

Aitkin Wetland Mitigation Site

Wetland Mitigation Plan

Poly Met Mining Inc.



May 2014

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1.0 Introduction

On behalf of Poly Met Mining Inc. (PolyMet), Barr Engineering Co. has prepared this wetland restoration plan to provide compensatory wetland mitigation to replace unavoidable wetland impacts associated with PolyMet's NorthMet Project (Project). The Project site is located in the St. Louis River #3 major watershed and a total of 939 acres of wetland impacts are proposed. The compensatory mitigation activities described in this report include those planned within one site located near Aitkin, Minnesota in Aitkin County.

The Aitkin mitigation location is the site of an active sod production facility that encompasses approximately 1,070 acres of land, on which, 808 acres of wetland restoration and 83 acres of upland buffer preservation is proposed (Figure 1). The site is located in the Mississippi River-Brainerd #10 major watershed. PolyMet has entered into an option agreement with the landowner formalizing the intent to conduct wetland restoration activities.

This report includes discussions of the restoration site, construction activities, vegetation establishment and management activities, wetland restoration goals, performance standards, schedules, and monitoring plans. A preliminary wetland restoration plan was submitted to the U.S. Army Corps of Engineers (USACE) and Minnesota Department of Natural Resources (MDNR) Division of Lands and Minerals in August 2007. The plan was reviewed by the USACE, MDNR, and MPCA; comments were provided, and the plan was resubmitted for review. A final review was conducted by the same agencies and a final plan was submitted in January 2008. A revised permit application was submitted to the USACE and MDNR in August 2013 to start the permitting process. The agencies determined that hydrologic monitoring should be conducted to justify the proposed crediting in the plan and the plans should be revised to comply with standards that have changed since the initial submittal. Therefore, this plan was developed to comply with the current Wetland Conservation Act (WCA) rules (Minnesota Rules Chapter 8420) as administered by the Minnesota Department of Natural Resources – Division of Lands and Minerals, Section 404 of the Clean Water Act as administered by the USACE, and Minnesota Rules 7050.0186 (wetland mitigation) as administered by the Minnesota Pollution Control Agency.

Permanent Conservation Easements similar to the example provided in Appendix A will be prepared and recorded to cover the wetland restoration and associated upland buffer areas within one year after starting the restoration activities at the site.

2.0 Wetland Mitigation Crediting

Because the wetland mitigation site included in this plan is located outside of the project watershed, all mitigation associated with this plan will be conducted at a ratio of 1.25:1 or 1.5:1 in accordance with USACE guidance. Current guidance from the USACE regarding conditions that constitute in-advance compensatory mitigation was provided in a memo dated May 29, 2013. Restoration successfully completed following the guidance in that memo and comprised of the same type as the impacted wetlands will be credited at a 1.25:1 ratio and replacement out-of-kind will be credited at a 1.5:1 ratio. Should in-kind compensatory mitigation be deemed unsuccessful such that an equal area of in-kind replacement is not provided for the impacts, those impacts will be replaced at a 1.5:1 ratio. Wetland replacement completed at the site will be required at a 1.5:1 ratio in accordance with the WCA, because it is located outside of the project watershed. Should additional wetland mitigation credits be established beyond the needs for direct impacts, the excess credits will be utilized to compensate for indirect wetland impacts.

The proposed wetland replacement credit areas are shown in Figure 2. The credits were calculated based on:

- Hydrology monitoring (Reference (1))
- Soil survey information (Figure 3)
- Target plant communities (Figure 1) developed based on existing elevations, proposed elevations, and planned hydrologic restoration
- Existing wetland boundaries (Figure 4)
- Other site conditions

These credits are summarized in Table 1 based on actions eligible for credit in the USACE's policy (2009) for wetland mitigation in Minnesota and in the WCA rules. Proposed actions eligible for credit include the following with references to the applicable USACE's policy (2009) and subpart under the WCA Chapter 8420.0526:

- Upland buffer credit [Section 404 (upland buffers) and WCA-Subp. 2] is applied to areas that are not expected to develop as wetland after restoration is complete. These areas will be restored to native, non-invasive vegetation. Upland buffer credits are credited at 25% of the area maintained as upland buffer (4:1 ratio of upland acres to credit). Credit from upland buffers will not exceed 25% of the total credit from the site. A total of 83.2 acres of upland buffer and 20.8 credits are estimated to result from the proposed wetland restoration work (Table 1).
- Credit for restoration of completely drained wetlands [Section 404 (restoration via reestablishment) and WCA-Subp. 3] is applied to the majority of the wetland restoration areas on the site presently under cultivation. The estimated area of wetland that is expected to develop is discussed in Section 7.0. Areas that are presently non-wetland and develop as wetland after restoration are proposed as 100% credit for the area restored (1:1; wetland to credit). An

estimated 758.3 acres of drained wetland are planned to be restored with the project for 758.3 credits (Table 1).

- Restoration of partially-drained wetland [Section 404 (restoration via rehabilitation) and WCA-Subp. 4] currently applies to the wetland in the northwest portion of the site located east of Highway 1 (Figure 2). Hydrology monitoring in 2012-2013 documented that this area is partially-drained by the drainage system managed throughout the site. The minimum wetland hydrology criteria were met in both years of monitoring, but the duration was only 12 percent to 26 percent of that documented within the reference wetland. Restoration will restore natural hydrology to this wetland by removing the drainage system. This would qualify as credit for restoration via rehabilitation under the USACE's policy (Reference (2)) and is proposed for 50% credit of the area restored (2:1; wetland to credit). The partially-drained wetland area encompasses 50.0 acres for 25.0 credits (Table 1).

Table 1 Wetland Mitigation Credit Summary

Restoration Method	Area (acres)	Percent Credit	Credits
Upland buffers	83.2	25%	20.8
Partially-drained wetlands	50.0	50%	25.0
Restoration of drained wetlands	758.3	100%	758.3
Total for Site	891.5		804.1

All of the private ditch wetlands within the site, encompassing 31.5 acres, will be filled to eliminate drainage effects. Those areas will remain wetland and are proposed to receive no credit. The areas within the Diversion Channel easement are not proposed for credits because those areas may be modified by the local ditch authority in the future to manage regional drainage. No credits are proposed for areas within the County Highway 1 right-of-way.

In order to adequately track the timing of wetland mitigation construction and wetland impacts, a structured accounting system may be needed to determine the required mitigation ratios. This information could be provided in the MDNR Permit to Mine annual report. The annual report could include a tabulation of wetland mitigation that was constructed, including the dates when construction was completed and wetland impacts that occurred by December 31 of each year. This information would be submitted using the schedule for the Permit to Mine annual report, typically within one month after the end of the year.

3.0 Wetland Mitigation Goals

To the degree feasible, the primary goal of the wetland mitigation plan for PolyMet is to restore high quality wetland communities (Reference (3)) of the same types as those impacted by the project. While it is not practicable to replace all impacted wetland types with an equivalent area of in-kind wetland due to site limitations, technical feasibility, and other considerations; the goal of the mitigation plan is to replace the wetland types in-kind to the degree practicable in order to replace lost wetland functions and values. A summary of the acreage of each targeted wetland restoration community is provided in Table 2. A total of 808.3 acres of wetland restoration is proposed (Figure 1), including four wetland community types that are planned to replace impacts in-kind to the degree practicable, constrained by the restoration of wetland types that are ecologically suitable and sustainable for the landscape area.

Table 2 Wetland Mitigation Target Community Summary

Targeted Plant Community	Area (acres)	Credit
Shallow Marsh	39.2	32.4
Shrub-Carr	36.5	18.2
Hardwood Swamp	171.0	171.0
Conifer Swamp	561.6	554.5
Wetland Total	808.3	783.3
Upland Buffer	83.2	20.8
Total for Site	891.5	804.1

Detailed descriptions of the targeted wetland communities within the wetland restoration area are provided in the following sections.

3.1 Shallow Marsh

A total of 39.2 acres of shallow marsh wetland is planned in two areas of the site (Table 2, Figure 1). Shallow marsh communities typically form with a slightly wetter landscape position than wet meadows, with saturation near the surface typical and shallow inundation of 2-3 inches common, particularly early in the growing season. The sedge meadow community is targeted for a dominance of primarily native sedges, however, grasses such as Canada bluejoint and manna grass may be present along with scattered perennial forbs and some shrubs. The muck soils are typically saturated close to the surface for most of the growing season with shallow inundation common for long periods of time.

3.2 Shrub-Carr

A total of 36.5 acres of shrub-carr wetland is planned in one area of the site (Table 2, Figure 1). Shrub-carr communities are typically saturated close to the surface for much of the growing season with occasional

short-term inundation during floods and following snowmelt, particularly where a hummocky surface is present. The vegetation is expected to be composed of at least 50 percent areal coverage of shrubs, including primarily willow, meadowsweet, and dogwood. The understory vegetation is expected to be composed of grasses such as Canada bluejoint and manna grass along with scattered, perennial forbs. The tree coverage is variable in shrub-carr wetlands, typically with less than 25 percent coverage of trees taller than six feet. The majority of the shrub-carr restoration area contains muck and hemic peat soils.

3.3 Hardwood Swamp

A total of 171.0 acres of hardwood swamp wetland is planned on the western part of the site (Table 2, Figure 1). Hardwood swamps are typically dominated by black ash, but other tree species such as quaking aspen, balsam poplar, and yellow birch may develop. Shrub layer cover is expected to be variable with black ash common, along with mountain maple and swamp red currant likely. Herbaceous plants may include various grasses, sedges, ferns, and forbs suited to the microtopography present at the site. The hardwood swamp communities are planned in the transition zones between the organic soil wetlands and mineral soil uplands. In mature hardwood swamps (older than 75 years) the tree canopy ranges from interrupted to continuous in coverage (50 to 100 percent cover). The majority of the hardwood swamp restoration area at the site is underlain by mineral soils.

3.4 Coniferous Swamp

A total of 561.6 acres of coniferous swamp wetland is planned on the eastern part of the Aitkin site (Table 2, Figure 1). Tamarack-dominated coniferous swamp is the targeted community in this plan. While tamarack is targeted as the dominant tree species, black spruce and balsam fir may also be present. Shrub layer cover is expected to be considerable, and may be composed of species such as speckled alder, winterberry, Labrador tea, blueberries, and various tree species. The groundlayer is expected to be variable, and may include mosses, grasses, sedges, ferns, and forbs suited to the microtopography present at the site. In coniferous swamps, the tall shrub layer coverage is variable and the tree canopy is patchy to interrupted (50 to 75 percent cover). The planned coniferous swamp restoration areas are predominantly underlain by muck soils.

4.0 Wetland Mitigation Performance Standards

Performance standards have been developed for each wetland community type targeted in this plan to guide the restoration activities and to determine success. The performance criteria include measures to evaluate whether or not the hydrology and vegetation meet the plan goals. Should the performance standards not be met during the established monitoring period (five years for shallow marsh, eight years for the shrub communities, and twenty years for the forested communities), a proposal will be submitted to the USACE and the MDNR Division of Lands and Minerals describing the corrective actions proposed and an implementation schedule.

4.1 General Performance Standards

Several general performance standards apply to all wetland restoration areas:

- More than 75 percent areal coverage of the vegetation in each wetland community shall be facultative (FAC) or wetter (FACW, OBL) as listed in the current version of the National Wetland Plant List (NWPL, current version) for the Northcentral and Northeast region.
- Invasive plant species shall not comprise more than 15 percent cumulative areal coverage by the end of the monitoring period. Invasive species include those identified in Table 3 and non-native species listed by the MDNR (Reference (4)).
- Native, non-invasive species shall comprise at least 85 percent areal coverage.

Table 3 Potentially Problematic Invasive Species

Common Name	Scientific Name
Flowering rush	<i>Botomus umbellatus</i>
Smooth brome grass	<i>Bromus inermis</i>
Canada thistle	<i>Cirsium arvense</i>
Glossy false buckthorn	<i>Frangula alnus</i>
Yellow iris	<i>Iris pseudacorus</i>
Non-native honeysuckles	<i>Lonicera x bella</i> ; <i>Lonicera tartarica</i> , etc.
Bird's Foot trefoil	<i>Lotus corniculatus</i>
Purple loosestrife	<i>Lythrum salicaria</i>
Sweet clover	<i>Melilotus alba</i> or <i>M. officianalis</i>
Reed canary grass	<i>Phalaris arundinacea</i>
Common reed	<i>Phragmites australis</i>
Common buckthorns	<i>Rhamnus cathartica</i>
Curly dock	<i>Rumex crispus</i>
Foxtail	<i>Setaria spp.</i>
Perennial sow thistle	<i>Sonchus arvensis</i>
Common tansy	<i>Tanacetum vulgare</i>
Narrowleaf cattail	<i>Typha angustifolia</i>
Blue cattail	<i>Typha x glauca</i>

4.2 Hydrology

Due to the nature of the site, it is expected that the extent and duration of soil saturation and high water table will gradually increase as the site develops more dense vegetation and hydrology stabilizes following removal of the drainage system. Therefore, it is expected that the duration of the high water table at the site will gradually become more similar to the reference wetlands as these conditions develop. The hydrology success criteria are designed to reflect the incremental changes in hydrology. All restored wetland areas must meet the minimum hydrology standard during each year of monitoring in which precipitation conditions are within or wetter than the normal range.

4.2.1 Shallow Marsh

The shallow marsh communities will develop in the wettest portions of the site subject to inundation and extended periods of soil saturation. The hydrology in the shallow marsh community is likely to consist of water table at the surface to inundation by up to 6 inches of water for a minimum of 56 consecutive days

or four periods of 14 consecutive days during the growing season, under normal to wetter than normal conditions (70 percent of years based on the most recent 30-year record of precipitation). During the growing season, inundation by up to 18 inches of water may occur, but will not exceed 30 consecutive days (e.g., water depth drops from 18 inches to 6 inches within the 30 days).

4.2.2 Shrub-Carr

The hydrology in the shrub-carr community is likely to consist of saturation to the surface throughout much of the growing season, under normal to wetter than normal conditions (70 percent of years based on the most recent 30-year record of precipitation). Inundation shall not occur (unless there are site-specific conditions). An exception can be made for sites with hummocky microtopography: hollows between hummocks can have standing water depths of up to 6 inches for extended duration. For years in which precipitation conditions are drier than normal, the duration of saturation is expected to be within 25 percent of that documented within the reference wetland.

