State of Minnesota
DEPARTMENT OF NATURAL RESOURCES
Trails & Waterways

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Subject: ***Virginia OHV Recreation Area***
Soils & Geology Report

I. RESOURCE DESCRIPTION

Bedrock Geology

The Virginia OHVRA lies north of the Biwabik Iron Formation and south of the Giant's Ridge Granite. The site marks the conjunction of the Lower Precambrian metavolcanics and metasediments. These units are thought to be, in some ways, similar to the Ely Greenstone and the Knife Lake Group. They are approximately 2,700 million years old and consist primarily of basalts and andesites, with minor amounts of diabase. The primary component of the metasediments is graywacke, although some volcaniclastics are present. Recent exploration suggests a fault which runs about parallel to State Highway 135, separating the metavolcanics and metasediments to the north from the Virginia Formation to the south. The bedrock beneath the project area generally slopes to the southeast. A small bedrock valley occurs in the SE corner of Section 15, and a larger valley occurs southeast of the landfill in Sections 21 and 22.

Glacial Geology

The glacial history of this area is even more complicated. The Laurentian Divide (also referred to as the Mesabi range or Giant's Range) stood as a controlling factor during glacial deposition, and today still controls surface and groundwater flow directions. The Divide serves as a drainage basin which channels water north towards Hudson's Bay. The land surface is controlled by the bedrock topography, with hills of the Divide sweeping south and north in a horseshoe shape, known as the Virginia Horn. The north side of the Divide slopes towards the center of the horseshoe, where the perennial Pike River drains these forested uplands and wetlands flowing northeast about 34 miles before emptying into Lake Vermillion.

Thin, highly compacted glacial sediments are draped over bedrock topography lying beneath the project area. The Rainy Lobe deposited this non-calcareous brown silty till some 25,000 years ago as it retreated north of the Mesabi Range. The deposits occurring in the area, ranging from 2 to 36 feet thick, represent the Nashwauk Moraine Association sediments. When combined with subsequent glacial deposits of surfical red clayey and silty till, bouldery till, and associated glaciofluvial sand and gravel, the total thickness of the glacial materials in the area ranges from 50 to 60 feet.

The St. Louis Sublobe and glacial Lake Upham deposited the clay-rich sediments west and south of the Laurentian divide. These sediments reach a thickness greater than 135 feet south of the Divide in the structural depression known as the Virginia Syncline. Meanwhile, areas east of the Divide are blanketed with only a thin layer of glacial drift. Bedrock is found at or near the surface. Surfical geology is mapped as rubble: thin drift overlying bedrock.

Regional Physiography

The regional topography is primarily the result of mining activity. Areas surrounding this site are defined by mine pits, dumps, tailings basins and ore piles. Unmined areas are characterized by gently rolling hills separated by small stream valleys. The land surface slopes gently towards the southeast. The small east-west trending knob on the property is surrounded by wetlands. The marsh on the south side of the knob is an intermittent stream and tributary of the Pike River. The (former) railroad tracks at the south of the property parallel another small ridge along the edge of the property.

Open pit mining operations south of the Laurentian Divide involved the excavation and disposal of glacial overburden. Overburden dumps are located in Sections 10 and Section 3, north and east of the divide. The mine dumps are relatively flat-topped plateaus constructed by linear embankments dumped by rail cars. These embankments, composed of primarily silt, clay and sand, form dike-like structures from 20 to 80 feet thick across the natural land surface. Forested uplands and a forested wetland were buried in this manner during mining operations some 65 years ago.

II. DISCUSSION

General Description of the Soil Resource

Area soils are representative of the Mesabi Range geomorphic region. The soils are light-colored, well-drained cobbly and stony loam to sandy loam. Soils also include some non-native mine dump materials. Mine dump materials are of highly variable composition and range from clay to sand to large boulder-sized materials. Soils data compiled by the Natural Resource Conservation Service (NRCS) of Northern St. Louis County was used to prepare the Soil Survey Map (Figure 1). There are 14 soil map units delineated. Each soil map unit consists of one or more different soil types. A soil type is defined by dominant soil characteristics such as texture, color, structure and parent material. A summary of soil types found on the Virginia Site is provided in Table 1.

