Hydrological balance for selected wetlands. v. 6

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HYDROLOGICAL BALANCE
FOR
SELECTED WETLANDS
[redacted]
CRANDON PROJECT

Report

IEP inc.

HYDROLOGICAL BALANCE
FOR
SELECTED WETLANDS

CRANDON PROJECT

Prepared For

EXXON MINERALS COMPANY
Rhinelander, Wisconsin

By

INTERDISCIPLINARY ENVIRONMENTAL PLANNING
Wayland, Massachusetts

December 1982

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1.0 INTRODUCTION

Public awareness of the importance and need for protection of wetland functions has resulted in wetland protection laws such as Wisconsin Administrative Code NR 132. This regulation requires that mining applicants conduct assessments of wetland functions, define those essential elements which give rise to those functions, and relate the wetland functions to siting of Project facilities. The assessment of the Crandon Project wetland functions was performed previously by Normandeau Associates, Inc. (NAI) and Interdisciplinary Environmental Planning (IEP) (1982) and IEP (1982). These two wetland assessment reports establish the existing function of each inventoried wetland; however, potential impacts of the proposed Project facilities on existing wetland functions were not considered. The location of proposed and alternative Project facilities in relation to wetlands inventoried in the study area is shown on Figure 1.0-1.

To determine the potential impact of the Crandon Project facilities on inventoried wetlands, an analysis of the change in wetlands hydrology was performed. A wetlands hydrologic balance is a primary modifier of wetland water levels, vegetation, and soils which give rise to the wetlands function (Gosselink and Turner, 1978). Alterations in a wetlands water balance (the quantities of inflowing and outflowing water) could result in changes in its functions. More water (a "wetter" condition) or less water (a "drier" condition) flowing through a wetland may cause changes in vegetative community types.

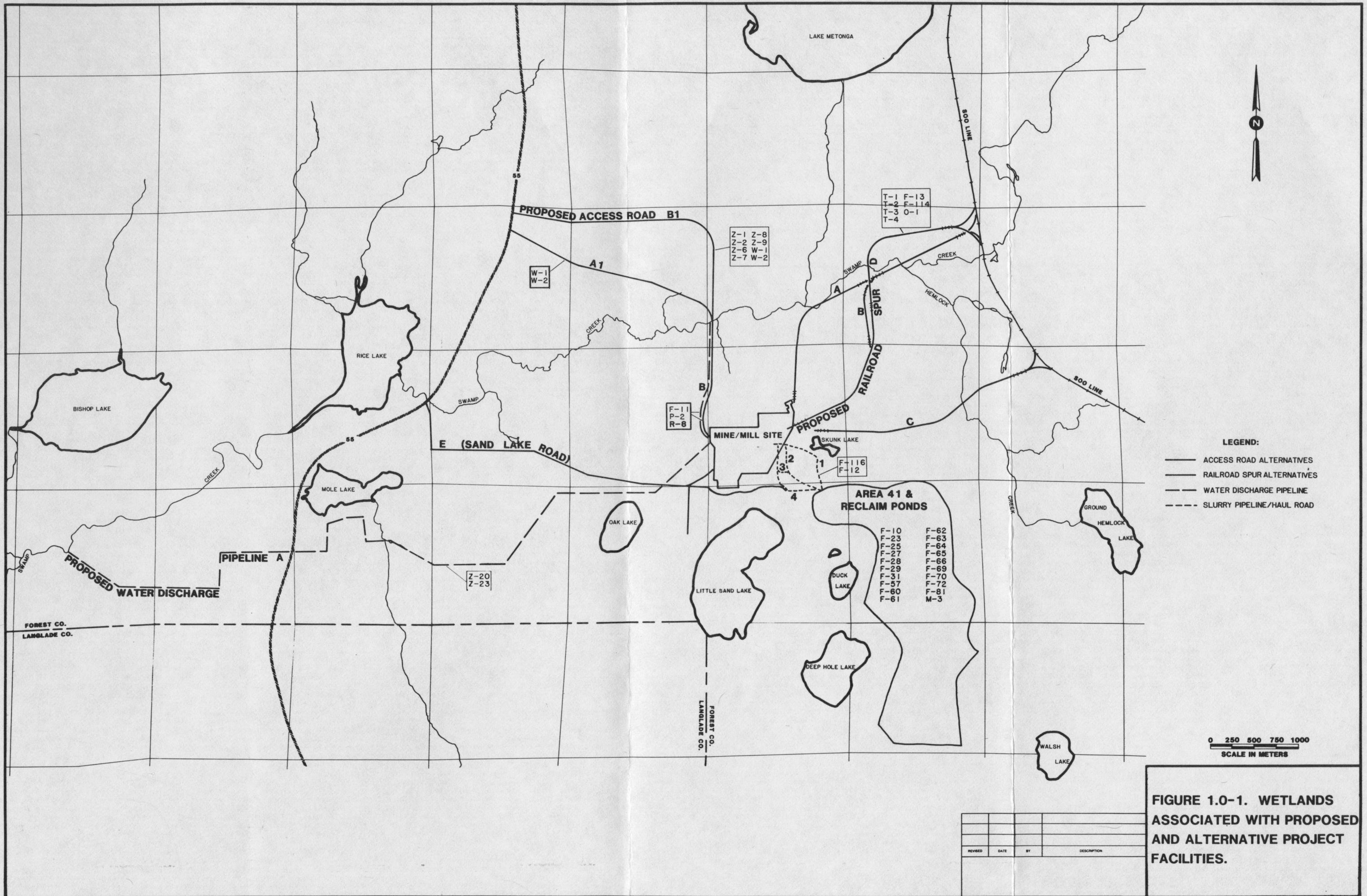


FIGURE 1.0-1. WETLANDS ASSOCIATED WITH PROPOSED AND ALTERNATIVE PROJECT FACILITIES.

The primary objective of this study was to determine the relative change in the water balance of perched and water table wetlands caused by the proposed Crandon Project facilities and activities. To accomplish this objective, a perched wetland water balance computer model was developed to evaluate inflow and outflow of water to these types of wetlands. Changes in Swamp Creek discharge were utilized to evaluate the effects of the Project on water table wetlands.

Limited hydrologic data exist specific to the hydrology of the study area of perched wetlands (Exxon Minerals Company, 1982). No measurements of actual surface water discharge in perched wetlands were used in modeling their water balance. Some site-specific data (i.e., recharge values) of perched wetlands were available (Exxon Minerals Company, 1982) and were used in the perched wetland water balance computer modeling. Regional climatic data from the National Oceanic and Atmospheric Administration (NOAA) were used in the modeling in conjunction with watershed measurements for each wetland. Using these data and actual field notes, theoretical surface water discharge flows were determined.

The perched wetland water balance computer model (modified from Soil Conservation Service, 1972) used was intended to identify theoretical changes in perched wetland surface water discharge flow by comparing calculated existing hydrologic rates with projected flows as a result of Project facilities and activities. Increases or decreases in surface water discharge (outflow) were determined for each perched wetland potentially affected by construction, operation, and closure of the Project facilities.

Potential hydrologic impacts to water table table wetlands were determined by using Swamp Creek discharge as the primary indicator of water balance for the water table wetlands associated with the creek. Swamp Creek discharge rates were obtained from the U.S. Geological Survey (1978, 1979, 1980 and 1981), the best available stream flow data for study area water table wetlands. Impacts to water table wetlands were determined by assessing the change in wetland watershed elements, such as size of watershed and vegetative type, which could affect the water balance of the water table wetlands. Existing and projected hydrologic conditions were calculated and compared over the life of the Project.

Overall, the results are intended to identify relative changes in theoretical wetland watershed discharge and to identify trends that could result in wetland impacts. Means to mitigate the projected impacts are also presented and discussed.

2.0 HYDROLOGIC ASSESSMENT METHODS

2.1 PERCHED WETLANDS

A Wetland Hydrology Model (see Appendix A for program listing) was developed to establish the water discharge (inflow/outflow) rates of the perched wetlands which may be affected by phased construction, operation, and closure of the proposed Mine Waste Disposal Facility (MWDF) and reclaim ponds. By modeling the existing and phased development hydrological conditions of perched wetlands, the computed discharge rates during all phases may be compared and any hydrological impacts thereby quantified. The Model is an expansion, modification and computerization of mathematical methods developed by Thornthwaite and Mather (1957) and Soil Conservation Service (1972).

The following equations define the formulation used in the Model to perform monthly water balances:

AM = L + SI + IM - GW.

ET = KPT or AM, whichever is less, + EV

RM = AM - ET, but not <0

FM = RM or LM, whichever is less

SD1 = RM - FM

SD2 = SD1 x conversion factor.

The following list identifies and explains the derivations of each Model parameter:

LIQUID (L) is the net monthly sum of rainfall and snowmelt. Data were derived from daily and monthly records of the National

Oceanic and Atmospheric Administration (NOAA) weather station at Laona (6SW), Forest County, Wisconsin.

STREAM INFLOW (SI) is the water discharge (surface water and interflow) to the wetland watershed from other upstream drainage areas. The computed monthly values of outflow from each wetland were stored in the program for recall where required as inflow.

INITIAL SOIL MOISTURE (IM) is the volume of water stored in the watershed soils at the beginning of each month. The initial value of IM was calculated by modeling a wetland system for the year (1973) prior to the established period of record. Subsequent values of IM were generated in the model as RM from the previous month.

GROUND WATER (GW) is the net monthly outflow volume of ground water from each wetland watershed. GW is assumed to be a monthly distribution of the annual average value of 0.18 inches of "Underflow" established by Exxon Minerals Company (1982).

AVAILABLE MOISTURE (AM) is the sum of monthly values of L, SI, and IM minus GW.

POTENTIAL EVAPOTRANSPIRATION (KPT) is the monthly volume of the potential consumptive water use by vegetation throughout each watershed. Potential ET = KPT is the Blaney-Criddle formula used in the model (Soil Conservation Service, 1970). K is the consumptive use coefficient, a factor which is a function of the distribution of the various vegetative cover types mapped within each watershed. It approximates the ability of each type to consume moisture and is dependent on the growing season length and monthly growth and stage of each type. P is the monthly percentage of daylight hours of the year, a function of latitude. T is the mean monthly air temperature as reported at the NOAA weather station, Laona, Wisconsin.

EVAPORATION (EV) is the monthly volume of evaporation from surface water bodies. It was calculated from open water area measurements and adjusted pan evaporation data from the NOAA weather station at Rainbow Falls, Wisconsin.

ACTUAL EVAPOTRANSPIRATION (ET) is the monthly volume of moisture consumed by watershed vegetation. Thus, ET is KPT limited by AM, plus EV.

LIMITING SOIL MOISTURE (LM) is the maximum volume of water that the watershed soils can hold. LM was calculated for each watershed as a function of the areal distribution, and porosities of the surficial geologic cover types and depths of the intensive root zones of the vegetative cover types.

FINAL SOIL MOISTURE (FM) is equal to RM but limited by LM.

STREAM DISCHARGE (SD1) is the monthly computed value of surface water outflow and interflow, in inches, from each watershed.

STREAM DISCHARGE (SD2) is SD1 converted to cubic feet per second (cfs).

Fundamentally the Model balances all inflowing and outflowing water to and from a perched wetland watershed for each month of each year for a specified period of record. This stochastic approach yields more accurate water budgets than the use of "annual average" values of input parameters such as rainfall and evapotranspiration.

As proposed, the MWDF and reclaim ponds will be developed in six phases as shown by Figures 2.1-1 through 2.1-6. The Model was run to establish a water balance for each potentially affected wetland during each of the six phases.

Construction of the waste disposal system will begin (Phase 1) by developing an area for storage of pre-production mine waste rock, constructing reclaim pond R1 and beginning to place the pre-production waste rock in its storage area which will ultimately become part of the common embankment between tailings ponds T1, T2, T3 and T4. No tailings will be produced during this period.

The next major stage (Phase 2) will be construction of the second reclaim pond, R2, and tailings pond T1. These facilities will be completed prior to production of tailings. The reclaim ponds will be filled to provide startup water for the mill. The next three major stages (Phases 3, 4, and 5) of development are construction of tailings ponds T2, T3 and T4, respectively. Construction schedules will be set so that each tailings pond is completed up to the lowest berm prior to filling of the preceding tailings pond.

During the first and second phases of construction, all excavated glacial till material will be utilized. However, during Phase 3 there will be surplus material. The surplus material will be placed in a long-term stockpile located east of the construction support area. It will remain in that area during Phases 3 and 4 and additional surplus material will be added

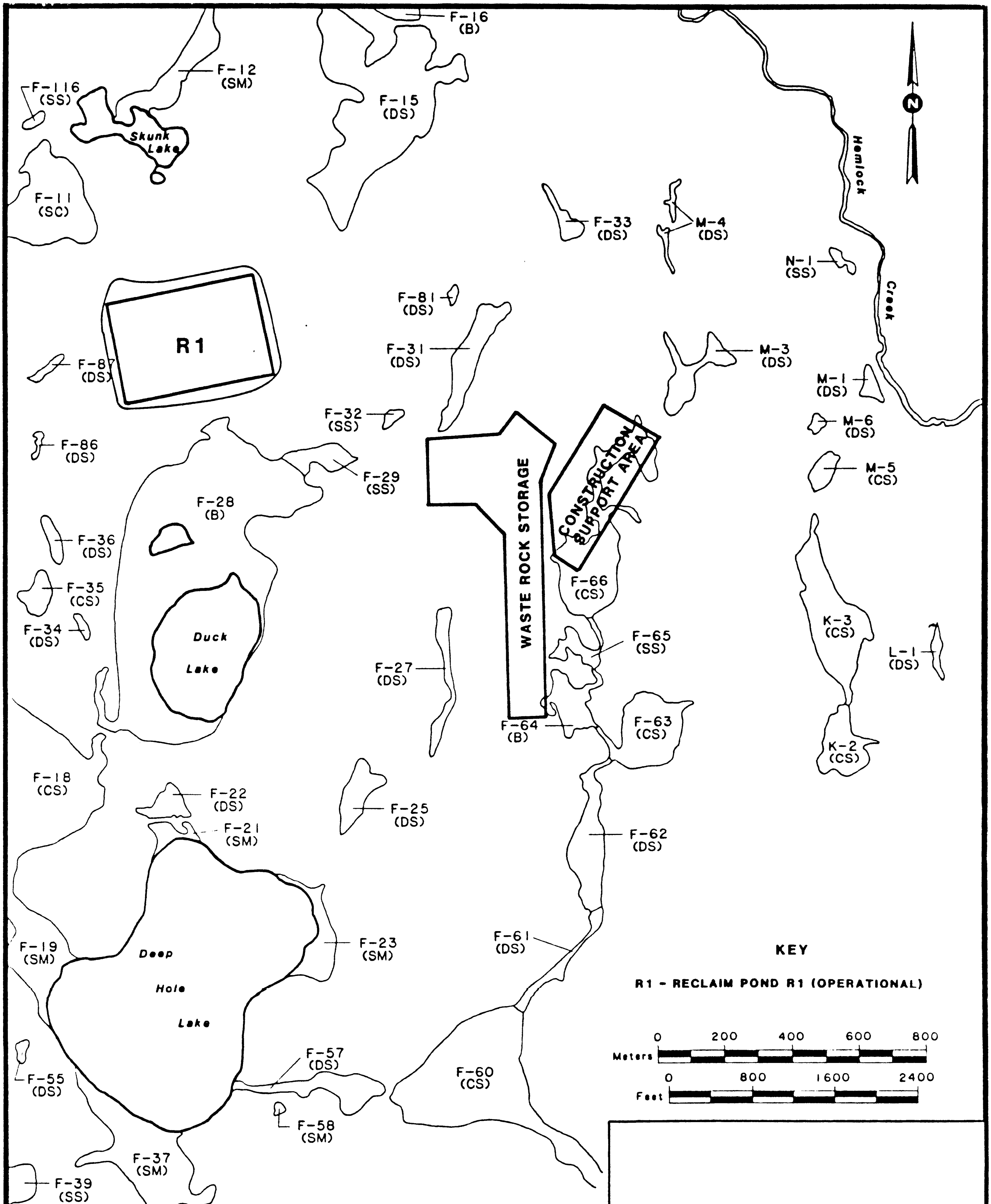


FIGURE 2.1-1. WETLANDS AFFECTED DURING PHASE 1.

