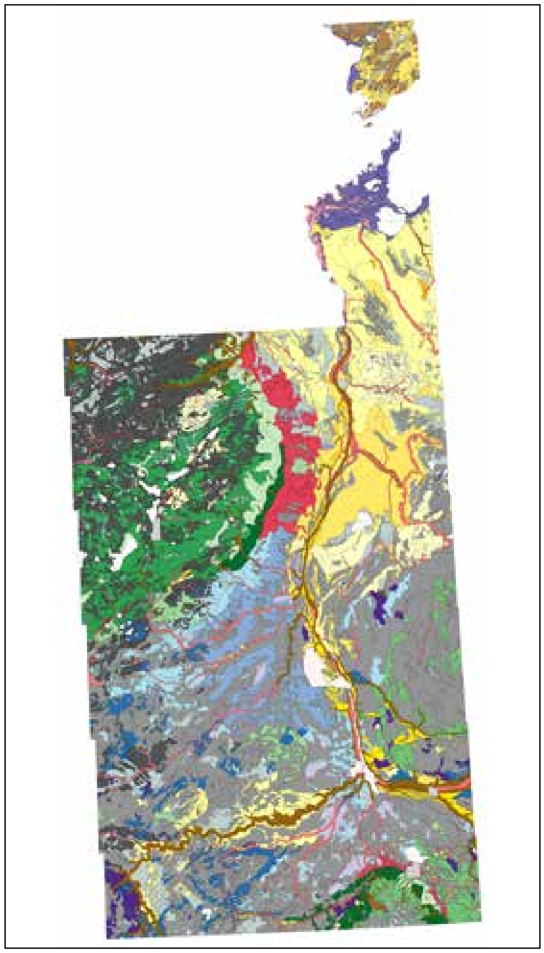
APPENDIX 1.
METADATA FOR SHAPEFILE COVERAGE

Data on soil polygon attributes (AOSERP Report 122, Tables 9, 11, 12, 13)



Tags: Alberta, soils map, Fort McMurray, AOSERP

Summary

The Alberta Oil Sands Digital Soils Inventory is a spatial data set derived from the Soils Inventory of the Alberta Oil Sands Environmental Research Program (AOSERP) study area, prepared by Turchenek and Lindsay (1982) for AOSERP and published in the form of a report (AOSERP Report 122) and accompanying soils map sheets.

Description

A soils inventory of the AOSERP study area was initiated in 1976. Soil profiles were classified according to the Canadian system of soil classification (Canada Soil Survey Committee 1998) using an ecological framework based on interpretation of aerial photographs. The classified profiles were mapped at a final scale of 1:126,720. Eight adjoining soils map sheets were created using base maps provided by Alberta Energy and Natural Resources. The survey methodology, soil profile descriptions, and other information were published as AOSERP Report 122 (Turchenek and Lindsay 1982), which should be used as the reference for the digital soils data. The digital soils inventory consists of soil polygons with a linked table of soil attributes.

Data Definitions from AOSERP Report 122 (Turchenek and Lindsay 1982)

SoilType	Soil type
SoilGroup	Soil group
DomSoilU	Dominant soil unit (see AOSERP Report 122, Table 9)
SubSoilU	Subordinate soil unit
SubSoilU2	Additional subordinate soil unit
SurfaceExp	Surface expression (see AOSERP Report 122, Table 9)
MapSheet	Map sheet (1 to 8)
AreaHa	Area of soil polygon (ha)
GeneticMat	Genetic material
DomOrder	Order of dominant soil
DomDesc	Dominant soils description (> 40% of the area)
SignifDesc	Significant soils description (15%–40% of the area)
Inclusions	Inclusions description (< 15% of the area)
SurfDesc	Surface description
TextClass	Texture class
ClayPct	Percent clay
SandPct	Percent sand
PeatySurf	Thickness of the peaty layer
SlopePct	Slope angle (%)
Drainage	Drainage class
Perm	Permeability class (see also AOSERP Report 122, Table 12, Perviousness)
MoistStat	Moisture status
OrgThick	Thickness of organic layer
ErosionHaz	Soil potential erosion hazard (see AOSERP Report 122, Table 9)
WindHaz	Potential windthrow hazard
WHC	Moisture holding capacity
SensToAcid	Relative sensitivity to acid deposition
L1_React	Layer 1 reaction (see AOSERP Report 122, Table 11)
L1_pH	Layer 1 pH range
L1_BufCap	Layer 1 buffering capacity
L2_React	Layer 2 reaction (see AOSERP Report 122, Table 11)
L2_pH	Layer 2 pH range
L2_BufCap	Layer 2 buffering capacity
L3_React	Layer 3 reaction (see AOSERP Report 122, Table 11)
L3_pH	Layer 3 pH range
L3_BufCap	Layer 3 buffering capacity
L4_React	Layer 4 reaction (see AOSERP Report 122, Table 11)
L4_pH	Layer 4 pH range
L4_BufCap	Layer 4 buffering capacity

Credits

There are no credits for this item.

