MINERAL CHARACTER DETERMINATION

For
Minnesota State School Trust Land Exchange – Case #4558

Nonfederal Land and Mineral Ownership Information

PURPOSE

This mineral character determination report, covering state-owned land parcels located inside or partly inside the Boundary Waters Canoe Area Wilderness (BWCAW), is compiled on behalf of the School Trust Administrator at Minnesota's Department of Natural Resources in response to a request from lands staff at USDA-Forest Service, Superior National Forest. The purpose of the report is to provide a summary of geologic features and mineral occurrence information for State-owned BWCAW land interests, with emphasis on Permanent School Fund lands. While other state-owned BWCAW land interests, including Permanent University Fund lands, State Acquired lands, and Tax Forfeited lands are carried as part of the analysis, and for similar evaluation purposes, these other land classes are counted separately for reporting purposes.

The effective date of this evaluation is March 11, 2014.
Date of this report draft is March 18, 2014.

NONFEDERAL TRACT LOCATION AND STATUS

Parcels evaluated in this report consist of the BWCAW portions of the following five state land classes and other parcels, totaling 107,704.85 deeded acres of surface estate ownership in 3,018 parcels (see attached table). 82,385.69 deeded acres in 2,316 parcels are School Trust lands.

I. School Trust Lands reserved under "An Act to Establish the Territorial Government of Minnesota" passed by Congress March 3, 1849, and subsequently offered as a grant to the State of Minnesota in "The Enabling Act for a State of Minnesota" passed by Congress February 26, 1857 and accepted by the state Constitutional Convention of 1857.

Based on a September 13, 2013 extract from the state's land records system, present-day State surface ownership of these lands within or touching into the BWCAW consists of 1,112 parcels (39,288.76 deeded acres) in sections numbered sixteen and thirty-six, plus 628 indemnity selection parcels (21,265.45 deeded acres) in other sections. These counts represent all parcels granted in sections sixteen and thirty-six plus indemnity selections within or partially in the BWCAW, with the exception of section 36 of Township 65 North, Range 15 West previously reserved by federal forest reservation; and 139 parcels whose State surface ownership has been conveyed to federal entities in previous exchanges dating back to 1951.

These parcels comprise 75% of the State's Permanent School Fund (PSF) lands located within or partly within the BWCAW. The state's land records system identifies these parcels as "TRUST FUND: SCHOOL" and "TRUST FUND: IND SCHOOL" (IND meaning indemnity lands granted due to portions of other sections sixteen and thirty-six otherwise unavailable to the State).

II. **School Trust Lands** granted to the State of Minnesota under the "Swamp Land Act" passed by Congress March 12, 1860, and subsequently designated by the State of Minnesota for school purposes (most recently MN Statutes 2013, Ch. 11A, Sec. 16, Subd. 2).

Based on a September 13, 2013 extract from the state's land records system, present-day state swamplands act surface ownership within or touching into the BWCAW consists of 576 parcels (21,831.48 deeded acres), which is all BWCAW-associated parcels granted under the act, excepting 140 parcels whose State surface ownership has been conveyed to federal entities in previous exchanges dating back to 1951.

These parcels comprise 25% of the State's Permanent School Fund (PSF) lands located within or partly within the BWCAW. The state's land records system identifies these parcels as "TRUST FUND: SWAMP".

III. **University Trust Lands** granted to the State of Minnesota under the Enabling Act of 1857 previously cited, and accepted by the state Constitutional Convention of 1857.

Based on a September 13, 2013 extract from the state's land records system, present-day state surface ownership of lands granted for university purposes (Permanent University Fund (PUF) lands) within or touching into the BWCAW consists of 71 parcels (2,361.36 deeded acres), which is all of the BWCAW-associated parcels granted under the act.

These parcels are included in the analysis for convenience but are counted separately from School Trust (Permanent School Fund (PSF)) land parcels. The state's land records system identifies these parcels as "TRUST FUND: UNIV".

IV. Acquired Forest Lands granted to the State of Minnesota in 1904 for experimental forest purposes (Burntside State Forest).

Based on a September 13, 2013 extract from the state's land records system, present-day state surface ownership of these granted lands (located west and northwest of Burntside Lake) within or touching into the BWCAW consists of 466 parcels (17,217.11 deeded acres), which is all of the BWCAW-associated parcels granted under the act.

These parcels are included in the analysis for convenience but are counted separately from Permanent School Fund (PSF) land parcels. The state's land records system identifies these parcels as "ACQUIRED".

V. Tax Forfeit Lands forfeited to the State of Minnesota for nonpayment of property taxes and held in trust for the local taxing districts.

Based on a September 13, 2013 extract from the state's land records system, present-day state tax forfeit surface ownership within or touching into the BWCAW consists of 164 parcels (5,702.49 deeded acres), which is all of the BWCAW-associated parcels held by the State in trust for the taxing districts (55 in Cook Co., 18 in Lake Co., and 91 in St. Louis Co.), excepting 267 parcels previously exchanged or sold (83 in Cook Co., 165 in Lake Co., and 19 in St. Louis Co.).

These parcels are included in the analysis for convenience but are counted separately from Permanent School Fund (PSF) land parcels. The state's land records system identifies these parcels as "TAX FORFEITED".

VI. Other State Owned Lands The only other parcels of BWCAW-associated State-owned surface or mineral interest listed in the state's land records system and not already described are a parcel at the very northwest corner of the BWCAW listed as a Forestry Division parcel acquired by purchase (SW of NW of Section 6, Township 67 North, Range 16 West, 38.2 deeded acres), and 11 parcels (378 acres) of severed mineral interest ownership gifted to St. Louis County (?), in the vicinity of Trout Lake and Little Trout Lake.

State Ownership Information Used in This Report

The primary source of State ownership information used for this report is a GIS shapefile of "State Lands by Interest Type" as extracted from the state's land records system on September 13, 2013. A similar GIS-based shapefile of state-owned mineral interests entitled "MinOwn", also extracted on September 13, 2013 was used as needed to determine the location and land class of parcels of State-owned mineral interests. Mineral Character of the State-owned lakebeds of meandered waters is not considered in this report.

State-owned surface and mineral interests selected for analysis include those state-owned land parcels located inside or partly inside the BWCAW based on overlap with a GIS shapefile of the BWCAW boundary constructed in-house by MnDNR staff from notes titled "Legal Description of the Boundary Waters Canoe Area Wilderness, Superior National Forest, Minnesota August 1979". The boundary of the BWCAW as described bisects a number of State-owned parcels, including some School Trust (Permanent School Fund (PSF)) land parcels, for instance at the very eastern end of the BWCAW. Given the uncertainty of disposition of the acreage of these parcels as to whether they will be considered in part or in entirety, analysis reported here uses the entirety of the parcels. Most descriptions in this report are in terms of Public Land Survey parcel counts, which are sufficient for present purposes. The GIS surface ownership shapefile has not been checked

for potential isolated cases of duplicate records, which, if present, would cause summation of some parcel acreages to exceed the deeded acreage of the parcel. Such records, if present, are usually due to multiple undivided split ownership interests in tax forfeit land parcels.