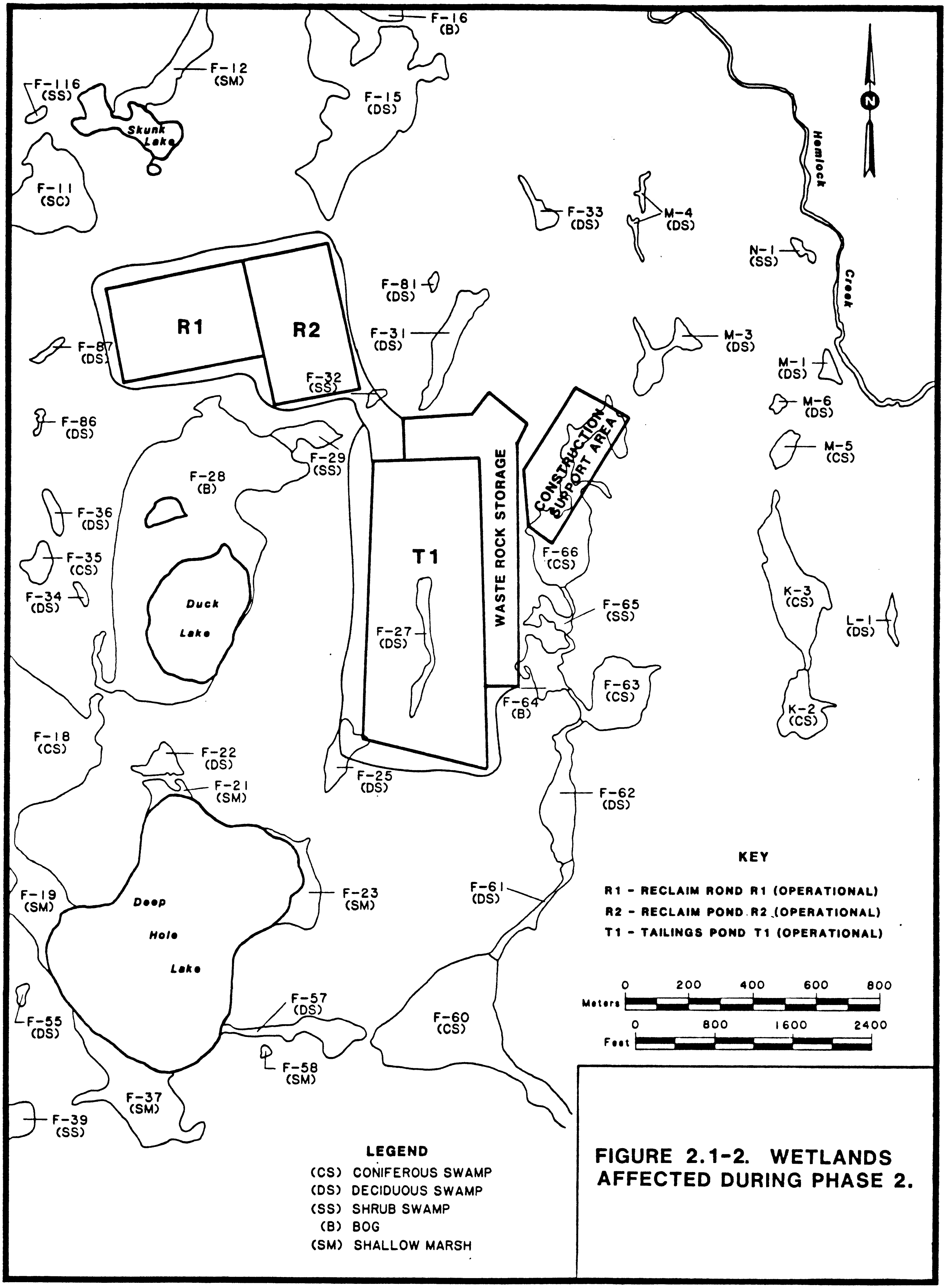


FIGURE 2.1-2. WETLANDS AFFECTED DURING PHASE 2.

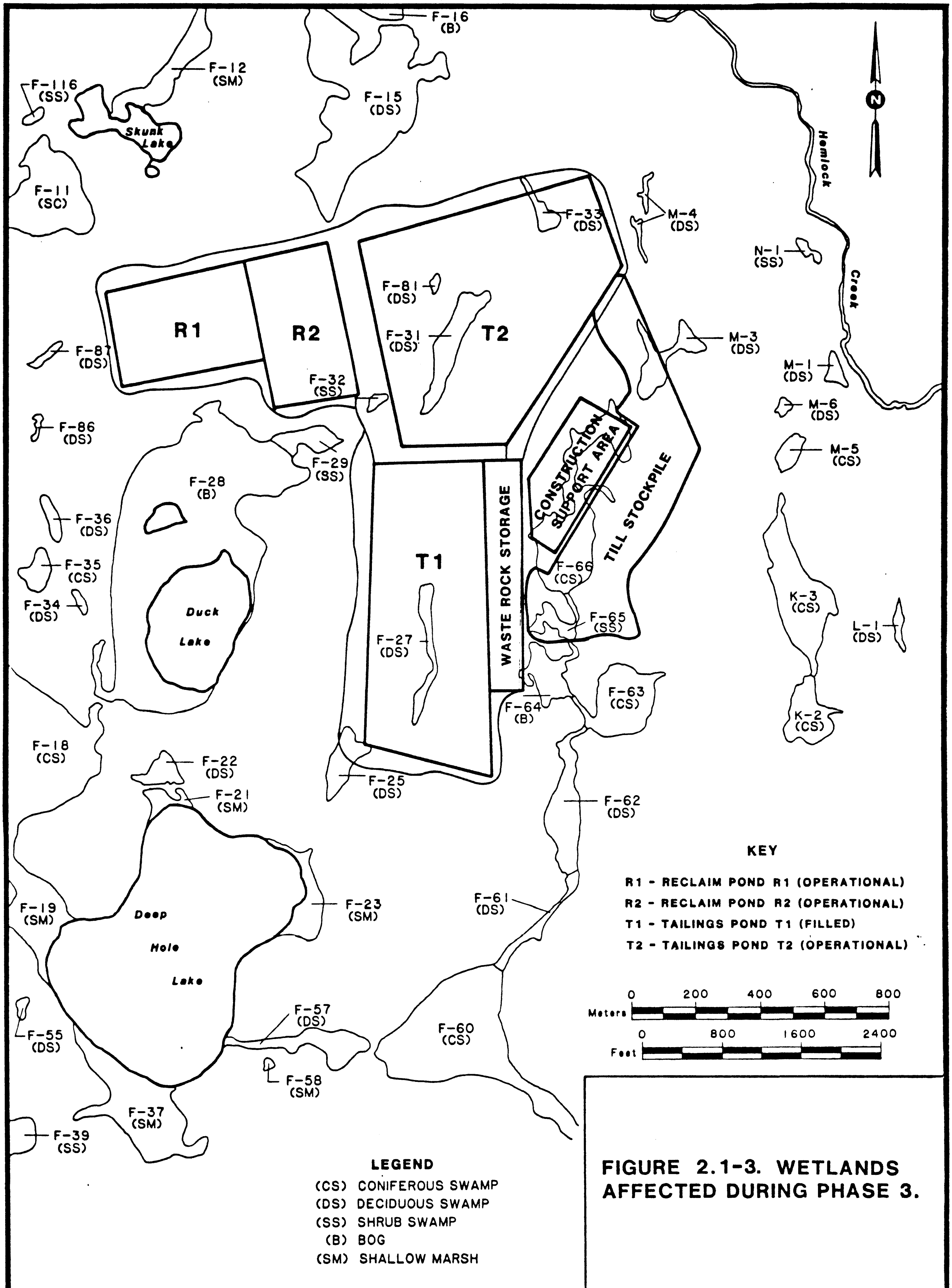


FIGURE 2.1-3. WETLANDS AFFECTED DURING PHASE 3.

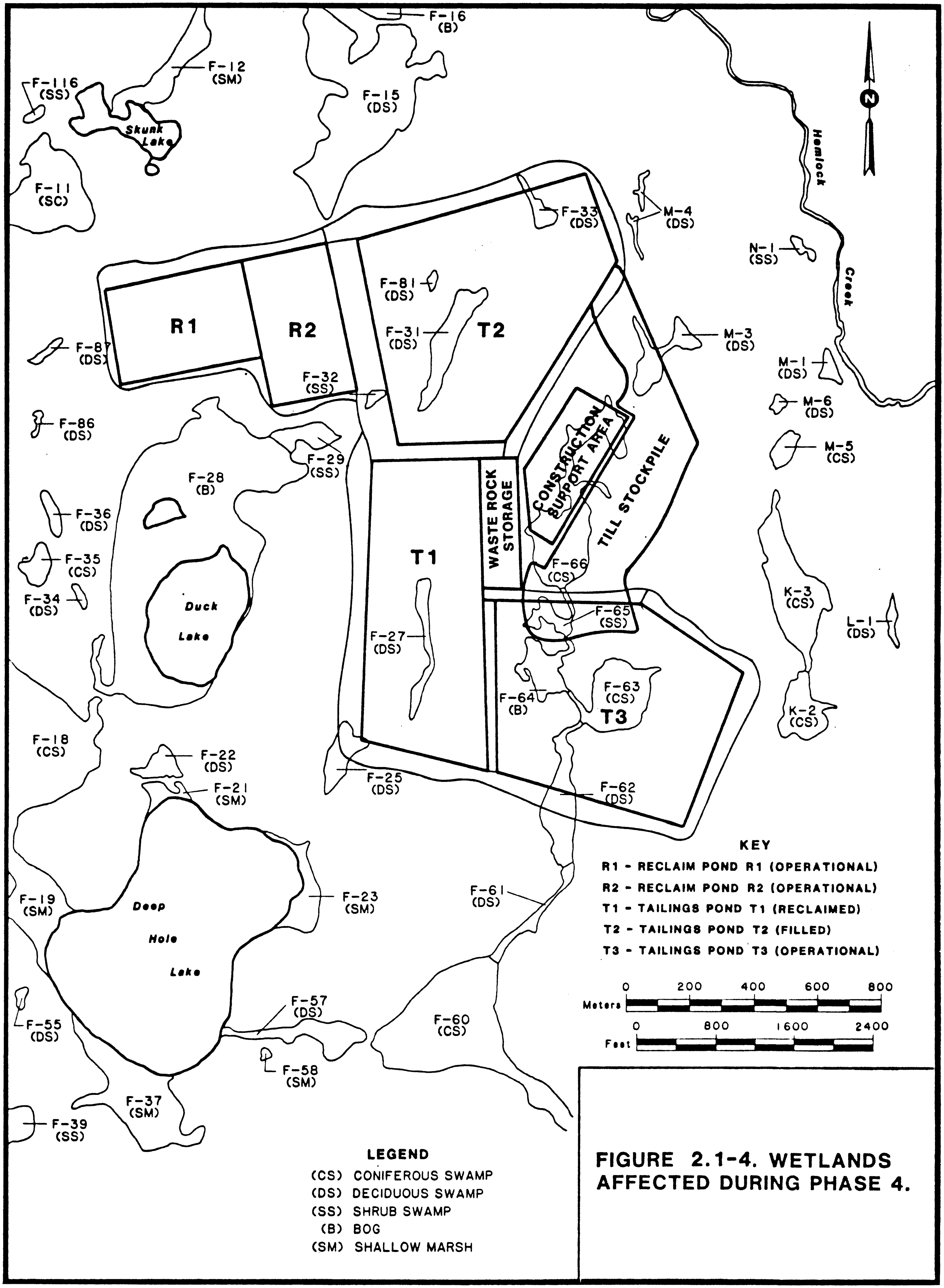


FIGURE 2.1-4. WETLANDS AFFECTED DURING PHASE 4.

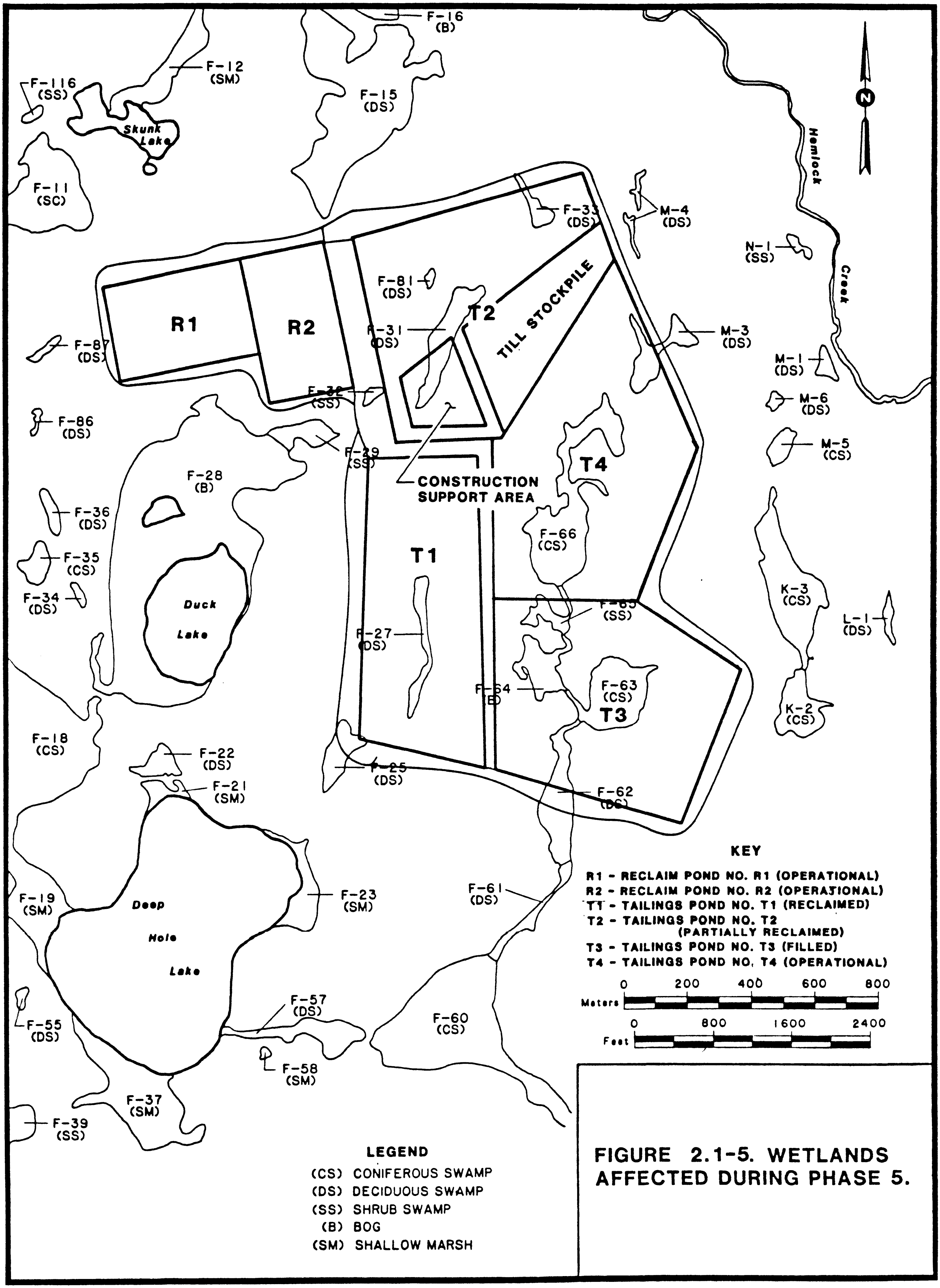


FIGURE 2.1-5. WETLANDS AFFECTED DURING PHASE 5.

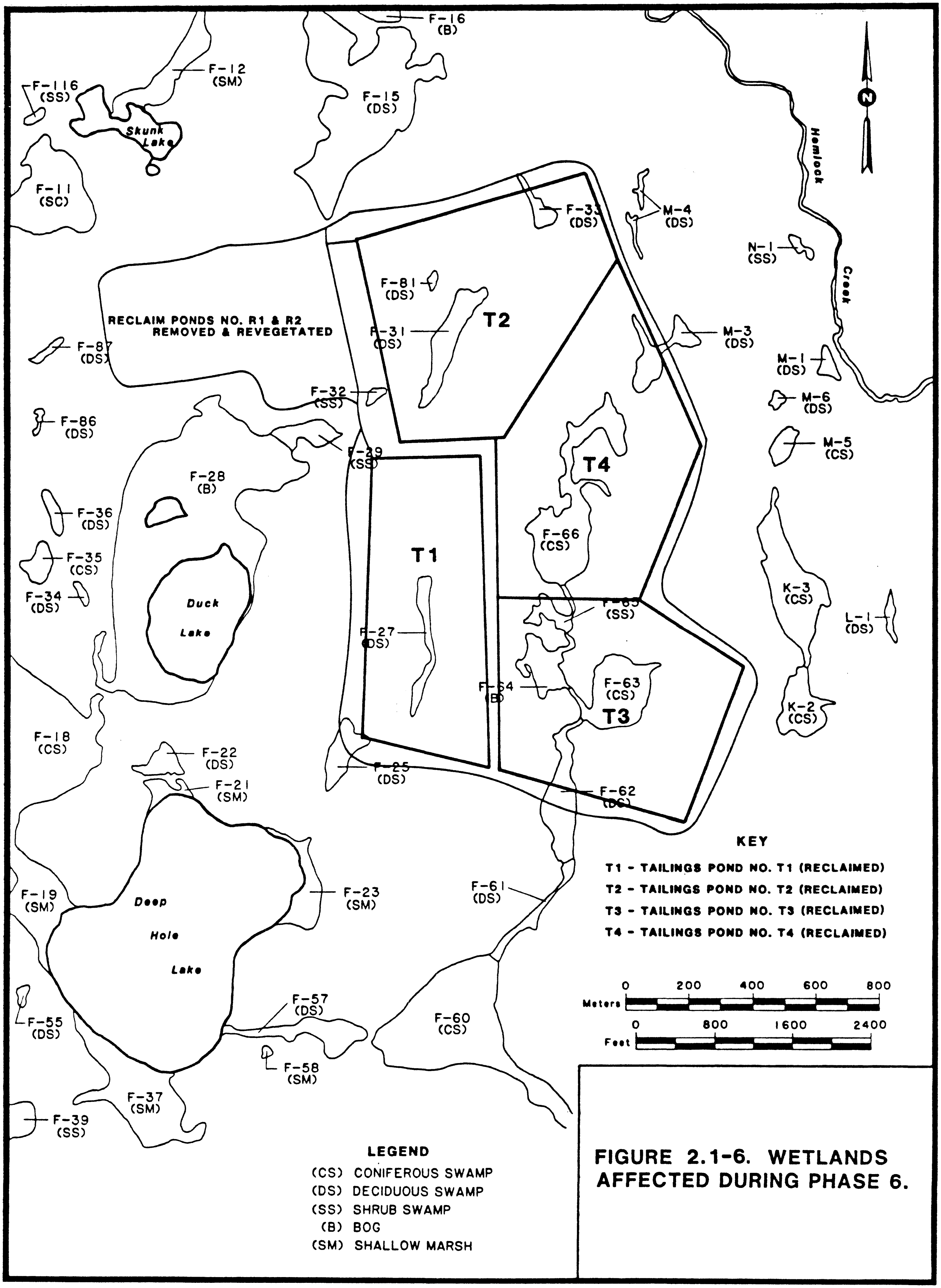


FIGURE 2.1-6. WETLANDS AFFECTED DURING PHASE 6.

to the long-term stockpile. Then, it will be removed and placed on a portion of the completed surface of tailings pond T2. Following the filling of tailings pond T4, the stockpile will be removed and used for the reclamation of pond T4 and final site reclamation (Phase 6). During the long-term storage period, the fill material will be stabilized against surface erosion by establishing a temporary vegetative cover. The extent to which pond T4 is constructed and utilized for tailings is dependent upon the ultimate total tonnage of ore mined. Table 2.1-1 summarizes the phased construction schedule.