Use limitations

There are no access and use limitations for this item.

Metadata

Keywords	Alberta, soils inventory, surficial geology, maps, oil sands
Content type	Downloadable data

Citation

Title	AOSERP digital soils
Alternate titles	Digital soils data for the Alberta Oil Sands Environmental Research Program (AOSERP) study area
Creation date	2017-10-03 00:00:00
Presentation formats	Digital map

Citation Contacts

Responsible party	Digital coverage created by G.S. Soundarapandian, E.H.Y. Li, B. Lu, B.D. Pinno, D.T. Price, 2017, Natural Resources Canada, Northern Forestry Centre, Edmonton, Alberta, Canada.
Corresponding author	David Price (david.price@canada.ca)
Organization's name	Natural Resources Canada
Data sources	Soil information collected by Soils Department, Alberta Research Council (ARC), 1982. Base maps provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Maps compiled by ARC and published by Research Management Division, Alberta Environment. Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area, AOSERP Report 122 (Turchenek and Lindsay 1982) http://sis.agr.gc.ca/cansis/publications/surveys/ab/ab42/index.html

Locale

Location	Fort McMurray, AB, Canada

Resource Details

Data set languages	English (Canada)
Data set character set	UTF8
Spatial representation type	Shapefile
Processing environment	Microsoft Windows 7 Version 6.1 (Build 7601) service pack 1; ESRI ArcGIS 10.0.5.4400
ArcGIS item properties name	AOSERP_soils_map

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Bounding rectangle	
Extent type	Extent used for searching
West longitude	–113.0
East longitude	–110.8
North latitude	59.0
South latitude	56.2
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Extent in the item's coordinate system	
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North latitude	6544926.43
Extent contains the resource	Yes

Spatial Reference

ArcGIS coordinate system	
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Geographic coordinate reference	GCS_North_American_1983
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Distribution

Distribution format	
Name	Shapefile data set
Row count	4847

Field	SoilType
Alias	Soil type
Data type	String
Width	254
Precision	0
Field description	Mineral soils have 4 layers (L1 to L4) Organic soils have 3 layers (L1 to L3) See Turchenek and Lindsay (1982), AOSERP Report 122, Tables 12 and 13.

Field	SoilGroup
Alias	Soil group
Data type	String
Width	254
Precision	0
Field description	A soil group is a group of closely related soils developed on similar parent materials under somewhat similar climatic conditions. This definition is adapted from Twardy and Corns (1980), as applied to the soil survey of the Wapiti area, Alberta. The soil group is strictly a mapping convenience used to bring together various collections of soils. Soil groups are named after the predominant soil in each group, and the names were taken from geographic features in the study area. The names of soil groups Heart, Kenzie, and Eaglesham were adopted from previous soil survey projects. Different names are used for soils in different soil orders (at a different level of taxonomy), even when these soils were developed on the same parent materials. Each soil group may contain several soils, but the full range may not be found everywhere in a given landscape. The soil groups are therefore subdivided into "soil units" that are found in predictable geographic associations but that have distinct profile morphologies and drainage regimes.

Field	DomSoilU
Alias	Dominant soil unit
Data type	String
Width	254
Precision	0
Field description	Dominant soil units occupy more than 40% of the soil polygon area. In most cases, only one soil is dominant. Where two or more soils are listed as "dominant," these soils together make up more than 40% of the soil unit; where they are listed as "significant," they make up 15% to 40% of the soil unit. "Soil units are areal subdivisions of soil groups such that, within a given soil unit, they identify both the group and the proportions of the soils within the unit, along with the relative landscape and consequent drainage conditions" (Twardy and Corns 1980). Because of the low intensity level of this survey, a maximum of three soil units was recognized within a single soil group.