Users of this report are further cautioned that an official listing of state-owned parcels touching into or inside the BWCAW should be independently confirmed as part of due diligence title research. While every effort has been made to produce and use accurate GIS data and database records, the state's land records system and the derived GIS shapefiles are not original documents. The possibility of transcription error exists in the state's land records system, and in the derivation of the GIS shapefiles, including the GIS shapefile of the BWCAW boundary.

Previous exchanges of state surface ownership in the BWCAW area began in 1951, some 50 years after implementation of state laws requiring reservation of state-owned mineral rights. As a result, state-owned mineral rights are still present at sites of previous land exchange within the BWCAW, even though the surface estate ownership is now held by the federal government. This is the case for 281 Permanent School Fund severed mineral parcels and 267 Tax Forfeit severed mineral parcels in the BWCAW. The federal government also owns the surface estate for 6 of the 11 parcels of severed mineral rights gifted to St. Louis County.

Mineral Information Used in This Report

Typical Mineral Character Determination reports provide baseline mineral potential descriptions and mineral occurrence information. Most reports additionally evaluate mineral development potential, evaluate likelihood that any of the parties would develop minerals, and evaluate access for development. Federal and State BWCA and BWCAW wilderness policies have restricted or prohibited mineral exploration, evaluation and

development of State-owned land interests located within or partly within the BWCAW for many years. Consequently private and public funding for information gathering to evaluate the likelihood of mineral resource occurrence, potential for mineral development, and likelihood for mineral development have been minimal since these restrictions went into effect, and have not been evaluated in this report. State-owned mineral interests in the BWCAW are under-evaluated with respect to other state-owned mineral interests located outside the BWCAW.

Permanent School and Permanent University Trust lands that host mineral deposits have historically produced the vast majority of revenue principal added to the permanent funds. Most of these parcels that have reached economic production have been considered economically unattractive at one time or another. Short-term and present-day economic parameters are generally insufficient criteria for judging nonrenewable mineral value to the Trusts over the course of a century or more. Parcels that host mineral deposits, and parcels that host incompletely evaluated mineral occurrences, and lands that host potential for additional discovery of mineral deposits are considered key assets from which substantial additions to the permanent funds may be realized over the long term. This approach reflects Minnesota's century-long experience managing Permanent School, Permanent University, Tax Forfeit, and other Acquired lands mineral assets located outside the BWCAW.

The mineral potential of State-owned land and mineral interests in this report is evaluated based on geologic criteria and status of mineral occurrence achieved thus far at sites within and along trend of geologic features in the BWCAW. Present-day development likelihood, present-day feasibility consideration, and present-day access to sites are aspects beyond the scope for this report due to the overriding influence of legislative and policy controls.

Definitions

ISO-31000 risk management terms are used, where possible, to supplant traditional Low-Moderate-High mineral potential vocabulary. Quantitative risk evaluation is beyond the scope of the current analysis, but qualitative aspects of the framework can be applied. In this report, likelihood of mineral resource occurrence (presuming absence of legislative or policy restriction) in a 40-acre parcel is described by the following tier of terms and inferring the following orders of magnitude:

- **Almost Certain** mineral resource likelihood approaches 1:1
- **Likely** mineral resource likelihood at or above 1:10
- **Possible** mineral resource likelihood at or above 1:100
- **Unlikely** mineral resource likelihood at or above 1:1,000
- **Rare** mineral resource likelihood at or above 1:10,000
- **Exceptionally Rare** mineral resource likelihood at or above 1:100,000
- **Almost Random** mineral resource likelihood at or below 1:100,000

Consequence, in terms of royalty revenue per 40-acre parcel, is generally not described in this report, though the general magnitudes of mineral deposit model consequences are considered. Consequence terms, where used, infer the following orders of magnitude:

- **Insignificant** consequence per parcel up to $1,000
- **Minor** consequence per parcel up to $10,000
- **Moderate** consequence per parcel up to $100,000
- **Major** consequence per parcel up to $1,000,000
- **Highly Significant** consequence per parcel up to $10,000,000
- **Exceptionally Significant** consequence per parcel up to $100,000,000
- **Extremely Significant** consequence per parcel above $100,000,000

Risk, the product of Likelihood x Consequence, is defined in two-magnitude steps:

- **Negligible** risk is at or below $0.01 per parcel
- **Inconsequential** risk is at or below $1.00 per parcel
- **Low** risk is at or below $100 per parcel
- **Moderate** risk is at or below $10,000 per parcel
- **High** risk is at or below $1,000,000 per parcel
- **Critical** risk is at or below $100,000,000 per parcel
- **Extreme** risk is above $100,000,000 per parcel

Mineral resource potential of state-owned BWCAW parcels is described in terms of underlying geologic features or trends that may host undiscovered mineral resources. The following terms convey occurrence status achieved thus far for geologic features, trends or rock packages. In the GIS shapefile and in the printed (PSF) table of parcels a status number code is used:

- **Exceptional Resource Potential**	6	parcel is in an established deposit trend
- **High Resource Potential**	5	geologic feature hosts known occurrences
- **Moderate Resource Potential**	2-4	geologic feature hosts occurrence criteria
- **Low Resource Potential**	1	geologic feature hosts very few occurrence criteria

Mineral occurrence status, corresponding to accumulated successful sampling investment at a site, is defined as follows:

- **Deposit** A site of *in situ* mineral occurrence, that has achieved a 3-dimensional volumetric estimate, based on intercepts, expressed in terms of grade and tonnage.

- **Prospect** A site of *in situ* mineral occurrence, that has identified a 2-dimensional area containing intercepts (at least 3), that is prospective for volume.

- **Intercept** A site of *in situ* mineral occurrence, that intercepts occurrence grade material, over an interval length typically greater than 1 meter (approaching minimum mineable width).

- **Showing** A site of found, *in situ*, mineralized material, sufficiently enriched to show that a mineral system has acted with intensity, to yield material of interest, though the dimension of occurrence is unresolved.

- **Anomaly(s)** Geophysical, geochemical or geologic features that may be associated with, or point toward, a site of mineral occurrence.