Table 1. Dominant Soil Types – Virginia OHV Recreation Area

Soil Class	Soil Type	Acres
1028	Pits – Gravel, Udorthents complex	3.3
1041	Pits – Iron mine, open-pit	306.5
1042	Dumps, iron mine (mostly rock fragments)	856.6
1043	Udorthents, nearly level to very steep	264.7
1044	Slickens – settling basins	54.6
1072	Udorthents, shallow (sanitary landfill)	13.3
1076	Histosols/Fluvaquents, frequently flooded	110.4
19-1A	McQuade-Buhl complex, 0-3% slopes	33.7
19-2B	Hibbing-Buhl complex, 1-8% slopes	36.4
19-5A	McQuade-Fayal complex, 0-1% slopes	8.0
3401	Aquents & Histols, frequently flooded	99.3
4-1C	Eaglenest stony loam, 4-12% slopes, very bouldery	159.7
541	Rifle peat	54.8
544	Cathro muck	39.8
6-1B	Wahsten/Eaglenest rock outcrop, 2-8% slopes, bouldery	147.4
6-2D	Eveleth-Conic rock outcrop, 8-18% slopes, bouldery	177.0
6-2E	Eveleth-Conic rock outcrop, 18-30% slopes, v. bouldery	26.9
6-3B	Babbitt-Whalsten rock outcrop, 1-8% slopes, bouldery	33.3
6-4D	Eveleth-Conic-Bugcreek, 0-18% slopes, bouldery	303.1
6-6B	Biwabik-Emmert rock outcrop complex, 1-8% slopes	11.6
7-2D	Cloquet-Pequaywan complex, pitted, 0-18% slopes	3.0
7-4D	Eveleth stony loam, 8-18% slopes, bouldery	4.1
7-5B	Babbitt-Eaglenest complex, 1-8% slopes, bouldery	103.0
7-6A	Babbitt-Bugcreek complex, 0-2% slopes, very bouldery	410.4
7-9A	Bugcreek extremely stony sandy loam, 0-1% slopes	74.6
Water	surface water	28.6
Total Acres		**3,364.2**

Source: *USDA, National Resource Conservation Service, Northern St. Louis County, MN. 1999.*

The soils on the proposed project area consist of two general groups; those in a relatively undisturbed state and those altered by iron mining activities. The majority of the undisturbed soils consist of eight to fourteen inches of loamy surface material (loam or silt loam textures) over a clay subsoil. The predominant soil drainage of this area is moderately well and somewhat poor. The range is from well to very poor. A small portion of the area consists of coarse loamy material (loamy sand or sandy loam) surface material over sand and/or gravel. Deep wet peat and wet mineral soils are also present.

III. RESOURCE ISSUES / MANAGEMENT OBJECTIVES

Data Limitations

The soil map units vary based upon the complexity of soil types and scale of mapping. The site was mapped in the field at a scale of 2.6 inches = one mile (1:24,000). At this scale, soil types are often so intricately mixed together on the landscape that they cannot be mapped separately. Areas smaller than 5-8 acres in size were not mapped. These maps and data are adequate, however, to assess potential soil erosion, compaction and rutting concerns stemming from planned OHV use. More detailed and site-specific soils data may be necessary in some areas to guide trail planning, engineering design and construction.

Minimizing Soil Erosion and Sedimentation Effects

The potential for soil erosion depends upon a complex interaction of soil characteristics, site factors and environmental variables. In general, the susceptibility of a soil to erode is based on the relative amounts of sand, silt and clay; the amount of organic matter and the soil structure. Generally, erodibility increases with increased amounts of silt and fine sand, with decreased amounts of organic matter and with decreased size and stability of structural aggregates.

Erosion is most likely to occur when unsurfaced trails are located on highly erodible soil types, especially if vegetation and the surface litter layers are removed through use. This poses an on-going maintenance concern and introduces the potential for soil movement and possibly sedimentation of adjacent wetlands and/or surface waters.

Minimizing Soil Compaction

Soil compaction is the rearrangement and compression of soil particles when the external pressure (i.e., wheel of a vehicle) applied to a soil is greater than the resistance or bearing strength of the soil. Soil strength, in turn depends upon moisture content. A soil is most susceptible to compaction when the moisture content is between the plastic limit and liquid limit. Under these conditions, compaction can occur in a single pass of heavy equipment or through repeated passes of light equipment.

