

Appendix E
Storm Water Design Calculations



Surface Water Design Calculations

1. Purpose

This memorandum documents the design analysis for managing stormwater at the Eagle Project site. Stormwater runoff from the main operations area will be managed separately from stormwater runoff outside of the main operations area (non-contact area). Stormwater runoff from the main operations area and contact water from the TDRSA and mine will be collected in lined contact water basins (CWBs) and pumped to the wastewater treatment plant (WWTP) for treatment prior to groundwater discharge. Stormwater runoff from the non-contact area will be collected in unlined infiltration basins referred to as non-contact water infiltration basins (NCWIBs).

2. Regulatory Requirements

Part 632 requires that water that may come in contact with reactive ore, development rock, overburden or tailings be managed to minimize adverse impacts to groundwater and surface water. Accordingly, all contact water pumped from the TDRSA and mine, as well as stormwater runoff from the main operations area will be collected in lined CWBs

Non-contact water (stormwater runoff from the non-contact area) – Per Part 632, soil erosion and sedimentation control plans must be developed that meet the standards of Part 91 of the Act.

3. Definition of Main Operations Area

The main operations area includes the portion of the main surface facility where stormwater runoff may come in contact with reactive ore, development rock, and mining equipment. Figure 1 shows the proposed main operations area. In the main operations area, stormwater runoff is generated from the following areas (approximately 32 acres total):

Truck wash	Truck scales	Fuel storage
Assay lab		Crusher (including ramp and dump)
Maintenance shop and plant	Crushed ore bins	Temporary development rock area
Core storage	Emulsion Tank	Ore Storage
Lay-down area	Generator plant	Mine air heater
Propane storage	Holding ponds #1 and #2	
WWTP	Underground day storage	
Portal		

Stormwater runoff from the main operations area as well as contact water from the TDRSA and mine will be conveyed to, and collected in the two lined CWBs on the west portion of the site.

4. Definition of Non-contact Areas

In general, non-contact areas are disturbed areas of the site where stormwater runoff will not come in contact with reactive ore, development rock or the main operations area. Figure 1 shows the proposed non-contact areas. The non-contact stormwater areas include the following:

Gate house	NCWIBs	Mine office
Loading dock	Emergency facilities	Parking areas
Roadways	Backfill plant area	Construction staging area



Non-contact water will be conveyed to, and collected in one of four NCWIBs, as shown on Figure 1. The drainage area associated with each NCWIB is listed below:

NCWIB #3	Southeastern portion of the main surface facility	9.85 acres
NCWIB #4	Northwestern portion of the main surface facility	6.03 acres
NCWIB #5	Backfill plant site area	3.05 acres
NCWIB #6	Main access road	3.03 acres
Total Non-contact Area		21.96 acres

5. Technical Approach

Stormwater runoff from the main operations area will be collected in the CWBs prior to treatment at the WWTP. Non-contact stormwater will be collected and conveyed to unlined NCWIBs such that no stormwater runoff is expected to leave the facility under normal operations. As a contingency measure, KEMC will apply for an stormwater discharge permit for the discharge of non-contact stormwater runoff should a major runoff event occur that exceeds the conservative design capacity planned for the NCWIBs facilities.

Both the CWBs and NCWIBs were sized for the largest of the following storm events:

- ♦ 100-year rainfall event – For the main operations area and the non-contact areas, provide storage for stormwater runoff generated by a 100-year, 24-hour rainfall event.
- ♦ 50-year combined rain and snowmelt runoff event – For the main operations area and non-contact areas provide storage for stormwater runoff generated by a 50-year event which includes both rainfall and snowmelt.

The calculations attached to this memo show that the combined 50 year event generates larger runoff volumes than the single 100-year storm event and therefore results in the more conservative design condition.

5.1 100 yr Rainfall Event

For the main operations and non-contact areas, the runoff volumes generated from a 100-year, 24-hour rainfall event were determined using the NRCS hydrologic model TR55. The methodology and input parameters are included at the end of this memo. For this location in the Upper Peninsula, the 100-year, 24-hour rainfall is approximately 4.5 inches. Runoff volumes estimated from the 100-year event are included in calculations for each basin (Attachments 2 through 6) and are included in the summary table at the end of this memo.