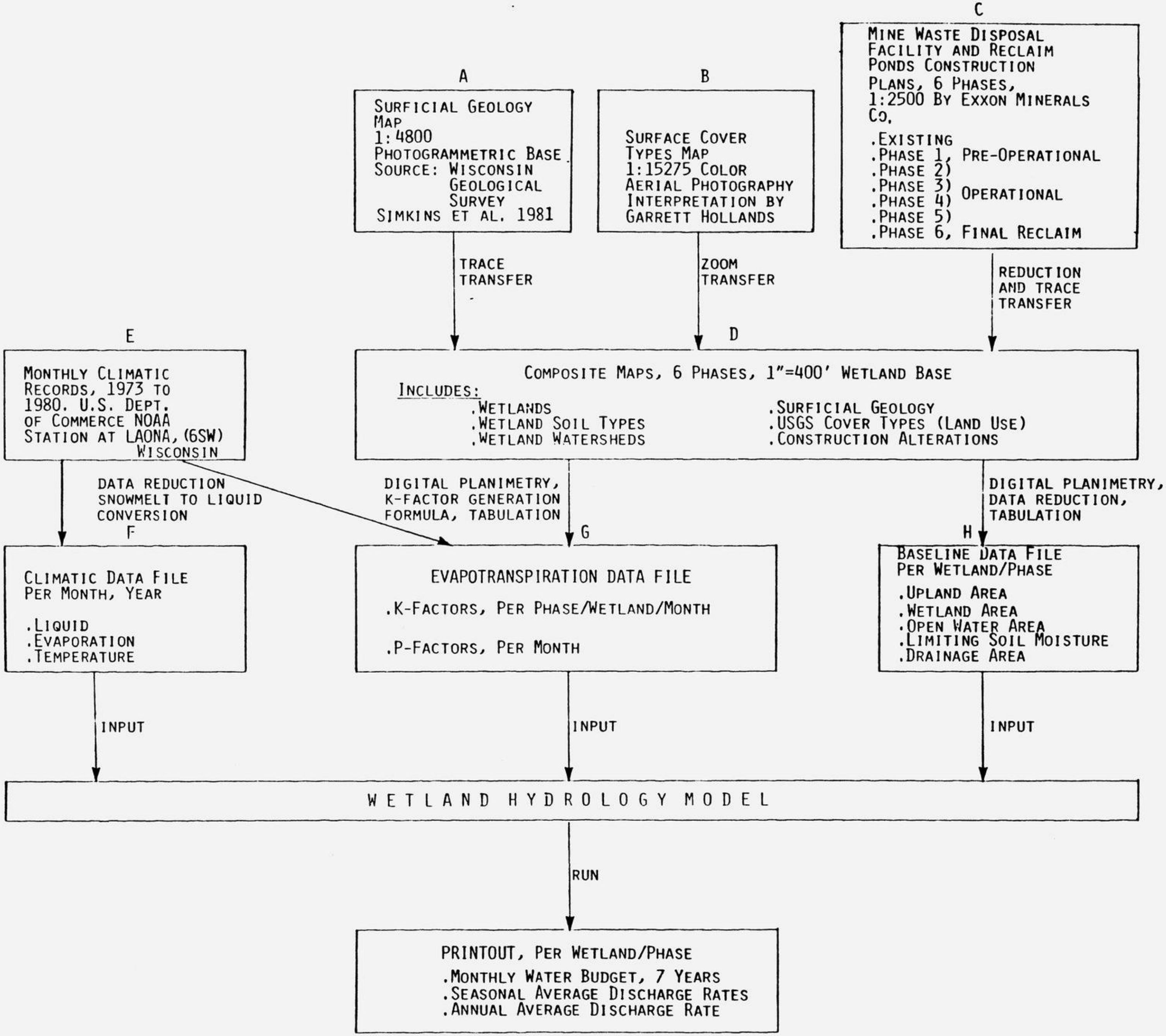
Figure 2.1-7 charts the development of Model input parameters for the MWDF associated perched wetlands. A mylar base map at scale 1:4800 (1 inch = 400 feet) was prepared from the orthophoto maps presented in the Wetlands Assessment Report, Figures 4.3-1A through 4.3-1I (NAI and IEP, 1982). The surficial geologic type were delineations transferred to the base map (A, Figure 2.1-7). Also added to the map were delineations of wetlands, wetland soil types and wetland watershed divides. Land use cover types were delineated on color aerial photographs and transferred to the base map by use of a Bausch and Lomb Zoom Transfer Scope (B, Figure 2.1-7). The six construction, operational and post-operational phase topographic maps (Exxon Minerals Company, 1982) (C, Figure 2.1-7) were photographically reduced to the base map scale and transferred to copies of the base map generating one composite map for each of the six phases mentioned above (Figure 2.1-7). These maps were generated as working copies and have not been included as part of this report; however, copies are available upon request. Area measurements were made of each surficial geologic type, land cover type,

Table 2.1-1. Phases of Construction and Reclamation of the Mine Waste Disposal Facility and Reclaim Ponds.

Phase	Construction Activities
1	Construct Reclaim Pond R1 Construct Waste Rock Storage Area and Construction Support Area
2	Construct Reclaim Pond R2 Construct Tailings Pond T1
3	Construct Tailings Pond T2 Reclamation of Tailings Pond T1
4	Construct Tailings Pond T3 Partial Reclamation of Tailings Pond T2
5	Construct Tailings Pond T4 Reclamation of Tailings Pond T3
6	Final Reclamation of Tailings Pond T2 Reclamation of Tailings Pond T4 Final Site Reclamation

Source: Exxon Minerals Company, 1982.

Figure 2.1-7. Procedural flow chart of perched wetlands hydrological modeling.



wetland soil type and project activity in each wetland watershed during each phase using a digital planimeter (H. Dell Foster Model RSS-4MGT-2). These area measurements were added to both the Evapotranspiration Data File (G, Figure 2.1-7; see example, Table 2.1-2) and to the Baseline Data File (H, Figure 2.1-7; see example, Table 2.1-3). Before the Evapotranspiration Data File could be completed, climatic data were required.

Monthly climatic records for 1974 through 1980 from the NOAA station at Laona were adapted for input to the Model program (E, Figure 2.1-7). Monthly values of snowmelt were converted to liquid and a Climatic Data File for each month of each year for liquid, evaporation and temperature was created (F, Figure 2.1-7; see example, Table 2.1-4) for input to the Model.

By measuring with the digital planimeter, the land cover type areas on each composite map (D, Figure 2.1-7) were determined and tabulated for entry into the Evapotranspiration Data File. Values of K (consumptive use coefficient) were derived for each cover type area. These values combined with P (daylight hours) and T (mean monthly temperature) yield Potential Evapotranspiration (KPT). This process was completed for each of the six phases of the MWDF, for each wetland watershed for each month.

Upland areas, wetland areas and total drainage areas were measured for each wetland watershed in each of the six phases. Measurements of surficial geologic type areas were used to establish soil moisture conditions (LM) of each watershed. This information was entered into the Baseline Data File of the Model (H, Figure 2.1-7).

Table 2.1-2. Example of Evapotranspiration Data File, Existing Conditions.

Wetland No.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Monthly Values of K											
M3	0.126	0.156	0.203	0.374	0.733	0.977	1.131	1.007	0.666	0.767	0.120	0.099
P2	0.162	0.189	0.233	0.384	0.712	0.924	1.066	0.920	0.646	0.350	0.198	0.163
F114	0.099	0.125	0.180	0.368	0.750	1.010	1.160	1.030	0.676	0.258	0.120	0.099
F13	0.134	0.161	0.209	0.377	0.729	0.962	1.107	0.968	0.659	0.310	0.764	0.135
F11	0.127	0.154	0.203	0.373	0.727	0.964	1.109	0.973	0.658	0.197	0.154	0.127
F10	0.100	0.127	0.181	0.368	0.749	1.008	1.158	1.028	0.675	0.260	0.122	0.100
F27	0.143	0.174	0.218	0.379	0.722	0.953	1.106	0.979	0.658	0.289	0.138	0.114
F25	0.132	0.164	0.209	0.376	0.728	0.968	1.123	1.001	0.663	0.269	0.120	0.099
F23	0.099	0.126	0.180	0.368	0.750	1.010	1.160	1.030	0.676	0.288	0.120	0.099
F31	0.112	0.140	0.191	0.371	0.742	0.994	1.144	1.014	0.671	0.268	0.126	0.104
F32	0.185	0.212	0.252	0.390	0.698	0.892	1.030	0.878	0.635	0.386	0.228	0.188
F81	0.150	0.184	0.224	0.380	0.717	0.946	1.103	0.986	0.657	0.275	0.120	0.099
F29	0.143	0.171	0.217	0.379	0.723	0.951	1.097	0.960	0.656	0.314	0.165	0.136
F28	0.109	0.134	0.180	0.340	0.671	0.894	1.029	0.907	0.607	0.259	0.129	0.106
F66	0.141	0.169	0.216	0.379	0.724	0.953	1.100	0.964	0.657	0.310	0.161	0.133
F65	0.134	0.166	0.210	0.376	0.727	0.966	1.121	1.000	0.663	0.270	0.120	0.099
F64	0.126	0.157	0.203	0.375	0.752	0.976	1.130	1.007	0.666	0.267	0.120	0.099
F63	0.129	0.160	0.206	0.375	0.730	0.972	1.127	1.004	0.665	0.268	0.120	0.099
F62	0.110	0.139	0.190	0.371	0.743	0.996	1.148	1.010	0.672	0.262	0.120	0.099
F72	0.099	0.126	0.180	0.368	0.750	1.010	1.160	1.020	0.676	0.258	0.120	0.099
F61	0.102	0.129	0.183	0.369	0.748	1.006	1.157	1.027	0.675	0.259	0.120	0.099
F70	0.099	0.126	0.180	0.368	0.750	1.010	1.160	1.030	0.676	0.258	0.120	0.099
F69	0.099	0.126	0.180	0.368	0.750	1.010	1.160	1.030	0.676	0.258	0.120	0.099
F60	0.103	0.130	0.183	0.369	0.748	1.005	1.156	1.027	0.675	0.259	0.120	0.099
F57	0.099	0.126	0.180	0.368	0.750	1.010	1.160	1.030	0.676	0.258	0.120	0.099
Values of P	0.0636	0.0652	0.0828	0.0910	0.1034	0.1050	0.1061	0.0977	0.0842	0.0760	0.0640	0.0610

Note: Symbols and data sources explained in text.

Table 2.1-3. Example of Baseline Data File, Existing Conditions.

Wetland No.	Soil Moisture Limit (inches)	Wetland Area (acres)	Upland Area (acres)	Open Water Area (acres)	Direct Drainage Area (acres)	Inflowing Wetland Numbers
M3	3.37	4.78	57.51	0	62.29	none
P2	4.12	20.78	134.82	0	155.60	none
F114	6.17	0.31	1.79	0	2.10	none
F13	6.38	1.15	5.34	0	6.49	F114
F11	5.23	76.42	427.65	3.70	507.77	F13
F10	5.12	12.01	65.57	0	77.58	F11
F27	3.34	4.18	37.29	0	41.47	none
F25	3.38	3.53	81.54	0	85.07	F27
F23	4.31	4.69	44.81	0	49.50	F25
F31	3.85	6.00	48.15	0	54.15	none
F32	3.47	0.55	6.86	0	7.41	none
F81	3.08	0.35	5.41	0	5.76	none
F29	3.22	3.43	65.42	0	68.85	F31,F32,F81
F28	5.48	65.56	176.36	24.07	265.99	F29
F66	4.78	16.20	64.56	0	80.76	none
F65	4.84	2.52	9.62	0	12.14	F66
F64	5.56	4.54	11.94	0	16.48	F65
F63	6.07	9.64	19.92	0	29.56	F64
F62	4.25	7.31	41.61	0	48.92	F63
F72	3.31	4.14	43.68	0	47.82	none
F61	3.07	2.04	39.34	0	41.38	F62,F72
F70	3.95	1.70	10.89	0	12.59	none
F69	3.27	1.01	17.31	0	18.32	F70
F60	4.43	24.16	120.86	0	145.02	F61,F69
F57	4.62	5.83	70.13	0	75.96	F60

Note: Data sources explained in text.

Table 2.1-4. Example of Climatic Data File.

Year	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Month											
73	Liquid (in)	1.62	0.81	5.01	4.47	6.95	1.95	3.01	5.01	1.68	2.72	1.38	0.44
	Temp (°F)	16.8	17.3	35.1	39.7	48.6	62.8	66.3	65.7	54.9	50.9	30.5	16.4
	Evap (in)	0	0	0	2.43	2.17	3.33	4.25	2.83	2.01	1.57	1.37	0
74	Liquid (in)	0.51	1.02	0.95	3.42	3.29	3.24	2.90	6.08	4.35	1.79	1.79	0.65
	Temp (°F)	12.4	14.1	26.9	42.8	49.6	58.0	67.1	61.9	50.0	44.7	32.1	22.9
	Evap (in)	0	0	0	2.43	2.97	3.81	4.69	3.53	1.83	1.57	1.37	0
75	Liquid (in)	0.74	1.33	1.24	5.53	2.03	4.57	2.17	3.39	3.86	1.20	3.30	1.96
	Temp (°F)	14.9	17.4	23.1	36.0	57.7	61.7	67.6	63.4	51.5	48.7	35.6	16.8
	Evap (in)	0	0	0	2.43	3.71	3.27	4.20	4.08	1.81	1.57	1.37	0
76	Liquid (in)	0.49	1.80	3.67	3.38	3.87	2.66	1.85	4.02	0.88	0.51	0.15	0.30
	Temp (°F)	9.8	22.9	25.9	44.1	50.7	64.9	67.6	63.6	54.5	39.2	22.5	7.2
	Evap (in)	0	0	0	2.43	4.08	5.04	5.46	4.73	3.07	1.57	1.37	0
77	Liquid (in)	0.35	0.93	6.13	4.24	2.44	3.86	3.40	6.13	5.79	2.58	3.04	2.06
	Temp (°F)	2.0	16.5	33.2	45.9	60.7	59.4	67.4	58.9	54.3	43.9	29.8	14.3
	Evap (in)	0	0	0	2.43	4.89	3.84	4.47	3.01	1.61	1.57	1.37	0
78	Liquid (in)	0.91	0.58	0.86	4.08	4.82	2.33	7.89	4.82	5.16	1.34	1.27	0.69
	Temp (°F)	9.3	10.3	24.3	37.6	55.4	59.9	62.4	63.4	58.4	43.7	29.0	12.6
	Evap (in)	0	0	0	2.43	4.99	3.73	3.44	3.79	2.69	1.57	1.37	0
79	Liquid (in)	1.00	1.11	6.06	2.04	3.52	5.15	4.77	3.25	3.15	3.79	2.57	1.00
	Temp (°F)	4.5	8.4	27.2	37.1	49.6	59.8	64.5	60.7	56.2	41.1	28.1	22.1
	Evap (in)	0	0	0	2.43	4.99	3.97	4.33	3.31	2.48	1.57	1.37	0
80	Liquid (in)	1.68	0.99	0.74	2.63	3.43	5.40	3.87	5.69	4.73	1.82	1.01	0.68
	Temp (°F)	11.8	12.5	23.6	43.6	55.9	59.1	65.1	63.0	53.3	39.7	31.7	18.0
	Evap (in)	0	0	0	2.43	3.94	3.82	3.84	2.93	1.94	1.57	1.37	0

Note: Data sources explained in text.

The three data files (F, G, and H, Figure 2.1-7) were used as input in the perched Wetland Hydrology Model. Results (program printout, see example, Table 2.1-5) were generated for each wetland in all six phases.

The results on each wetland printout were winter, spring, summer, autumn and annual average water discharge rates, in inches and cubic feet per second (cfs) along with the monthly water balances through the seven year period of climatic record at Laona. (Data taken from the computer printouts are presented in summary tables in this report. The actual printouts are available for review upon request). The reported discharge values include both surface water outflow and "interflow," the horizontal transmission of water through the shallow surface soils. Many of the observed hydraulic connections between wetlands (for example, F66 to F65) were not surface water streams flowing in defined channels, but were relatively wide areas of surface organic soils where interflow was active in approximately the upper one foot. Water flowing from one wetland to another commonly was not visible at the land surface during site inspections by NAI and IEP (1982). Holes dug into these organics revealed interflow in a downstream direction. A few wetlands, such as F61, contained surface water flowing in a defined surface stream channel.