Refinement of portions of deposits as inferred, indicated or measured resources is unnecessary for purposes of this report and broad scale land use planning, and from the long term viewpoint of perpetual land trusts. The goals of the refined classifications are more associated with details of mine planning and shorter term economic feasibility evaluation.

Each assignment of likelihood or consequence has an attendant uncertainty. Uncertainties associated with these assignments in this report place this overall analysis in the qualitative category. In this report it is recognized that complete understanding of each parcel's potential for hosting mineral resources, and the complete array of applicable mineral deposit types is not yet fully realized. It is also recognized that there are mineral estate details for which speculation is not yet possible, but for which future value may be inherent in the lands.

GEOLOGIC FEATURES AND MINERAL RESOURCE POTENTIAL

Glacially Derived and Post-Glacial Mineral Materials

Newly available State-acquired LIDAR elevation data, viewed as shaded relief imagery, reveals that the BWCAW land area is dominated by a (glacially) scoured bedrock surface. Only a few surface patches exhibit landforms suggestive of glacially-derived material accumulations or possible post-glacial peat accumulations. Minor instances of aggregate (sand and gravel) and peat are almost certainly present but are not easily resolved from the bedrock dominated landforms, even when using the high-resolution elevation imagery. For this reason resource potential for aggregate and peat is considered Low within the BWCAW, except at locations noted below. Detailed terrain analysis and field checking would be required to reduce the uncertainty that any significant (appraisable) aggregate or peat accumulations may have been overlooked in the cursory review.

There are State-owned surface ownership interests in the following Sections that coincide with readily recognizable glacially-derived material landforms. Aggregate occurrences are not yet known in these landforms therefore the aggregate resource potential of these localities is considered Moderate; many border water features:

- Township 67 N, Range 14 W, Section 36 (16 School Trust parcels).

- Township 66 N, Range 5 W, Sections 16, 20 (17 School Trust parcels).
- Township 64 N, Range 7 W, Sections 10, 16 (18 School Trust parcels).
- Township 64 N, Range 11 W, Section 36 (12 School Trust parcels).
- Township 64 N, Range 14 W, Sections 5, 17, 18 (4 School Trust parcels).
- Township 64 N, Range 15 W, Sections 10, 15, 16 (10 School Trust parcels).
- Township 63 N, Range 14 W, Sections 22, 23, 27 (6 Acquired and 2 Tax Forfeit parcels).
- Township 62 N, Range 4 W, Sections 4-9 (18 School Trust and 3 Tax Forfeit parcels).
- Township 62 N, Range 7 W, Section 36 (12 School Trust parcels).
- Township 61 N, Range 6 W, Section 4 (6 School Trust parcels).

Dimensional and Crushed Stone Bedrock Mineral Materials

The glacially-scoured bedrock terrain in the BWCAW, while mostly devoid of significant glacial and postglacial materials, offers some possibility for significant occurrence of dimensional stone or crushed stone mineral resources of unique quality. Detailed inventory information for State-owned BWCAW lands is unavailable. If present, higher quality dimensional materials (wide joint spacing, favorable texture and color) would be expected to be more associated with Quetico granitic bedrock located in St. Louis County, or within intrusive Duluth Complex bedrock located in Lake and Cook Counties (generally south of a line drawn through Birch, Perent, Kekekabic, and Gunflint Lakes).

Two established quarries are present south of the BWCAW in Duluth Complex bedrock (Mesabi Black and Lake Superior Green quarries in Lake County), and one newly developed quarry is located in the Quetico granitic bedrock (Echo Lake quarry near Gustafson Lake in St. Louis County). As a result, resource potential for quality dimensional stone materials in state-owned land interests in the BWCAW is considered High. Potential for occurrence of materials having crushed stone qualities is also considered High in the BWCAW, but such occurrence is considered non-unique as many other potential sites are located outside the BWCAW and closer to potential markets.

Metallic Mineral Bedrock Materials

Metallic mineral resources are known to occur along geologic features that transect northeastern Minnesota and adjacent Ontario. It is not surprising that within the BWCAW these same trends are found to be present. The general framework of northeastern Minnesota geologic features has been reported for more than 100 years (see for instance Winchell, 1899, Geology of Minnesota, Vol. IV). Further detail on mineral occurrence, geologic origin, distribution, and structural dynamics of these geologic features continues to emerge in modern times (for instance see Jirsa, et al, 2010, statewide bedrock geologic map compilation, Minnesota Geological Survey Map S-21, and related aeromagnetic and gravity geophysical datasets). Future revelations undoubtedly await discovery. For purposes of this report the bedrock geologic features of the BWCAW are considered in four major groups. Included with each of the following descriptive texts are links to U.S. Geological Survey or other available Mineral Deposit Models.

Volcanic and Intrusive Rocks of the Midcontinent Rift

The youngest bedrock group in the BWCAW is part of a volcanic and intrusive rock package emplaced during a period of tectonic rifting in the mid-continent, recognized to extend from Ontario/Michigan through Minnesota/Wisconsin, through Iowa, and as far south as Kansas. This bedrock group hosts copper-nickel-platinum group element magmatic deposits, titanium-bearing magmatic deposits, sediment-hosted copper deposits, native copper deposits, and 5-element silver-nickel-cobalt vein type deposits, and possibly other as-yet unrecognized types of deposits.

Within the BWCAW, the basal trend of the Duluth Complex is known to host occurrences of copper-nickel mineralization, and known resources are being actively evaluated along trend both southwest and northeast of the wilderness. The mineralized basal trend of the Duluth Complex is informally identified as extending 3 miles into the Duluth Complex and ½ mile outside the Duluth Complex. The three mile inside portion of the trend generally corresponds to the cutoff extent of mineral exploration drill sampling, which becomes cost

prohibitive once the basal zone becomes covered by more than several thousand feet of un-mineralized bedrock. The ½ mile outside portion of the trend accommodates the fact that mineralized materials have been found to be injected into zones beneath the Duluth Complex rock package, and the likelihood that the pre-erosional extent of the Duluth Complex may have reached some distance beyond the presently mapped contact location.