5.2 50-Year Combined Rain and Snowmelt Runoff Event

The basis for determining the 50-year combined rain and snowmelt runoff event (combined event) was to use the historical flow gauging data from nearby streams to find the dates of major runoff events and then use the actual rainfall and snowmelt amounts from those dates to determine runoff from the Eagle Site. Statistical placement of those actual events leads to the sizing necessary for the 50-year combined rain and snowmelt runoff condition. By following this procedure, the affect of snowmelt as well as rainfall is taken into account in the runoff calculations. This combined 50-year

event is larger than the 100-year rain event. Supporting information for this procedure is provided in Attachment 1.

To define the combined 50-year event, two major runoff events were identified at nearby stream gauging stations. Station 4062200 on the Peshekee River near Champion, and Station 4057800 on the Middle Branch Escanaba River at Humboldt were selected due to their proximity to the proposed Eagle Mine site (see Attachment 1). Statistical analyses of the historic streamflow data from these gauging stations results in computed peak flow estimates for various recurrence intervals as shown in Attachment 1.

Analysis of historic streamflow data for these two gauges identifies major runoff events near the Eagle Site. For the Peshekee River, an April 1965 event caused streamflow to reach about 3,500 cfs (cubic feet per second). This is obtained from streamflow hydrographs included in Attachment 1. Similarly, the Middle Branch Escanaba River peaked at 1,800 cfs during an April, 1985 flood. The Middle Branch Escanaba River hydrographs are also included in Attachment 1. Comparing these flow events to the computed recurrence interval flows show that the Peshekee River flow event in 1965 is less than a 25-year event, while the Middle Branch Escanaba flow event of April 1985 is over a 100-year event.

Climatological data from nearby NOAA stations provide the rainfall and snow melt associated with each of these major runoff events. The data from the Houghton FAA Airport Station for the 1965 event as defined in Attachment 1 shows this event to include 1.7 inches of precipitation and 39 inches of snow melting in 26 days. Similarly, Attachment 1 shows the 1985 event to include 5.64 inches of precipitation from the nearby Herman station and 26 inches of snow melting in 20 days from the slightly more distant Champion Van Riper Park station (no snowmelt data is available from the closer Herman station).

Next, climatological conditions for these major events were applied over the Main operations area and non-contact drainage areas to determine the volume of runoff these events would generate at the Eagle Project Site. A conservative estimate of the water fraction of the snowpack was made based on a report from the Upper Peninsula (Attachment 1). That document reported 11 inches of water equivalent in 41 inches of snowpack (27 percent water).

Finally, the results of these calculations for the 1965 and 1985 events (as summarized in Attachments 2-6) are plotted on log-frequency paper as shown at the end of Attachment 1. From these graphs, the 50-year runoff volumes generated from the main operations and non-contact areas of the site were estimated.

5.3 Wastewater Treatment Plant Flows

Since stormwater runoff from the main operations area will be collected in the CWB and treated at the WWTP, the capacity of the WWTP over the design event was also taken into consideration for sizing the CWBs. The WWTP has an excess capacity of 100 gpm (mine inflow design basis is assumed to be 250 gpm and the treatment capacity is 350 gpm). This capacity over the duration of the runoff event was subtracted from the stormwater inflows to size the CWBs.

It should be noted that, as a contingency, a condition whereby the WWTP would be shut down to cover maintenance or other disruption of service was also evaluated. To address this contingency, the contact water generated from groundwater pumped from the mine at 250 gpm for a 14 day



period was considered in the sizing of the CWBs. Based on their experience with similar projects, this duration has been selected by KEMC to provide operational flexibility and adequate storage for scheduled maintenance and other periods when the WWTP may be shut down. By calculation, the storage volume needed for this condition would be $250 \text{ gpm} \times 1440 \text{ min./day} \times 14 \text{ days} = 5.04$ million gallons. As the combined 50 year runoff event volume of 7.8 million gallons is larger, the 50-year runoff condition was used to determine the storage requirements for the CWBs (as well as the NCWIBs).