The values generated by the Model are presented as best estimates of surface water discharge based upon existing climatic data and field observations (NAI and IEP, 1982), but without benefit of definitive local discharge gaging data. Since records of actual discharge for the wetlands do not exist, calibration of the Model to actual observed discharge rates was not possible. The modeled discharge values are low, which compares favorably

WETLAND NUMBER F65

IMPACT ANALYSIS PHASE: EXISTING

DRAINAGE AREA 12.14 ACRES

MONTH	L	SI	IM	GW	AM	KPT	FM	SD1	SD2
12	.44	0	2.731	0	3.171	.0990	3.072	0	0
YEAR 1973								0 INCHES	
1	.51	0	3.072	0	3.582	.1056	3.476	0	0
2	1.02	0	3.476	0	4.496	.1526	4.343	0	0
3	.95	0	4.343	0	5.293	.4677	4.826	0	0
4	3.42	11.00	4.826	.045	19.20	1.464	4.84	12.90	.2194
5	3.29	0	4.84	.045	8.085	3.728	4.356	0	0
6	3.24	0	4.356	0	7.596	5.882	1.713	0	0
7	2.9	0	1.713	0	4.613	7.980	0	0	0
8	6.08	0	0	0	6.08	6.652	0	0	0
9	4.35	0	0	0	4.35	2.791	1.558	0	0
10	1.79	0	1.558	.045	3.303	.9172	2.386	0	0
11	1.79	0	2.386	.045	4.131	.2465	3.884	0	0
12	.65	0	3.884	0	4.534	.1382	4.396	0	0
YEAR 1974								12.9 INCHES	
1	.74	1.535	4.396	0	6.672	.1269	4.84	1.705	.0280
2	1.33	7.572	4.84	0	13.74	.1883	4.84	8.713	.1587
3	1.24	5.500	4.84	0	11.58	.4016	4.84	6.338	.1042
4	5.53	28.22	4.84	.045	38.55	1.231	4.84	32.48	.5522
5	2.03	0	4.84	.045	6.825	4.337	2.487	0	0
6	4.57	0	2.487	0	7.057	6.258	.7993	0	0
7	2.17	0	.7993	0	2.969	8.040	0	0	0
8	3.39	0	0	0	3.39	6.813	0	0	0
9	3.86	0	0	0	3.86	2.874	.9850	0	0
10	1.2	0	.9850	.045	2.140	.9993	1.140	0	0
11	3.3	0	1.140	.045	4.395	.2734	4.122	0	0
12	1.96	6.323	4.122	0	12.40	.1014	4.84	7.464	.1228
YEAR 1975								56.7 INCHES	
1	.49	2.675	4.84	0	8.005	.0835	4.84	3.081	.0507
2	1.8	10.29	4.84	0	16.93	.2478	4.84	11.84	.2158
3	3.67	21.33	4.84	0	29.84	.4503	4.84	24.55	.4039
4	3.38	12.06	4.84	.045	20.24	1.508	4.84	13.89	.2362
5	3.87	.1963	4.84	.045	8.861	3.811	4.84	.2101	0
6	2.66	0	4.84	0	7.5	6.582	.9171	0	0
7	1.85	0	.9171	0	2.767	8.040	0	0	0
8	4.02	0	0	0	4.02	6.835	0	0	0
9	.88	0	0	0	.88	3.036	0	0	0
10	.51	0	0	.045	.465	.8043	0	0	0
11	.15	0	0	.045	.105	.1728	0	0	0
12	.3	0	0	0	.3	.0434	.2565	0	0
YEAR 1976								53.58 INCHES	
1	.35	0	.2565	0	.6065	.0170	.5894	0	0
2	.93	0	.5894	0	1.519	.1785	1.340	0	0
3	6.13	13.82	1.340	0	21.29	.5772	4.84	15.87	.2612
4	4.24	17.37	4.84	.045	26.41	1.570	4.84	20.00	.3400
5	2.44	0	4.84	.045	7.235	4.562	2.672	0	0
6	3.86	0	2.672	0	6.532	6.024	.5071	0	0
7	3.4	0	.5071	0	3.907	8.016	0	0	0
8	6.13	0	0	0	6.13	6.329	0	0	0
9	5.79	0	0	0	5.79	3.031	2.758	0	0
10	2.58	.5954	2.758	.045	5.889	.9008	4.84	.1483	0
11	3.04	17.88	4.84	.045	25.71	.2288	4.84	20.64	.3510
12	2.06	12.93	4.84	0	19.83	.0863	4.84	14.90	.2452
YEAR 1977								71.57 INCHES	
1	.91	5.498	4.84	0	11.24	.0792	4.84	6.329	.1041
2	.58	3.103	4.84	0	8.523	.1114	4.84	3.571	.0650
3	.86	2.829	4.84	0	8.529	.4225	4.84	3.267	.0537
4	4.08	18.21	4.84	.045	27.09	1.286	4.84	20.96	.3564
5	4.82	4.175	4.84	.045	13.79	4.164	4.84	4.785	.0787
6	2.33	0	4.84	0	7.17	6.075	1.094	0	0
7	7.89	0	1.094	0	8.984	7.421	1.562	0	0
8	4.82	0	1.562	0	6.382	6.813	0	0	0
9	5.16	0	0	0	5.16	3.260	1.899	0	0
10	1.34	0	1.899	.045	3.194	.8967	2.298	0	0
11	1.27	0	2.298	.045	3.523	.2227	3.300	0	0
12	.69	0	3.300	0	3.990	.0760	3.914	0	0
YEAR 1978								38.91 INCHES	
1	1	3.064	3.914	0	7.978	.0383	4.84	3.100	.0510
2	1.11	6.768	4.84	0	12.71	.0909	4.84	7.787	.1418
3	6.06	37.07	4.84	0	47.97	.4729	4.84	42.66	.7019
4	2.04	4.759	4.84	.045	11.59	1.269	4.84	5.485	.0932
5	3.52	0	4.84	.045	8.315	3.728	4.586	0	0
6	5.15	0	4.586	0	9.736	6.065	3.670	0	0
7	4.77	0	3.670	0	8.440	7.671	.7694	0	0
8	3.25	0	.7694	0	4.019	6.523	0	0	0
9	3.15	0	0	0	3.15	3.137	.0126	0	0
10	3.79	0	.0126	.045	3.757	.8433	2.914	0	0
11	2.37	.4868	2.914	.045	5.726	.2158	4.84	.6703	.0113
12	1	5.459	4.84	0	11.29	.1334	4.84	6.326	.1040
YEAR 1979								66.03 INCHES	
1	1.68	10.47	4.84	0	16.99	.1005	4.84	12.05	.1982
2	.99	5.669	4.84	0	11.49	.1352	4.84	6.524	.1188
3	.74	2.114	4.84	0	7.694	.4103	4.84	2.444	.0402
4	2.63	7.193	4.84	.045	14.61	1.491	4.84	8.286	.1408
5	3.43	0	4.84	.045	8.225	4.202	4.022	0	0
6	5.4	0	4.022	0	9.422	5.994	3.428	0	0
7	3.87	0	3.428	0	7.298	7.742	0	0	0
8	5.69	0	0	0	5.69	6.770	0	0	0
9	4.73	0	0	0	4.73	2.975	1.754	0	0
10	1.82	0	1.754	.045	3.529	.8146	2.714	0	0
11	1.01	0	2.714	.045	3.679	.2434	3.436	0	0
12	.68	0	3.436	0	4.116	.0905	4.025	0	0
YEAR 1980								29.3 INCHES	

WINTER AVERAGE = 13.3442327 INCHES OR .0756211263 CFS

SPRING AVERAGE = 30.5938944 INCHES OR .169622891 CFS

SUMMER AVERAGE = 0 INCHES OR 0 CFS

FALL AVERAGE = 3.06658008 INCHES OR .0171882979 CFS

ANNUAL AVERAGE FLOW = 46.9985715 INCHES OR .0656717618 CFS

Table 2.1-5. Example computer printout of Wetland Hydrology Model.

to the field observations that there were few surface streams discharging from the wetlands, and interflow discharge was dominant. Tabulated values of modeled discharge are reported to two decimal places representing hundredths of one cfs. Accuracy to this degree is not claimed, yet, keeping these significant figures aids the comparison of discharge from one wetland to another and from one phase to another.

2.2 WATER TABLE WETLANDS

The water table wetlands are T1 through T4, W1, W2, Z1 through Z19 and Z23. All of these wetlands are associated with glaciofluvial (outwash) sand and gravel (Simpkins et al., 1981) and are considered to be connected to the main ground water aquifer (Exxon Minerals Company, 1982). The level of open water surfaces in the organic soils are influenced by the regional unconfined aquifer's water table elevation. These wetlands are also primarily discharge wetlands, where water leaves the ground water system to become surface water or to be evapotranspirated. Wetland Z18 contains "Hoffman's Spring" which flows continuously (Exxon Minerals Company, 1982). Springs were also observed in wetlands W1, W2 and T4 (NAI and IEP, 1982).

Wetlands T1, T2, T3, Z1 and Z3 all occur in isolated kettle holes and are not part of riparian systems (NAI and IEP, 1982 and IEP, 1982). These kettle holes are deep enough to intersect the main aquifer water table which, more than surface water inflow, influences the elevation of water in the wetlands. Wetlands Z4 through Z22 are within the watershed of Swamp Creek. This is an extensive wetland system occurring in melt-water channels and connected kettle holes which are tributary to Swamp Creek. Outlet Creek is part of the Swamp Creek system. Wetland Z23 exists at the headwaters of Pickerel Creek, which flows south into Rolling Stone Lake.

Because Swamp Creek has a very large (119.7 km^2[46.2 square miles]) watershed, is predominantly ground water fed, and is continuously flowing, the Wetland Hydrology Model for perched wetlands was not applied to the wetlands associated with Swamp Creek. Instead, the existing water discharge regime in Swamp Creek was established from stream gaging records (August 1977 to September 1981) at the US Geological Survey (USGS 1978, 1979, 1980, 1981) gaging station at Highway 55, upstream of Rice Lake on Swamp Creek. The method developed to assess impacts of some activities to water table wetlands contiguous to or associated with Swamp Creek was to use the existing discharge regime of Swamp Creek as a basis for comparing increases or decreases in discharge as a result of the proposed activities (i.e., changes in watershed area and cover type). Where a wetland hydrological impact was projected, the magnitude of discharge change was calculated using methods developed by the Soil Conservation Service (Soil Conservation Service, 1972). The amount of increase or decrease projected was compared to the recorded discharge rates of Swamp Creek and hydrological impacts were assessed based upon this comparison. The hydrologic impacts of some activities have not been quantified because: (1) they would cause only minor alterations to wetland watersheds or, (2) whereas final design details have not yet been prepared, it is assumed that standard engineering solutions (e.g., culverts and grassed swales) will be designed to maintain existing water balances.

3.0 RESULTS

3.1 EXISTING HYDROLOGY

The water balances of wetlands in their existing, natural condition were determined to provide a basis for evaluating changes of wetland water balances caused by project activities. The existing water balances of perched wetlands were calculated using the Perched Wetland Hydrologic Model. Water table wetland existing water balances were not modeled but were determined by a comparison to Swamp Creek's flow rates.

3.1.1 Perched Wetlands

The existing hydrology of the perched wetlands associated with the MWDF were determined using the modeling methods described in section 2.1 and the results are presented in Table 3.1-1. Wetlands presented in the table are grouped according to watershed flow systems, wherein the last listed wetland in each group receives the water discharged from those above it. For example (Figure 3.1-1), wetland F57 receives discharge from wetlands F66 through F60. Wetlands F69, F70 and F72 also discharge to F57, but are tributary to F60 below F61 and are not part of the F66 through F61 network.

The column headings of Table 3.1-1 are the modeled winter (December, January, February), spring (March, April, May), summer (June, July, August), autumn (September, October, November), and annual average of monthly water discharge rates for the period of record. Both the average and the range of the monthly discharge rates represent existing hydrology of the perched wetlands.

Table 3.1-1. Existing condition, Hydrologic Model results, seasonal average, annual average, and ranges of perched wetland monthly discharge rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING				
		Winter	Spring	Summer	Autumn	ANNUAL
M3	A	0.07	0.12	0	0.03	0.06
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47
P2	A	0.14	0.29	0	0.04	0.12
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17
F114	A	<0.01	<0.01	0	<0.01	<0.01
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01
F13	A	<0.01	0.01	0	<0.01	<0.01
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07
F11	A	0.38	0.92	0	0.08	0.34
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92
F10	A	0.44	1.06	0	0.09	0.40
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52
F27	A	0.04	0.08	0	0.02	0.04
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31
F25	A	0.14	0.25	0	0.06	0.11
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96
F23	A	0.19	0.35	0	0.07	0.15
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34
F31	A	0.06	0.11	0	0.02	0.04
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41
F32	A	<0.01	0.01	0	<0.01	<0.01
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06
F81	A	<0.01	0.01	0	<0.01	<0.01
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04
F29	A	0.14	0.27	0	0.06	0.12
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03
F28	A	0.38	0.74	0	0.11	0.31
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07
F66	A	0.07	0.15	0	0.02	0.06
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61
F65	A	0.08	0.17	0	0.02	0.07
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70
F64	A	0.09	0.20	0	0.02	0.08
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83
F63	A	0.10	0.25	0	0.02	0.09
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05
F62	A	0.15	0.34	0	0.03	0.13
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42
F72	A	0.05	0.10	0	0.02	0.04
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37
F61	A	0.25	0.52	0	0.08	0.21
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11
F70	A	0.01	0.02	0	<0.01	0.01
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10
F69	A	0.03	0.06	0	0.01	0.03
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24
F60	A	0.42	0.87	0	0.12	0.35
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45
F57	A	0.49	1.01	0	0.13	0.41
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.

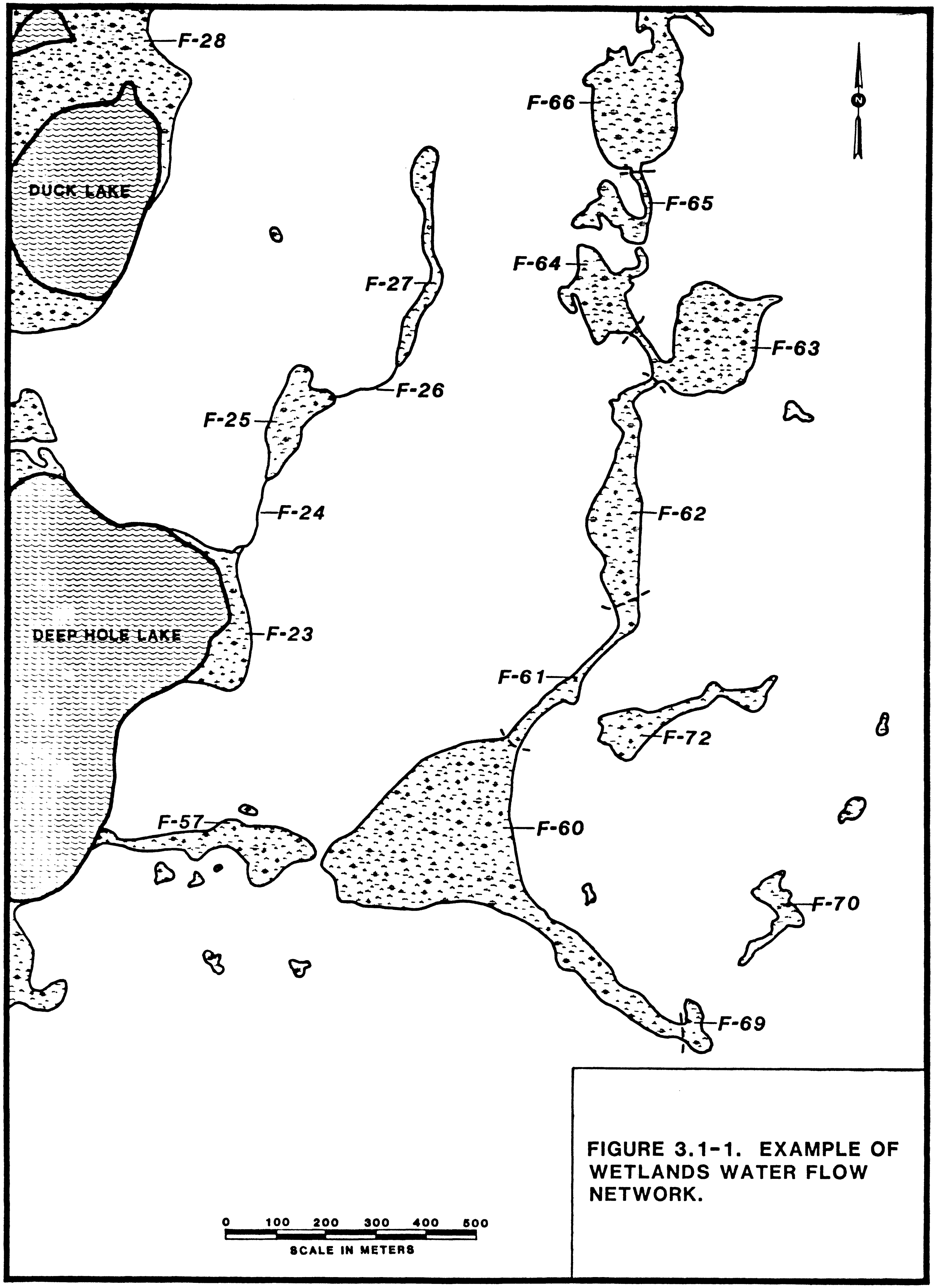


FIGURE 3.1-1. EXAMPLE OF WETLANDS WATER FLOW NETWORK.

The winter average discharge rates from all modeled perched wetlands varied from <0.01 (F114, F13, F32 and F81) to 0.49 cfs (F57). The spring average discharge rates varied from <0.01 (F114) to 1.06 cfs (F10). The summer average and range of discharge rates for all perched wetlands was zero cfs. The range of autumn average discharge rates was from <0.01 (F114, F13, F32, F81 and F70) to 0.13 cfs (F57). The range of the annual average water discharge rates for all perched wetlands was from <0.01 to 0.41 cfs.

The largest water discharge rates occurred in the spring with decreasingly smaller rates in the winter, autumn and summer. Spring was the period of year when the sum of rainfall and snowmelt was highest. During the summer the evapotranspiration was at its maximum and wetland vegetation was capable of using virtually all of the rainfall reaching the wetlands and their watersheds according to model results. This resulted in a summer average discharge rate of zero cfs.