Undisturbed soils can be especially susceptible to compaction, especially if these soils have loamy surface textures. The specific time or duration when moisture conditions are prime for compaction is unknown. The length of time that a soil stays moist enough is dependant on soil drainage, landscape position and rate of uptake from vegetation. It would be shortest on mid and upper hill sides and longer on lower hill slopes and level areas. These soils will likely have moisture conditions suitable for compaction in the spring, fall, and summer following significant rain events. Maintaining healthy vegetation helps to dry out these soils more quickly.

Compaction increases soil density and decreases the ability of a soil to absorb water. This will increase the likelihood of runoff and erosion on hill sides and will cause water to collect in depressions. Both of these conditions will be on-going trail maintenance concerns. Compaction can alter ecosystem processes, decrease timber productivity and induce subtle changes in plant communities. It is important that soil compaction be minimized both in the amount of land affected and in its' severity.

Minimizing Soil Rutting

Soil rutting is the displacement of soil by (sinking) wheels of vehicles. Most soil types are susceptible to rutting when wet (approximately at field capacity). Soil types that are somewhat poorly drained, poorly drained, and moderately well drained with a "hardpan" will be most susceptible for the longest periods of time.

Rutting interrupts the lateral subsurface flow of water through soils with "hardpans" such as the Hibbing Type. This will, in effect, make the soil up-slope from the rut wetter for a longer period. Ruts also collect and hold surface water. Both conditions will further decrease soil strength which can cause additional rutting in adjacent areas which would be of on-going maintenance concern. Rutting, if extensive and widespread, could alter normal ecosystem processes, plant communities, and timber productivity on a localized basis.

IV. IMPACT AVOIDANCE, MINIMIZATION & MITIGATION STRATEGIES

Soil Erosion

The principal concern is accelerated (mechanical) soil erosion due to improper design, construction, grading or failure to adequately control surface water runoff. This site is also at-risk for wind and gully erosion. Uncontrolled soil erosion can lead to the sedimentation of surface waters and wetlands, degradation of aquatic habitat, and disturbance to the natural (hydrologic) functioning of wetland areas. It is important that the OHVRA be established and maintained in a condition that allows for sustained long-term use. Accordingly, every effort must be made to anticipate and prevent accelerated or unnatural erosion, and to restore lands already damaged to the extent possible. The following guidelines should be observed:

1) All roads, trails and event areas should be managed for sustained use. No off-site soil loss should be allowed above and beyond naturally occurring levels.

2) Maximum disturbance should not exceed the ability to rehabilitate and restore pre-existing site conditions.

3) All roads and trails should be constructed, at a minimum, to the standards contained in the AMA Trail Design and Construction Guidebook *(Wernex, 1994)*.

4) No development or use should occur on areas rated "impossible" to revegetate.

5) Active erosion features should be avoided during facility construction, operation and use. Areas with a "high" erosion hazard rating should be avoided and travel restricted.

6) Information signs and physical barriers should be erected to limit the spread of open riding areas and vehicle 'scramble' areas.

7) Infield / parking areas should be covered when not in use (e.g., vegetation, mulch, straw), and be regularly watered and disked during event activity to reduce wind and mechanical erosion.

8) Unauthorized trails or tracks should either be designated and managed or closed and rehabilitated upon discovery.

9) Firebreaks or fuelbreaks should be constructed and gated such that they effectively restrict OHV use or vehicle access.

10) Necessary trail repairs, rehabilitation, re-routes or soil replacement plans should be consistent with both the erosion control plan and vegetation management plans for the facility.

Soil Compaction

The most obvious solution from a soils standpoint would be to restrict operation of vehicles during periods when compaction could occur. However, because portions of a trail could be dry enough to prevent damage while other portions may still be in prime conditions, this may not prove practical. Also, during some years the trails could potentially be closed for a majority of the snow-free seasons. Alternatives may include surfacing the trails, or restricting activities to specific areas to minimize the areal extent of compaction, while managing the consequences of compaction and rutting in other designated areas.

Soil Rutting

The best protection against rutting is to minimize vehicle operations during periods of wet weather, especially on soils suceptable to rutting. This may prove easier to do than preventing soil compaction since the time periods when the soils are wet enough for rutting are much more limited, except for poorly drained soils. Existing roads and trails should be used where possible avoiding new construction. Frequent maintenance or trail grooming, along with graveling some of the more heavily used trails can also limit soil rutting. Bridges over persistent wet spots, maintaining a crowned trail cross-section, together with proper surface drainage structures may also provide some level of protection against unacceptable soil rutting.

V. REFERENCES

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