Field	SubSoilU
Alias	Subordinate soil unit
Data type	String
Width	254
Precision	0
Field description	Subordinate soil units occupy less than 40% of the soil polygon area.
Field	SurfExp
Alias	Surface expression
Data type	String
Width	254
Precision	0
Field description	The surface expression of genetic materials is a description of form (assemblage of slopes) and pattern of forms. Form, as applied to unconsolidated deposits, refers to the product of the initial mode of origin of the materials and to the product of their modification by geological processes. Surface expression also describes how unconsolidated genetic materials relate to the underlying unit.

Field	MapSheet
Alias	Map sheet
Data type	Integer
Width	10
Precision	1
Field description	Map sheet origin (1 to 8) of the soil polygon.

Field	AreaHa
Alias	Area of soil polygon (ha)
Data type	Double
Width	20
Precision	5
Field description	Size of the soil polygon in hectares.

Field	GeneticMat
Alias	Genetic material
Data type	String
Width	254
Precision	0
Field description	Generalized profile characteristics are presented, along with parent genetic material and landform surface expression on which the soils are found.

Field	DomOrder
Alias	Order of dominant soil
Data type	String
Width	254
Precision	0
Field description	Canadian system of soil classification at the order level for the dominant soil.

Field	DomDesc
Alias	Dominant soils description
Data type	String
Width	254
Precision	0
Field description	Dominant soils occupy more than 40% of soil polygon area.

Field	SignifDesc
Alias	Significant soils description
Data type	String
Width	254
Precision	0
Field description	Significant soils occupy 15% to 40% of soil polygon area.

Field	Inclusions
Alias	Inclusions description
Data type	String
Width	254
Precision	0
Field description	Inclusions occupy less than 15% of soil polygon area.

Field	SurfDesc
Alias	Surface description
Data type	String
Width	254
Precision	0
Field description	The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form, as applied to unconsolidated deposits, refers to the product of the initial mode of origin of the materials, and as applied to unconsolidated materials, refers to the product of their modification by geological processes. Surface expression also describes how unconsolidated genetic materials relate to the underlying unit.

Field	TextClass
Alias	Texture class
Data type	String
Width	254
Precision	0
Field description	Reclassified from Genetic Material. Texture class as defined in the Canadian system of soil classification soil texture classification triangle (Canada Soil Survey Committee 1998).

Field	ClayPct
Alias	Percent clay
Data type	Integer
Width	10
Precision	0
Field description	Clay fraction estimated from mid-point of the Texture Class in the Canadian system of soil classification soil texture classification triangle (Canada Soil Survey Committee 1998).

Field	SandPct
Alias	Percent sand
Data type	Integer
Width	10
Precision	0
Field description	Sand fraction estimated from mid-point of the Texture Class in the Canadian system of soil classification soil texture classification triangle (Canada Soil Survey Committee 1998).

Field	PeatySurf
Alias	Thickness of the peaty layer
Data type	String
Width	254
Precision	0
Field description	Description of the unconsolidated soil material, consisting largely of undecomposed, or only slightly decomposed, organic material. Thickness of this layer is presented either as a numeric value in centimetres or a qualitative value (e.g., thin or present).

Field	SlopePct
Alias	Percent slope
Data type	String
Width	254
Precision	0
Field description	Percent slope of the soil unit, classified into 10 categories. The values are a quantification of the dominant, but not necessarily most abundant, slopes within a mapped unit of a local landform (Canada Soil Survey Committee 1998).

Field	Drainage
Alias	Drainage class
Data type	String
Width	254
Precision	0
Field description	The predominant drainage regime within a soil unit, from Turchenek and Lindsay (1982), AOSERP Report 122, Table 9. The drainage classes are explained in the Appendix of Turchenek and Lindsay (1982), AOSERP Report 122, Section 9.3. **Note:** The Dover (DOV1) drainage class is classified as 'well' in Table 9 but 'moderately well to well' in the map legend; we used 'well' in this data set.

Field	Perm
Alias	Permeability class
Data type	String
Width	254
Precision	0
Field description	The permeability rating provides an indication of the ease with which water can pass through the soil and depends on soil porosity or perviousness. The least permeable horizon or layer in a soil usually determines its overall rating.

Field	MoistStat
Alias	Moisture status
Data type	String
Width	254
Precision	0
Field description	The amount of moisture available for plant growth during the growing season. The rating is based on the moisture-holding capacity of soil, inferred from its texture (particle size distribution), as well as on internal and external drainage conditions. Soils are rated as good, moderate, or poor, with wet or dry conditions being given as the reason for poor ratings.