Given that the basal Duluth Complex mineralized trend hosts known deposits, resources and reserves outside the BWCAW, and incompletely evaluated occurrences are present along this trend inside the BWCAW (see 1974 BWCAW Management Plan, Exhibit 8), it is considered likely that the status of copper-nickel-platinum group mineral occurrences in the BWCAW would be increased if additional evaluation occurred, possibly extending the status of some occurrences in the basal trend into the deposit category. State-owned parcels associated with this basal trend and the Early Layered Series rock units are considered to have Exceptional resource potential. The following U. S. Geological Survey mineral deposit model is applicable:

- Zientek, M. L., 2012, Magmatic Ore Deposits in Layered Intrusions – Descriptive Model for Reef-Type PGE and Contact-Type Cu-Ni-PGE Deposits: U.S. Geological Survey Open-File Report 2012-1010, 48 p.
  http://pubs.usgs.gov/of/2012/1010/contents/OF12-1010.pdf

Potential for occurrence of titanium-bearing mineral resources is also considered Exceptional, given known occurrences within BWCAW and known deposits along the basal Duluth Complex trend outside BWCAW (Longnose, TiTac north, TiTac south, Section 17, Waterhen, Skibo and others). State-owned parcels along this trend are considered to have Exceptional mineral resource potential. The following U. S. Geological Survey mineral deposit model is applicable:

- Woodruff, L. G., Nicholson, S. W., and Fey, D. L., 2013, A Deposit Model for Magmatic Iron-Titanium-Oxide Deposits Related to Proterozoic Massif Anorthosite Plutonic Suites: U.S. Geological Survey Scientific Investigations Report 2013-5091, 47 p.
  http://pubs.usgs.gov/sir/2013/5091/SIR13-5091.pdf

Sediment-hosted copper, native copper, and 5-element silver-nickel-cobalt vein deposits are known in the volcanic rock package outside BWCAW, but significant deposits and occurrences are not yet known inside BWCAW. The volcanic rock package in the southern part of BWCAW in Cook County is considered to have Moderate potential for hosting copper occurrences, and the eastern end of BWCAW in Cook County is considered to have Moderate-High potential for hosting 5-element vein-type deposits (Spaulding silver prospect at Spaulding Lake). The following Ontario Geological Survey mineral deposit models are applicable:

- Rogers, M. C., Thurston, P. C., Fyon, J. A., Kelly, R. I., and Breaks, F. W., 1995, Descriptive Mineral Deposit Models of Metallic and Industrial Deposit Types and Related Mineral Deposit Potential Assessment Criteria: Model A-25, Cobalt Type Silver-Sulfarsenide Vein Deposits: Ontario Geological Survey Open-File Report 5916, pp. 133-136. http://www.geologyontario.mndmf.gov.on.ca/mndmfiles/pub/data/imaging/OFR5916/OFR5916.pdf

- Rogers, M. C., Thurston, P. C., Fyon, J. A., Kelly, R. I., and Breaks, F. W., 1995, Descriptive Mineral Deposit Models of Metallic and Industrial Deposit Types and Related Mineral Deposit Potential Assessment Criteria: Model A-8, Sedimentary-Hosted Copper Deposits: Ontario Geological Survey Open-File Report 5916, pp. 43-47. http://www.geologyontario.mndmf.gov.on.ca/mndmfiles/pub/data/imaging/OFR5916/OFR5916.pdf

- Cox, D. P., Model 23, Descriptive Model of Basaltic Cu, in Cox, D. P., and Singer, D. A., Mineral Deposit Models - U. S. Geological Survey Bulletin 1693, p. 130. http://pubs.usgs.gov/bul/b1693/Md23.pdf

Areas beyond the main mass of rift-related bedrock host potential for occurrence of higher grade, early, rift-related copper-nickel-platinum group metal deposits such as the Tamarack and Eagle deposits in Minnesota and northern Michigan. Potential for occurrence of such geologic features and deposits is considered Moderate. The following U. S. Geological Survey mineral deposit model is applicable:

- Schulz, K. J., Chandler, V. W., Nicholson, S. W., Piatak, Nadine, Seall, II, R. R., Woodruff, L. G., and Zientek, M. L., 2010, Magmatic Sulfide-Rich Nickel-Copper Deposits Related to Picrite and (or) Tholeiitic Basalt Dike-Sill Complexes - A

Preliminary Deposit Model: U.S. Geological Survey Open-File Report 2010-1179, 25 p. http://pubs.usgs.gov/of/2010/1179/pdf/ofr2010-1179.pdf

Portions of the Duluth Complex bedrock group located more than 3 miles inside the Duluth Complex contact are covered by the "anorthositic" rock series of the Duluth Complex or patches of volcanic cover rocks, neither of which are known to host metallic mineralization. It is clear in aeromagnetic geophysical imagery that a variety of geologic features are present (probably Duluth Complex Early Layered Series rocks) beneath the cover rocks. There has been little evaluation of geologic features and metallic mineral resource potential for features beneath the cover rocks. Given the fact that known mineralization is found beneath similar cover rocks outside the BWCA and that aeromagnetic features in the Lake County portion of the "anorthositic" block are nearly identical to features containing mineralized rock west of the BWCAW, the metallic mineral resource potential of geologic features beneath these cover rocks in Lake County is rated as Moderate-High. The following U. S. Geological Survey mineral deposit model is likely applicable:

- Zientek, M. L., 2012, Magmatic Ore Deposits in Layered Intrusions – Descriptive Model for Reef-Type PGE and Contact-Type Cu-Ni-PGE Deposits: U.S. Geological Survey Open-File Report 2012-1010, 48 p. http://pubs.usgs.gov/of/2012/1010/contents/OF12-1010.pdf

Lightly Metamorphosed Sedimentary Rocks of the Animikie Group

The second youngest bedrock group in the BWCAW is made up of a sequence of lightly metamorphosed sedimentary rocks including one iron-bearing unit known as the Gunflint or Biwabik iron formation, which accounts for more than 80% of the domestic iron supply in North America. The Biwabik iron formation extends southwest of the BWCAW; the Gunflint iron formation extends well into Ontario. In the BWCAW, the sedimentary rock package that includes the Gunflint iron formation lies sandwiched between the younger rift-related volcanic and intrusive rocks, and much older "greenstone belt" rocks.

The Gunflint formation is exposed along Seahorse, Warclub, Fay, Mine, Paulson, Magnetic and Gunflint Lakes. Historic workings and at least three shafts, as well as an historic

railroad grade extending into the area from the city of Thunder Bay, Ontario are known to the Forest Service, reaching into the vicinity of Mine Lake (Paulson Mine and vicinity). Rove-Virginia formation rock that overlies the Gunflint formation is considered have Low potential to host iron resources.