5.4 Infiltration Capacity

Non-contact water will be routed to the NCWIB where it will infiltrate. To be conservative the infiltration capacity of the onsite soils over the duration of the runoff event was not taken into consideration for sizing the NCWIBs. The potential for frozen ground conditions to occur was a consideration in the infiltration capacity although local experience in this area of the Upper Peninsula shows that it is not likely that the ground under the snow would remain frozen throughout the winter.

A calculation was made to confirm that the infiltration basins have adequate infiltration (outflow) capabilities to handle the annual runoff volumes being directed to them. To be conservative, it was assumed that infiltration would only take place for six months of the year. With this assumption, the annual infiltration conveyed by the infiltration basin was calculated and compared to the annual stormwater generated by the non-contact areas. Even using an infiltration rate of one-half that determined by on-site infiltrometer tests, the annual infiltration far exceeds the potential runoff (by a factor of over 5 times). As such, the infiltration basins have adequate storage and infiltration capacities to handle the runoff generated by the tributary drainage areas.

6. Summary

The following table summarizes the sizing for each of the CWBs and NCWIBs. As shown, the combined 50 yr rain/snowmelt event results in the larger volume of runoff and was used to size both the CWBs and NCWIBs.

Basin ID	Drainage Area (Acres)	Volume (Million Gallons)		Storage Basin Design
		100 yr rain event	50 yr combined event	Volume (Million Gallons)
Contact Basin #1 and #2	32.72	4.7	7.8	7.8
Non-contact Basin #3	9.85	0.9	3.5	3.5
Non-contact Basin #4	6.03	0.43	2.1	2.1
Non-contact Basin #5	3.05	0.25	1.0	1.0
Non-contact Basin #6	3.03	0.22	1.0	1.0

The following table and detail sheet (Figure 2) shows the design dimensions and lay-out of the proposed CWBs and NCWIBs.



Rainfall Data

Information from SCS-55, Release 55 Urban Hydrology for small watersheds.

SCS – 24 hrs Rainfall distribution (SCS. 1986)

100 yr event = 4.5 inches for 24 hr event

MDEQ Web Site Reference

1. Retention Basin side slopes not steeper than 3:1.
2. Freeboard = 2 ft

Runoff Curve Number for Urban Areas

Information obtained from Pondpack program from Haestad Inc.

Assume soil Type "B"