Field	OrgThick
Alias	Thickness of organic layer
Data type	String
Width	254
Precision	0
Field description	Organic materials overlay glacial deposits over a considerable portion of the study area. The only areas with a relatively minor areal extent of organic accumulations are the sandy plains and uplands in the northeastern parts of the study area. Organic deposits are characterized by an accumulation of peat, which, for soil classification purposes, exceeds a minimum thickness of 40 cm.

Field	ErosionHaz
Alias	Soil potential erosion hazard
Data type	String
Width	254
Precision	0
Field description	Soil erosion hazard is the expected rapidity and amount of soil loss due to wind or water or both that following removal of the protective vegetative cover in areas where proper erosion control measures are not implemented (Dumanski et al. 1972). Extensive areas of sandy soils in the study area are vulnerable to wind erosion. Two large, active sand dune areas and numerous small blowouts suggest that wind erosion should be a major concern if vegetative cover is disturbed or destroyed.

Field	WindHaz
Alias	Potential windthrow hazard
Data type	String
Width	254
Precision	0
Field description	Potential windthrow hazard refers to the risk of trees being toppled by normal winds as a result of soil characteristics that affect development of tree roots. Some factors that cause shallow rooting are high water tables, impermeable B horizons, and shallow depths to lithic layers. Organic, peaty Gleysolic and Solonetzic soils have high windthrow potentials. Soils in which trees root relatively deeply are described as having moderate or low windthrow potentials in Turchenek and Lindsay (1982), AOSERP Report 122, Table 9. The ratings are inferred from soil properties and from observations of windthrow in the field.

Field	WHC
Alias	Moisture holding capacity
Data type	String
Width	254
Precision	0
Field description	Moisture-holding capacity determines the rate and extent of movement of soil solutions and thus affects factors such as the time dissolved materials and soil particles have to react.

Field	SensToAcid
Alias	Relative sensitivity to acid deposition
Data type	String
Width	254
Precision	0
Field description	Soil groups are classified according to the following three broad categories of sensitivity (Holowaychuk and Lindsay 1980): most sensitive soils, soils of intermediate sensitivity, and least sensitive soils.

Field	L1_React
Alias	Layer 1 reaction (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	The degree of acidity or alkalinity of material in Layer 1 (top layer). Descriptive terms commonly associated with certain ranges in pH are: extremely acid, less than 4.5; very strong acid, 4.5–5.0; strongly acid, 5.1–5.5; moderately acid, 5.6–6.0, slightly acid, 6.1–6.5; neutral, 6.6–7.3; slightly alkaline, 7.4–7.8; moderately alkaline, 7.9–8.4; strongly alkaline, 8.5–9.0; and very strongly alkaline, greater than 9.0.

Field	L1_pH
Alias	Layer 1 pH range (see Turchenek and Lindsay (1982), AOSERP Report 122, Tables 11 and 13).
Data type	String
Width	254
Precision	0
Field description	Reclassification of the L1_React field to pH values based on Turchenek and Lindsay (1982), AOSERP Report 122, Table 11.

Field	L1_BufCap
Alias	Layer 1 buffering capacity (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	Buffering capacity of material in Layer 1. Three ranges of buffering capacity characterize the three broad categories of sensitivity. The buffering capacity is based on cation exchange capacity (CEC) of mineral soils as follows: Low buffering capacity — CEC ≤ 6 me/100 g soil Medium buffering capacity — CEC = 6 to 15 me/100 g soil High buffering capacity — CEC > 15 me/100 g soil Organic soils have very high CEC compared with mineral soils. However, their bulk densities are low; hence, their CEC per unit volume of soil is also relatively low.

Field	L2_React
Alias	Layer 2 reaction (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	The degree of acidity or alkalinity of material in Layer 2 (upper-middle layer). Descriptive terms commonly associated with certain ranges in pH are: extremely acid, less than 4.5; very strong acid, 4.5–5.0; strongly acid, 5.1–5.5; moderately acid, 5.6–6.0, slightly acid, 6.1–6.5; neutral, 6.6–7.3; slightly alkaline, 7.4–7.8; moderately alkaline, 7.9–8.4; strongly alkaline, 8.5–9.0; and very strongly alkaline, greater than 9.0.