The Gunflint iron formation contains known occurrences and past mine workings so is considered to have High potential to host iron deposits. The Rove formation meta-sedimentary rock units the BWCAW located north of the Gunflint corridor are intruded by younger intrusive rocks of the mid-continent rift group (the Logan sills). These inter-layered Rove-Logan rocks have Moderate potential to host 5 element silver-nickel-cobalt vein deposits similar to those historically mined near Thunder Bay, Ontario; and Moderate potential exists for these rocks to host copper-nickel-platinum group metal deposits. The following U. S. Geological Survey mineral deposits model are applicable:

- Du Bray, Edward A., Editor, Preliminary Compilation of Descriptive Mineral Geoenvironmental Mineral Deposit Models: U.S. Geological Survey Open-File Report 95-831 - Superior Fe Deposits, Model 34a; by Cannon, W. F., Hadley, D. G., and Horton, R. J., pp. 252-256. http://pubs.usgs.gov/of/1995/ofr-95-0831/CHAP32.pdf

- Schulz, K. J., Chandler, V. W., Nicholson, S. W., Piatak, Nadine, Seall, II, R. R., Woodruff, L. G., and Zientek, M. L., 2010, Magmatic Sulfide-Rich Nickel-Copper Deposits Related to Picrite and (or) Tholeiitic Basalt Dike-Sill Complexes - A Preliminary Deposit Model: U.S. Geological Survey Open-File Report 2010-1179, 25 p. http://pubs.usgs.gov/of/2010/1179/pdf/ofr2010-1179.pdf

Highly Metamorphosed Sedimentary and Granitic Rocks of the Quetico Subprovince

The third bedrock group in the BWCAW covers a large part of the St. Louis County portion of the BWCAW and is composed of a sequence of more highly metamorphosed sedimentary and granitic rocks that in some cases have been sufficiently heated to partially melt the original sedimentary rock units. This sequence of bedrock units is collectively identified as the Quetico Subprovince of the Superior craton.

Near the southern subprovince boundary (generally near lakes Vermilion, Burntside and Basswood) mineral deposit models indicate potential for occurrence of gold deposits and rare metal deposits in pegmatites. Gold prospects, intercepts and showings are found south and west of BWCAW along this boundary, and numerous deposits, prospects, intercepts and showings are found along the same trend on the north side of the BWCAW in Ontario. Potential for gold resources is considered High where this trend occurs within the BWCAW.

Rare metal deposits are also known along and near similar subprovince boundaries, associated with granitic intrusions; none are yet recognized adjacent to or within the BWCAW. Potential for occurrence of rare metal resources in the BWCAW is considered to be Moderate. Historical lake sediment sampling in the Johnson Lake area west of the BWCAW shows some low level metal anomalies (U) in the vicinity of partially melted (migmatite) and pegmatitic granitic rock units, but whether these anomalies are due to rare metal pegmatites or other metallic mineral accumulations is unknown. The following U. S. Geological Survey mineral deposits are applicable:

- Klein, T. L., and Day, W. C., 1994, Descriptive and Grade-Tonnage Models of Archean Low-Sulfide Au-Quartz Veins and a Revised Grade-Tonnage Model of Homestake Au: U.S. Geological Survey Open-File Report 94-250 http://pubs.usgs.gov/of/1994/ofr-94-0250/Of94-250.PDF

- Bradley, Dwight, and McCauley, Andrew, 2013, A Preliminary Deposit Model for Lithium-Cesium-Tantalum (LCT) Pegmatites: U.S. Geological Survey Open-File Report 2013-1008, 7 p. http://pubs.usgs.gov/of/2013/1008/OF13-1008.pdf

Volcanic, Intrusive and Sedimentary Rocks of the Wawa Subprovince

The fourth and oldest bedrock group in the BWCAW is composed of a sequence of lightly metamorphosed volcanic, intrusive and sedimentary bedrock units collectively identified as belonging to the Wawa Subprovince of the Superior craton. This rock package is locally referred to as the Vermilion greenstone belt in Minnesota, and as the Shebandowan greenstone belt in Ontario. The greenstone belt is known to host deposits and occurrences of Algoma-type iron formation (including historical mines in the Soudan area, and historical

mines located at Ely, Minnesota). The belt also hosts deposits, prospects and other occurrences of gold mineralization, and hosts prospects, intercepts and showings of volcanic-hosted zinc copper mineralization. The Wawa Subprovince in the BWCAW is considered to have High potential to host metallic mineral resources of these varieties, and the Quetico Subprovince rocks adjacent to the Wawa-Quetico subprovince boundary are considered to have High potential for hosting gold mineralization within two miles of the subprovince boundary.

- Klein, T. L., and Day, W. C., 1994, Descriptive and Grade-Tonnage Models of Archean Low-Sulfide Au-Quartz Veins and a Revised Grade-Tonnage Model of Homestake Au: U.S. Geological Survey Open-File Report 94-250 http://pubs.usgs.gov/of/1994/ofr-94-0250/Of94-250.PDF

- Shanks, W. C. Pat, III, and Thurston, Roland, eds., Volcanogenic Massive Sulfide Occurrence Model: U.S. Geological Survey Scientific Investigations Report 2010-5070-C, 345 p. http://pubs.usgs.gov/sir/2010/5070/c/SIR10-5070-C.pdf

- Du Bray, Edward A., Editor, Preliminary Compilation of Descriptive Mineral Geoenvironmental Mineral Deposit Models: U.S. Geological Survey Open-File Report 95-831 - Superior Fe Deposits, Model 28b; by Cannon, W. F., Hadley, D. G., and Horton, R. J., pp. 209-213. http://pubs.usgs.gov/of/1995/ofr-95-0831/CHAP27.pdf

Acquired Liabilities

Historical prospect pits may be encountered associated with early exploration reconnaissance activities conducted prior to establishment of the BWCAW or its precursor management units. An archeological inventory of such pits is not known to exist. A MnDNR report entitled “A Compilation of Ore Mineral Occurrences, Drill Core, and Test Pits in the State of Minnesota; literature search on publicly reported mineral occurrences” (Martin, D. P., 1985, 360 p. and 4 plates) identifies two test pits on state-owned land interests in the BWCAW, one in Township 63 North, Range 14 West, Section 16, and one in Township 65 North, Range 5 West, Section 13. The report also lists 20 historical drill hole locations in the BWCAW, but none on state-owned land interests in the BWCAW.

Geologic Sources for Report

The analysis is based on research of geological literature, maps, and the author's personal knowledge of the area. The sources used are published by State or Federal agencies, Universities, and private individuals, or are from collections of mineral exploration data held at the Minnesota Department of Natural Resources, or from news releases and technical reports of exploration activities. No field work was conducted to determine any of the conclusions.

References Cited

(See citations at appropriate sites within the report).

/S/ SIGNATURE

(Insert Title…State of MN) Geologist

Date

I review and concur with the content of the nonfederal Mineral Character Determination and recommend incorporating it into the Final MCD for this project.