4.2.3 Hardwood Swamp

The hydrology in the hardwood swamp community is likely to consist of saturation within 6 inches of the surface, to inundation by up to 6 inches of water, for a minimum of 28 consecutive days or two periods of 14 consecutive days, during the growing season, under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation by more than 6 inches of water during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. Inundation greater than 6 inches of water shall have a duration of less than 14 days. An exception can be made for sites with hummocky micro-topography: hollows between hummocks can have standing water depths of 6 to 12 inches for extended duration.

4.2.4 Conifer Swamp

The hydrology in the conifer swamp community is likely to consist of saturation to the surface throughout the growing season, except in drought years (driest 10 percent of the most recent 30-year period of precipitation record). Inundation shall not occur (unless there are site-specific conditions). An exception can be made for sites with hummocky microtopography: hollows between hummocks can have standing water depths of up to 6 inches for extended duration. For years in which precipitation conditions are drier than normal, the duration of saturation is expected to be within 25 percent of that documented within the reference wetland.

A similar reference wetland has the same wetland community type or a comparable hydrologic regime to the restored target community type. Reference wetlands have been identified with shrub-carr and conifer swamp communities. A similar reference wetland could not be found for the planned shallow marsh wetland.

4.3 Vegetation

Vegetation development within the restored wetlands is planned to start with emphasis on developing the herbaceous layer in the first one to two years followed by the addition of shrubs and trees in the shrub-carr, hardwood swamp, and conifer swamp communities. While no seeding is planned within the first couple of years, our experience indicates that a diverse, native herbaceous community is likely to develop from the seedbank and natural seed dispersal mechanisms. This natural regeneration has been observed to result in similar diversity and cover compared to sites that have been seeded. If vegetation development is not adequate to meet the success criteria, seed may be installed after the first or second growing season. These community type success criteria will be used to determine success of the wetland replacement site.

4.4 Shallow Marsh

This area will meet the following vegetation success criteria described below for each growing season following construction:

4.4.1 Growing Season 1

- Herbaceous vegetation shall cumulatively comprise at least 50 percent areal cover.
- At least 30 percent areal cover shall be comprised of at least 3 species of native, non-invasive plants.
- No more than 30 percent areal cover shall be comprised of non-native or invasive species.

4.4.2 Growing Season 2

- Herbaceous vegetation shall cumulatively comprise at least 60 percent areal cover.
- At least 40 percent areal cover shall be comprised of at least 4 species of native, non-invasive plants.
- No more than 25 percent areal cover shall be comprised of non-native or invasive species.

4.4.3 Growing Season 3

- Herbaceous vegetation shall cumulatively comprise at least 60 percent areal cover.
- At least 65 percent areal cover shall be comprised of at least 8 species of native, non-invasive plants.
- No more than 15 percent areal cover shall be comprised of non-native or invasive species.

4.4.4 Growing Seasons 4-5

- Herbaceous vegetation shall cumulatively comprise at least 60 percent areal cover.
- At least 10 species of native, non-invasive plants shall be present and at least 3 species shall be dominants as determined by an approved vegetation dominance test or will have a vegetative diversity/integrity rating of high quality using the Minnesota Routine Assessment Method (MnRAM) for Evaluating Wetland Functions.

- No more than 15 percent areal cover shall be comprised of non-native or invasive species.

4.5 Shrub-Carr

Shrub-carr will meet the following success criteria described below for each growing season following construction:

4.5.1 Growing Season 1

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 40 percent areal cover shall be comprised of at least 5 species of native, non-invasive plants.
- No more than 50 percent areal cover of non-native or invasive herbaceous species will be present.

4.5.2 Growing Season 2

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 60 percent areal cover shall be comprised of at least 6 species of native, non-invasive plants.
- No more than 35 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 200 stems per acre of woody plants over 80 percent of the designated shrub-carr community will be present, including willow, dogwood, alder, and other native species present in the reference wetlands. No more than 5 percent areal cover of non-native or invasive shrub species will be present.

4.5.3 Growing Season 3

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 6 species of native, non-invasive plants shall be present or the community will have a vegetative diversity/integrity rating of high quality using the current version of MnRAM.
- No more than 20 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 200 stems per acre of woody plants over 80 percent of the designated shrub-carr community will be present, including willow, dogwood, alder, and other native species present in the reference wetlands. No more than 5 percent areal cover of non-native or invasive shrub species will be present.

4.5.4 Growing Seasons 4-8

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 8 species of native, non-invasive plants shall be present or the community will have a vegetative diversity/integrity rating of high quality using the current version of MnRAM.
- No more than 15 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 200 stems per acre of woody plants over 80 percent of the designated shrub-carr community will be present, including willow, dogwood, alder, and other native species present in

the reference wetlands or the total native shrub and tree sapling cover will exceed 60 percent. No more than 5 percent areal cover of non-native or invasive shrub species will be present.

4.6 Hardwood Swamp

The hardwood swamp community will meet the following vegetation success criteria for each growing season following construction.

4.6.1 Growing Season 1

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 40 percent areal cover shall be comprised of at least 5 species of native, non-invasive herbaceous plants.
- No more than 50 percent areal cover of non-native or invasive herbaceous species will be present.

4.6.2 Growing Season 2

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 60 percent areal cover shall be comprised of at least 6 species of native, non-invasive herbaceous plants.
- No more than 30 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 200 living tree seedlings per acre will be present, including quaking aspen and balsam poplar, but other species may be present consistent with the species present in the natural forested reference wetlands. No more than 5 percent areal cover of non-native or invasive tree species will be present.

4.6.3 Growing Season 3

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 8 species of native, non-invasive herbaceous plants shall be present or the community will have a vegetative diversity/integrity rating of high quality using the current version of MnRAM.
- No more than 20 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 150 living tree seedlings per acre will be present, or the number of trees per acre will be at least 80 percent of the trees per acre in a reference wetland of similar community type. The tree species will include quaking aspen and balsam poplar, but other species may be present consistent with the species present in the natural forested reference wetlands. No more than 5 percent areal cover of non-native or invasive tree species will be present.

4.6.4 Growing Seasons 4-20

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 8 species of native, non-invasive herbaceous plants shall be present or the community will have a vegetative diversity/integrity rating of high quality using the current version of MnRAM.
- No more than 15 percent areal cover of non-native or invasive herbaceous species will be present.

- At least 150 living tree seedlings per acre will be present or the number of trees will be at least 80 percent of a reference wetland of similar community type. At least 75 of those living trees will be at least 4 feet in height. The tree species will include quaking aspen and balsam poplar, but other species may be present consistent with the species present in the natural forested reference wetlands. No more than 5 percent areal cover of non-native or invasive tree species will be present.

4.7 Coniferous Swamp

4.7.1 Growing Season 1

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 40 percent areal cover shall be comprised of at least 5 species of native, non-invasive herbaceous plants.
- No more than 50 percent areal cover of non-native or invasive herbaceous species will be present.

4.7.2 Growing Season 2

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 60 percent areal cover shall be comprised of at least 6 species of native, non-invasive herbaceous plants.
- No more than 30 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 200 living tree seedlings per acre will be present, including tamarack and black spruce, but other species may be present consistent with the species present in the natural forested reference wetlands. No more than 5 percent areal cover of non-native or invasive tree species will be present.

4.7.3 Growing Season 3

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 8 species of native, non-invasive herbaceous plants shall be present or the community will have a vegetative diversity/integrity rating of high quality using the current version MnRAM.
- No more than 20 percent areal cover of non-native or invasive herbaceous species will be present.
- At least 150 living tree seedlings per acre will be present, or the number of trees per acre will be at least 80 percent of the trees per acre in a reference wetland of similar community type. The tree species will include tamarack and black spruce, but other species may be present consistent with the species present in the natural forested reference wetlands. No more than 5 percent areal cover of non-native or invasive tree species will be present.

4.7.4 Growing Seasons 4-20

- Herbaceous vegetation shall cumulatively comprise at least 70 percent areal cover.
- At least 8 species of native, non-invasive herbaceous plants shall be present or the community will have a vegetative diversity/integrity rating of high quality using the current version of MnRAM.
- No more than 15 percent areal cover of non-native or invasive herbaceous species will be present.

- At least 150 living tree seedlings per acre will be present or the number of trees will be at least 80 percent of a reference wetland of similar community type. At least 75 of those living trees will be at least 4 feet in height. The tree species will include quaking aspen and balsam poplar, but other species may be present consistent with the species present in the natural forested reference wetlands. No more than 5 percent areal cover of non-native or invasive tree species will be present.

4.8 Upland Buffer

The upland buffer areas will meet the success criteria described below for each growing season following construction.

4.8.1 Growing Season 1

- Vegetation will comprise at least 50 percent areal cover, which shall be composed of native perennial species, including at least six species of native/non-invasive plant species.
- The herbaceous layer or herbaceous communities shall be comprised of four or more species of native/non-invasive plants.
- No more than 50 percent areal cover shall be comprised of non-native or invasive vegetation and no more than 5 percent areal cover of non-native or invasive shrub and tree species shall be present.

4.8.2 Growing Season 2

- Vegetation will comprise at least 60 percent areal cover, which shall be composed of native perennial species, including at least seven species of native/non-invasive plant species.
- The herbaceous layer or herbaceous communities shall be comprised of five or more species of native/non-invasive plants.
- No more than 35 percent areal cover shall be comprised of non-native or invasive vegetation and no more than 5 percent areal cover of non-native or invasive shrub and tree species shall be present.

4.8.3 Growing Season 3

- Vegetation will comprise at least 70 percent areal cover, which shall be composed of native perennial species, including at least eight species of native/non-invasive plants.
- The herbaceous layer or herbaceous communities shall be comprised of six or more species of native/non-invasive plants.
- No more than 20 percent areal cover shall be comprised of non-native or invasive vegetation and no more than 5 percent areal cover of non-native or invasive shrub and tree species shall be present.

4.8.4 Growing Seasons 4-5

- Vegetation will comprise at least 90 percent areal cover, which shall be composed of native perennial species, including at least ten species of native/non-invasive plants.
- The herbaceous layer or herbaceous communities shall be comprised of eight or more species of native/non-invasive plants.
- No more than 15 percent areal cover shall be comprised of non-native or invasive vegetation and no more than 5 percent areal cover of non-native or invasive shrub and tree species shall be present.

5.0 Wetland Restoration Site Description

5.1 Aitkin Wetland Mitigation Site Description

The Aitkin wetland mitigation plan includes the restoration of 808 acres of wetland and the preservation of 83 acres of upland buffer on a row-crop farm (Figure 1). The wetland restoration site is located in Section 6, Township 47 North, Range 26 West; and Section 1, Township 47 North, Range 27 West, Aitkin County, Minnesota. The site is located in the upper portion of the Mississippi River-Brainerd #10 major watershed and Bank Service Area #5 (Figure 1). The National Wetland Inventory map for the wetland restoration area is provided in Figure 5.

5.1.1 Geology and Soils

Oakes and Bidwell (Reference (5)) mapped the surficial geology within the restoration area as glacial lake peat deposits, silts, sands and clays with flat topography. The site is located in an area of extensive peat deposits in the glacial Lake Upham area. County Well Index boring logs in the vicinity of the site indicate layered deposits of primarily clay and sand to a depth of 150 feet or more below the surficial soils. The soils within the wetland restoration areas are mapped in the Soil Survey of Aitkin County, Minnesota (Reference (6)) as primarily muck soils, including the Cathro (Map Unit 1983), Sago (Map Unit 532), and Sax (Map Unit 1154) soil series (Figure 3). Mineral hydric soils including: Baudette silt loam (Map Unit 1982), Spooner silt loam (Map Unit 147), Sandwick loamy sand (Map Unit 625), and Waukenabo fine sandy loam (Map Unit 759) are mapped within portions of the site (Figure 3).

All soils mapped within the wetland restoration areas are hydric. The majority of the entire land area located upstream of the site is also mapped as hydric soils, and includes predominantly muck and peat soils in the large wetland complexes and mineral hydric soils in the mesic forested areas. The water table appears to be near the surface throughout much of the general area, as indicated by the large wetland complexes underlain by muck and peat soils.

Soil profiles and water table information were collected during fieldwork conducted on April 25, 2007 and June 5-6, 2007. A topographic survey was completed for the site and a one-foot contour map was created from the data. The survey data along with soil information was used to create stratigraphic fence diagrams that show the complexity of the soils in the area. The water table information collected during the field survey was also plotted on the diagrams (Figures B2-B9, Appendix B). A discussion of the site, based on the fieldwork, is presented in the following sections.

5.1.1.1 East Area Soils

Soil borings were completed on the east side of the site and showed that deep organic soils were present across the majority of Fields 17, 18, 21, 22, and 23 (Figure B1, Appendix B). Soils that have an organic layer that is 16 or more inches thick (within the upper 32 inches of soil) are classified as Histosols. These soils are typically found in the areas likely to have been the wettest historically. These soils are in areas that are poorly to very poorly drained with long periods of saturation in their undisturbed state. The depth of peat

and/or muck at the sites ranged from 16 inches to more than 48 inches in depth, typically underlain by either sand or fine textured materials (e.g., clay, silt, silt loam, etc.). These profiles are described at sites 1-4, 7, 8, 18-21, and 24 (Figure B1, Appendix B).

Soils with an organic layer that is more than eight inches but less than 16 inches in depth have a histic epipedon. These soils are typically formed under somewhat poorly drained conditions with frequent periods of high water tables. The depth of peat and/or muck at these sites ranges from 6 to 15 inches in depth, and is typically underlain by either fine sand, silt, clay, and/or clay loam soils. These profiles are described at sites 5, 6, 16, and 17 (Figure B1, Appendix B).

The remainder of the sites have mineral soil profiles that typically contain up to seven different textural horizons within 36 to 42 inches below the soil surface. The textures throughout the profiles include fine sand, loam, silt, clay, clay loam, loamy fine sand, fine sandy loam, fine sandy clay loam, and fine sandy clay. The presence of multiple strata within 3 to 4 feet of soil indicates these soils were created in near-shore conditions with little wave action so that finer textured materials settle out over time. These profiles are generally formed under poorly drained conditions with periods of short inundation. All the profiles were classified as hydric except at sites 10, 11, and 12, which are located in the northeast area (Figure 1) at elevations above 1202 feet Mean Sea Level (MSL) (Appendix B).