Field	L2_pH
Alias	Layer 2 pH range (see Turchenek and Lindsay (1982), AOSERP Report 122, Tables 11 and 13).
Data type	String
Width	254
Precision	0
Field description	Reclassification of the L2_React field to pH values based on Turchenek and Lindsay (1982), AOSERP Report 122, Table 11.

Field	L2_BufCap
Alias	Layer 2 buffering capacity (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	Buffering capacity of Layer 2 (upper-middle layer). Three ranges of buffering capacity characterize the three broad categories of sensitivity. The buffering capacity is based on cation exchange capacity (CEC) of mineral soils as follows: Low buffering capacity — CEC ≤ 6 me/100 g soil Medium buffering capacity — CEC = 6 to 15 me/100 g soil High buffering capacity — CEC > 15 me/100 g soil Organic soils have very high CEC compared with mineral soils. However, their bulk densities are low; hence, their CEC per unit volume of soil is also relatively low.

Field	L3_React
Alias	Layer 3 reaction (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	The degree of acidity or alkalinity of a soil in Layer 3 (lower-middle layer of mineral soils, bottom layer of organic soil profiles). Descriptive terms commonly associated with certain ranges in pH are: extremely acid, less than 4.5; very strong acid, 4.5–5.0; strongly acid, 5.1–5.5; moderately acid, 5.6–6.0, slightly acid, 6.1–6.5; neutral, 6.6–7.3; slightly alkaline, 7.4–7.8; moderately alkaline, 7.9–8.4; strongly alkaline, 8.5–9.0; and very strongly alkaline, greater than 9.0.

Field	L3_pH
Alias	Layer 3 pH range (see Turchenek and Lindsay (1982), AOSERP Report 122, Tables 11 and 13).
Data type	String
Width	254
Precision	0
Field description	Reclassification of the L3_React field to pH values based on Table 11.

Field	L3_BufCap
Alias	Layer 3 buffering capacity (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	Buffering capacity of Layer 3 (lower-middle layer of mineral soils, bottom layer of organic soil profiles). Three ranges of buffering capacity characterize the three broad categories of sensitivity. The buffering capacity is based on cation exchange capacity (CEC) of mineral soils as follows: Low buffering capacity — CEC ≤ 6 me/100 g soil Medium buffering capacity — CEC = 6 to 15 me/100 g soil High buffering capacity — CEC > 15 me/100 g soil Organic soils have very high CEC compared with mineral soils. However, their bulk densities are low; hence, their CEC per unit volume of soil is also relatively low.

Field	L4_React
Alias	Layer 4 reaction (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11).
Data type	String
Width	254
Precision	0
Field description	The degree of acidity or alkalinity of a soil in Layer 4 (bottom layer of mineral soil profiles). Descriptive terms commonly associated with certain ranges in pH are: extremely acid, less than 4.5; very strong acid, 4.5–5.0; strongly acid, 5.1–5.5; moderately acid, 5.6–6.0, slightly acid, 6.1–6.5; neutral, 6.6–7.3; slightly alkaline, 7.4–7.8; moderately alkaline, 7.9–8.4; strongly alkaline, 8.5–9.0; and very strongly alkaline, greater than 9.0.

Field	L4_pH
Alias	Layer 4 pH range (see Turchenek and Lindsay (1982), AOSERP Report 122, Tables 11 and 13).
Data type	String
Width	254
Precision	0
Field description	Reclassification of the L4_React field to pH values based on Table 11.

Field	L4_BufCap
Alias	Layer 4 buffering capacity (see Turchenek and Lindsay (1982), AOSERP Report 122, Table 11)
Data type	String
Width	254
Precision	0
Field description	Buffering capacity of Layer 4 (bottom layer of mineral soil profiles). Three ranges of buffering capacity characterize the three broad categories of sensitivity. The buffering capacity is based on cation exchange capacity (CEC) of mineral soils as follows: Low buffering capacity — CEC ≤ 6 me/100 g soil Medium buffering capacity — CEC = 6 to 15 me/100 g soil High buffering capacity — CEC > 15 me/100 g soil

Metadata Contact

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Organization's name	Natural Resources Canada