Paved, curb, stormsewers CN = 98

Gravel CN = 85

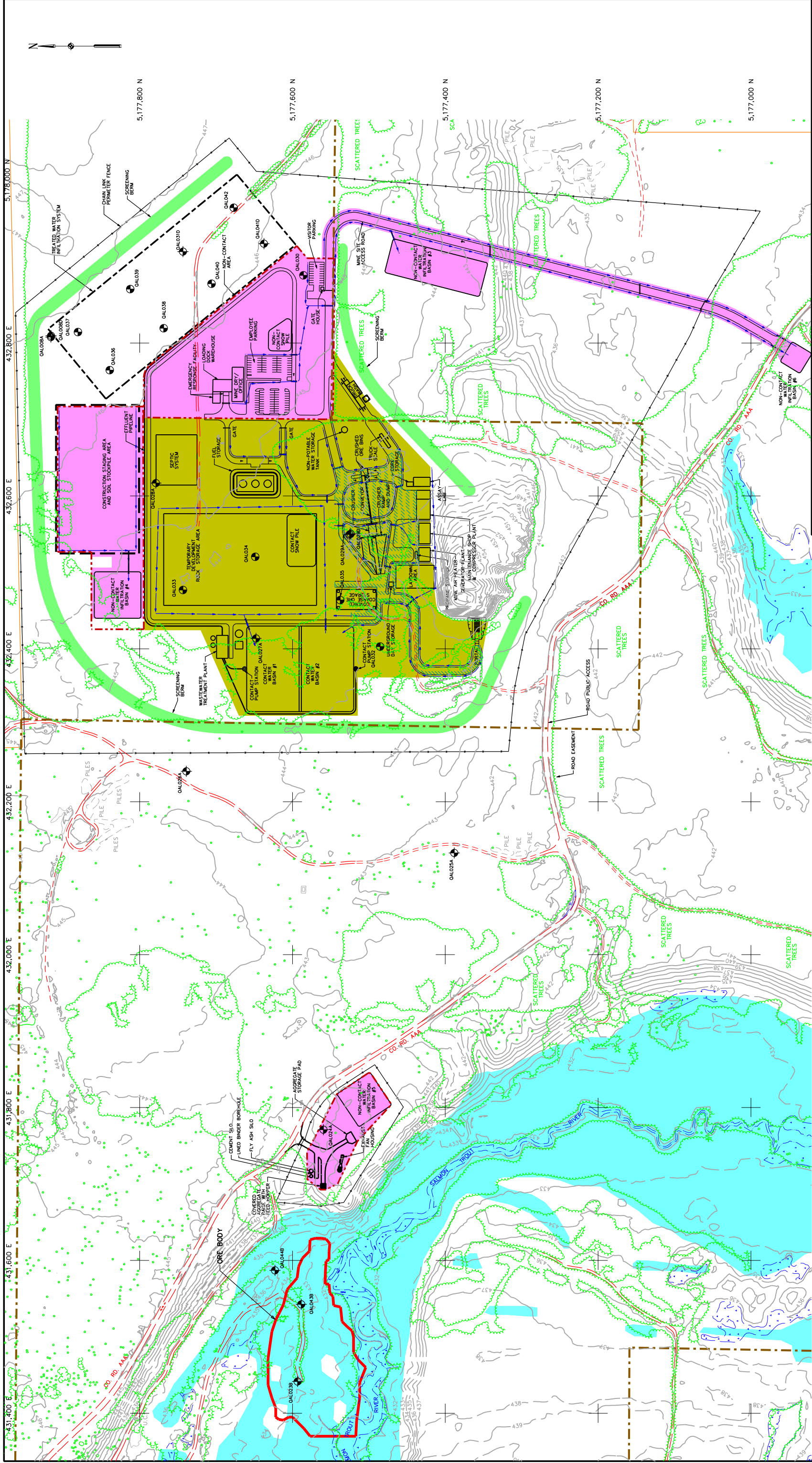
Dirt CN = 82

Industrial CN = 88

Basin Design Assumptions

Mannings coefficient "n" from Pondpack SCS-55
Guide manual.

Asphalt	Smooth	n = 0.013
Gravel Roads	Rough	n = 0.016
Grass (Fair Standing)		n = 0.14 – 0.08



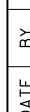
Foth & Van Dyke							Kennecott Eagle Minerals
REVISED	DATE	BY	DESCRIPTION				
CHECKED BY:	REM		DATE: FEB. '06				
APPROVED BY:	JOSI			DATE: FEB. '06			
APPROVED BY:	SVDI			DATE: FEB. '06			

FIGURE 1

FACILITY PLAN



Scale: 0 60M 120M Date: FEBRUARY, 2006

Prepared By: Foth & Van Dyke By: DAT 04W018

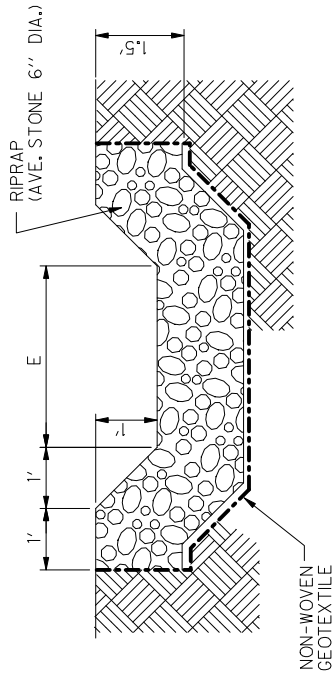
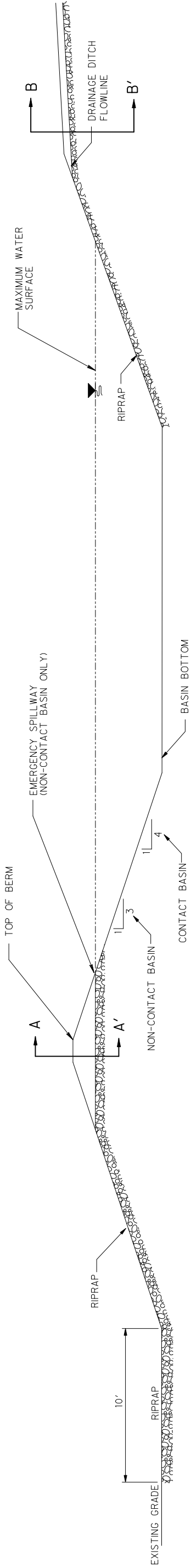
LEGEND