5.1.1.2 West Area Soils

Soil borings were completed on the west side of the site in Fields 2, 6, 8, 9, 10, and 11 (Figures B-1 to B-9, Appendix B). These borings show that organic soils are present to a depth of at least 15 inches below the soil surface. In addition, soil samples were collected throughout the west area of the site for a seedbank germination project. A walk-over of the west area during the collection of soil samples indicated that organic soils were present throughout the ditch system and the sod fields.

The soil survey indicates that nearly the entire west area is mapped as Cathro muck, which typically has peat and/or muck to a depth of 16 to 51 inches below the soil surface. There are two areas of mapped mineral soil, Spooner silty loam, in the northwest and southwest portions of the west area. This series is typically a poorly drained soil that formed from glaciolacustrine parent material and it is classified as hydric. These soils typically formed under poorly to very poorly drained conditions with long periods of saturation.

5.1.2 Topography

The topographic relief is fairly minimal throughout the site. The United States Geological Survey (USGS) quadrangle topography indicates an elevation of 1205 feet MSL in the west-central portion of the site to an elevation of 1204 feet MSL in the east-central portion of the site. The USGS topography does not show any contours through most of the fields. Detailed survey data indicates ground elevations in the wetland restoration areas ranging from 1196 feet MSL to 1201 feet MSL with elevations on the dikes up to 1213 feet MSL. The gradient in the wetland restoration area ranges from flat to about 1.5 percent in the

northwest and northeast corners of the site. The gradient in the wetland complex located north of the restoration area appears to be about 1.5 feet per mile or 0.03%.

5.1.3 Climate

The average annual precipitation for Aitkin, based on the current 30-year normal period 1971-2000 is 28.9 inches (Reference (7)). A water budget completed by Oakes and Bidwell (Reference (5)) for the Mississippi River headwaters watershed calculated general runoff in the watershed to be 5.34 inches based on annual, average precipitation of 25.33 inches. The wetland restoration site is located in the downstream portion of the Mississippi River headwaters watershed, for which the water budget was calculated. While the average annual runoff value calculated by Oakes and Bidwell (Reference (5)) may not accurately reflect runoff conditions in all areas of the watershed, it provides a reasonable estimate for computing an order-of-magnitude water volume that might be expected to discharge from various portions of the watershed.

5.1.4 Hydrology

The Mississippi River Diversion Channel (Diversion Channel), constructed in the 1950s to prevent flood damages to the city of Aitkin, is located on the north side of the site (Figure 6). The flood channel diverts a portion of the Mississippi River flows downstream to lower portion of the river during high flows. A flood study was published for the Aitkin County area in 1981 (Reference (8)) in which specific flood elevations were determined for the Aitkin project area. The 10-year flood elevation for the site is approximately 1200.5 feet MSL and the 100-year flood elevation for the site is approximately 1203 feet MSL. The flood channel also intercepts the Little Willow River and carries its discharge to the Mississippi River. It appears that the Diversion Channel may also intercept some surface and subsurface drainage from the north that may have historically made its way to the restoration site. However, based on a review of historic topography maps and aerial photographs, it appears that the drainage area affecting the wetland restoration site may be limited. There is an artesian well located near the central part of the site that will flow freely when not restricted. However, the specifications of that well are unknown. It does indicate that there is a general upward groundwater head gradient at some depth at the site. The Mississippi River abuts the east side of the site. The existing contributing watershed area to the site is currently confined to the site itself and there is no upstream drainage that enters the site (Figure 6).

The primary drainage features affecting the farm are surface ditches spaced approximately every 700 feet with the fields contoured to drain to the ditches. There are four outlets from the west part of the site; two in the northwest part (one north through the Diversion Channel dike and one through the west dike), one in the southeast corner, and another near the center of the east side. These outlets range in elevation from 1193.6 feet MSL in the northwest to 1195 feet MSL in the east and southeast, generally 5 to 7 feet below the field elevations. There is a small county ditch located west of the site. The west half of the site is bordered by dikes on the north and west sides. The north dike ranges in elevation from about 1205 feet MSL to 1210 feet MSL. The west dike ranges in elevation from about 1200 feet MSL to about 1204 feet MSL. County Highway 1 acts as a dike along the east and south sides of the west part of the site ranging in elevation from about 1205 feet MSL to more than 1207 feet MSL.

There are two outlets from the east half of the site; one crossing County Highway 1 through the double ditch and one along the east side discharging to the Mississippi River. The culvert through the Diversion Channel dike in the northwest corner generally only carries discharge from the County Highway 1 ditch. The site outlets range in elevation from 1194.4 feet MSL in the northwest corner to 1196.2 feet MSL in the east, generally 5-6 feet below the field elevations. The east outlet has an adjustable control structure that can be modified to control water levels. The east half of the site is bordered by a dike on the north side ranging in elevation from about 1205 feet MSL to 1213 feet MSL. County Highway 1 acts as a dike on the west side, ranging in elevation from about 1205 feet MSL to more than 1207 feet MSL. The south side of the east half of the site is bordered by a dike that ranges in elevation from about 1201 feet MSL to 1205 feet MSL. The east side of the east half of the site is bordered by 391st Lane which ranges in elevation from about 1202 feet MSL in the south to 1205 feet MSL in the north.

Review of the 1940 aerial photograph indicates that much of the site was under agricultural production at that time and some of the drainage ditches had already been constructed (Figure 7). The 1991 aerial photograph (Figure 8) shows the site during the years of wild rice production, which apparently extended from as early as the late 1950s until about 1998 when the site was converted for sod production. Hydrology will be restored within the majority of the proposed wetland restoration areas by reconnecting the site to the Diversion Channel with surface overflows/inlets, filling the drainage ditches, and blocking or raising outlet structures to historic elevations to the degree feasible.

5.1.5 Hydrology Monitoring

In 2012 and 2013, hydrology was monitored to collect baseline data for the proposed wetland restoration, to determine if wetland hydrology is present on the site, and to provide further justification for the credit plan. The two years of monitoring data, from 2012 and 2013, indicate that the majority of the site no longer has wetland hydrology. During 2012, a total of 73 of the first 80 days of the growing season (May 15 through August 2) were characterized by antecedent precipitation wetter than the normal range. Precipitation at the site during the first three months of the growing season exceeded the total for the same 3-month period during the past 122 years by over 5 inches. In addition, hydrology on the site was influenced by Mississippi River flood conditions during late June and early July.

The monitoring locations had sustained water levels above the wetland threshold for 29 days to 37 days during the wetter than normal period in 2012. However, during the normal or drier than normal periods, only two locations (Wells 10 and 11) had sustained water levels for more than 14 days, which is the wetland hydrology criteria stated in the Regional Supplement.

During 2013, a total of 34 of the first 67 days of the growing season were characterized by antecedent precipitation wetter than the normal range. The 2013 monitoring data showed that, when considering data from the entire growing season, including the periods with wetter than normal antecedent precipitation; only Well 10 had sustained water levels above the wetland threshold for more than 14 days. However, during periods with normal and drier than normal antecedent precipitation, the longest

sustained duration for Well 10 was 3 days. Water levels in all other monitoring locations were sustained above the wetland threshold for 8 days or less throughout the entire growing season.

Considering the two years of monitoring data collected so far, wetland hydrology criteria have been met in Wells 10 and 11 during one of the two years. Wetland hydrology criteria have not been met in the remaining wells during normal or drier than normal periods during 2012 and 2013.

5.1.6 Wetland Delineation

Existing wetlands on the site have been preliminarily identified as shown on Figure 4. The final delineation of wetlands present within the site will be conducted in the field early in the 2014 growing season. All private ditches within the site have wetland characteristics, which will be specifically documented and located in the field. The existing, seasonally flooded wetland located east of County Highway 1 has been preliminarily mapped based on the hydrology monitoring data collected and interpretation of topography and aerial photograph information. The final delineation of the wetland will be conducted based on additional hydrology monitoring data from early in the 2014 growing season along with field evaluation.

6.0 Wetland Restoration Plan

The site is currently in row crop agricultural production, which requires considerable control over the hydrology of the site. Prior to about 2009, the site was managed for sod production and previously had been managed as a wild rice production facility. The site hydrology is controlled by a series of ditches throughout with outlet structures through the diversion channel dikes and crossing perimeter roads. Water levels in the ditches are typically maintained approximately 2 to 4 feet below the field elevations to ensure an aerated rooting zone without soil saturation. The goal for each step in the restoration process is to continually progress toward the final goal of establishing a variety of wetland communities with the appropriate hydrology and dominated by characteristic native vegetation within each community.

6.1 Aitkin Wetland Restoration Construction Plan

The ultimate objective of the plan is to restore the hydrology within the site by removing the internal drainage system and constructing outlets to establish specific hydrologic conditions that will meet the goals and performance standards described in Sections 4.0 and 5.0. The hydrology will be restored utilizing broad, rock-lined weirs, and eliminating culverts with the exception of the culverts crossing County Highway 1 and the east outlet crossing 391st Lane.

The restoration process will start with activities to restore the hydrology. Prior to constructing the surface inlets and outlets, silt fence/barrier will be installed downstream of the restoration areas within the primary outlet ditches. A ring dike will first be constructed around the homestead property that is excluded from the restoration plans. The dike will be constructed to elevation 1202 feet MSL to prevent surface flooding.

The proposed outlet modifications will be constructed next, then moving upstream within the site, culverts will be removed and internal ditches will be filled in accordance with the plan. The next step will involve raising the dikes and land area to prevent flooding of neighboring properties. The west dike will be raised to elevation 1202 feet MSL. The land along the south and southeast corner of the west half will be raised to elevation 1201 feet MSL to prevent water from the restoration area from entering the County Highway 1 drainage system.

A rock-lined surface weir will be constructed in the southeast corner of the west half of the site with an overflow elevation of 1200 feet MSL. The weir will consist of approximately a 20 foot bottom width with 20H:1V slopes cutting into the berm. The overflow would then be covered with 1/2-inch to 4-inch rock over geotextile fabric to a depth of 12 inches and extending up the sides of the overflow 1 to 2 feet in elevation. The rock will also extend on the upstream and downstream slopes. The weir will allow water to discharge from the site into the County Highway 1 ditch and flow through the culvert easterly under the highway to the Mississippi River, maintaining saturated soil conditions over the majority of the area.

The culverts under County Highway, 1 connecting the east and west parts of the site, will not be modified and therefore will allow water movement between them. The culverts that cross County Highway 1 near

the south part of the site will also remain in place to maintain drainage from the road generally as it currently exists. The east outlet across 391st Lane will be reconstructed with a concrete weir and pipe with a control elevation of 1201 feet MSL. The organic or mineral hydric soils removed from the dike during construction would be utilized to fill the interior field ditches where practical. After the water supply has been reestablished, efforts will be focused on establishment of the targeted wetland communities as described in Section 7.3.

6.2 Vegetation Restoration Establishment

An adaptive management program is proposed to guide the development of the restored wetlands to the targeted conditions. The vegetative restoration community types proposed in the Aitkin wetland restoration area are shown on Figure 1 and are summarized in Table 2. The vegetative restoration of the herbaceous layer in each wetland community will be conducted to promote the establishment of characteristic native species that are present in the seed bank or that may be transported to the area from adjacent wetlands. The process for restoration of the wetlands is designed to meet the goals described in Section 4.0 and the performance objectives described in Section 5.0 in the most effective manner.

The goal of the restoration is to provide a setting and conditions in which the restoration areas will be restored to naturally self-sustaining and functioning wetlands to the extent feasible. The proposed wetland communities have been planned in areas that appear to match the natural hydrologic characteristics of each community type. However, during the restoration process, it is expected that the defined areas and wetland communities may change to some degree and the plan will allow for adaptation to the conditions.

Where feasible, reference wetlands will be identified in the vicinity of the site for each restoration community type that represent an approximation of the wetland communities anticipated after restoration. It is recognized that this process cannot be accomplished within a year or two, but will take time, and therefore, short-term interim goals are also included in the performance standards.

6.2.1 General Site Preparation

Prior to or concurrent with conducting hydrologic restoration activities, existing, non-native and invasive vegetation will be removed from the restoration site through mechanical means or herbicide application. Areas where vegetation is present will be assessed to determine the most appropriate vegetation management treatments. Treatment methods that may be used include mowing (for annual weeds), selective herbicide application (for broadleaf weeds or non-native or invasive grasses), or broad-spectrum herbicide application (for areas where limited desirable species are present).

6.2.2 Natural Regeneration - All Communities

The proposed vegetation establishment and maintenance activities anticipated to meet the goals of the plan are listed for the conditions described as appropriate to the restoration schedule:

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- **Presence of reed canary grass or other non-native grasses.** Spray grass-selective herbicide at label rates in late fall (after desirable native vegetation has senesced) within wetland restoration areas containing more than 20 percent areal coverage of reed canary grass or other non-native or invasive grasses and all dikes and ditch slopes adjacent to the wetland restoration areas. The purpose of this treatment is to kill reed canary grass and other actively growing non-native grasses while desirable native plants are dormant. Other restoration projects have had considerable success using this treatment recently.
 - **Presence of broadleaf weeds.** Spray perimeter dikes and slopes adjacent to wetland restoration areas and other areas where warranted with a broadleaf herbicide (e.g., Transline) at recommended rates targeting stinging nettle, Canada thistle, and other broadleaf non-native species.
 - **Revegetate berms and dikes.** Seed ditch banks and dikes with an appropriate native grass seed mix.
 - **Hydrologic restoration and monitoring.** Construct hydrologic restoration activities as described in Section 6.1 within 4 weeks after initial herbicide application where invasive or non-native vegetation is a concern. Monitor water levels in restored wetlands to determine if target hydrology is present.
 - **Presence of annual weeds.** Where annual weeds are present, mow seeded areas to 6-8 inch height with low ground-pressure mower to prevent any annual weeds present from going to seed.
 - **Vegetation characterization.** Characterize vegetation establishing in each wetland restoration area in June and August of each year to determine necessary management and establishment procedures. Vegetation characterization will include documenting all species present and the approximate areal coverage of each species by conducting meandering surveys within each wetland restoration area as described in Section 8.0.
 - **General weed control.** Continue treatments 1, 2, and 5 annually until reed canary grass, stinging nettle, Canada thistle and other non-native or invasive species are adequately controlled (see list in Table 3).
 - **Site specific treatment.** Spot spray wetland restoration areas two times annually to control reed canary grass and other perennial non-native or invasive species for up to 8 years in shrub communities, 20 years in bog and forested communities, and 5 years in other communities following initial restoration. Extensive treatments may not be needed after a sustainable wetland dominated by characteristic native vegetation is established such that the performance standards described in Section 5.0 are achieved.