Literature Cited

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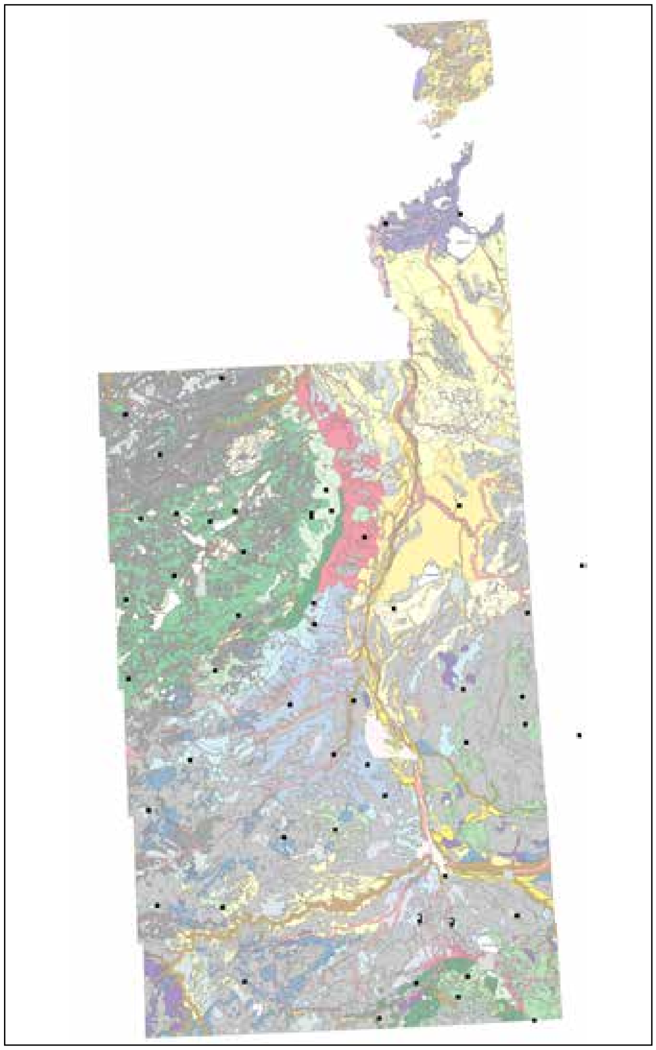
APPENDIX 2.
METADATA FOR POINT COVERAGE



Data from engineering test soil profiles (AOSERP Report 122, Table 10)

Tags: Alberta, soils map, Fort McMurray, AOSERP

Summary

Data on engineering test profiles in the Alberta Oil Sands Environmental Research Program (AOSERP) study area are derived from Table 10 of the Soils Inventory of the AOSERP study area, prepared by Turchenek and Lindsay (1982) for the AOSERP, published as AOSERP Report 122 and accompanying soils maps.

Description

This data set provides soil profile data sampled at representative locations within and surrounding the AOSERP study area. Samples for engineering tests were taken using hand auger from the Bt, BC, or C horizons, mainly at a depth of 1.0 m to 1.5 m. The engineering tests of soil chemistry and physical properties are important in the design, construction, and maintenance of roads, power lines, airfields, buildings, and other facilities.

This data set supplements the Alberta Oil Sands Digital Soils Inventory data sets for the AOSERP study area.

Data Definitions from Table 10 in AOSERP Report 122 (Turchenek and Lindsay 1982)

Soil_Group	Soil group
Lat	Latitude (estimated from legal subdivision address)
Lon	Longitude (estimated from legal subdivision address)
DLS_LSD	Dominion land survey — legal subdivision coordinate system
Site	Site identifier
Horizon	Soil horizon
Depth_cm	Depth of sampled soil
Sieve_1	Percentage passing through 1.0000 inch (25.400 mm) mesh sieve
Sieve_075	Percentage passing through 0.7500 inch (19.000 mm) mesh sieve
Sieve_0625	Percentage passing through 0.6250 inch (16.000 mm) mesh sieve
Sieve_N4	Percentage passing through No. 4 sieve (0.1870 inch; 4.760 mm mesh)
Sieve_N10	Percentage passing through No. 10 sieve (0.0787 inch; 2.000 mm mesh)
Sieve_N40	Percentage passing through No. 40 sieve (0.0165 inch; 0.420 mm mesh)
Sieve_N200	Percentage passing through No. 200 sieve (0.0029 inch; 0.074 mm mesh)
Pct_LT_05	Percentage of particles smaller than 0.050 mm diameter
Pct_LT_002	Percentage of particles smaller than 0.002 mm diameter
Liquid_Lim	Liquid limit
Plasticity	Plasticity index
Class_USDA	Texture class according to United States Department of Agriculture system for describing soil texture. Methodology and classification systems are described in USDA (1971), Portland Cement Association (1956, 1962), and Greenlee (1981).
Class_USCS	Results of tests for Atterberg limits and particle size composition used to classify the soil materials according to the Unified Soil Classification System (USCS). Methodology and classification systems are described in Portland Cement Association (1956, 1962) and Greenlee (1981).
Clas_AASHO	Results of tests for Atterberg limits and particle size composition used to classify the soil materials according to American Association of State Highway Officials (AASHO, now renamed the American Association of State Highway and Transportation Officials, AASHTO) texture classification system (AASHTO 1991). The methodology and classification systems are also described in Portland Cement Association (1956, 1962) and Greenlee (1981).