All discharge rates for perched wetlands were low. Most perched wetlands have small watersheds with no inflowing streams or streams with low inflow and thus they received only the water that fell directly into their watersheds. None of them received inflowing ground water. During April, May, October and November they discharged a small amount of water to the ground water system as seepage. The watersheds of these wetlands are densely vegetated and as a result, evapotranspiration was high during the growing season. The soils of the watersheds contain an upper layer of forest litter and roots capable of attenuating surface water runoff.

During the climatic record period each wetland had a monthly average discharge rate of zero for at least one month in the seven years.

The zero discharge rates occurred during periods of low precipitation recorded for at least one month of each season of the seven year period. During these dry periods, almost all precipitation was evapotranspirated by vegetation or stored in the permeable organic soils, thereby leaving little or no excess discharge water.

3.1.2 Water Table Wetlands

The USGS operates a stream gaging station at Swamp Creek above Rice Lake at State Highway 55 (Exxon Minerals Company, 1982). Gaging at this station has been continuous since August 1977. Table 3.1-2 lists the minimum, annual average and maximum daily discharge rates of water for the years 1977 through 1981. As shown, the minimum daily discharge rate during the period of record was 8.3 cfs and the maximum 212 cfs.

Swamp Creek discharge is used as the primary indicator of the water balance of wetlands associated with Swamp Creek because of the proportional relationship between the two. The tabulated discharge rates (Table 3.1-2) served as the basis for evaluating the hydrological impacts to the water table wetlands from the Crandon Project activities.

A discussion of the projected impacts to both the perched and the water table wetlands follows. Each Crandon Project activity is divided, where applicable, into separate sections assessing hydrological impacts to perched and water table wetlands.

Table 3.1-2. Normal, Maximum, and Minimum Annual Discharge Rates, Swamp Creek at State Highway 55.

	Swamp Creek Daily Discharge Rates, CFS				
Water Year	Minimum	Date	Maximum	Date	Annual Average
1977*	8.3	8/25/77	63	9/20/77	
1978	16	2/23/78 to 3/05/78	98	7/24/78	33.5
1979	13	9/23/79	151	4/20/79	36.4
1980	14	10/18/79	107	4/09/80	29.1
1981	9.4	9/19/81	212	6/15/81	28.8

*Partial record, August and September 1977 only.

Source: USGS data as reported in Exxon Minerals Company, 1982.

3.2 CONSTRUCTION IMPACTS

Whereas the construction periods are short in relation to operation periods most hydrological impacts to wetlands would occur during the operational phases of activities. The MWDF has four operational phases (Phases 2 through 5) and the greater hydrologic impacts would occur following completion of a construction phase, when changes in watershed areas, cover types and wetland areas are completed. Each construction phase consists of a number of steps (i.e., cutting, grubbing, excavation and filling), each of which may slightly alter hydrology, yet modeling each of the construction steps would be of little value because the completed activity would cause the greatest hydrologic change. It is assumed that standard acceptable construction methods applicable in the State of Wisconsin will be used so that construction impacts of most activities to wetland hydrology will be short-term and minimized. The narrow (15 m, 50 ft) corridor of the buried water discharge pipeline will temporarily disturb 0.04 ha (0.09 acre) of water table wetland Z20 and 0.13 ha (0.33 acre) of water table wetland Z23. The only site activity considered as a construction phase for modeling is Phase 1 of the MDWF and reclaim ponds (R1 and R2). The remaining MWDF phases were evaluated as operational impacts. Other activities such as the site access road, railroad spur and slurry pipeline/haul road were not phased and were modeled for operational conditions only. All construction will progress as expeditiously as possible so that temporary periods of water diversion will be minimized.

Phase 1 (see Figure 2.1-1) is the preoperational (construction) phase of the MWDF during which reclaim pond R1, the waste rock storage area and the construction support area are developed. The watersheds of wetlands F66, F65, F64, F29, F31 and F27 will decrease in size because of diversion of water (to sumps) from the waste rock storage area and retention of this water in a synthetically lined pond. The watersheds of wetlands F11 and F28 will also decrease in size because of area taken by reclaim pond R1. Wetland F66 will be the only wetland subject to filling during this phase. The area of wetland F66 will decrease from 6.56 ha (16.20 acres) to 3.72 ha (9.20 acres) due to grading of the construction support area.

The Phase 1 seasonal and annual average water discharge rates are compared to the existing discharge rates and ranges of the modeled perched wetlands in Table 3.2-1. The spring discharge rates from wetlands F11 and F10 will decrease by 0.01 cfs because a small portion of the watershed of wetland F11 will be removed by reclaim pond R1. The yearly discharge rates from wetlands F25, F27, F28, F29 and F31 will decrease because portions of the watersheds of wetlands F27, F31 and F29 will be removed for the waste rock storage area. Although the waste rock storage area will also remove some watershed area from wetlands F66, F65 and F64, their discharge rates will increase due to greater surface water runoff from the construction support area in the watershed of wetland F66. As a result of increased inflow, the discharge rates of downstream wetlands (F63, F62, F61, F60 and F57) will increase slightly.

Table 3.2-1. Phase 1, Hydrologic Model Results, Seasonal Average, Annual Average, and Ranges of Wetland Discharge Rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING					PHASE 1, PRE-OPERATIONAL					
		Winter	Spring	Summer	Autumn	ANNUAL	Winter	Spring	Summer	Autumn	ANNUAL	EFFECT/ACTIVITY
M3	A	0.07	0.12	0	0.03	0.06	0.07	0.12	0	0.03	0.06	no change
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47						
P2	A	0.14	0.29	0	0.04	0.12	0.14	0.29	0	0.04	0.12	no change
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17						
F114	A	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01						
F13	A	<0.01	0.01	0	<0.01	<0.01	<0.01	0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07						
F11	A	0.38	0.92	0	0.08	0.34	0.38	0.91	0	0.08	0.34	very slight spring decrease/RP1
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92						
F10	A	0.44	1.06	0	0.09	0.40	0.44	1.05	0	0.09	0.40	very slight spring decrease/reduced inflow
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52						
F27	A	0.04	0.08	0	0.02	0.04	0.03	0.05	0	0.01	0.02	decrease/waste rock storage area
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31						
F25	A	0.14	0.25	0	0.06	0.11	0.12	0.22	0	0.05	0.10	slight decrease/ reduced inflow
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96						
F23	A	0.19	0.35	0	0.07	0.15	0.17	0.32	0	0.06	0.14	slight decrease/ reduced inflow
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34						
F31	A	0.06	0.11	0	0.02	0.04	0.05	0.10	0	0.02	0.04	very slight decrease/ reduced inflow
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41						
F32	A	<0.01	0.01	0	<0.01	<0.01	<0.01	0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06						
F81	A	<0.01	0.01	0	<0.01	<0.01	<0.01	0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04						
F29	A	0.14	0.27	0	0.06	0.12	0.11	0.22	0	0.04	0.10	decrease/waste rock storage area
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03						
F28	A	0.38	0.74	0	0.11	0.31	0.34	0.65	0	0.11	0.28	decrease/RP1 and reduced inflow
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07						
F66	A	0.07	0.15	0	0.02	0.06	0.08	0.15	0	0.06	0.07	increase/construction support area
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61						
F65	A	0.08	0.17	0	0.02	0.07	0.09	0.17	0	0.06	0.08	increase/increased inflow
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70						
F64	A	0.09	0.20	0	0.02	0.08	0.10	0.20	0	0.05	0.09	slight increase/ increased inflow
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83						
F63	A	0.10	0.25	0	0.02	0.09	0.12	0.25	0	0.04	0.10	slight increase/ increased inflow
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05						
F62	A	0.15	0.34	0	0.03	0.13	0.17	0.34	0	0.05	0.14	slight increase/ increased inflow
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42						
F72	A	0.05	0.10	0	0.02	0.04	0.05	0.10	0	0.02	0.04	no change
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37						
F61	A	0.25	0.52	0	0.08	0.21	0.27	0.52	0	0.10	0.22	increase/increased inflow
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11						
F70	A	0.01	0.02	0	<0.01	0.01	0.01	0.02	0	<0.01	0.01	no change
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10						
F69	A	0.03	0.06	0	0.01	0.03	0.03	0.06	0	0.01	0.03	no change
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24						
F60	A	0.42	0.87	0	0.12	0.35	0.45	0.87	0	0.13	0.36	slight increase/ increased inflow
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45						
F57	A	0.49	1.01	0	0.13	0.41	0.51	1.01	0	0.14	0.42	slight increase/ increased inflow
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04						

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.

RP- designates retention pond.

3.3 OPERATIONS IMPACTS

Impacts to wetland water balances will be greatest during the operational phase of the Mine Waste Disposal Facility. The use and operation of other facilities, such as the water discharge pipeline will result in less impact. The following sections describe the various operations impacts.

3.3.1 Perched Wetlands

3.3.1.1 Slurry Pipeline/Haul Road

The construction and use of the proposed (route 1, Figure 3.3-1) slurry pipeline and the gravel haul road will not measurably change the hydrology of the affected wetlands and their associated watersheds. The proposed slurry pipeline would consist of a 30 m (100 feet) corridor in which three pipelines would be buried and the surface regraded to the existing topography. Low earthen berms would parallel the pipelines and bound the pipeline corridor. Parallel to the pipeline corridor is proposed a 50 m (165 feet) corridor consisting of a gravel haul road and overhead powerline. The pipeline and road will be constructed between wetlands F11 and F12 (Skunk Lake), along the drainage divide between their watersheds. Slight (presently unknown) alterations of their watershed areas may result. Surface water runoff from the haul road will drain into each watershed in much the same manner as existing. Ditches along the sides of the road will convey water into both watersheds. There may be a slight increase in surface water runoff generated by the change in land surface cover of the gravel roadway surface, but this minor change would not be sufficient to cause "wetter" conditions in

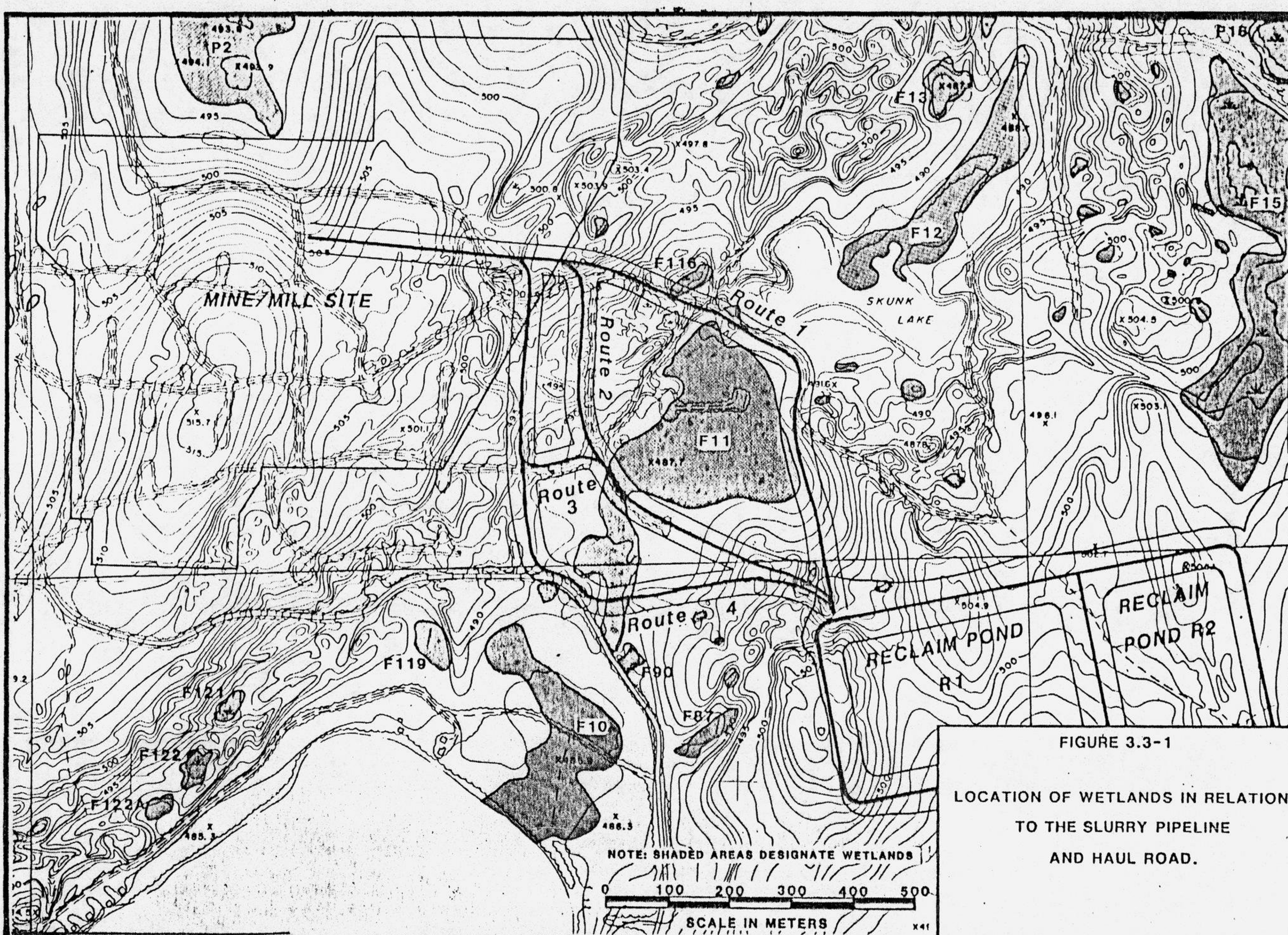


FIGURE 3.3-1

LOCATION OF WETLANDS IN RELATION TO THE SLURRY PIPELINE AND HAUL ROAD.

either F11 or F12. There will not be a decrease in surface water runoff to either wetland. No means to mitigate these possible slight increases in rate of surface water runoff will be necessary.

3.3.1.2 Mine Waste Disposal Facility and Reclaim Ponds

Phase 2 is the first operational phase during which reclaim pond R2 and tailings pond T1 will be operational (see Figure 2.1-2). Wetlands F27 and F32 will be completely filled. Wetland F25 will be partially filled. The watersheds of wetlands F31 and F62 will increase slightly in size whereas the watersheds of wetlands F25, F28, F29 and F11 will decrease in size because of filling for the embankments of ponds R2 and T1. The water discharge rates for Phase 2 are compared with existing discharge rates in Table 3.3-1. Without providing drainage relief (i.e., a culvert), water discharge from wetland F31 would be blocked by an embankment. Therefore, the discharge rates from this wetland, as specified in Table 3.3-1, represent an accumulation of water storage (and subsequent evapotranspiration or infiltration) and not actual water outflow. The discharge rates from wetlands F11 and F10 will again be slightly decreased by the additional removal of watershed area of wetland F11 for reclaim pond R2. The discharge rates from wetland F29 will be greatly reduced because of the combined effects of watershed area reduction for pond T1 and R2 and the blockage of inflow from wetland F31. Wetland F28, downstream from F29, will have a subsequently decreased discharge because of the lesser inflow. The discharge rates from wetland F25 and its downstream wetland F23 will decrease because of the area occupied by pond T1 in the watershed of wetland F25 area and its

Table 3.3-1. Phase 2, Hydrologic Model Results, Seasonal Average, Annual Average, and Ranges of Wetland Discharge Rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING Winter	Spring	Summer	Autumn	ANNUAL	PHASE 2, OPERATIONAL Winter	Spring	Summer	Autumn	ANNUAL	EFFECT/ACTIVITY
M3	A	0.07	0.12	0	0.03	0.06	0.07	0.12	0	0.03	0.06	no change
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47						
P2	A	0.14	0.29	0	0.04	0.12	0.14	0.29	0	0.04	0.12	no change
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17						
F114	A	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01						
F13	A	<0.01	0.01	0	<0.01	<0.01	<0.01	0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07						
F11	A	0.38	0.92	0	0.08	0.34	0.37	0.90	0	0.08	0.34	very slight decrease/ RP1, RP2
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92						
F10	A	0.44	1.06	0	0.09	0.40	0.43	1.04	0	0.09	0.39	very slight decrease/ reduced inflow
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52						
F27	A	0.04	0.08	0	0.02	0.04	0	0	0	0	0	filled, Phase 2
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31						
F25	A	0.14	0.25	0	0.06	0.11	0.07	0.12	0	0.03	0.06	decrease/reduced inflow, TP1
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96						
F23	A	0.19	0.35	0	0.07	0.15	0.12	0.22	0	0.04	0.09	decrease/reduced inflow
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34						
F31	A	0.06	0.11	0	0.02	0.04	0	0	0	0	0	discharge blocked
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41						
F32	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, Phase 2
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06						
F81	A	<0.01	0.01	0	<0.01	<0.01	<0.01	0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04						
F29	A	0.14	0.27	0	0.06	0.12	0.02	0.03	0	<0.01	0.01	decrease/inflow blocked, TP1, RP2
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03						
F28	A	0.38	0.74	0	0.11	0.31	0.20	0.38	0	0.07	0.17	decrease/reduced inflow
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07						
F66	A	0.07	0.15	0	0.02	0.06	0.08	0.15	0	0.06	0.07	increase/construction support, TP1 grading
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61						
F65	A	0.08	0.17	0	0.02	0.07	0.09	0.15	0	0.06	0.08	increase/increased inflow
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70						
F64	A	0.09	0.20	0	0.02	0.08	0.10	0.20	0	0.05	0.09	increase/increased inflow
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83						
F63	A	0.10	0.25	0	0.02	0.09	0.13	0.25	0	0.04	0.11	increase/increased inflow
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05						
F62	A	0.15	0.34	0	0.03	0.13	0.18	0.35	0	0.05	0.15	increase/increased inflow, TP1 grading
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42						
F72	A	0.05	0.10	0	0.02	0.04	0.05	0.10	0	0.02	0.04	no change
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37						
F61	A	0.25	0.52	0	0.08	0.21	0.28	0.54	0	0.10	0.23	increase/increased inflow
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11						
F70	A	0.01	0.02	0	<0.01	0.01	0.01	0.02	0	<0.01	0.01	no change
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10						
F69	A	0.03	0.06	0	0.01	0.03	0.03	0.06	0	0.01	0.03	no change
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24						
F60	A	0.42	0.87	0	0.12	0.35	0.45	0.88	0	0.13	0.37	increase/increased inflow
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45						
F57	A	0.49	1.01	0	0.13	0.41	0.52	1.02	0	0.15	0.42	increase/increased inflow
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04						

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.
TP- designates tailings pond.
RP- designates retention pond.

upstream wetland F27. Other slight changes of the discharge rates of wetlands in the F66 through F57 system will occur because of minor watershed alterations caused by the embankment grading of pond T1.