EXISTING CONTOUR
UNPAVED ROAD
TREE
TREE LINE
WCR MAPPED WETLAND BOUNDARY PROVIDED BY GOLDER & ASSOCIATES, INC.
KENNEBECOTT PROPERTY BOUNDARY
ORE BODY
PERIMETER FENCE

TREATED WATER INFILTRATION SYSTEM
PLANIMETRIC WETLAND NOTATION
GROUNDWATER MONITORING WELL NUMBER AND LOCATION
SOIL BORING NUMBER AND LOCATION
ORE BODY
EXCESS SOIL BERM
BITUMINOUS LINED OPERATIONS AREA
PROPOSED MAIN OPERATIONS AREA
PROPOSED NON-CONTACT AREA

NOTES:

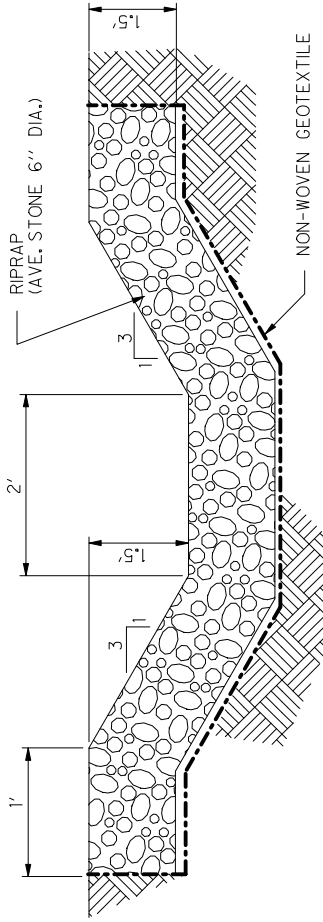
- TOPOGRAPHIC AND PLANIMETRIC DATA SUPPLIED BY AERO-METRIC ENGINEERING, SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY: JUNE 2, 2004.
- MINE PLAN DATA AREA ADAPTED FROM MCINTOSH ENGINEERING, INC., TEMPE, ARIZONA.
- SURFACE PROPERTY BOUNDARY AS OF NOVEMBER 18, 2004 SUPPLIED BY KENNEBECOTT VA. GOLDER & ASSOCIATES INC., AUGUST, 2005.
- CONTOUR INTERVAL BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988. HORIZONTAL DATUM BASED ON NAD 83/94. HORIZONTAL COORDINATES BASED ON UTM ZONE 16.
- ORE BODY, GROUNDWATER DISCHARGE AREA, WETLAND BOUNDARY (WETLAND AREA) AND WETLAND RESOURCE (WETLAND RESOURCES) SUPPLIED BY GOLDER & ASSOCIATES, INC. AUGUST, 2005.



SECTION A - A'
TYPICAL EMERGENCY OUTFALL (NON-CONTACT ONLY)

NOT TO SCALE

BASIN NO.	A	B	C	D	E (EMERGENCY OUTFALL)	VOLUME	
						CY	MILLION GALLONS
CONTACT AREA #1 & #2	400'	370'	400'	370'	NONE	38,600	7.8
NON-CONTACT #3	150'	420'	150'	420'	15'	17,100	3.5
NON-CONTACT #4	200'	200'	200'	200'	8'	10,500	2.1
NON-CONTACT #5	170'	170'	170'	170'	5'	5,300	1.0
NON-CONTACT #6 (@ CTH AAA)	160'	160'	160'	160'	5'	5,300	1.0