/S/ SIGNATURE

Forest Geologist

Superior National Forest

Date

Plate I. Mineral Character Determination Summary

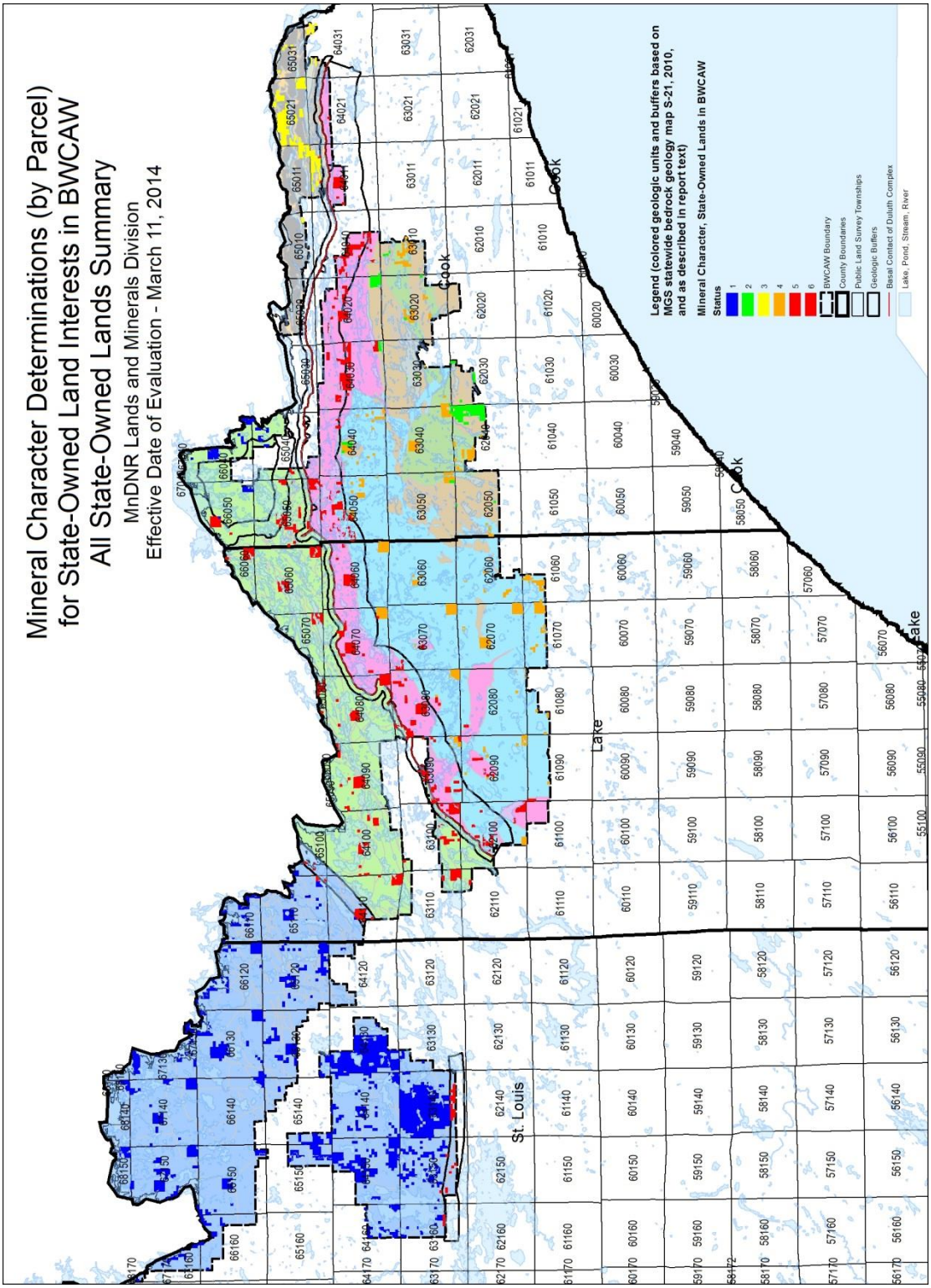

Plate II. Mineral Character Determination–School Trust 16/36/Indemnity