- **Weed control.** Conduct a spring burn in the sedge meadow and wet meadow communities after the second or third growing season to kill weed seed and promote germination of native plants, assuming that there is sufficient fuel for burning and assuming that there are no concerns with fire management due to climate conditions or potential for peat fires.
- **Shallow and deep marsh weed control.** Should narrow-leaved cattails, hybrid cattails or other invasive, non-native emergent species become denser than described in the performance standards, control measures will be implemented. A herbicide approved for use over water may be wick-applied selectively to the species in need of control.

6.2.3 Seeding/Planting - Shallow Marsh and Shrub-Carr Communities

Diverse, native, herbaceous wetland vegetation is expected to develop in the restoration wetlands from the existing seedbank and from the wetland vegetation that surrounds the wetland restoration site (both through vegetative propagation and through seed transport) or by other seed dispersal methods. At the end of the second growing season, a detailed assessment of seed bank re-establishment will be conducted within the wetland areas. Based upon the results of the assessment as per the performance standards in Section 4.0, areas that have not met the requirements will be seeded as follows:

- **Shallow marsh drawdown vegetation development.** Shallow marsh communities that have not developed adequate species diversity and cover after the second full growing season may be drawn down to expose the soils and promote vegetation development.
- **Emergent fringe seeding.** After the second full growing season, shallow marsh fringe areas that have not had adequate wetland vegetation cover established will be drawn down to expose the soils and the emergent wetland fringe will be seeded with State seed mix 34-181 Emergent Wetland at a rate of 5.6 pounds/acre.
- **Shrub-carr communities.** Shrub-carr wetlands that do not meet the performance standards after the second full growing season will be planted with locally collected dormant cuttings of willow and dogwood species, which will be staked in the fall or spring at approximately 220 shrubs per acre. Shrub survival will be closely monitored and corrective measures will be planned and implemented if shrub mortality surpasses 50 percent.

6.2.4 Planting Hardwood Swamp Community

In the hardwood swamp community, trees will be planted in the spring of the second or third year after construction, depending on the success of herbaceous species establishment, the presence of invasive species, and the stability of the hydrology. Trees planted in this area will likely include black ash, quaking aspen, yellow birch, and American elm, but will be planned to correspond closely to the species present in a local hardwood swamp reference community. These trees will be planted at about 300 trees per acre. Tree survival will be closely monitored and corrective measures will be planned and implemented if tree mortality surpasses 50 percent.

If tree densities do not appear to be on a trajectory to meet the performance standards after the fifth full growing season, bare root seedlings of similar species will be interplanted to achieve a stem densities of 200 trees per acre.

6.2.5 Seeding/Planting Coniferous Swamp Community

Coniferous swamp communities will be established initially by direct seeding tamarack at a rate of 4 ounce/acre. As tamarack seed does not exhibit dormancy, it will be planted in the spring.

If tree growth does not appear to be on a trajectory to meet the performance standards after the second full growing season, trees will be planted in the spring of the third year after construction, depending on the success of herbaceous species establishment, the presence of invasive species, and the stability of the hydrology. Trees planted in this area will include predominantly tamarack with some black spruce. These trees will be planted at about 300 trees per acre. Tree survival will be closely monitored and corrective measures will be planned and implemented if tree mortality surpasses 50 percent.

If tree growth does not appear to be on a trajectory to meet the performance standards after the fifth full growing season, bare root seedlings of similar species will be interplanted to achieve a stem densities of 200 trees per acre.

6.2.6 Upland Area Establishment

Existing vegetation in the upland areas will be managed to promote development of native plant communities. The primary maintenance activity will be control of non-native invasive species and seeding to develop diverse, native communities. Protecting the site from further disturbances and allowing natural colonization and successional processes will maintain ecosystem biodiversity and structure.

Establishment activities will include:

- Monitoring site to identify invasive species and management needs prior to seeding. Particular attention will be paid to edges of the upland sites.
- Removing or treating with appropriate herbicides all non-native or invasive plant species.
- Seeding of upland buffers with State seed mix 36-311 Woodland Edge Northeast at a rate of 8.5 pounds/acre native species.

7.0 Wetland Management Schedule

The following schedule represents a preliminary plan of the expected activities that may be involved in restoring wetlands at the Aitkin site. However, with an adaptive management perspective, it should be recognized that the timing of specific establishment and management activities are likely to change as the restoration work progresses. The overall schedule for restoration activities at the site is to complete the majority of the restoration work within the first 4 years of the project. Within the first year after permit issuance, the Year 1 restoration work will be completed within the site. The remaining restoration activities will generally follow the conceptual schedule provided below.

The wetlands restored as mitigation for the Project will require regular management to become established. This is critical in the first five to ten years and should be recognized as integral to the wetland mitigation success. Management will include both eliminating non-native and invasive species, creating ideal conditions for the native plants to flourish, and seeding/planting to supplement natural regeneration. Weeds can establish quickly as the wetlands develop because the ground is bare at the time of restoration. Some weeds are very aggressive and will out-compete the desirable wetland seedlings. Therefore, weed removal and careful monitoring is important during the early stages of the restoration. As native plants grow and spread over the years, and as thatch builds, the site will become less vulnerable to weed species. Removal of weeds will continue to be important during the first five to ten years to ensure that the native plant communities become established. Structures constructed to control hydrology within the restoration areas will be inspected annually during the 20 year monitoring period established and repairs will be made to maintain the goals of the plan. After final certification of the restored wetlands by the appropriate regulatory agencies, the land owner will be required by the *Permanent Conservation Easement* that will be recorded after completion of construction (examples provided in Appendix A), to regularly inspect and maintain those structures to sustain the goals of the approved plan.

7.1 Year 1

7.1.1 Fall/Winter

- Apply herbicide to areas where undesirable vegetation is present.
- Construct berms (around excluded homestead area) and fill ditches as shown on the plans.
- Complete hydrologic restoration construction as described in Section 6.1 and as shown on the wetland restoration plans.
- Spray grass-selective and broad-leaf herbicides on dikes and dike slopes adjacent to restoration areas.
- Seed dike and dike slopes with appropriate native grass seed mix.
- Spray restoration fields containing at least 20 percent areal coverage of non-native or invasive grass species with grass-selective herbicide.
- Seed upland buffer areas with State seed mix 32-241.

7.1.2 Spring/Summer

- Monitor water levels in restored wetlands.
- Seed tamarack and black spruce during late winter/early spring in conifer wetland communities.
- Characterize vegetation in restoration areas in June and August followed by development of specific management objectives for the remainder of the year based on the findings.
- Mow wetlands in spring if annual weeds are present but no trees or shrubs are present.
- Apply grass-selective and broad-leaf herbicide to upland buffers, dikes, and dike slopes where non-native or invasive species are present.
- Spot spray wetland restoration areas to eliminate non-native or invasive species.

7.2 Year 2

7.2.1 Fall – End of First Full Growing Season

- Complete monitoring report, including documentation of wetland establishment activities completed during the previous year conducted in comparison to the plan and recommended actions for the following year.
- Monitor water levels in restored wetlands.
- Apply herbicides as necessary to control non-native and invasive species in all communities.

7.2.2 Spring/Summer

- Monitor water levels in restored wetlands.
- Spray grass-selective and broad-leaf herbicides (typically in early June) in upland areas adjacent to restoration areas where non-native or invasive grass and forb species are present before seed production is complete.
- Characterize vegetation in restoration areas in June and August followed by development of specific management objectives for the remainder of the year based on the findings.
- Spot spray or wick-apply wetland restoration areas with grass-selective and non-selective or other appropriate herbicide to eliminate non-native or invasive species.
- Mow wetlands if annual weeds are present prior to seed production.

7.3 Year 3

7.3.1 Fall – End of Second Full Growing Season

- Complete monitoring report, including documentation of wetland establishment activities completed during the previous year conducted in comparison to the plan and recommended actions for the following year. Make recommendations for permanent water level control adjustments that may be needed for restored wetlands to better promote vegetation development that meets performance standards.
- Monitor water levels in restored wetlands.
- Apply herbicides as necessary to control non-native and invasive species in all communities.

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- If shrub development does not conform to performance standards, conduct shrub staking or seeding.
 - If species diversity or vegetative cover development in wetland herbaceous layers do not conform to performance standards, conduct seeding.
 - If shallow marsh communities do not meet performance standards, draw down water levels and seed fringe areas.

7.3.2 Spring/Summer

- Monitor water levels in wetlands.
- Spray grass-selective and broad-leaf herbicides (typically in early June) on dikes and dike slopes adjacent to restoration areas where non-native or invasive grass and forb species are present before seed production is complete, reseed if bare soils are present.
- If shrub development does not conform to performance standards, conduct shrub staking.
- Conduct tree planting in hardwood and conifer swamp communities.
- Characterize vegetation in restoration areas in June and August followed by development of specific management objectives for the remainder of the year based on the findings.
- Spot spray or wick-apply wetland restoration areas with grass-selective, broad-leaved, or non-selective herbicide to eliminate non-native or invasive species.

7.4 Years 4-5

Many of the management activities described for Year 3 will be continued in Years 4 and 5 along with the monitoring activities. If tree development in hardwood and coniferous swamp communities does not conform with performance standards, seedlings will be planted as described in Sections 6.2.4 and 6.2.5. The monitoring report completed after the fifth growing season will assess whether or not restored wetland communities (with the exception of shrub and forested communities) are in conformance with performance standards such that the five year monitoring would be sufficiently complete.

7.5 Years 6-20

Because establishment of shrub, forested, and bog wetland communities can take longer, active management and monitoring will be conducted for eight years within shrub communities and twenty years in forested communities. Many of the management activities described for Years 4-5 will be continued in Years 6-20 along with the monitoring activities.

8.0 Wetland Mitigation Monitoring

The wetland restoration area will be monitored for at least five years (eight years for shrub communities and twenty years for forest communities) beginning in the first full growing season after beginning hydrologic restoration to document the progress and condition of the wetland communities at the mitigation site. For wetlands other than shrub and forest communities, monitoring reports will be prepared each year in years 1 through 5 following construction. For shrub communities, monitoring reports will be prepared and submitted in years 1, 2, 3, 5, and 8 following construction. For forested communities, monitoring reports will be prepared and submitted in years 1, 2, 3, 5, 10, and 20 following construction. The monitoring report completed after the final growing season will assess whether or not the restored wetlands are in conformance with performance standards.

Hydrologic parameters will be evaluated in the mitigation area more intensively during the first five years and then at a level appropriate to the hydrologic characteristics of each area thereafter. Any significant modifications to the monitoring frequency proposed herein will be described in a revised monitoring plan to be submitted for review and approval prior to implementation. In addition to monitoring the restored wetlands, one reference wetland of each wetland restoration community type (if available) will be monitored within the general area of the restoration site, in areas with relatively natural hydrologic conditions. A monitoring plan will be submitted for review and approval that will include proposed locations of reference wetlands prior to implementing the monitoring program. Continuous recording wells will be utilized to the extent feasible.

8.1 Hydrologic Monitoring Years 1-5

8.1.1 Shallow Marsh

Hydrologic monitoring in these inundated wetland communities will be conducted using monitoring wells placed within each restored wetland area. Water elevations will be recorded several times per day during the growing season.

8.1.2 All Other Communities

Hydrologic monitoring in these generally saturated wetland communities will be conducted using shallow wells placed within each restored wetland area. Water elevations will be recorded several times per day throughout the growing season.

8.2 Hydrologic Monitoring Years 6-20

8.2.1 All Other Communities

If the monitoring conducted during Years 1-5 indicate a stable and consistent hydrologic regime similar to the reference wetlands, water elevations will be recorded several times per day throughout the growing season during Years 6-8 for the shrub and forest communities, but data will only be collected one time at the end of the growing season.

In wetlands where water elevation fluctuations differ substantially from the reference wetlands, water elevations will be recorded several times per day throughout the growing season in Years 6-8 for shrub and forest communities. Water level data will be collected approximately two times during the growing season to assist in determining the need for any corrective actions. If hydrology in the forested communities differs substantially from the performance standards through Year 8, monitoring will continue in years 9-20 utilizing recording wells with water levels recorded several times per day during the growing season and downloaded approximately twice.

8.3 Vegetation Monitoring

A detailed vegetation survey will be conducted once per year (typically August) in each wetland mitigation community, as well as the reference wetland communities, to evaluate the success of the restoration during the appropriate monitoring period for each community type. A time meander search will randomly sample 20 percent of each wetland restoration community. Documentation photographs will also be taken in August from fixed reference points around each restored wetland area.