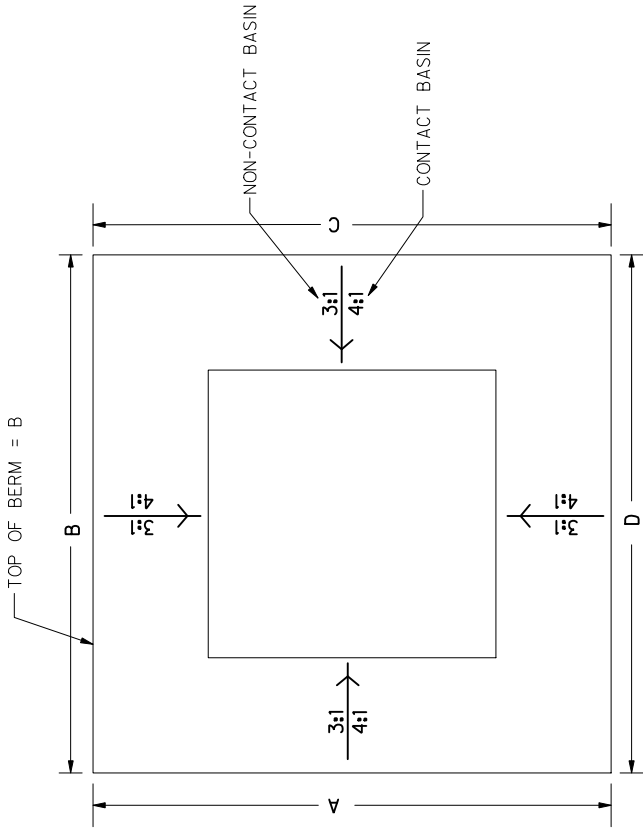


SECTION B - B'
TYPICAL RIPRAP INFLUENT DITCH

NOT TO SCALE

TYPICAL SECTION - STORAGE BASIN

NOT TO SCALE



TYPICAL PLAN VIEW - STORAGE BASIN

NOT TO SCALE

Foth & Van Dyke			
REVISED	DATE	BY	DESCRIPTION
CHECKED BY:	DATE: FEB, '06	REM	
APPROVED BY:	DATE: FEB, '06	SAD2	
APPROVED BY:	DATE: FEB, '06	MDL	

FIGURE 2			
SURFACE WATER STORAGE BASINS			
TYPICAL DETAILS			
Scale:	NOT TO SCALE	Date:	FEBRUARY, 2006
Prepared By:	Foth & Van Dyke	By:	GJB
			04W018