Phase 3 is the second operational phase during which tailings pond T2 will be operational and tailings pond T1 will be filled but not reclaimed (see Figure 2.1-3). Additionally, a till stockpile (TSP) will be created next to the construction support area. Table 3.3-2 compares the water discharge rates of wetlands during Phase 3 to existing discharge rates. Part of wetland M3 will be filled by the TSP and, consequently, the discharge rates from M3 will increase slightly because of higher surface runoff from the till surface. Wetlands F31 and F81 will be filled during the construction and operation of tailings pond T2. The remainder of wetland F66 will be filled for the TSP resulting in higher surface water discharge rates in downstream wetlands F65, F64, F63, F62, F61, F60 and F57, some of which, as projected, will have surface water discharge during summer periods. [Recent design layouts (see Figure 2.1-3) for the TSP indicate that it may extend over and require the filling of wetland F65 during Phase 3 instead of Phase 4 as modeled. In this eventuality, wetlands downstream of F65 would likely have slightly higher discharge rates than those reported in Table 3.3-2].

Phase 4 is the third operational phase during which tailings pond T3 will be operational, tailings pond T2 filled and tailings pond T1 reclaimed (see Figure 2.1-4). Wetlands F65, F64 and F63 will be completely filled and wetland F62 partially filled for tailings pond T3. Table 3.3-3 compares Phase 4 with existing water discharge rates. The discharge rates

Table 3.3-2. Phase 3, Hydrologic Model Results, Seasonal Average, Annual Average, and Ranges of Wetland Discharge Rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING					PHASE 3, OPERATIONAL					
		Winter	Spring	Summer	Autumn	ANNUAL	Winter	Spring	Summer	Autumn	ANNUAL	EFFECT/ACTIVITY
M3	A	0.07	0.12	0	0.03	0.06	0.06	0.12	0	0.03	0.05	slight decrease/ TP2
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47						
P2	A	0.14	0.29	0	0.04	0.12	0.14	0.29	0	0.04	0.12	no change
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17						
F114	A	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01						
F13	A	<0.01	0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07						
F11	A	0.38	0.92	0	0.08	0.34	0.33	0.82	0	0.07	0.31	decrease/RP1, RP2, TP2
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92						
F10	A	0.44	1.06	0	0.09	0.40	0.39	0.97	0	0.08	0.36	decrease/reduced inflow
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52						
F27	A	0.04	0.08	0	0.02	0.04	0	0	0	0	0	filled, phase 2
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31						
F25	A	0.14	0.25	0	0.06	0.11	0.07	0.12	0	0.03	0.06	decrease/reduced inflow, TP1
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96						
F23	A	0.19	0.35	0	0.07	0.15	0.12	0.22	0	0.04	0.09	decrease/reduced inflow
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34						
F31	A	0.06	0.11	0	0.02	0.04	0	0	0	0	0	filled, phase 3
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41						
F32	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 2
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06						
F81	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 3
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04						
F29	A	0.14	0.27	0	0.06	0.12	0.02	0.04	0	<0.01	0.01	decrease/inflow blocked, TP1,RP2,TP2
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03						
F28	A	0.38	0.74	0	0.11	0.31	0.20	0.39	0	0.07	0.17	decrease/reduced inflow
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07						
F66	A	0.07	0.15	0	0.02	0.06	0	0	0	0	0	filled, phase 3
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61						
F65	A	0.08	0.17	0	0.02	0.07	0.11	0.30	0.19	0.24	0.21	increase/construction support, till stockpile
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70						
F64	A	0.09	0.20	0	0.02	0.08	0.13	0.33	0.16	0.26	0.22	increase/increased inflow
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83						
F63	A	0.10	0.25	0	0.02	0.09	0.16	0.38	0.09	0.30	0.23	increase/increased inflow
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05						
F62	A	0.15	0.34	0	0.03	0.13	0.21	0.47	0.04	0.35	0.27	increase/increased inflow
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42						
F72	A	0.05	0.10	0	0.02	0.04	0.05	0.10	0	0.02	0.04	no change
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37						
F61	A	0.25	0.52	0	0.08	0.21	0.32	0.64	0.02	0.40	0.35	increase/increased inflow
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11						
F70	A	0.01	0.02	0	<0.01	0.01	0.01	0.02	0	<0.01	0.01	no change
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10						
F69	A	0.03	0.06	0	0.01	0.03	0.03	0.06	0	0.01	0.03	no change
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24						
F60	A	0.42	0.87	0	0.12	0.35	0.51	0.97	0	0.42	0.48	increase/increased inflow
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45						
F57	A	0.49	1.01	0	0.13	0.41	0.60	1.12	0	0.42	0.54	increase/increased inflow
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04						

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.
TP- designates tailings pond.
RP- designates retention pond.

Table 3.3-3. Phase 4, Hydrologic Model Results, Seasonal Average, Annual Average, and Ranges of Wetland Discharge Rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING					PHASE 4, OPERATIONAL					
		Winter	Spring	Summer	Autumn	ANNUAL	Winter	Spring	Summer	Autumn	ANNUAL	EFFECT/ACTIVITY
M3	A	0.07	0.12	0	0.03	0.06	0.06	0.12	0	0.03	0.05	slight decrease/TP2
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47						
P2	A	0.14	0.29	0	0.04	0.12	0.14	0.29	0	0.04	0.12	no change
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17						
F114	A	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01						
F13	A	<0.01	0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07						
F11	A	0.38	0.92	0	0.08	0.34	0.33	0.82	0	0.07	0.31	decrease/RP1, RP2, TP2
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92						
F10	A	0.44	1.06	0	0.09	0.40	0.39	0.97	0	0.08	0.36	decrease/reduced inflow
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52						
F27	A	0.04	0.08	0	0.02	0.04	0	0	0	0	0	filled, phase 2
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31						
F25	A	0.14	0.25	0	0.06	0.11	0.11	0.20	0	0.06	0.09	decrease/reduced inflow
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96						
F23	A	0.19	0.35	0	0.07	0.15	0.16	0.30	0	0.07	0.13	decrease/reduced inflow
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34						
F31	A	0.06	0.11	0	0.02	0.04	0	0	0	0	0	filled, phase 3
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41						
F32	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 2
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06						
F81	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 3
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04						
F29	A	0.14	0.27	0	0.06	0.12	0.06	0.12	0	0.03	0.05	decrease/inflow blocked, TP2, RP2
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03						
F28	A	0.38	0.74	0	0.11	0.31	0.27	0.51	0	0.10	0.22	decrease/reduced inflow
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07						
F66	A	0.07	0.15	0	0.02	0.06	0	0	0	0	0	filled, phase 3
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61						
F65	A	0.08	0.17	0	0.02	0.07	0	0	0	0	0	filled, phase 4
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70						
F64	A	0.09	0.20	0	0.02	0.08	0	0	0	0	0	filled, phase 4
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83						
F63	A	0.10	0.25	0	0.02	0.09	0	0	0	0	0	filled, phase 4
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05						
F62	A	0.15	0.34	0	0.03	0.13	0.02	0.05	0	< 0.01	0.02	decrease/reduced inflow, TP3
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42						
F72	A	0.05	0.10	0	0.02	0.04	0.05	0.09	0	0.02	0.04	very slight spring decrease/TP3
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37						
F61	A	0.25	0.52	0	0.08	0.21	0.12	0.22	0	0.05	0.10	decrease/reduced inflow
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11						
F70	A	0.01	0.02	0	<0.01	0.01	0.01	0.02	0	0.01	0.01	no change
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10						
F69	A	0.03	0.06	0	0.01	0.03	0.03	0.06	0	0.01	0.03	no change
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24						
F60	A	0.42	0.87	0	0.12	0.35	0.29	0.56	0	0.09	0.23	decrease/reduced inflow
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45						
F57	A	0.49	1.01	0	0.13	0.41	0.36	0.71	0	0.10	0.29	decrease/reduced inflow
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04						

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.
TP- designates tailings pond.
RP- designates retention pond.

from wetlands F25, F23, F29 and F28, though still less than existing rates will increase over the rates in Phase 3 because of the increased watershed area resulting from the reclamation of pond T1. The discharge from the watershed of wetland F66 (filled during Phase 3) will be blocked by the embankment of pond T3. The discharge rates of wetlands F62, F72, F61, F60 and F57 will be further reduced because of the removal of upstream areas (including wetlands F65, F64 and F63) for tailings pond T3.

Phase 5 is the fourth operational phase during which tailings pond T4 will be operational, tailings pond T3 filled but not reclaimed, tailings pond T2 partially reclaimed and the waste rock storage area and construction support area replaced by tailings pond T4 (see Figure 2.1-5). A comparison is presented in Table 3.3-4 of Phase 5 water discharge rates with existing water discharge rates. The water discharge rates from wetland M3 will still be less than the existing rates despite watershed alterations caused by the embankment of pond T4 and the partial reclamation of pond T2. The discharge rates from wetlands F29 and F28, although still lower than existing rates, will be greater than those of Phase 4 because of more watershed area afforded by the partial reclamation of tailings pond T2. Wetland F11 will gain watershed area due to the regrading of tailings pond T2 and, as a result, its discharge rates will be higher than the existing rates. The discharge rates from downstream wetland F10 will also increase. Adjustments in the grading of the embankment of tailings pond T2 to increase the watershed area of F29 and F28 would mitigate the decreases in these wetlands' water balances. The increased watershed area which has been provided to wetland F11 could be reduced and directed toward the watersheds

Table 3.3-4. Phase 5, Hydrologic Model Results, Seasonal Average, Annual Average, and Ranges of Wetland Discharge Rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING					PHASE 5, OPERATIONAL					
		Winter	Spring	Summer	Autumn	ANNUAL	Winter	Spring	Summer	Autumn	ANNUAL	EFFECT/ACTIVITY
M3	A	0.07	0.12	0	0.03	0.06	0.06	0.10	0	0.03	0.05	decrease/TP4, TP2 reclaim
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47						
P2	A	0.14	0.29	0	0.04	0.12	0.14	0.29	0	0.04	0.12	no change
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17						
F114	A	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01						
F13	A	<0.01	0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07						
F11	A	0.38	0.92	0	0.08	0.34	0.41	0.95	0	0.09	0.36	increase/TP2 reclaim
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92						
F10	A	0.44	1.06	0	0.09	0.40	0.47	1.09	0	0.10	0.41	increase/increased inflow
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52						
F27	A	0.04	0.08	0	0.02	0.04	0	0	0	0	0	filled, phase 2
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31						
F25	A	0.14	0.25	0	0.06	0.11	0.11	0.20	0	0.06	0.09	decrease/reduced inflow
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96						
F23	A	0.19	0.35	0	0.07	0.15	0.16	0.30	0	0.07	0.13	decrease/reduced inflow
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34						
F31	A	0.06	0.11	0	0.02	0.04	0	0	0	0	0	filled, phase 3
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41						
F32	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 2
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06						
F81	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 3
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04						
F29	A	0.14	0.27	0	0.06	0.12	0.09	0.18	0	0.05	0.08	decrease/inflow blocked, RP1, TP4
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03						
F28	A	0.38	0.74	0	0.11	0.31	0.31	0.57	0	0.11	0.25	decrease/reduced inflow
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07						
F66	A	0.07	0.15	0	0.02	0.06	0	0	0	0	0	filled, phase 3
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61						
F65	A	0.08	0.17	0	0.02	0.07	0	0	0	0	0	filled, phase 4
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70						
F64	A	0.09	0.20	0	0.02	0.08	0	0	0	0	0	filled, phase 4
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83						
F63	A	0.10	0.25	0	0.02	0.09	0	0	0	0	0	filled, phase 4
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05						
F62	A	0.15	0.34	0	0.03	0.13	0.02	0.05	0	<0.01	0.02	decrease/reduced inflow, TP3
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42						
F72	A	0.05	0.10	0	0.02	0.04	0.05	0.09	0	0.02	0.04	very slight spring decrease/TP3
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37						
F61	A	0.25	0.52	0	0.08	0.21	0.12	0.22	0	0.05	0.10	decrease/reduced inflow
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11						
F70	A	0.01	0.02	0	<0.01	0.01	0.01	0.02	0	0.01	0.01	no change
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10						
F69	A	0.03	0.06	0	0.01	0.03	0.03	0.06	0	0.01	0.03	no change
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24						
F60	A	0.42	0.87	0	0.12	0.35	0.29	0.56	0	0.09	0.23	decrease/reduced inflow
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45						
F57	A	0.49	1.01	0	0.13	0.41	0.36	0.71	0	0.10	0.29	decrease/reduced inflow
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04						

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.
TP- designates tailings pond.
RP- designates retention pond.

of F29 and F28. This could restore the existing water discharge rates for F11 and could augment the water balances of F29 and F28.

3.3.1.3 Railroad Spur

The proposed railroad spur (route D, Figure 3.3-2) crosses the watersheds of perched wetlands F116, F12, F13, F114 and O1. It approximately follows the watershed divide between the F watershed and the O watershed, yet does not cross any perched wetlands. Grassed drainage ditches which retard water flow, and culverts which allow flow through the railroad bed, will be designed so that the watersheds of the perched wetlands will not be altered. The majority of the railroad spur will be in the watershed of wetland O1, yet the area of this watershed will not change.

The surface area of the railroad will consist of crushed rock railroad bed ballast, ties and rails resulting in a permeable surface which will permit rapid infiltration of surface water. The side slopes will be graded, seeded and will become revegetated. These types of land cover materials will hydrologically approximate existing cover types and will not cause an increase or decrease in surface water runoff. Therefore, no measureable changes in perched wetland water balances will occur because of the proposed railroad spur.

3.3.1.4 Access Road

The proposed Mine/Mill Site access road (route B1, Figure 3.3-3) will cross the watersheds of perched wetlands R8 and P2. It will begin at the Mine/Mill Site and follow approximately the watershed divide between P2

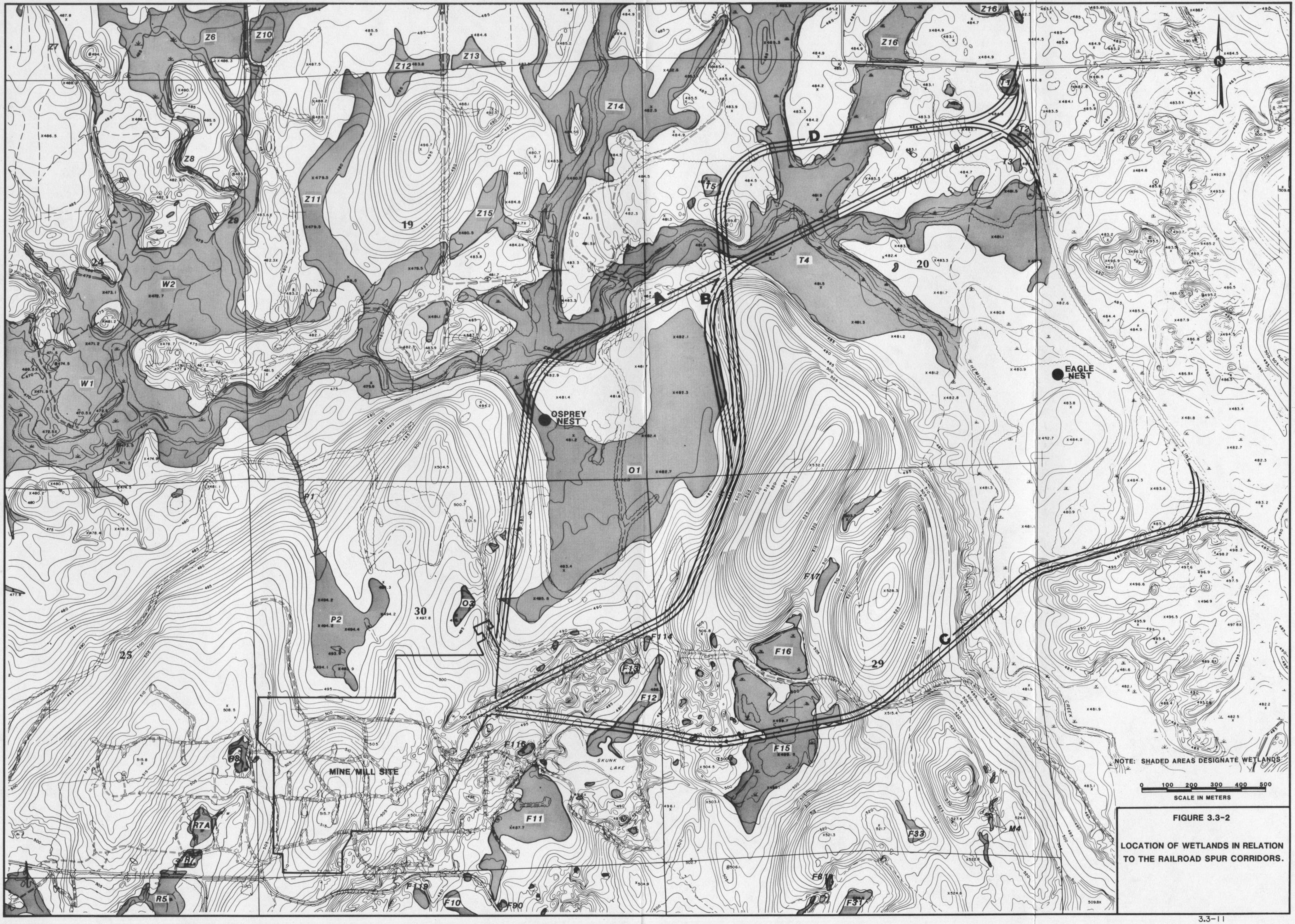


FIGURE 3.3-2

LOCATION OF WETLANDS IN RELATION TO THE RAILROAD SPUR CORRIDORS.