8.4 Monitoring Report

A monitoring report will be prepared annually during the 5-year monitoring period. In addition, annual monitoring reports will be prepared following growing season 8 following restoration for the shrub communities and following growing seasons 8, 10, and 20 for the forested communities. The report will describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, and discuss management activities and corrective actions conducted during the previous year, and activities planned for the following year. The report will be submitted to the USACE and MDNR by December 31 of each year. The annual report will include the following information at a minimum:

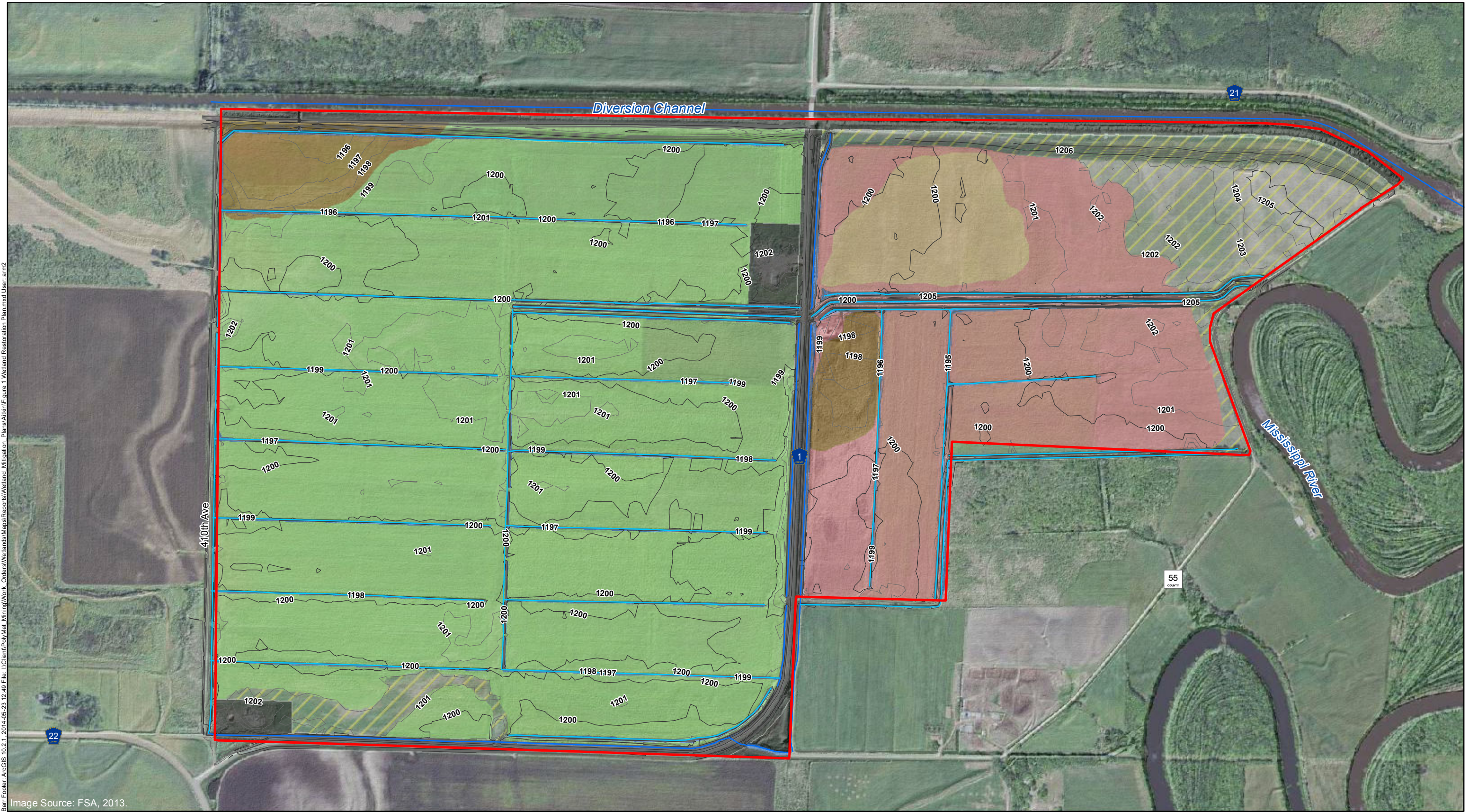
- A brief description of the wetland mitigation area, including location, size, vegetative and hydrologic monitoring data, current wetland types and desired wetland types.
- Preparation of an as-built survey within the first year after construction is complete along with a comparison of the as-built survey to the approved plans. This as-built survey will be prepared upon the completion of establishing the permanent overflow structures, which may not be completed during the first year.
- A summary of water level measurements taken to date and a determination whether the hydrology in the wetlands meets the design elevations and wetland hydrology criteria as defined in the performance standards.
- Vegetation survey information, including species and percent areal coverage within each restored wetland community and a determination of whether the vegetation meets the performance criteria.
- A map of the various plant communities present within the restoration areas will be prepared as distinctly different communities develop.
- Color photographs of the wetland mitigation sites taken in August of each year at designated photo-reference points.

-
- A summary of management activities and/or corrective actions conducted in the wetlands during the previous year and activities planned for the following year.

9.0 References

1. **Barr Engineering Company.** Aitkin Mitigation Site Hydrology Monitoring 2012-2013. Prepared for Poly Met Mining Inc. May 2014.
2. **U.S. Army Corps of Engineers St. Paul District.** St. Paul District Policy for Wetland Compensatory Mitigation in Minnesota. January 2009.
3. **Eggers, S.D. and D.M. Reed.** Wetland Plants and Plant Communities of Minnesota and Wisconsin: Second Edition. U.S. Army Corps of Engineers, St. Paul District. 1997.
4. **Minnesota Department of Natural Resources.** Invasive terrestrial plants. *Minnesota Department of Natural Resources*. [Online] 2002. <http://www.dnr.state.mn.us/invasives/terrestrialplants/index.html>.
5. **Oakes, E L and Bidwell, L E.** Water Resources of the Mississippi River Headwaters Watershed North-Central Minnesota. Washington, D.C. : U.S. Geological Survey, 1968.
6. **Natural Resources Conservation Service.** Soil Survey of Aitkin County, Minnesota. Washington, D.C. : U.S. Department of Agriculture, 1999.
7. —. WETS Climate Information. *U.S. Department of Agriculture NRCS*. [Online] 2007. <http://www.wcc.nrcs.usda.gov/cgibin/getwetco.pl?state=mn>.
8. **Federal Emergency Management Agency.** Flood Insurance Study, Aitkin County, Minnesota, Unincorporated Areas. 1981.

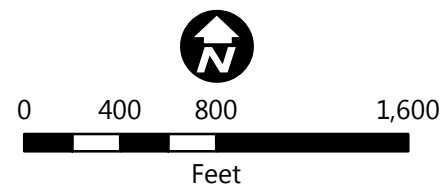
Figures



Bar Footer: ArcGIS 10.2.1, 2014-05-23 12:49 File: I:\Client\PolyMet_Mining\Work_Orders\Wetlands\Maps\Reports\Wetland_Mitigation_Plans\Aitkin\Figure 1 Wetland Restoration Plan.mxd User: arm2

Image Source: FSA, 2013.

- | | | |
|--------------------------|---------------|------------------------|
| Wetland Restoration Plan | Shrub-carr | Aitkin Mitigation Site |
| Conifer swamp | Ditch | Private Ditch |
| Hardwood swamp | Upland Buffer | Public Ditch |
| Shallow marsh | None | Surface Elevation |
| | | 5-Ft Contour |
| | | 1-Ft Contour |

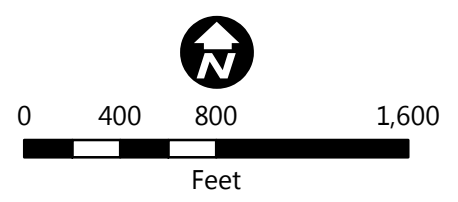


DRAFT
 Figure 1
 WETLAND RESTORATION PLAN
 NorthMet Project
 Poly Met Mining Inc.
 Hoyt Lakes, MN

Bar Footer: ArcGIS 10.2.1, 2014-05-23 13:38 File: I:\Client\PolyMet_Mining\Work - Orders\Wetlands\Maps\Reports\Wetland_Mitigation_Plans\Aitkin\Figure 2 Wetland Mitigation Credit Areas.mxd User: am2



- Wetland Credits
- Drained - 100%
 - Partially Drained - 50%
 - Upland Buffer - 25%
 - No Credit - 0%
- Aitkin Mitigation Site



DRAFT
Figure 2
WETLAND MITIGATION CREDIT AREAS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



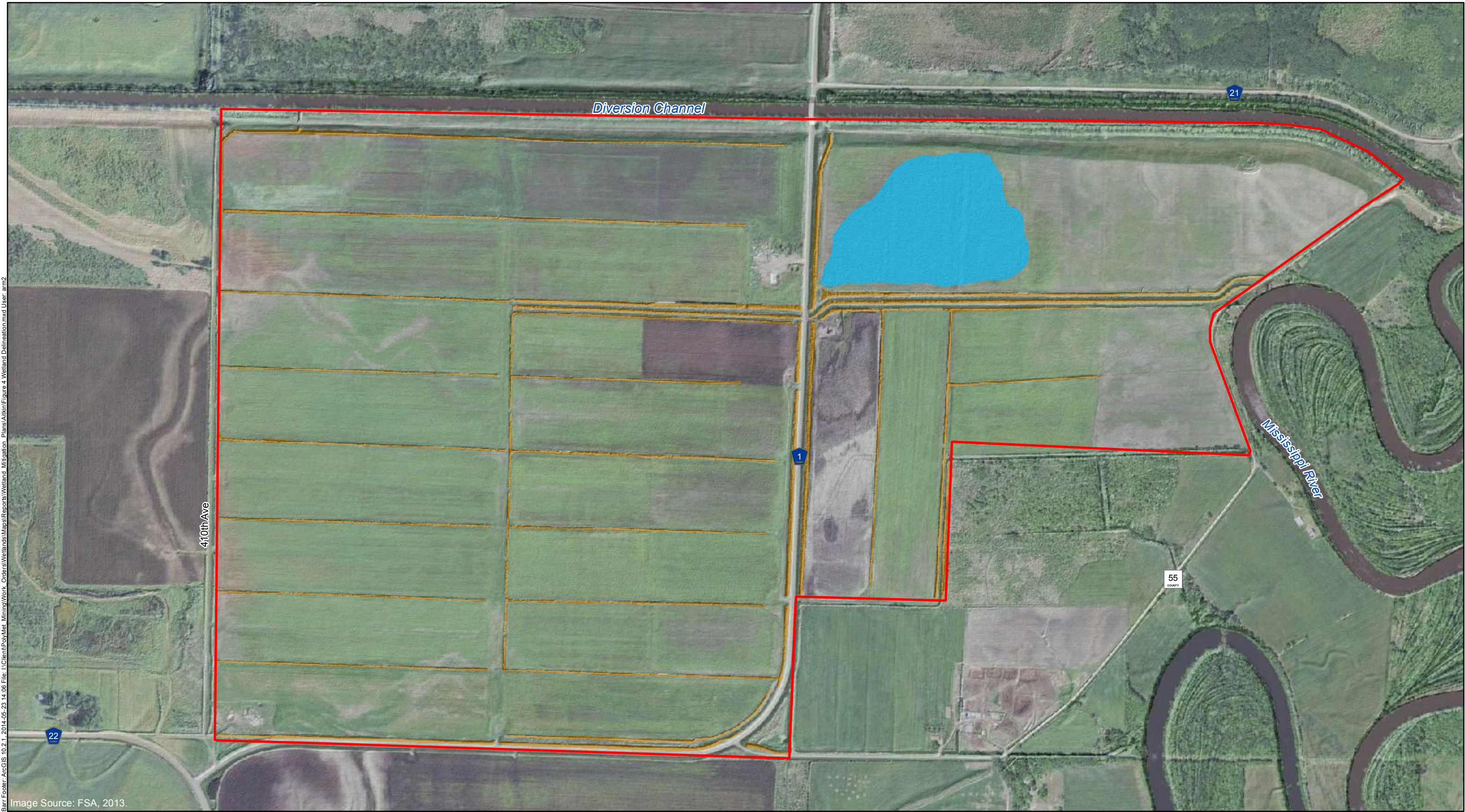
Bar Footer: ArcGIS 10.2.1, 2014-05-23 13:57 File: I:\Client\PolyMet_Mining\Work - Orders\Wetlands\Maps\Reports\Wetland_Mitigation_Plans\Aitkin\Figure 3 Aitkin County Soil Survey.mxd User: am2

Image Source: FSA, 2013.

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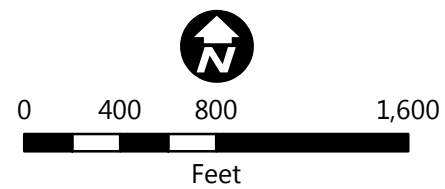
Figure 3
SOILS

NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Wetland Delineations

- Seasonally flooded basin
- Shallow marsh
- Aitkin Mitigation Site



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Figure 4
WETLAND DELINEATION
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



- National Wetlands Inventory (NWI)