Attachment 1

Combined Rain and Snowmelt 50 Year Event

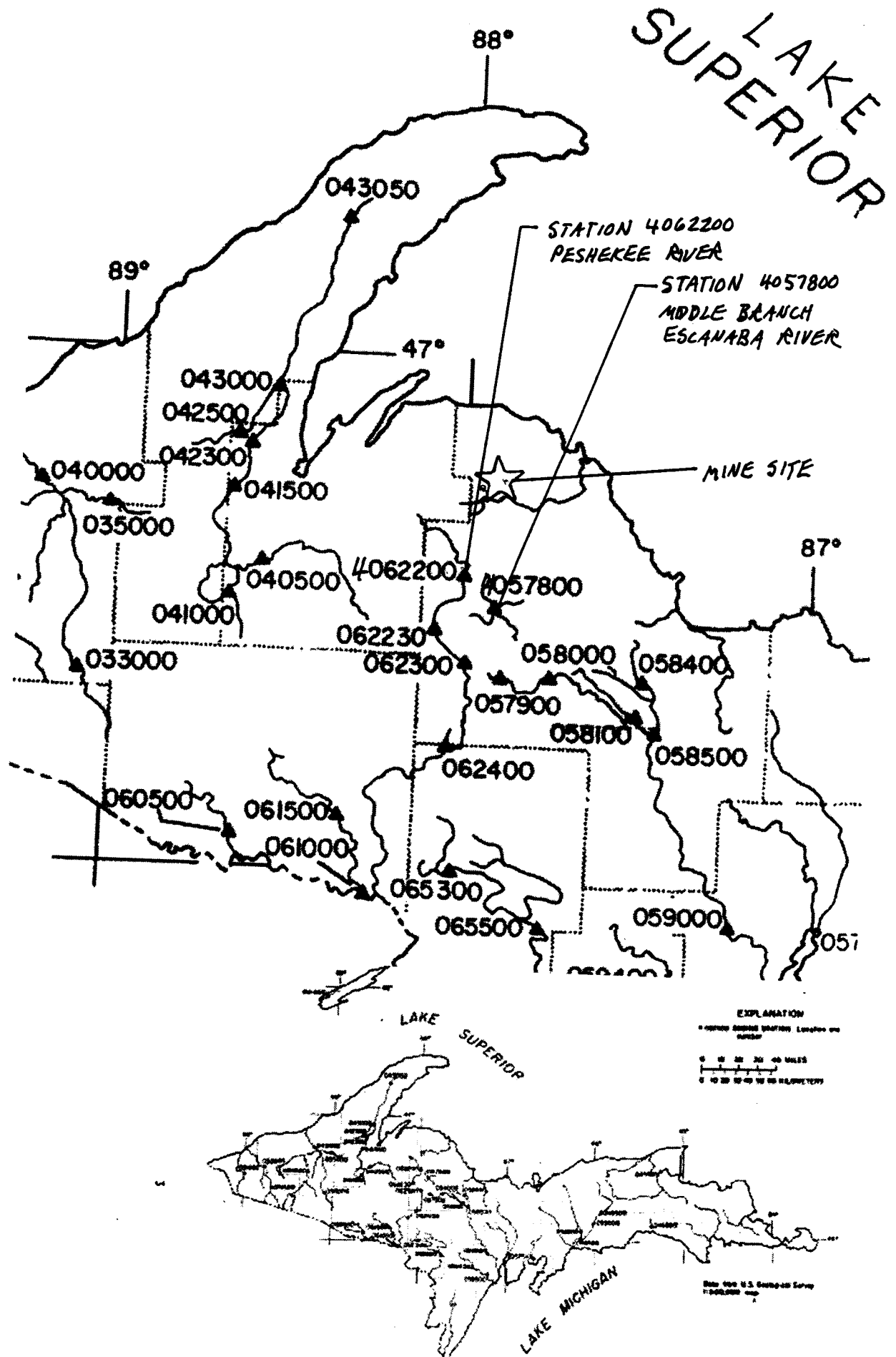


Figure 1. Location of selected gaging stations in Michigan's Upper Peninsula (Prefix 84 to all station numbers)