Credits

There are no credits for this item.

Use limitations

There are no access and use limitations for this item.

Metadata

Keywords	Alberta, soils inventory, surficial geology, maps, oil sands
Content type	Downloadable data

Citation

Title	AOSERP_engineering_test_data
Alternate titles	Engineering Test Data in the Alberta Oil Sands Environmental Research Program (AOSERP) study area
Creation date	2017-11-28 00:00:00
Presentation formats	Digital map

Citation Contacts

Responsible party	Digital coverage created by G.S. Soundarapandian, E.H.Y. Li, B. Lu, B.D. Pinno, D.T. Price, 2017, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB.
Corresponding author	David Price (david.price@canada.ca)
Organization's name	Natural Resources Canada
Data sources	Soil information collected by Soils Department, Alberta Research Council, 1982. Base maps provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Maps compiled by ARC and published by Research Management Division, Alberta Environment. Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area, AOSERP Report 122 (Turchenek and Lindsay 1982)

Locale

Location	Fort McMurray, AB, Canada

Resource Details

Data set languages	English (Canada)
Data set character set	UTF8
Spatial representation type	Shapefile
Processing environment	Microsoft Windows 7 Version 6.1 (Build 7601) Service Pack 1; ESRI ArcGIS 10.0.5.4400
ArcGIS item properties name	AOSERP_engineering_test_data

Extents

Extent	
Geographic extent	
Bounding rectangle	
Extent type	Extent used for searching
West longitude	–112.881
East longitude	–110.551
North latitude	58.4694
South latitude	56.0934
Extent contains the resource	Yes
Extent in the item's coordinate system	
West longitude	126890.77
East longitude	266533.75
South latitude	6220977.48
North latitude	6485093.36
Extent contains the resource	Yes

Spatial Reference

ArcGIS coordinate system	
Type	Projected
Geographic coordinate reference	GCS_North_American_1983
Projection	ESRI: NAD_1983_10TM_AEP_Resource
	EPSG: 3401 Alberta 10-TM (Resource)

Well-known text

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Distribution

Distribution Format	
Name	Shapefile data set
Row count	59

Field	Soil_Group
Alias	Soil group
Data type	String
Width	254
Precision	0
Field description	A soil group is a group of closely related soils developed on similar parent materials under somewhat similar climatic conditions. This definition is adapted from Twardy and Corns (1980), as applied to the soil survey of the Wapiti area, Alberta. The soil group is strictly a mapping convenience used to bring together various collections of soils. Soil groups are named after the predominant soil in each group, and the names were taken from geographic features in the study area. The names of soil groups Heart, Kenzie, and Eaglesham were adopted from previous soil survey projects. Different names are used for soils in different soil orders (at a different level of taxonomy), even when these soils were developed on the same parent materials. Each soil group may contain several soils, but the full range may not be found everywhere in a given landscape. The soil groups are, therefore, subdivided into "soil units" that are found in predictable geographic associations, but that have distinct profile morphologies and drainage regimes.

Field	Lat
Alias	Latitude
Data type	Double
Width	20
Precision	6
Field description	Latitude units were derived using the SCADALink Locator web-based tool. http://locator.scadalink.com/dls2latlng.html (Accessed 1 Dec. 2017)

Field	Lon
Alias	Longitude
Data type	Double
Width	20
Precision	6
Field description	Longitude units were derived using the SCADALink Locator web-based tool. http://locator.scadalink.com/dls2latlng.html (Accessed 1 Dec. 2017)

Field	DLS_LSD
Alias	Dominion land survey legal subdivision coordinate system
Data type	String
Width	254
Precision	0
Field description	Dominion Land Survey Legal Subdivision Coordinate System units. Latitude and longitude units were derived using the SCADALink Locator web-based tool. http://locator.scadalink.com/dls2latlng.html (Accessed 1 Dec. 2017)

Field	Site
Alias	Test site
Data type	String
Width	254
Precision	0
Field description	Site identifier

Field	Horizon
Alias Soil	Horizon
Data type	String
Width	254
Precision	0
Field description	Soil horizon corresponding to the depth of the soil sample.