■ Freshwater Emergent Wetland

■ Freshwater Forested/Shrub Wetland

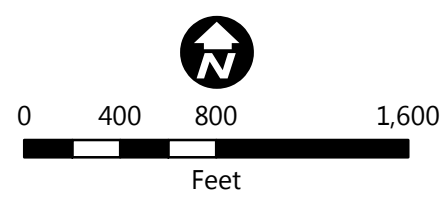
■ Freshwater Pond

■ Riverine

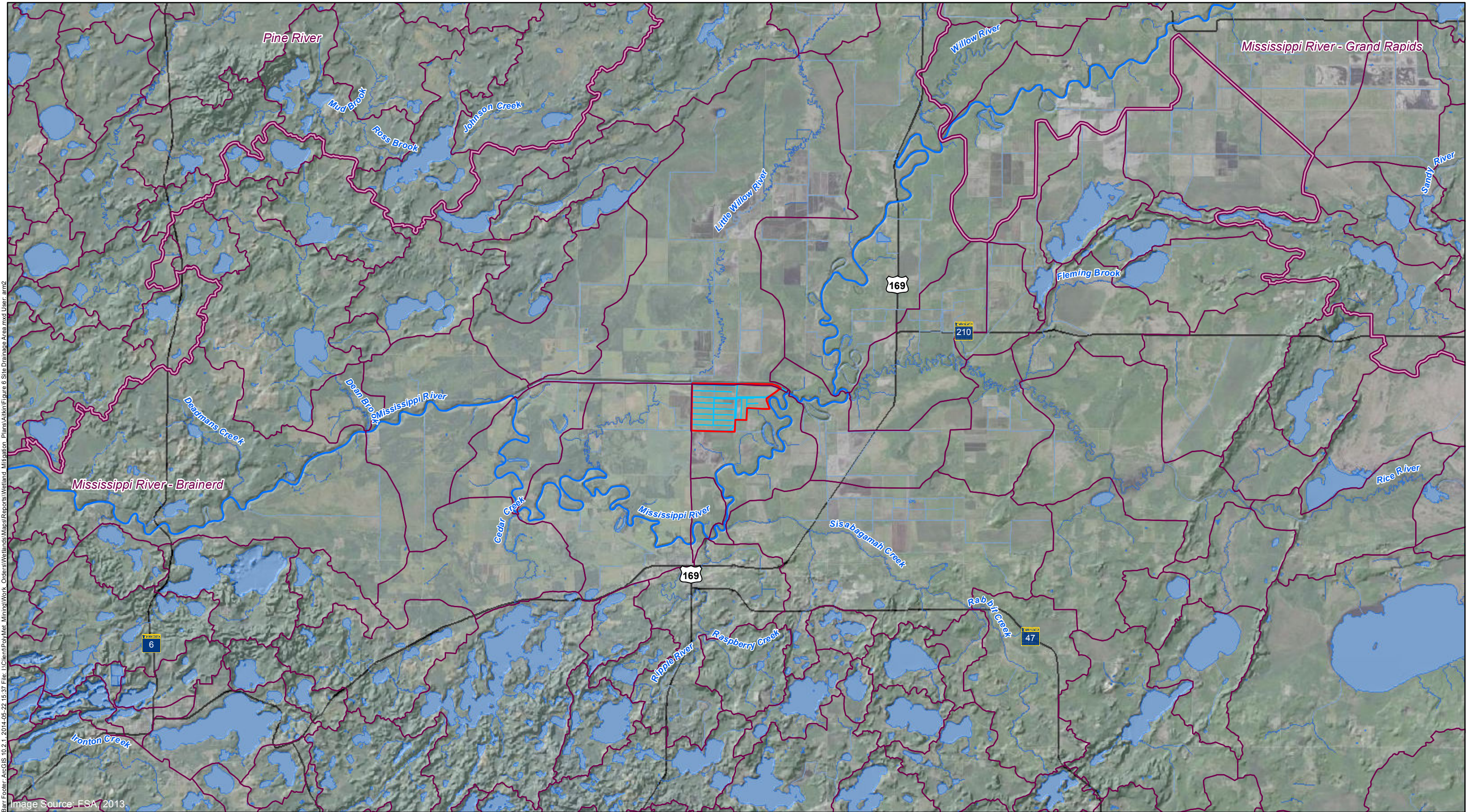
■ Aitkin Mitigation Site

— Private Ditch

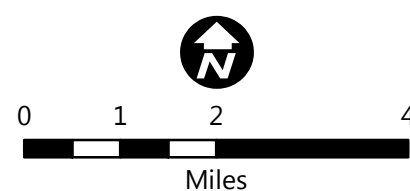
— Public Ditch



DRAFT
 Figure 5
 NATIONAL WETLANDS INVENTORY
 NorthMet Project
 Poly Met Mining Inc.
 Hoyt Lakes, MN



- Aitkin Mitigation Site
- Watersheds - DNR Level 4
- Watersheds - DNR Level 8
- Ditches
- ~ Flowlines
- ~ Waterbodies

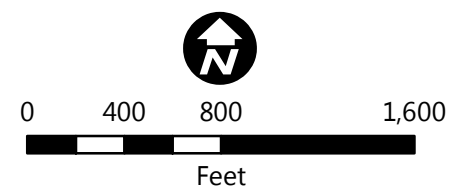


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Figure 6
SITE DRAINAGE AREA
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Bar Footer: ArcGIS 10.2.1, 2014-05-23 14:27 File: I:\Client\PolyMet_Mining\Work - Orders\Wetlands\Maps\Reports\Wetland_Mitigation_Plans\Aitkin\Figure 7 1940 Aerial Photo.mxd User: am2

 Aitkin Mitigation Site

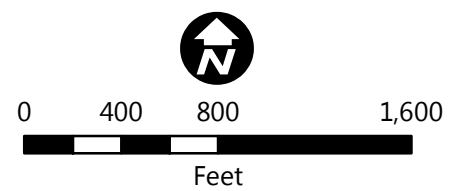


DRAFT
Figure 7
1940 AERIAL PHOTO
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Barr Footer: ArcGIS 10.2.1, 2014-05-23 14:27 File: I:\Client\PolyMet_Mining\Work_Orders\Wetlands\Maps\Reports\Wetland_Mitigation_Plans\Aitkin\Figure 8 1991 Aerial Photo.mxd User: am2

 Aitkin Mitigation Site



DRAFT
Figure 8
1991 AERIAL PHOTO
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

Appendices

Appendix A

Permanent Conservation Easement Example

(Above Space is Reserved for Recording Information)

**PERPETUAL CONSERVATION EASEMENT
FOR WETLAND BANK**

Grantor:

Location: within Section 5, Township 39 North, Range 22 West, County of Pine

This Perpetual Conservation Easement for Wetland Replacement ("Easement") is made on (date) by the undersigned, hereinafter referred to collectively as the "Grantor":

RECITALS

A. This Easement is made pursuant to and in furtherance of the Wetland Conservation Act of 1991, as amended, Minn. Stat. §103G.222, *et. seq.* ("WCA") and the rules implementing WCA, Minn. R. ch. 8420 ("WCA Rules").

B. This Easement pertains to all or part of the real property in Pine County, Minnesota, which is legally described on *Exhibit A* attached hereto and made a part hereof ("Real Property").

C. The Real Property is the subject of a wetland bank plan pursuant to Minn. R.8420.0740.

D. The Grantors include all of the following (1) all the fee owners of the Real Property and (2) the applicants under the bank plan if different from the fee owners. The term "Grantor" includes all of the Grantors if there is more than one. The Grantors are jointly and severally responsible for complying with the terms of this instrument. This Easement and the duties and restrictions contained in it shall also run with the land.

E. WCA is administered by the State of Minnesota through its Board of Water and Soil Resources ("State").

F. The local government unit ("LGU") charged under WCA with approval of the subject wetland replacement plan ("replacement plan") is the Minnesota Department of Natural Resources – Division of Lands and Minerals. The subject wetland mitigation plan includes all fully executed forms provided by the State, all supporting maps, engineering plans, drawings, monitoring plan, vegetation establishment plan and management plan and facilities maintenance plan. A complete copy of the replacement plan is on file at the LGU. The address of the LGU is 1525 Third Avenue East, Hibbing, MN 55746. The State is responsible for the acceptance of this Easement.

G. The replacement plan requires the restoration or creation of a wetland on the portion of the Real Property designated in Exhibit B attached hereto and made a part hereof ("Replacement Area"). The replacement plan may also require the establishment of upland buffer within the Replacement Area. This Easement pertains to both wetlands and specified uplands within the Replacement Area.

H. The Replacement Area is subject to the WCA, WCA Rules and all other provisions of law that apply to wetlands, except that the exemptions in Minn. Stat. §103G.2241 and Minn. R. 8420.0122 do not apply to the Replacement Area, pursuant to Minn. Stat. §103G.222, subd. 1(h) and Minn. R. 8420.0115.

I. All references in this Easement to Minnesota Statutes and to Minnesota Rules are to the statutes and rules currently in effect and as amended or renumbered in the future.

J. The purposes of this Easement are to maintain and improve the ecological values of the Replacement Area through the means identified in the replacement plan and to preserve the Replacement Area in a natural condition in perpetuity.

IN ADDITION, THE GRANTORS, FOR THEMSELVES, THEIR HEIRS, SUCCESSORS AND ASSIGNS COVENANT THAT THEY:

1. Shall establish and maintain wetlands and upland buffers within the Replacement Area as specified in the replacement plan approved by the LGU and on file at the offices of the LGU. The wetland and any specified upland buffer area shall be the size and type specified in the replacement plan. Grantor shall not make any use of the Replacement Area that would adversely affect any of the functions or values of the area. Those functions and values are identified in Minn. R. 8420.0540, subp. 10, or specified in the approved replacement plan.

2. Shall pay the costs of establishment, maintenance, repairs and reconstruction of the wetlands and specified upland buffers within the Replacement Area, which the LGU or the State may deem necessary to comply with the specifications for the Replacement Area in the approved replacement plan. The Grantor's obligations under this paragraph include the payment of any lawful taxes or assessments on the Real Property.

3. Shall establish and maintain visible monuments such as signs, numbered fence posts or survey posts at prominent locations along the boundary of the Replacement Area in accordance with the approved replacement plan. If numbered fence posts are used, Grantor's Replacement Plan must contain a survey or scaled drawing of the property that corresponds to the fence post numbering. Posts

must be at least 4 feet high and notably visible on the landscape. If signs are used, such signs must be have a surface area of at least one quarter (1/4) square feet, mounted on a fence post at least 4 feet above ground, and minimally contain the words "Boundary of Wetland Replacement Area - Subject to Perpetual Conservation Easement Restrictions – Contact MN Board of Water and Soil Resources or Local Soil and Water Conservation District for Further Information." Said monuments must be made of non-degradable material and shall be at least four feet in height.

4. Grants to the LGU, the State, and the agents and employees of the LGU and the State, reasonable access to the Replacement Area for inspection, monitoring and enforcement purposes. The LGU, the State, and the agents and employees of the State are hereby granted a perpetual ingress and egress easement ("Access Easement") for access to and from the Replacement Area. The Access Easement shall be over and across the area ("Access Area") that is specified on Exhibit A attached hereto and made a part hereof or, if not specified on Exhibit A, the most reasonably direct and convenient route between the Replacement Area and a public road. If all or any part of the Access Area is owned by a person or entity other than Grantor, then the owner has joined in this Easement for purposes of granting the Access Easement by signing below. The signed written consent and subordination of all other holders of interests in the Access Area has been or will be obtained by Grantor and recorded in the same manner as specified in paragraph 5 below. This Easement grants no access to or entry to the Real Property, the Replacement Area, or the Access Area to the general public.

5. Represents that Grantor is (a) the fee owner of the Real Property and (b) the applicant under the replacement plan, if different from the fee owner. Grantor represents that all other parties who may have an interest in the Real Property (e.g., mortgagees, contract for deed vendees, holders of easements, etc.) have consented and subordinated their interests to this Easement by signing below. If it is determined at any time that there is any other party who may have an interest in the Real Property that is prior to this Easement, then Grantor shall immediately obtain and record a consent and subordination agreement signed by such other party. Acceptance of this Easement does not release Grantor from the obligation to obtain and record a consent and subordination agreement signed by any party who may have an interest in the Real Property that is prior to this Easement, even if such interest was of record at the time of acceptance.

6. Will record this easement at Grantor's expense in the real property records of the county where the Real Property is located. Said recording shall take place within 30 days of the State's acceptance of this Easement. The Grantor shall provide the original copy of the recorded easement to the State prior to making any credits from this replacement area available for use.

7. Acknowledge that this Easement shall be unlimited in duration, without being re-recorded. This Easement shall be deemed to be a perpetual conservation easement pursuant to Minn. Stat. ch. 84C.

8. Acknowledge that, unless expressly authorized in writing by the LGU in the approved replacement plan, Grantor:

- (a) Shall not produce agricultural crops on the Replacement Area, except that this provision does not restrict the harvest of the seeds of native vegetation if only the seed-head is

removed in the process of harvest and does not involve the use of vehicular, motorized equipment;

- (b) Shall not cut hay, mow vegetation or cut timber on the Replacement Area except as allowed or prescribed in the Replacement Plan;
- (c) Shall not make any vegetative alterations on the Replacement Area that do not enhance or would degrade the ecological functions and values of the Replacement Area. Vegetative alterations shall be limited to those listed in the approved replacement plan;
- (d) Shall not graze livestock on the Replacement Area;
- (e) Shall not place any materials, substances or other objects, nor erect or construct any type of structure, temporary or permanent, on the Replacement Area.
- (f) Shall not allow vehicular traffic on the Replacement Area except for the purpose of implementing construction or maintenance activities specifically authorized in the replacement plan.
- (g) Shall not alter the topography of the Replacement Area by any means including plowing, dredging, filling, mining or drilling except for the purpose of implementing construction or maintenance activities specifically authorized in the replacement plan.
- (h) Shall not modify the hydrology of the Replacement Area in any way or by any means including pumping, draining, ditching, diking, impounding or diverting surface or ground water into or out of the Replacement Area except for the purpose of implementing construction or maintenance activities specifically authorized in the replacement plan.
- (i) Shall regularly inspect and maintain structures specified in the Replacement Plan in good working condition to sustain the goals in the approved Replacement Plan.

9. Acknowledge that the Grantor is responsible, at Grantor's cost, for weed control by complying with noxious weed control laws and emergency control of pests necessary to protect the public health on the Replacement Area.

10. Acknowledge that this Easement may be modified only by the joint written approval of the LGU and the State. If the Replacement Area has been used to mitigate wetland losses under the Federal Water Pollution Control Act, the U.S. Army Corps of Engineers (or successor agency) must also agree to the modification in writing.

11. Acknowledge that this Easement may be enforced, at law or in equity, by the LGU or the State. The LGU and the State shall be entitled to recover an award of reasonable attorney's fees from Grantor in any action to enforce this Easement. The right to enforce the terms of this Easement is not waived or forfeited by any forbearance or failure to act on the part of the State or LGU. If the subject Replacement Area is to be used partially or wholly to fulfill permit requirements under the Federal Water Pollution Control Act or a federal farm program, then the provisions of this Easement

that run to the State or the LGU may also be enforced by the United States of America in a court of competent jurisdiction.

12. Acknowledge that this Easement is not valid until the Easement has been accepted by the State, the Grantor has recorded this Easement and the State has received evidence of such recording.

SIGNATURE OF GRANTOR

SIGNATURE OF FEE OWNER(S):

[illegible]

This instrument was acknowledged before me this _____ day of _____, _____ by (name(s) with marital status).

Notarial Stamp or Seal

Notary Public

**SIGNATURE OF BANK APPLICANT (S),
IF DIFFERENT FROM FEE OWNER:**

[illegible]

This instrument was acknowledged before me this _____ day of _____, _____ by (name(s) with marital status).

Notarial Stamp or Seal

Notary Public

ACCEPTANCE

The State accepts the foregoing Easement.

MINNESOTA BOARD OF WATER AND SOIL RESOURCES:

By: _____

Its: _____

STATE OF MINNESOTA)
) ss.