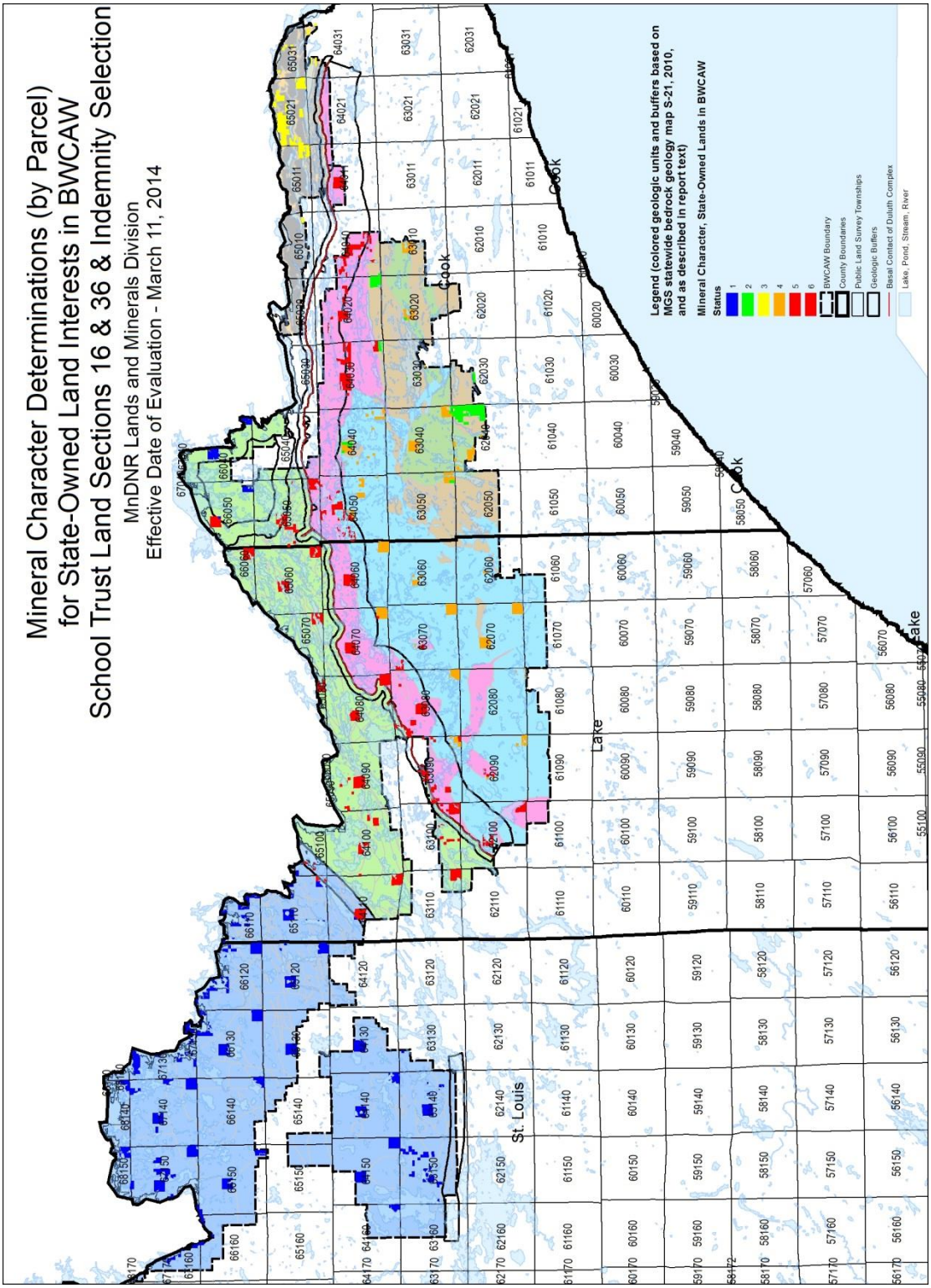

Plate III. Mineral Character Determination–School Trust Swamp

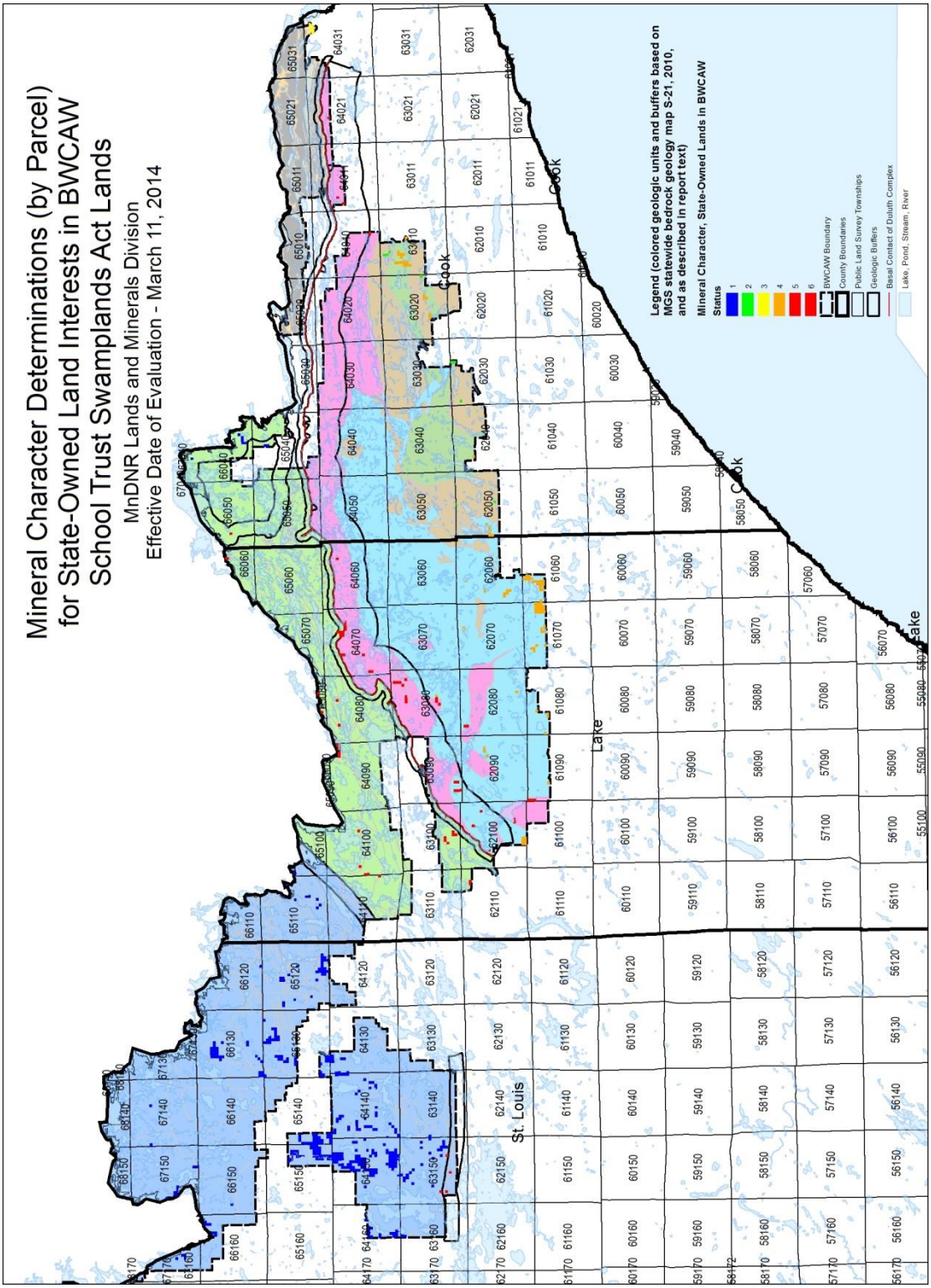

Plate IV. Mineral Character Determination–University Trust