Field	Depth_cm
Alias	Soil depth
Data type	String
Width	254
Precision	0
Field description	Using an auger, samples were taken by hand from the Bt, BC, or C horizons, typically at a depth of 1.000 m to 1.500 m. The numerical range of this field is the depth at which the sample was taken.

Field	Sieve_1
Alias	Percentage passing sieve 1.0000 inch
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through 1 inch (25.400 mm) mesh sieve.

Field	Sieve_075
Alias	Percentage passing sieve 0.7500 inch
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through 0.7500 inch (19.000 mm) mesh sieve.

Field	Sieve_0625
Alias	Percentage passing sieve 0.6250 inch
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through 0.6250 inch (16.000 mm) mesh sieve.

Field	Sieve_N4
Alias	Percentage passing sieve No. 4
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through sieve No. 4 (0.1870 inch; 4.760 mm mesh).

Field	Sieve_N10
Alias	Percentage passing sieve No. 10
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through sieve No. 10 (0.0787 inch; 2.000 mm mesh)

Field	Sieve_N40
Alias	Percentage passing sieve No. 40
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through sieve No. 40 (0.0165 inch; 0.420 mm mesh)

Field	Sieve_N200
Alias	Percentage passing sieve No. 200
Data type	Integer
Width	254
Precision	0
Field description	Percentage passing through sieve No. 200 (0.0029 inch; 0.074 mm mesh)

Field	Pct_LT_05
Alias	Percentage smaller than 0.050 mm
Data type	Integer
Width	254
Precision	0
Field description	Percentage of particles smaller than 0.050 mm diameter

Field	Pct_LT_002
Alias	Percentage smaller than 0.002 mm
Data type	Integer
Width	10
Precision	0
Field description	Percentage of particles smaller than 0.002 mm diameter

Field	Liquid_Lim
Alias	Liquid limit
Data type	String
Width	254
Precision	0
Field description	Liquid limit is the water content corresponding to an arbitrary limit between the plastic and the semi-solid states of consistence of a soil. It is the water content at which a soil will just begin to crumble when hand-rolled into a thread approximately 3.000 mm in diameter.

Field	Plasticity
Alias	Plasticity limit
Data type	String
Width	254
Precision	0
Field description	Plasticity limit is the numerical difference between the liquid limit and the plastic limit. Soils with the highest plasticity indexes and clay contents are clayey glaciolacustrine sediments, fluvial materials of the Buckton Plain, and shale subsoils in some morainal deposits. Sands, gravels, and some coarse till materials are non-plastic.

Field	Class_USDA
Alias	USDA classification
Data type	String
Width	254
Precision	0
Field description	United States Department of Agriculture system for describing texture. Methodology and classification systems are described in USDA (1971), Portland Cement Association (1956, 1962), and Greenlee (1981). Most of the subsoils in the AOSERP area are classified as clay loam in the USDA soil texture classification system.

Field	Class_USCS
Alias	Unified classification
Data type	String
Width	254
Precision	0
Field description	Results of tests for Atterberg limits and particle size composition were used to classify the soil materials according to the Unified Soil Classification System (USCS). Methodology and classification systems are described in a publication of the Portland Cement Association (1962) and Greenlee (1981). Most of the subsoils in the AOSERP area are classified as CL in the USCS (see page 157 in Turchenek and Lindsay 1982).

Field	Clas_AASHO
Alias	AASHO classification
Data type	String
Width	254
Precision	0
Field description	Results of tests for Atterberg limits and particle size composition used to classify the soil materials according to American Association of State Highway Officials (AASHO, now renamed the American Association of State Highway and Transportation Officials, AASHTO) texture classification system (AASHTO 1991). The methodology and classification systems are also described in Portland Cement Association (1956, 1962) and Greenlee (1981). Most of the subsoils in the AOSERP area are classified as A-6(4–11) in the AASHO system (see page 157 in Turchenek and Lindsay 1982).

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