COUNTY OF _____)

This instrument was acknowledged before me this _____ day of _____, _____ by _____ (name of person) as _____ (title) of the Board of Water and Soil Resources.

Notary Public

Notarial Stamp or Seal

This instrument was drafted by the Board of Water and Soil Resources
One West Water Street, St. Paul, MN 55107

If there are additional holders of interest the subject real property CHECK HERE ☐ and attach their Consent and Subordination agreement [BWSR Form Number: wca-bank-03 (consent).doc].

EXHIBIT A

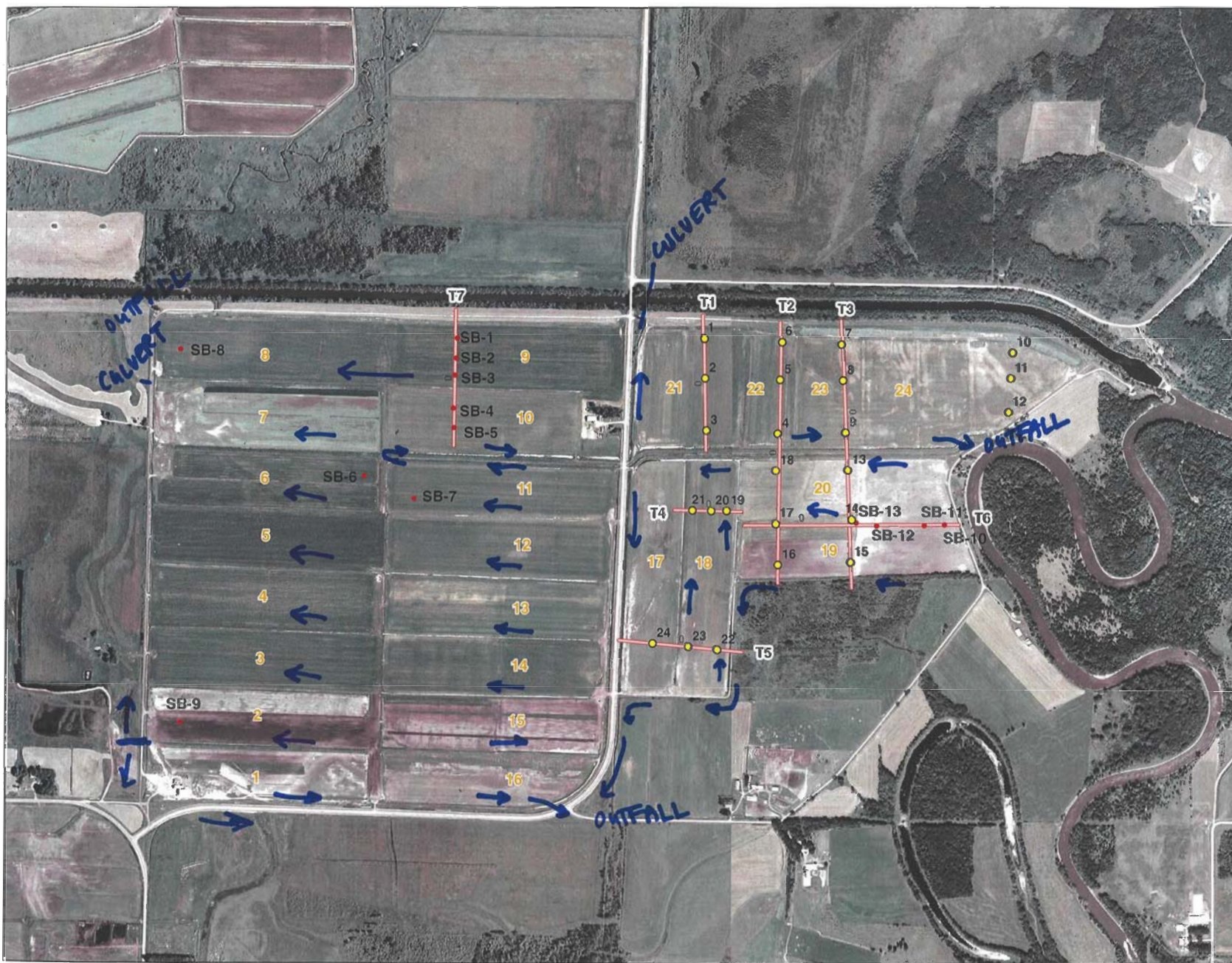
Legal Description of Real Property

EXHIBIT B

Map or Survey of Bank Area

Appendix B

Soil and Water Transect Data



- Soil Samples/WT depth - June 5 and 6, 2007
- Soil Borings April 25, 2007
- Transect
- Field Numbers
- Water Flow Direction in Ditches



0 500 1,000 2,000 Feet

Figure B-1

TRANSECT LOCATIONS
Aitkin Sod Farm
Wetland Restoration
PolyMet Mining Co.

Figure B-2

Legend for Soil Stratigraphy and Water Table Diagrams

Organic Soil



Sod/Oe = grass sod layer that is usually about 4 inches thick with peat soil



Oe = peat soil (Organic, Hemic)



Oa = mucky soil (Organic, Sapric)

Mineral Soil (ordered from coarse to fine textured)