FIGURE 3.3-3

LOCATION OF WETLANDS IN RELATION TO THE ACCESS ROAD CORRIDORS.

and R8, then along the P2 and U watershed divide and through the U watershed, where there are no wetlands. Because of the location of the access road along surface watershed divides there will be no significant change in wetland watershed areas. Grassed roadside drainage ditches and culverts will be designed to maintain existing watershed areas and surface water drainage patterns.

The road surface will be nearly impervious pavement and will therefore cause a change of land cover type. The pavement area is very small in relation to the area of the watersheds of the perched wetlands. Although it is expected that the previously mentioned design features will attenuate increased surface water runoff from paved surfaces, slight increases (not quantified) of water discharge rates to wetlands R8 and P2 may result.

3.3.1.5 Water Discharge Pipeline

The proposed water discharge pipeline corridor (Figure 3.3-4) extends from the Mine/Mill Site west to Swamp Creek below County Road M. It passes, from east to west, through the watersheds of perched wetlands R8, R7A, R7, R5, R3, Z20, Z21, and Z22 (Figure 3.3-4). For much of this distance the corridor would follow the existing route of Sand Lake Road.

The pipeline will be buried and the land surface regraded to original contours, disturbed areas seeded and existing vegetation types allowed to recolonize. As a result, there will be no changes in watershed areas or land cover types and there will be no impacts to the water balance of the perched wetlands associated with the water discharge pipeline.

FIGURE 3.3-4

LOCATION OF WETLANDS IN RELATION TO THE WATER DISCHARGE PIPELINE ROUTES AND MINE/MILL SITE.

3.3.1.6 Mine/Mill Site

The Mine/Mill Site (Figure 3.3-4), including the backfill sand storage area, encompasses about 81.3 ha (201 acres) of existing upland forest. No wetlands will be filled because of construction of this site. The watersheds of perched wetlands F11 and P2 will be slightly altered.

The hydrologic alterations (unmitigated) at the Mine/Mill Site would include the changing of drainage patterns (watershed delineations), replacement of surface vegetative cover with impervious surfaces of buildings and pavement, and the diversion of surface water drainage from some potentially contaminated areas to the water treatment system. The total proposed impervious surface is approximately 35 ha (86 acres). Uncontrolled, increased runoff from this surface would increase water discharge rates from wetlands F11 and P2. However, retention basins are planned (Exxon Minerals Company, 1982) for the northern and southern perimeter regions of the site to mitigate increased runoff from impervious surfaces to the watersheds of these wetlands. The basins will have culvert controlled outlets and permeable bottom material thereby reducing runoff by three functions: (1) storage, (2) infiltration, and (3) controlled discharge. The final basin designs have not yet been developed and the existing and proposed discharge rates from the site not quantified; however, proper basin design coupled with diversion of some runoff to the treatment system should maintain the existing surface water runoff to wetlands F11 and P2.

3.3.2 Water Table Wetlands

The method used to assess impacts to water table wetlands as they relate to the existing hydrology of Swamp Creek, was described in section 2.2. As previously noted, changes in land cover type and wetland watershed area are the important factors associated with site activities which may cause hydrologic impacts to water table wetlands. The potential impacts of the various project activities which affect water table wetlands and/or their watersheds are discussed below.

3.3.2.1 Railroad Spur

The proposed railroad spur (route D, see Figure 3.3-2) will connect the Mine/Mill Site to the Soo Line railroad crossing water table wetlands (NAI and IEP, 1982, and IEP, 1982) associated with the sand and gravel deposits (Simpkins, et al., 1979) of the Swamp Creek region.

The railroad bed will require some filling and bridging in wetland T4 to cross Swamp Creek. Small kettlehole wetland Tl will be partially filled and similar wetland T3 will be completely filled. The railroad spur will be constructed of permeable fill and its bed will consist of crushed rock ballast, ties and rails. Side slopes will be seeded with grass and will become revegetated. Ditches, culverts, bridges, cuts and fills will be constructed using standard engineering methods and practices for railroad construction, so that existing drainage patterns and watershed areas will be preserved.

Wetland T4 is a large (18.1 ha [44.8 acres]) conifer swamp on both sides of Swamp Creek. The proposed railroad corridor (assumed 60 m, [200 feet wide]) will cover 2.7 ha (6.6 acres) of wetland area and 11.8 ha (29.3 acres) of its very large watershed area 51.5 ha (127.4 acres). The railroad bed and side slopes will be as permeable as the existing land cover thereby causing no increase in surface water runoff to wetland T4.

3.3.2.2 Access Road

The proposed access road (route B1, Figure 3.3-3) is 4.8 km (3.0 miles) long and will require the filling of 2.7 ha (6.6 acres) total of wetlands (all water table wetlands) assuming a conservatively large width (60 m, [200 feet]) of the limit of construction corridor. The worst-case hydrological effects of the road were quantified wherein the width of pavement was assumed to be 15.2 m (50 feet) and the effects of proposed mitigative measures such as grassed drainage channels were not considered. The water table wetlands which would be affected by the proposed access road are W1, W2, Z9, Z6 and Z7.

The effect of the access road on Swamp Creek and associated wetlands will be an increase in water discharge rates due to the higher surface water runoff resulting from the replacement of current land cover (e.g., forest) with nearly impervious asphalt surface. No decreases in Swamp Creek's discharge rates will occur because culverts and/or bridges will allow water to flow through. The area of the Swamp Creek watershed to Highway 55 is 119.7 km (46.2 square miles). The amount of area changed to paved road surface will be 0.168 km^2 (0.65 square miles) or 0.14 percent of the watershed's area.

Whereas the road would only increase Swamp Creek discharge, the worst-case impact would occur during an intense storm. The worst-case effect of the road to the hydrology of Swamp Creek would occur if all the water which fell on the impervious road surface flowed directly to Swamp Creek, reaching the Creek at its peak discharge, and increasing that peak. The 100-year (return frequency) storm was chosen for this analysis. The calculated surface water peak discharge rates from the road (3.58 cfs) was added to the known minimum and maximum discharge rate of Swamp Creek (see Table 3.1-2).

The maximum daily discharge rate in Swamp Creek during the USGS gaging period was 212 cfs on June 16, 1981. The 100-year runoff from the access road would have yielded a total discharge rate of 215.58 cfs, an increase of only 1.7 percent.

The minimum daily discharge rate in Swamp Creek during the USGS gaging period was 8.3 cfs which occurred on August 25, 1977. If the 100-year storm had occurred on this day with the access road constructed (without mitigative measures) the peak discharge rate would have been 11.88 cfs, assuming, of course, that the large Swamp Creek watershed had not yet responded to the storm. This comparison is presented only for perspective whereas an increase in discharge rate during a low flow (drought) period would be beneficial.

The wetlands transmitting this runoff to Swamp Creek (W1, W2, Z6, Z7 and Z9) have above average values for flood and storm water storage and hydrologic support functions (NAI and IEP, 1982). This indicates that they have the ability to store flood waters and maintain base flows. They should therefore be capable of absorbing without impact the calculated worst-case runoff from the proposed access road.

Another factor influencing water table wetland water balances would be the mine dewatering activity. During normal storm events, any increased surface water runoff from the road would tend to offset the small decreases (0.02 to 0.38 m^3/sec, 0.71 to 1.35 cfs) in Swamp Creek discharge rates from mine dewatering operations (D'Appolonia Consulting Engineers, 1982). Also, the above average values of ground water recharge, hydrologic support and flood and storm water storage functions of these wetlands (NAI and IEP, 1982, and IEP, 1982) would tend to offset any effect of water table drawdown impacts on Swamp Creek discharge rates.

Grassed roadside drainage ditches will be designed to assure minimal change in the water balances of isolated wetlands Z1 and Z2 (having watersheds through which the access road would pass). The proposed access road approximately follows the drainage divide between these wetlands and the existing watershed areas of these wetlands will be maintained. No other means to mitigate impacts will be necessary.

3.3.2.3 Water Discharge Pipeline

Water table wetlands Z20, Z21 and Z23 are the only wetlands assessed which will be crossed by this proposed pipeline corridor (Figure 3.3-4). Both of these wetlands have large water balances, are not hydrologically sensitive wetlands and scored above average for their functional values (NAI and IEP, 1982). Two unassessed water table wetlands west of State Highway 55 will be crossed by the water discharge pipeline (IEP, 1982).

The water discharge pipeline will have no effects on the hydrology of either of these wetlands. The pipeline will be buried and follow mostly upland courses. Construction will consist of cutting a corridor through the vegetation, excavating a ditch, laying the pipe, backfilling the ditch, reseeding and allowing vegetation to become established. No changes in the post-construction contour of the upland or wetland surface will result and thus no watershed areas will be altered. Cover types of the pipeline ground surface, upland and wetland, will have the same runoff characteristics as the existing types. Where the pipeline crosses streams or ditches in wetlands Z20 and Z23, it will be buried below these flow channels and the channels restored to their original size and shape, so that no existing surface water flow characteristic will be altered. The pipeline will be installed as quickly as possible. It will be a progressive operation whereby cutting, trenching, pipelaying, backfilling, grading and seeding will be occurring simultaneously, resulting in a minimal period of disturbance.

3.3.2.4 Mine/Mill Site

Increased surface water runoff from the Mine/Mill site will be mitigated by retention basins as discussed in subsection 3.3.1.6. Dewatering of the mine will not impact the water balance of perched wetlands, but will alter the water balance of water table wetlands which occur within the cone-of-influence of the mine dewatering. The details of the mine dewatering are discussed in Prickett and Associates (1982) and the hydrological impacts to ground water are discussed in D'Appolonia Consulting Engineers, (1982).

Water table wetland Z17 is located, in part, within a zone of drawdown (one meter or more) around the mine. Whereas ground water discharge is the dominant input to the inflow portion of the water balance of the wetland it is possible as a worst-case that the projected cone-of-influence may result in a lowering of the water level in the wetland to equal that of the projected drawdown water table in the adjacent aquifer. Also, the organic wetland soils may become dewatered because there are no impermeable layers separating the wetland from the aquifer and the two are hydrologically connected. Therefore, if surface water inflow cannot maintain adequate soil moisture, wetland Z17 could become dryer. Although not quantified, the actual impact should be less severe. Surface inflow may maintain the wetland and the mine may be dewatered at lower pumping rates. The worst-case projected drawdown was based upon a pumping rate of $0.126/m^3/s$ (2,000 gallons per minute) (Exxon Minerals Company, 1982) whereas actual rates may be approximately 0.063 m^3/s (1,000 gallons per minute). Lower pumping rates will result in less of a lowering of water tables.

3.4 POST OPERATIONS IMPACTS

Post operational impacts to wetland water balances will occur when the facilities are removed and final reclamation is completed. The following sections describe these impacts and compare them to existing conditions.

3.4.1 Perched Wetlands

3.4.1.1 Slurry Pipeline/Haul Road

Post operational renovation includes the removal of the slurry pipeline and haul road. The slurry pipeline/haul road corridor will be regraded, seeded and allowed to become vegetated with natural vegetation. Wetland F116, a small shrub swamp, will remain filled and will not be restored. The watershed divide between wetlands F11 and F12 will be restored, if previously altered, to existing topography. The revegetated cover of the reclaimed slurry pipeline/haul road will restore the runoff characteristics of wetlands F11 and F12 to those of existing conditions.

3.4.1.2 Mine Waste Disposal Facility and Reclaim Ponds

During the post operational phase (Phase 6), all tailings ponds and water reclaim ponds will have been reclaimed and the final grading and revegetation of the previous pond areas will have been implemented.

Table 3.4-1 is a comparison of the discharge rates of Phase 6, and the final reclamation surface, to existing rates. The final grading will increase the watershed areas of wetlands M3 and F25 resulting in higher than

Table 3.4-1. Phase 6, Hydrologic Model Results, Seasonal Average, Annual Average, and Ranges of Wetland Discharge Rates (cfs), 1974-1980.

WETLAND NUMBER		EXISTING					PHASE 6, POST-OPERATIONAL					
		Winter	Spring	Summer	Autumn	ANNUAL	Winter	Spring	Summer	Autumn	ANNUAL	EFFECT/ACTIVITY
M3	A	0.07	0.12	0	0.03	0.06	0.07	0.15	0	0.04	0.07	increase/reclamation grading
	R	0-0.17	0-0.47	0-0	0-0.24	0-0.47						
P2	A	0.14	0.29	0	0.04	0.12	0.14	0.29	0	0.04	0.12	no change
	R	0-0.40	0-1.17	0-0	0-0.57	0-1.17						
F114	A	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	0	<0.01	<0.01	no change
	R	0-<0.01	0-0.01	0-0	0-<0.01	0-0.01						
F13	A	<0.01	0.01	0	<0.01	<0.01	<0.01	0.01	0	<0.01	<0.01	no change
	R	0-0.02	0-0.07	0-0	0-0.01	0-0.07						
F11	A	0.38	0.92	0	0.08	0.34	0.38	0.90	0	0.08	0.34	very slight spring decrease/reclamation
	R	0-1.36	0-3.92	0-0	0-1.66	0-3.92						
F10	A	0.44	1.06	0	0.09	0.40	0.44	1.04	0	0.09	0.39	slight decrease/ reduced inflow
	R	0-1.57	0-4.52	0-0	0-1.90	0-4.52						
F27	A	0.04	0.08	0	0.02	0.04	0	0	0	0	0	filled, phase 2
	R	0-0.11	0-0.31	0-0	0-0.09	0-0.31						
F25	A	0.14	0.25	0	0.06	0.11	0.14	0.26	0	0.08	0.12	slight increase/ reclamation grading
	R	0-0.34	0-0.96	0-0	0-0.49	0-0.96						
F23	A	0.19	0.35	0	0.07	0.15	0.19	0.36	0	0.09	0.16	slight increase/ increased inflow
	R	0-0.47	0-1.34	0-0	0-0.68	0-1.34						
F31	A	0.06	0.11	0	0.02	0.04	0	0	0	0	0	filled, phase 3
	R	0-0.15	0-0.41	0-0	0-0.21	0-0.41						
F32	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 2
	R	0-0.02	0-0.06	0-0	0-0.03	0-0.06						
F81	A	<0.01	0.01	0	<0.01	<0.01	0	0	0	0	0	filled, phase 3
	R	0-0.02	0-0.04	0-0	0-0.02	0-0.04						
F29	A	0.14	0.27	0	0.06	0.12	0.08	0.16	0	0.04	0.07	decrease/reclamation grading
	R	0-0.36	0-1.03	0-0	0-0.52	0-1.03						
F28	A	0.38	0.74	0	0.11	0.31	0.41	0.78	0	0.14	0.34	increase/reclamation grading
	R	0-1.07	0-3.07	0-0	0-1.49	0-3.07						
F66	A	0.07	0.15	0	0.02	0.06	0	0	0	0	0	filled, phase 3
	R	0-0.21	0-0.61	0-0	0-0.30	0-0.61						
F65	A	0.08	0.17	0	0.02	0.07	0	0	0	0	0	filled, phase 4
	R	0-0.25	0-0.70	0-0	0-0.35	0-0.70						
F64	A	0.09	0.20	0	0.02	0.08	0	0	0	0	0	filled, phase 4
	R	0-0.29	0-0.83	0-0	0-0.40	0-0.83						
F63	A	0.10	0.25	0	0.02	0.09	0	0	0	0	0	filled, phase 4
	R	0-0.37	0-1.05	0-0	0-0.46	0-1.05						
F62	A	0.15	0.34	0	0.03	0.13	0.06	0.11	0	0.03	0.05	decrease/reduced inflow, TP3
	R	0-0.50	0-1.42	0-0	0-0.65	0-1.42						
F72	A	0.05	0.10	0	0.02	0.04	0.05	0.10	0	0.02	0.04	no change
	R	0-0.13	0-0.37	0-0	0-0.19	0-0.37						
F61	A	0.25	0.52	0	0.08	0.21	0.15	0.29	0	0.07	0.13	decreae/reduced inflow
	R	0-0.74	0-2.11	0-0	0-0.99	0-2.11						
F70	A	0.01	0.02	0	<0.01	0.01	0.01	0.02	0	0.01	0.01	no change
	R	0-0.03	0-0.10	0-0	0-0.05	0-0.10						
F69	A	0.03	0.06	0	0.01	0.03	0.03	0.06	0	0.01	0.03	no change
	R	0-0.08	0-0.24	0-0	0-0.07	0-0.24						
F60	A	0.42	0.87	0	0.12	0.35	0.33	0.63	0	0.11	0.27	decrease/reduced inflow
	R	0-1.21	0-3.45	0-0	0-1.67	0-3.45						
F57	A	0.49	1.01	0	0.13	0.41	0.40	0.78	0	0.12	0.32	decrease/reduced inflow
	R	0-1.41	0-4.04	0-0	0-1.97	0-4.04						

Wetlands are listed upstream to downstream; grouped by drainage systems.