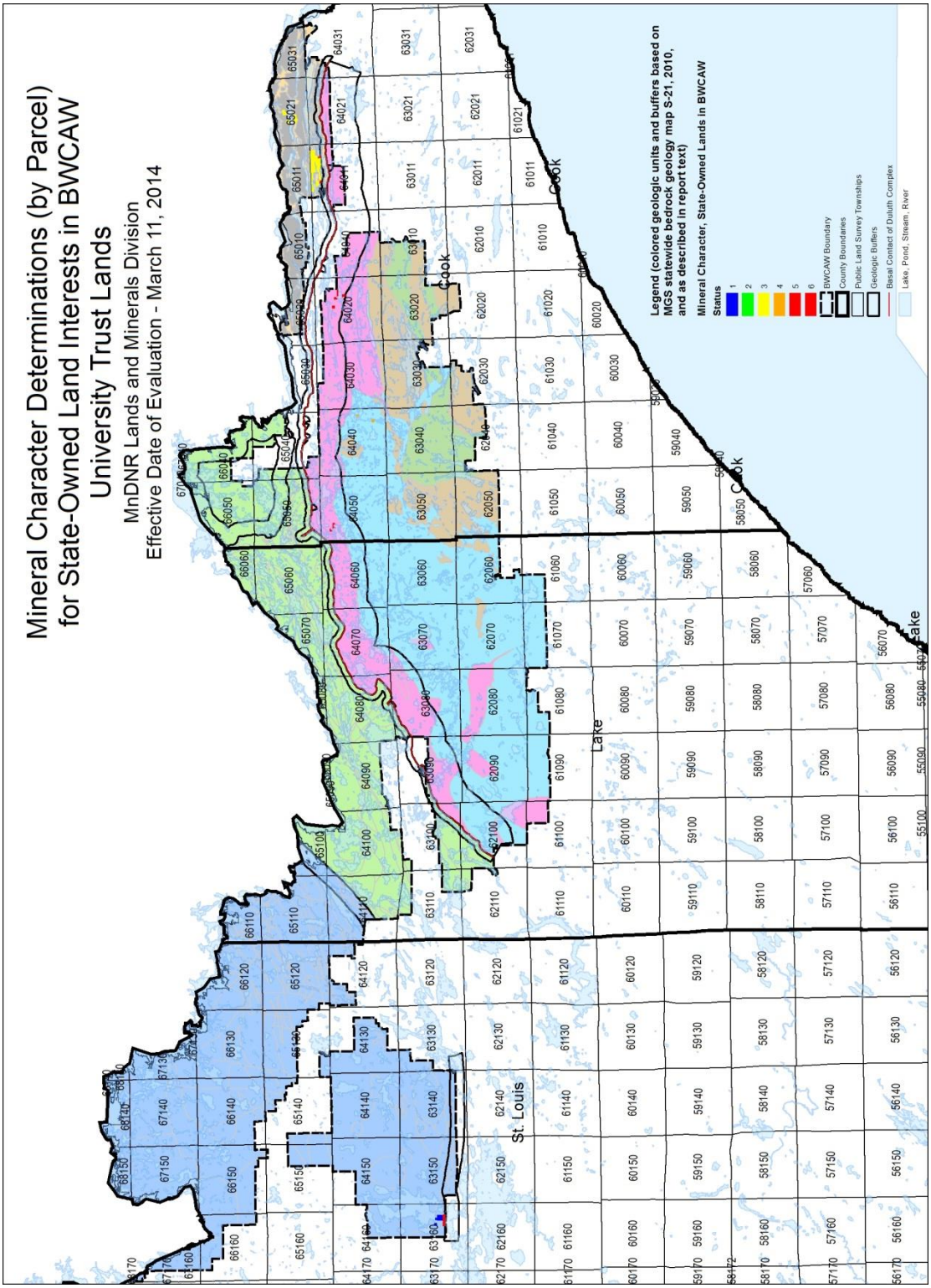

Plate V. Mineral Character Determination–Burntside Forest

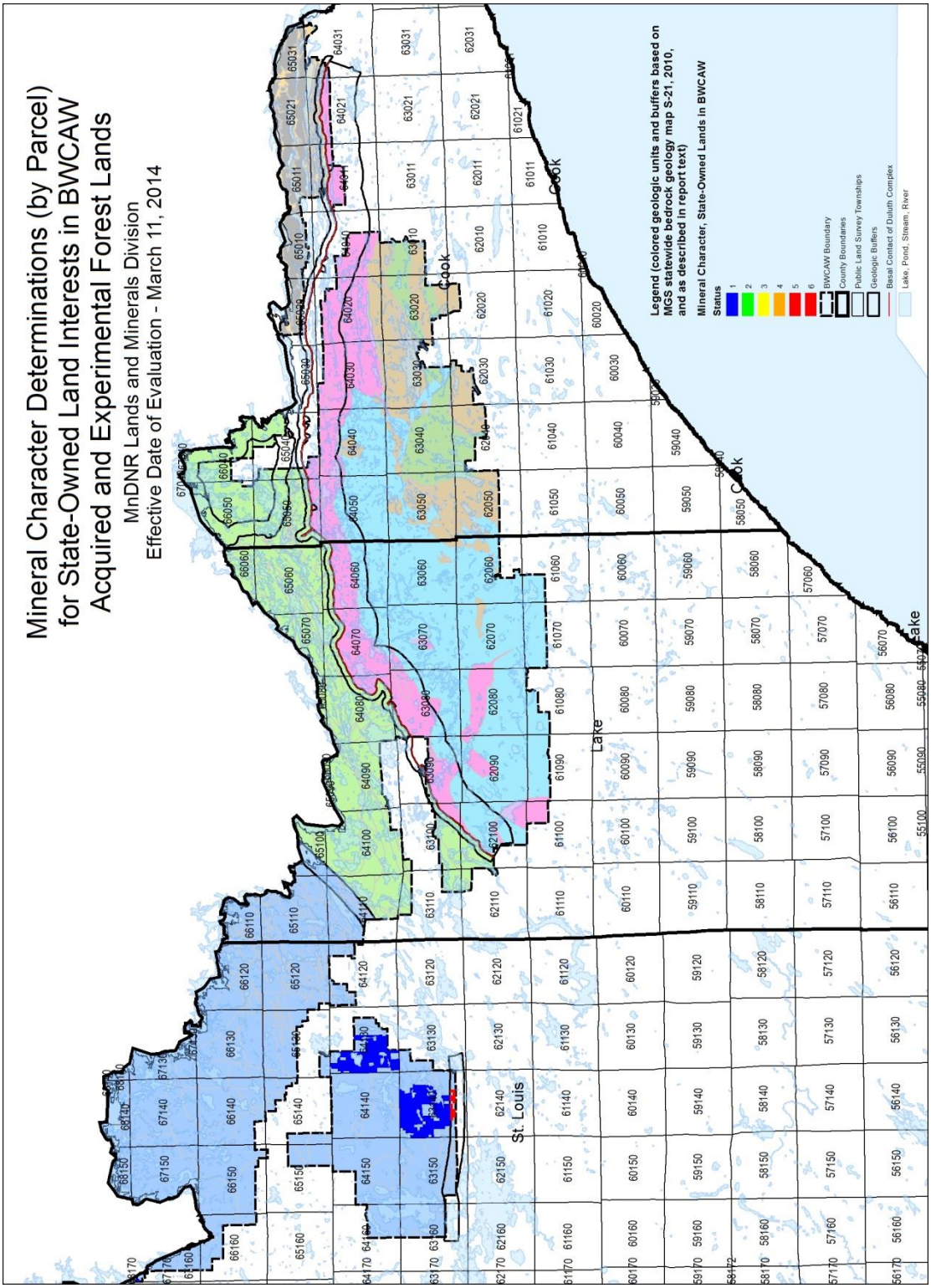

Plate VI. Mineral Character Determination–Tax Forfeit Lands