s = sand



fs = fine sand



lfs = loamy fine sand



sl = sandy loam



fsl = fine sandy loam



l = loam



scl = sandy clay loam



fscl = fine sandy clay loam



cl = clay loam



si = silt



sicl = silty clay loam



sic = silty clay



sc = sandy clay



c = clay



Measured /observed water Table



Assumed Water Table - below the
bore hole depth

Figure B-3

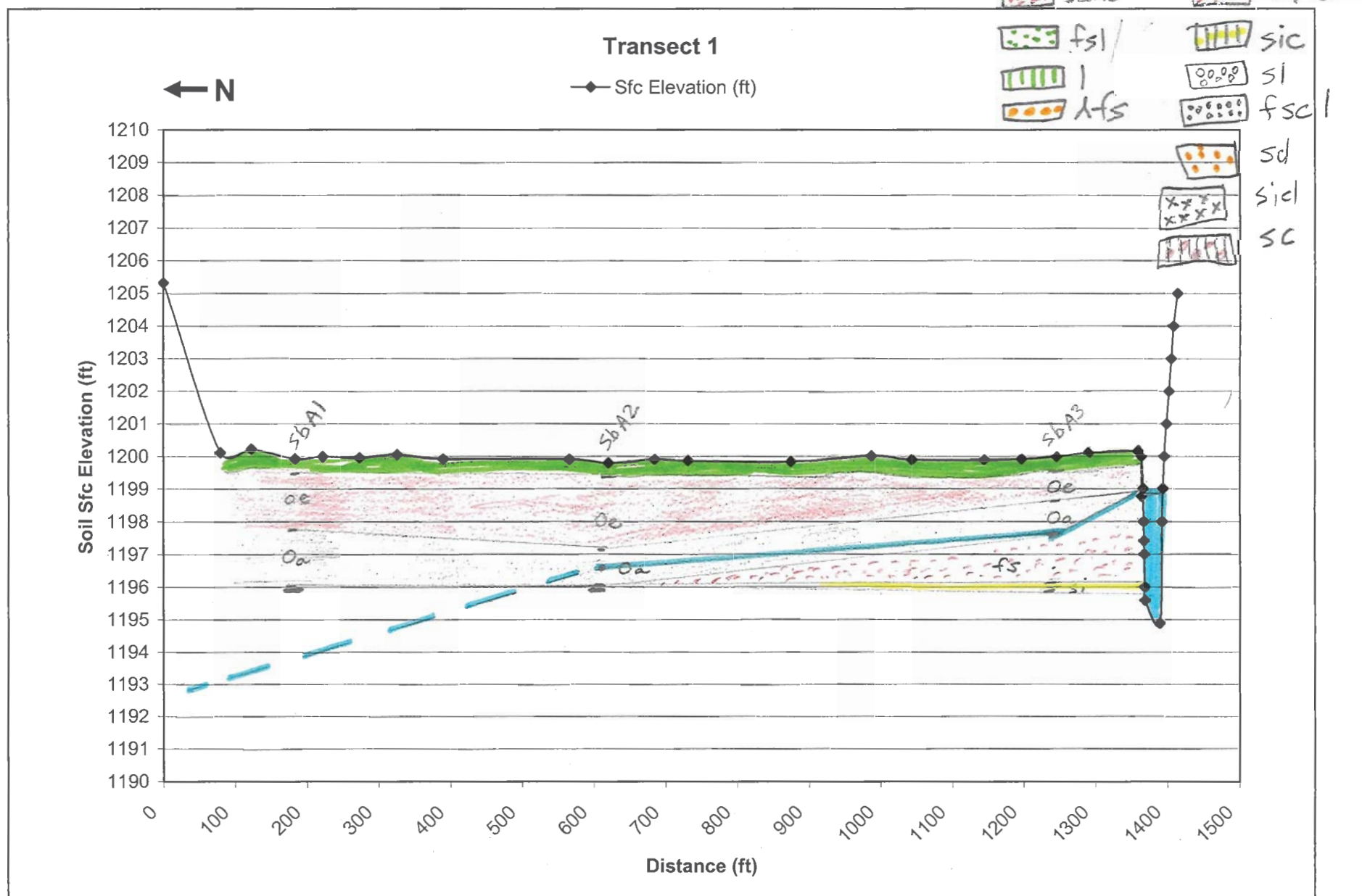


Figure B-4

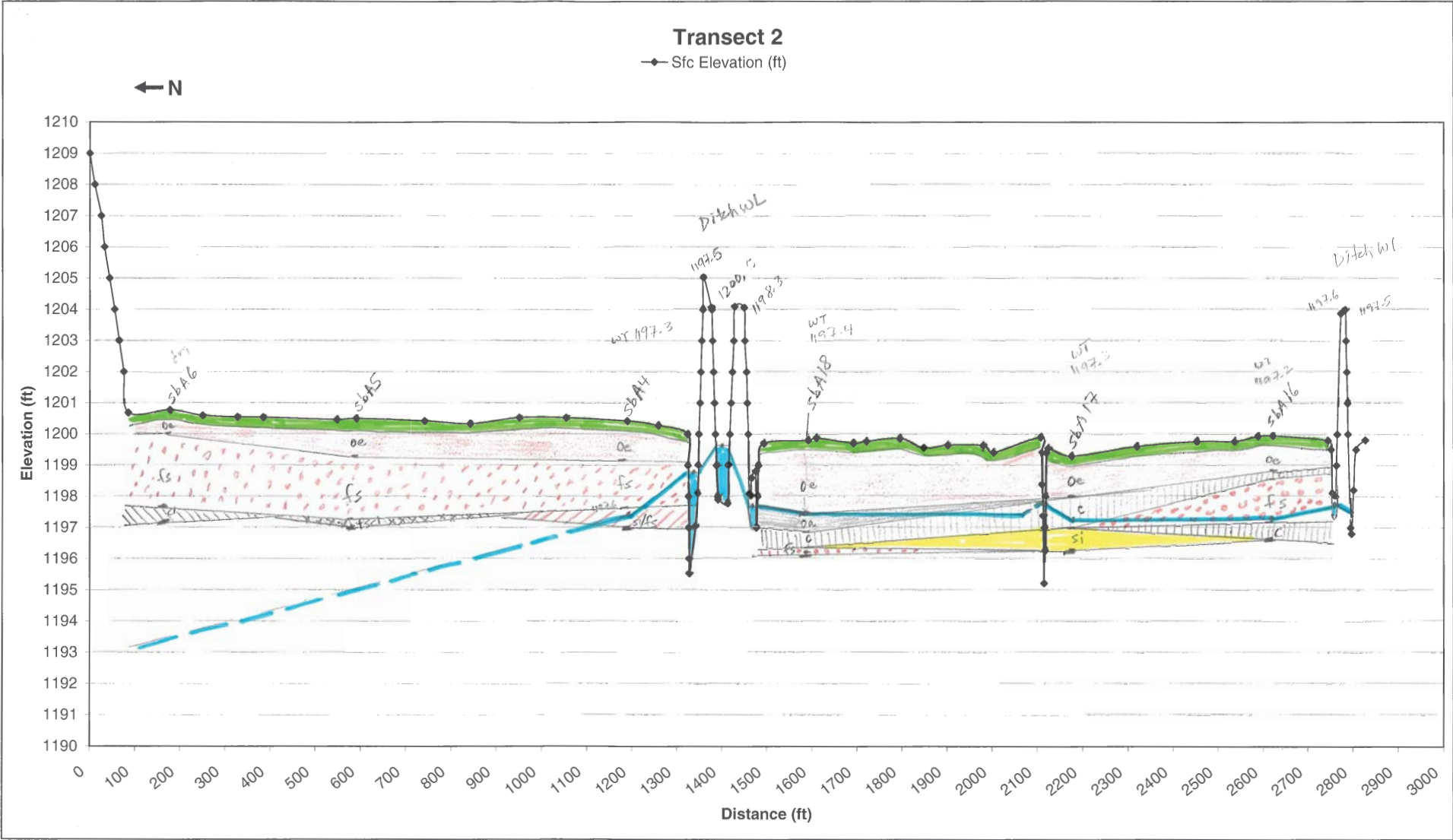


Figure B-5

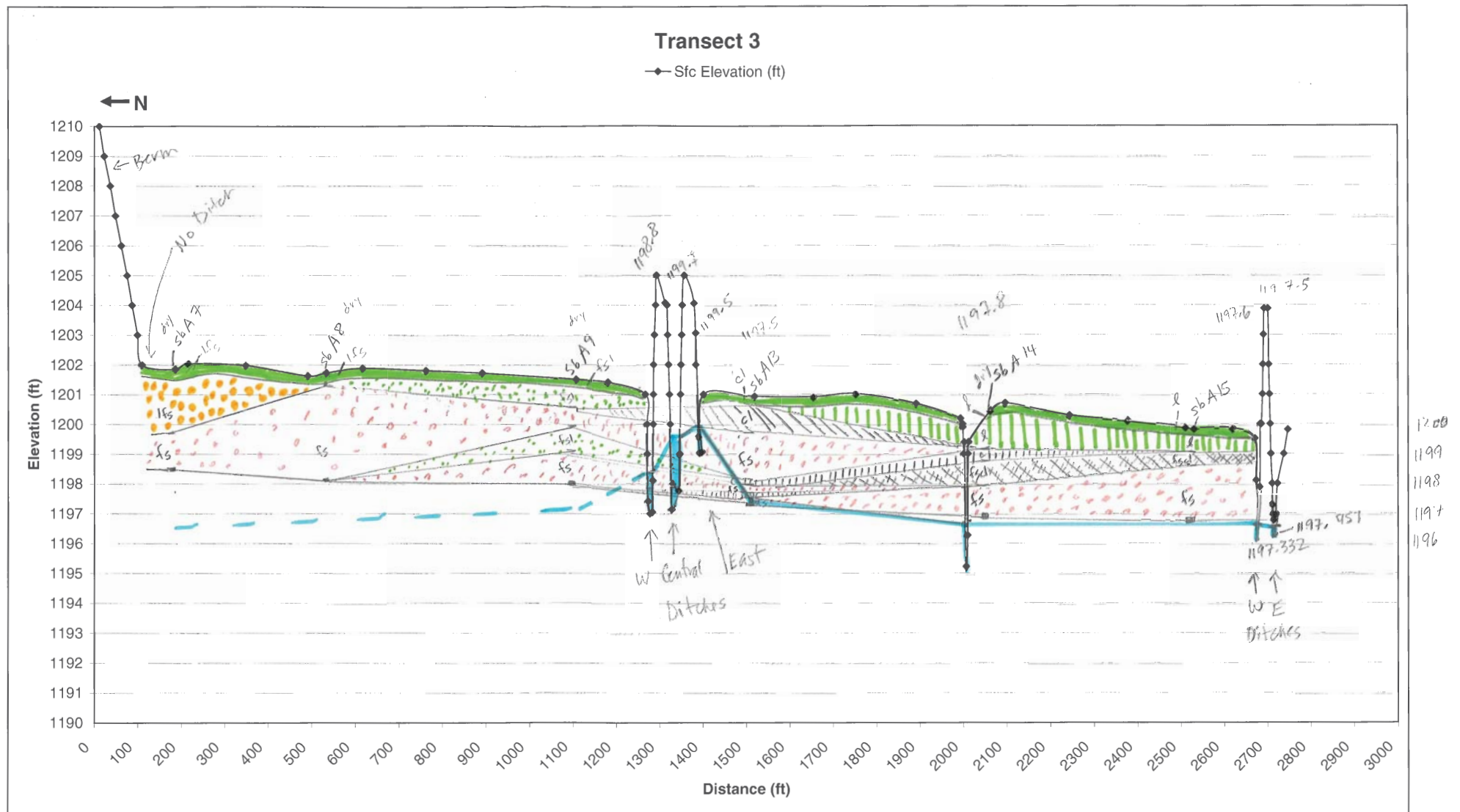


Figure B-6

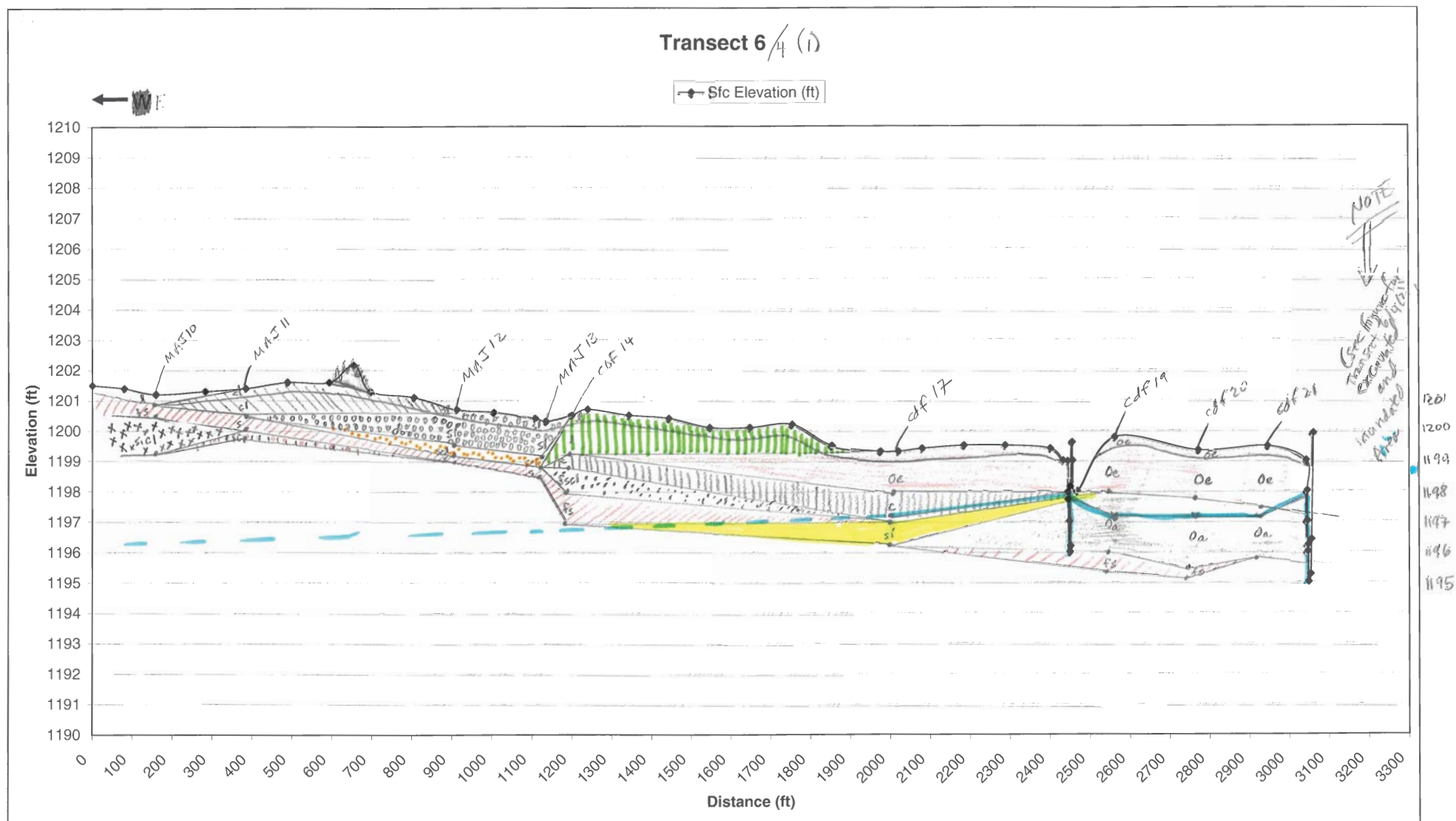


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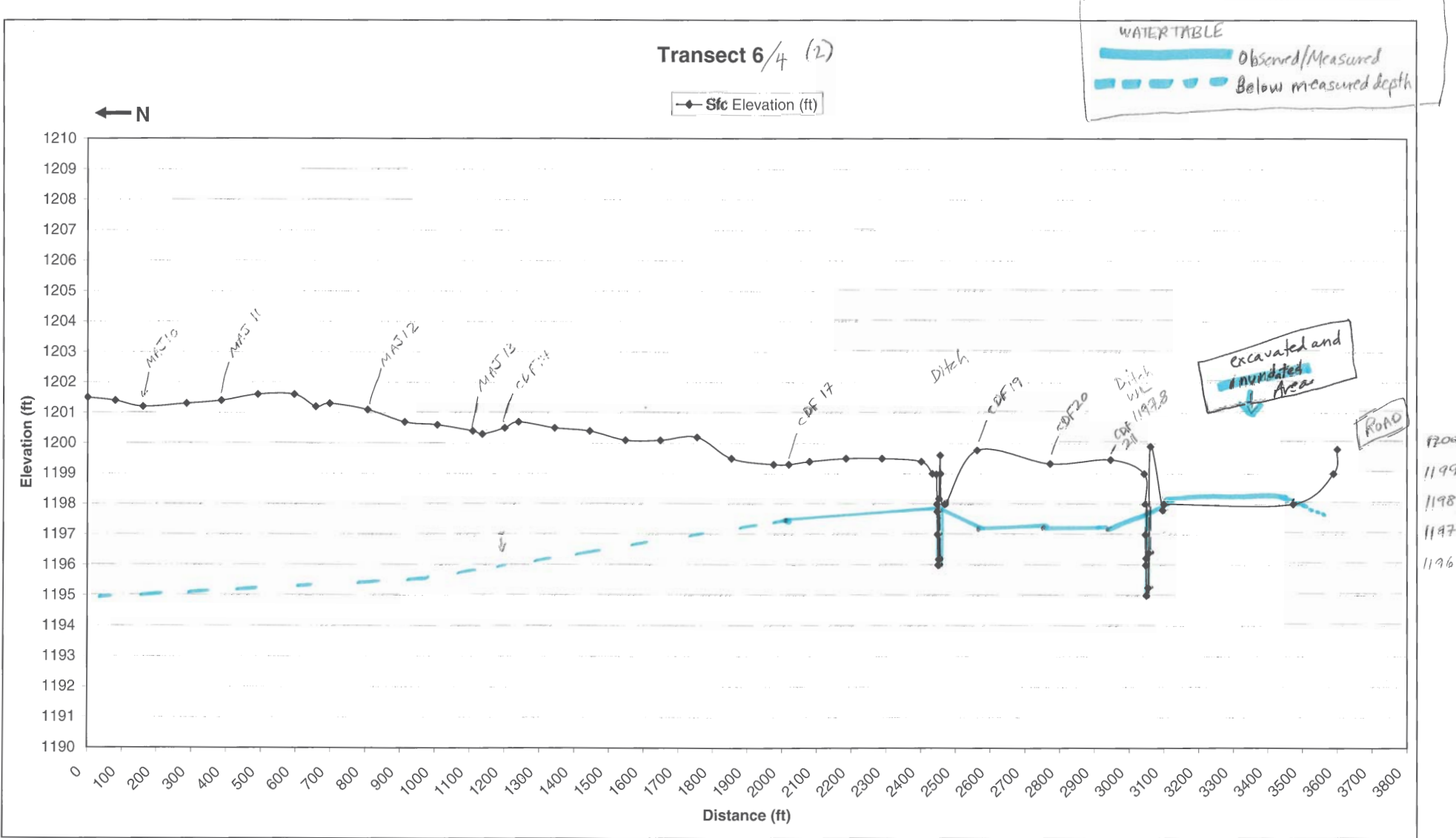


Figure B-8

West Side

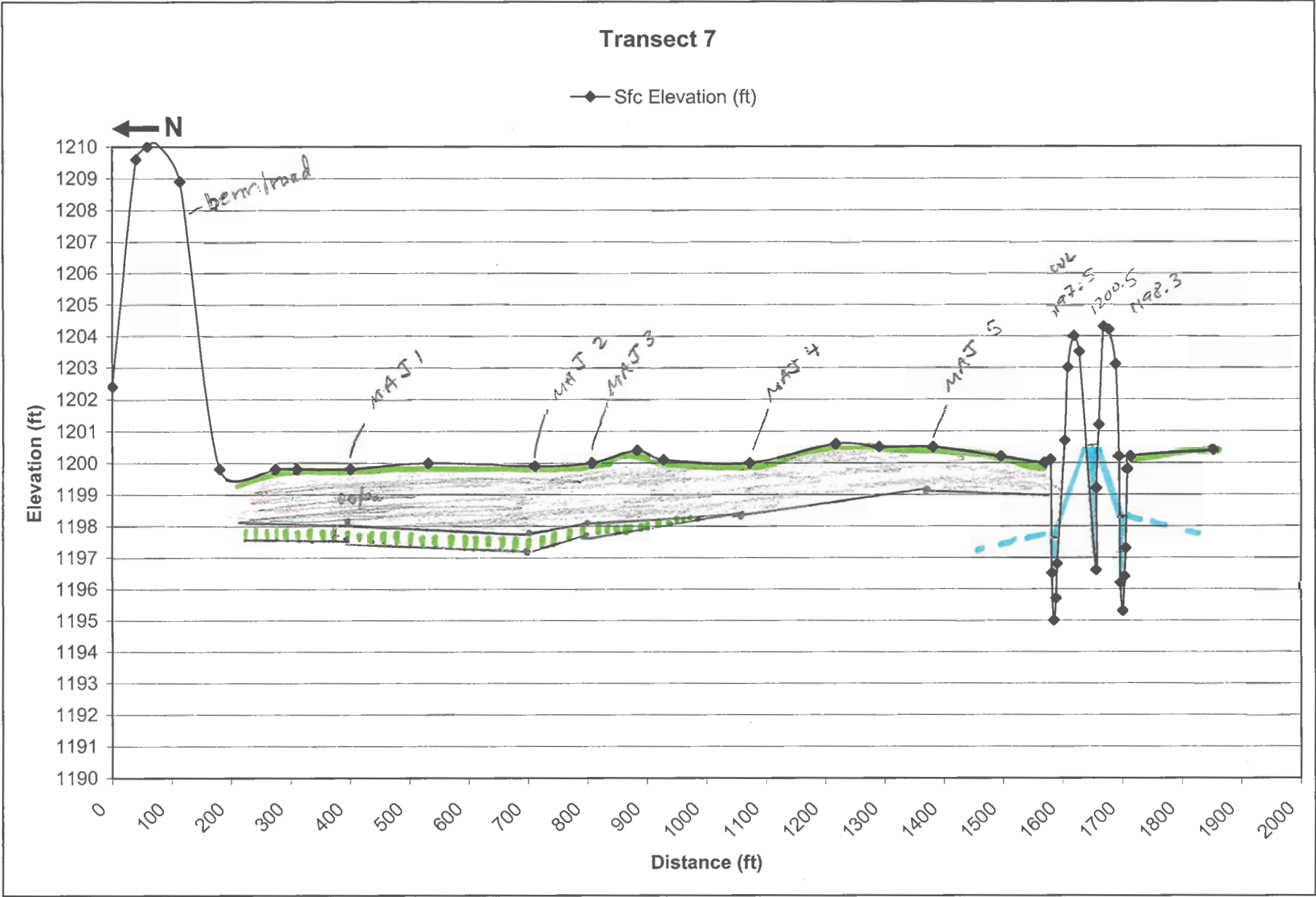


Figure B-9