A - designates average value.
R - designates range of monthly values.
TP- designates tailings pond.

existing discharge rates from these wetlands. The discharge rates of downstream wetland F23 will consequently increase. The discharge rates from wetland F11 and downstream wetland F10 will decrease slightly due to diminished watershed area of F11. The discharge rates from F28 will increase despite a decrease of inflow from its upstream wetland F29. The discharge rates from wetland F62 and its downstream wetlands F61, F60 and F57 will still be less than existing rates though higher than those during Phase 5.

For additional mitigation, the design of the final reclamation surface could be adjusted to add more watershed area to the F62 wetland watershed and remove some of the increased watershed area of wetland F28. This would lower the increased discharge rate of wetland F28 and increase the lowered discharge rate of wetland F62.

3.4.1.3 Railroad Spur

Post operational activities will include the reclamation of the railroad spur by regrading to approximate the existing topography after removal of rails, ties and ballast. All distributed areas will then be seeded and natural vegetation will become re-established. Wetland watershed areas, land cover types and post operational hydrology of all affected wetlands should be similar to those of existing conditions.

3.4.1.4 Access Road

The access road will remain in place as a public road and its post operational impacts will be identical to those defined in section 3.3.1.4.

3.4.1.5 Mine/Mill Site

In the post operational phase, the buildings and impervious surfaces of the Mine/Mill Site will be removed. The site may be regraded to approximate existing land surface contours. If this is not possible, the retention basins discussed in section 3.3.1.6 will be preserved to maintain controlled surface water runoff rates. Disturbed areas will be seeded and allowed to become revegetated.

3.4.2 Water Table Wetlands

3.4.2.1 Railroad Spur

The proposed railroad spur is associated with water table wetlands T1, T2, T3 and T4. The railroad will be reclaimed to restore existing topography except that filled wetlands (section 3.3.2.1) will remain filled. The existing wetland water balances will be closely approximated after the railroad spur is regraded.

3.4.2.2 Access Road

The proposed access road will remain as a public road and its impacts will continue to be as described previously in section 3.3.2.2.

4.0 ALTERNATIVES

4.1 SLURRY PIPELINE/HAUL ROAD

Alternatives 2, 3, and 4 (see Figure 3.3-1) are all slightly shorter than the preferred alternative Route 1, yet all three would cause a disturbance to and partial filling of wetland F11. They would not cross wetland F116, thus preserving this wetland which the proposed route would encroach upon. Alternatives 2 and 3 would fill slightly more of wetland F11 than would Alternative 4. Alternatives 2 and 3 would exist entirely in the watershed of wetland F11 and might increase the discharge of wetland F11 slightly because of increased runoff from the banks of haul road. Alternative 4 would exist mostly in the watershed of wetland F11, but partly along the watershed divide between wetlands F11 and F10.

4.2 MINE WASTE DISPOSAL FACILITY

4.2.1 Alternative 41-103

This Alternative (Figure 4.2-1) covers 15.37 ha (37.98 acres) of wetlands whereas the proposed mine waste disposal facility 41-114b covers 11.14 ha (54.96 acres) of wetlands. This diminished area is the result of only three tailings ponds planned for Alternative 41-103 while the proposed facility would have four tailings ponds. The reduction in the number of tailings ponds reduces the ultimate total land area from 233.6 ha (577 acres) proposed to 204.4 ha (505 acres) with Alternative 41-103 (Exxon Minerals Company, 1982). The Alternative 41-103 layout would be located closer to Duck Lake (F28) than the proposed facility layout, thus shifting impact potential to the wetland F28 watershed and to Duck Lake.

4.2.2 Alternative 41-121

This layout (Figure 4.2-2) has two tailings ponds and covers only 196.3 ha (485 acres) of land. It is located to the south and west of the proposed facility (41-114b). Alternative 41-121 would cover 20.62 ha (50.94 acres) of wetland, slightly less than the 22.24 ha (54.96 acres) covered by the proposed facility. The alternative location would bring potential hydrologic impacts closer to Deep Hole Lake and Duck Lake thereby filling wetland F60 which would serve as a buffer to hydrologic impacts to Deep Hole Lake for the proposed MWDF.

FIGURE 4.2-1

LOCATION OF WETLANDS IN RELATION TO THE ALTERNATIVE RECLAIM POND AND MWDF 41-103.

FIGURE 4.2-2

LOCATION OF WETLANDS IN RELATION TO THE ALTERNATIVE RECLAIM POND AND MWDF 41-121.

4.3 RAILROAD SPUR

4.3.1 Alternative A

Railroad Spur Alternative A (see Figure 3.3-2) would be 4.2 km (2.6 miles) long which would be 0.4 km (0.2 miles) shorter than the proposed route, yet Alternate A would require the filling (or bridging) of approximately 6.2 ha (15.3 acres) of wetlands which is twice that of the preferred route (see Figure 3.3-2). Alternative A would cross Swamp Creek once and encroach upon its adjacent wetlands at two other locations.

Alternative A would cross wetlands O1, T4 and T2. Wetland T2 would be completely filled. Wetland T4 is one of the most valuable wetlands in the study area. Alternative A would cross it twice and would be approximately parallel to the Creek's channel in some places, requiring more extensive bridging and culverts to maintain existing surface water runoff characteristics.

4.3.2 Alternative B

Alternative B (see Figure 3.3-2) would be 4.1 km (2.6 miles) long which is 0.5 km (0.2 miles) shorter than the proposed route, yet Alternative B would require the filling of approximately 4.3 ha (10.6 acres) of wetland which would be 1.2 ha (3.0 acres) more than for the proposed route. This additional filling would all be in wetland O1.

4.4 ACCESS ROAD

4.4.1 Alternative A1

Access road alternative A1 (see Figure 3.3-3) would be 3.9 km (2.5 miles) in length or 0.8 km (0.4 miles) shorter than the proposed route, thereby resulting in a slight (unmitigated) decrease in the projected increased runoff from the pavement to Swamp Creek. However, alternative A1 would require the filling of approximately 5.0 ha (12.5 acres) of wetland compared to only 2.7 ha (6.6 acres) filled by the proposed route (see Figure 3.3-3). Alternative A1 crosses wide sections of Swamp Creek wetlands W1 and W2, whereas the proposed route crosses very narrow sections of W2, Z6, Z7 and Z9. Wetlands W1 and W2 have high biological and hydrological functional values (NAI and IEP, 1982 and IEP, 1982) whereas wetlands Z6, Z7 and Z9 have lower values (IEP, 1982). Alternative A1 would thus have a greater potential (unmitigated) hydrologic impact to the wetland functions than would the proposed route.

4.4.2 Alternative E

Alternative E (see Figure 3.3-3) would follow the existing route of Sand Lake Road, from Highway 55 to the Mine/Mill Site. As a result, it would not disturb any wetlands. The road would require upgrading that would consist of some widening and paving and would result in minor increases of surface runoff to adjacent wetlands. These increases would be small, however, when compared with the unmitigated runoff from a new road such as the proposed route or Alternative Al. Alternative E would require no new crossing of Swamp Creek and there would, therefore, be no hydrologic alterations of associated wetlands.

4.5 WATER DISCHARGE PIPELINE

4.5.1 Alternative B

Alternative route B (see Figure 3.3-4) is the shortest and most direct route for surface water discharge to Swamp Creek. The route is less than 1.6 km (1 mile) long and could be constructed in the proposed access road corridor, which would minimize the area of disturbed wetland. However, the Alternative B discharge location is upstream of Rice Lake and in a section of Swamp Creek designated by the DNR as a Class II trout stream.

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APPENDIX A

COMPUTER PROGRAM LISTING FOR WETLAND HYDROLOGY MODEL

Appendix A. Computer Program Listing for Wetland Hydrology Model.

```
100  REM  THIS PROGRAM DOES A WATER BUDGET ON A MONTHLY BASIS FOR EXXON CO
     RP.
110  DIM MM(125),Y(125),L(125),EV(125),T(125)
120  DIM W(600),KK(600),GW(600)
130  DIM SI(125),P(12),K1(12),G1(12)
140  DIM S1(125)
141  FOR I = 1 TO 12
142  READ P(I):P(I) = P(I) / 10000
143  NEXT I
150 D$ =  CHR$ (4)
160  HOME : PRINT : PRINT
161  PRINT  TAB( 5);"ENTER THE DATE": INPUT DA$
162  PRINT : PRINT : PRINT
170  PRINT  TAB( 5);"ENTER THE NUMBER OF MONTHS ";: INPUT M
171  PRINT : PRINT : PRINT : PRINT  TAB( 5);"ENTER THE INPUT FILE NAME ";:
      INPUT F6$
172  PRINT : PRINT : PRINT
173  PRINT  TAB( 5);"ENTER THE PHASE";: INPUT PH$
180  PRINT D$;"OPEN EXXON WEATHER"
190  PRINT D$;"READ EXXON WEATHER"
199 M = 96
200  FOR I = 0 TO M
210  INPUT MM(I),Y(I),L(I),T(I),EV(I)
220  NEXT I
230  PRINT D$;"CLOSE EXXON WEATHER"
240  HOME : PRINT : PRINT
250  PRINT  TAB( 5);"ENTER THE NUMBER OF WETLANDS ";: INPUT N
260  PRINT D$;"OPEN";F6$
270  PRINT D$;"READ";F6$
280 K = 0
290  FOR I = 1 TO N
300  FOR J = 1 TO 12
310 K = K + 1: INPUT W(K),MMM,KK(K),GW(K)
320  NEXT J
330  NEXT I
340  PRINT D$;"CLOSE";F6$
350  HOME : PRINT : PRINT
360  PRINT  TAB( 5);"ENTER THE WETLAND ID ";: INPUT NN$
370  PRINT : PRINT
380  PRINT  TAB( 5);"ENTER THE SEQUENCE NUMBER ";: INPUT N3
390  IF N3 = 0 THEN  GOTO 1620
400  PRINT : PRINT
410  PRINT  TAB( 5);"ENTER THE DIRECT DRAINAGE AREA ";: INPUT AA
420  PRINT : PRINT
430  PRINT  TAB( 5);"ENTER THE UPLAND AREA ";: INPUT UU
440  PRINT : PRINT
450  PRINT  TAB( 5);"ENTER THE POND AREA ";: INPUT PP
460  HOME : PRINT : PRINT
470  PRINT : PRINT : PRINT  TAB( 5);"IS THERE ANY STREAM INFLOW ";: INPUT
     A1$
480  FOR I = 1 TO M
490 SI(I) = 0.0
500  NEXT I
510 K = 0.0
520  IF A1$ = "N" GOTO 680
530 K = K + 1
540 I = K
```

```
550  PRINT : PRINT
560  PRINT : PRINT
570  PRINT  TAB( 5);"ENTER THE SEQUENCE # FOR INFLOW #";I: SPC( 2);: INPUT
     I3
580  PRINT D$;"OPEN STREAM INFLOW,L1000"
590  PRINT D$;"READ STREAM INFLOW, R";I3
600  FOR J = 1 TO M
610  INPUT X6
620 X6 = X6 / AA
630 SI(J) = SI(J) + X6
640  NEXT J
650  PRINT D$;"CLOSE STREAM INFLOW"
660  PRINT  TAB( 5);"ANY MORE INFLOWS ";: INPUT A1$
670  IF A1$ = "Y" GOTO 530
680 M1 = 1.0
690  IF N3 = 3 OR N3 = 4 OR N3 = 5 THEN M1 = UU / AA
700 K = 0: FOR J = 1 TO N: FOR I = 1 TO 12:K = K + 1
710  IF W(K) = N3 GOTO 730
720  NEXT I: NEXT J
730  FOR I = 1 TO 12
740 G1(I) = M1 * GW(K + I - 1)
750 K1(I) = KK(K + I - 1)
780  NEXT I
790  RESTORE
800  HOME : PRINT : PRINT
810  PRINT  TAB( 5);"ENTER THE INITIAL  SOIL MOISTURE ";: INPUT MOI
820  PRINT : PRINT : PRINT  TAB( 5);"ENTER THE LIMITING SOIL MOISTURE ";: INPUT
     LM
830  PRINT D$;"PR#1"
840  PRINT : PRINT : PRINT
850  PRINT "EXXON CORPORATION, RHINELANDER WISCONSIN"
851  PRINT
860  PRINT DA$
861  PRINT
870  PRINT "WETLAND NUMBER ";NN$
871  PRINT
872  PRINT "IMPACT ANALYSIS PHASE: ";PH$
873  PRINT
880  PRINT "DRAINAGE AREA ";AA;" ACRES"
881  PRINT : PRINT : PRINT
890  PRINT "MONTH      L       SI          IM       GW          AM       KPT        FM
        SD1      SD2"
900 S2 = 0:S3 = 0:S4 = 0:S5 = 0:S6 = 0:S7 = 0:S8 = 0:S9 = 0
910 SS = 0.0
920  FOR I = 1 TO M
921 K6 = 0.0013553
922  IF MM(I) = 2 THEN K6 = .0015005
923  IF MM(I) = 4 THEN K6 = .0014005
924  IF MM(I) = 6 THEN K6 = .0014005
925  IF MM(I) = 9 THEN K6 = .0014005
926  IF MM(I) = 11 THEN K6 = .0014005
930 K4 =  INT (((I - 1) / 3 -  INT ((I - 1) / 3)) * 3 + .05) + 1
940 K =  INT (((I - 1) / 12 -  INT ((I - 1) / 12)) * 12 + .05) + 1
950 AM = L(I) + SI(I) + MOI - G1(K)
960 KPT = T(I) * K1(K) * P(K)
970 RM = AM - KPT
980  IF RM <  = 0.0 THEN RM = 0.0
990 SD = RM - LM - EU(I) * (PP / AA)
1000  IF SD <  = 0.0 THEN SD = 0.0
1010  IF SD > 0.0 THEN RM = LM
1011 MS = MOI
1012 MOI = RM
```

```
1020 SE = SD * AA
1030 S1(I) = SE
1040 SC = SE * K6
1050  IF I < 12 GOTO 1330
1060  PRINT
1070 E$ =  STR$ (MM(I))
1080  GOSUB 1640
1090 E$ =  STR$ (L(I))
1100  GOSUB 1640
1110 E$ =  STR$ (SI(I))
1120  GOSUB 1640
1130 E$ =  STR$ (M9)
1140  GOSUB 1640
1150 E$ =  STR$ (G1(K))
1160  GOSUB 1640
1170 E$ =  STR$ (AM)
1180  GOSUB 1640
1190 E$ =  STR$ (KPT)
1200  GOSUB 1640
1210 E$ =  STR$ (RM)
1220  GOSUB 1640
1230 E$ =  STR$ (SD)
1240  GOSUB 1640
1250  IF SC < 0.01 THEN SC = 0.0
1260 E$ =  STR$ (SC)
1270  GOSUB 1640
1290 S3 = S3 + SD
1300 S4 = S4 + SD
1310  IF K = 12 THEN  GOSUB 1710
1320  IF K4 = 2 THEN  GOSUB 1770
1330  NEXT I
1340  PRINT : PRINT
1350 S5 = S5 / 7
1370 SC = AA * S5 * .0004668
1380  PRINT  TAB( 10);"WINTER AVERAGE = ";S5;" INCHES OR ";SC;" CFS": PRINT

1390 S6 = S6 / 7
1410 SC = AA * S6 * .0004567
1420  PRINT  TAB( 10);"SPRING AVERAGE = ";S6;" INCHES OR ";SC;" CFS": PRINT

1430 S9 = S9 / 7
1450 SC = AA * S9 * .0004567
1460  PRINT  TAB( 10);"SUMMER AVERAGE = ";S9;" INCHES OR ";SC;" CFS": PRINT

1470 S2 = S2 / 7
1490 SC = AA * S2 * .0004617
1500  PRINT  TAB( 10);"FALL AVERAGE = ";S2;" INCHES OR ";SC;" CFS": PRINT

1510 SS = SS / 7
1520 SC = SS * AA * .0001151
1550  PRINT  TAB( 10);"ANNUAL AVERAGE FLOW = ";SS;" INCHES OR ";SC;" CFS":
      PRINT : PRINT : PRINT
1560  PRINT D$;"PR#0"
1570  PRINT D$;"OPEN STREAM INFLOW,L1000"
1580  PRINT D$;"WRITE STREAM INFLOW, R";N3
1590  FOR I = 1 TO M: PRINT S1(I): NEXT I
```

```
1600  PRINT D$;"CLOSE STREAM INFLOW"
1610  GOTO 350
1620  END
1630  DATA  636,652,828,910,1034,1050,1061,977,842,760,640,610
1640 X =  LEN (E$)
1650  IF X > 5 THEN E$ =  LEFT$ (E$,5)
1660  FOR JJ = X TO 5
1670 E$ = E$ + " "
1680  NEXT JJ
1690  PRINT E$; SPC( 2)
1700  RETURN
1710  PRINT : PRINT
1720 S3 =  VAL ( LEFT$ ( STR$ (S3),5))
1730  PRINT  TAB( 5);"YEAR 19";Y(I); SPC( 51);S3;" INCHES": PRINT
1731  IF I = 12 THEN S3 = 0.0
1740 SS = SS + S3
1750 S3 = 0.0
1760  RETURN
1770  IF K = 2 GOTO 1850
1780  IF K = 5 GOTO 1830
1790  IF K = 8 GOTO 1870
1800  IF K = 11 GOTO 1810
1810 S2 = S2 + S4
1820  GOTO 1880
1830 S6 = S6 + S4
1840  GOTO 1880
1850 S5 = S5 + S4
1860  GOTO 1880
1870 S9 = S9 + S4
1880 S4 = 0
1890  RETURN
1900  END
1910 LL =  VAL ( LEFT$ ( STR$ (LL),5))
1920  RETURN
1930  END
```