USGS station number	Station name	Peak flow, P_t (ft^3/s)					Flood volume, $V_{d,t}$ (ft^3/s)	
		P_5	P_{10}	P_{25}	P_{50}	P_{100}	$V_{7,10}$	$V_{30,10}$
04050500	EAST BRANCH ESCANABA RIVER AT GWINN, MICH.	1,290 1,370	1,550 1,570	1,910 1,820	2,190 2,080	2,480 2,180	1,050 1,330	620 801
04059400	TEMMLE CREEK AT PERDONVILLE, MICH.	558 596	671 733	825 910	947 1,040	1,080 1,180	- -	- -
04059500	FORD RIVER NEAR HYDE, MICH.	3,930 5,030	4,610 6,100	5,560 7,470	6,310 8,520	7,090 9,600	3,690 4,330	2,460 2,370
04060500	IRON RIVER AT CASPIAN, MICH.	780 680	972 820	1,220 1,000	1,410 1,150	1,610 1,290	- -	- -
04061008	SHULE RIVER NEAR FLORENCE, MISC.	2,180 2,500	2,650 3,030	3,270 3,720	3,780 4,250	4,270 4,800	1,520 2,310	1,210 1,430
04061500	PAINT RIVER AT CRYSTAL FALLS, MICH.	5,830 5,300	7,090 6,330	8,810 7,690	10,200 8,740	11,600 9,820	4,990 4,610	3,080 2,790
04062200	KESWEE RIVER NEAR CHAMPION, MICH.	2,980 1,970	3,310 2,800	3,780 2,820	3,970 2,890	4,240 3,750	2,480 1,840	1,430 1,118
04062238	NICHGAMME RIVER NEAR NICH- IGAMME, MICH.	2,590 2,340	3,000 2,670	3,510 3,080	3,890 3,380	4,270 3,670	2,660 2,470	1,680 1,538
04062308	NICHGAMME RIVER AT REPUBLIC, MICH.	3,050 2,710	3,520 3,880	4,120 3,540	4,560 3,870	5,010 4,200	- -	- -
04062408	NICHGAMME RIVER NEAR WITCH LAKE, MICH.	3,650 3,780	4,220 4,190	4,830 4,800	5,450 5,260	5,970 5,710	3,740 4,380	2,330 2,700
04065308	WEST BRANCH STURGEON RIVER NEAR RANDVILLE, MICH.	429 819	496 1,000	583 1,240	648 1,430	715 1,620	- -	- -
04065500	STURGEON RIVER NEAR FOSTER CITY, MICH.	1,580 2,970	1,850 3,600	2,200 4,400	2,470 5,010	2,750 5,620	- -	- -
04066400	ST. JOSEPH RIVER NEAR DUBLINGTON, MICH.	900 1,090	1,080 1,310	1,300 1,600	1,470 1,820	1,640 2,050	837 947	601 609
04066515	HOG CREEK NEAR ALLEN, MICH.	337 360	407 443	501 557	573 647	648 743	259 254	179 165
04066800	COLMATER RIVER NEAR HODUNK, MICH.	1,620 1,740	1,940 2,130	2,350 2,650	2,650 3,070	2,950 3,510	1,360 1,818	939 911
04066900	NOTTAWA CREEK NEAR ATHENS, MICH.	663 910	765 1,100	898 1,300	1,000 1,570	1,110 1,780	660 774	406 505
04067060	LITTLE PORTAGE CREEK NEAR FULTON, MICH.	330 285	485 356	508 455	590 535	676 622	- -	- -
04067170	PORTAGE RIVER NEAR VICKSBURG, MICH.	287 580	389 610	363 760	423 878	442 1,000	264 313	185 198
04067370	FLOWERFIELD CREEK AT FLOWER- FIELD, MICH.	87 96.9	96.9 115	109 139	117 159	125 180	- -	- -
04067540	PRAIRIE RIVER NEAR NOTTAWA, MICH.	460 559	545 669	651 818	730 936	808 1,060	406 432	276 284
04068500	PAN RIVER NEAR WHITE PIGEON, MICH.	532 692	608 828	696 1,010	797 1,150	815 1,300	446 668	358 459
04101800	DOMAGLAC RIVER AT SUMMER- VILLE, MICH.	1,040 1,380	1,130 1,650	1,290 2,820	1,330 2,310	1,410 2,620	785 1,110	568 771
04102500	PAN PAN RIVER AT RIVERSIDE, MICH.	1,910 1,990	2,320 2,410	2,890 2,980	3,368 3,820	3,870 3,890	1,590 1,860	1,080 1,220
04102700	BLACK RIVER NEAR SANDON, MICH.	1,020 1,110	1,210 1,310	1,460 1,570	1,658 1,800	1,850 2,000	647 690	361 399



Table 4.--Computed and estimated peak flow and flood volume values

USGS station number	Station name	Peak flow, F_t (ft^3/s)					Flood volume, $V_{d,t}$ (ft^3/s)	
		F_5	F_{10}	F_{25}	F_{50}	F_{100}	$V_{T,10}$	$V_{30,10}$
04001000	WASHINGTON CREEK AT WINDIGO, MICH.	814 382	490 448	584 532	651 596	716 663	281 224	156 124
04031000	BLACK RIVER NEAR DESSENER, MICH.	4,950 4,030	6,260 4,830	6,170 5,930	9,780 6,810	11,600 7,750	3,380 3,180	1,640 1,780
04031500	PRESCUE ISLE RIVER AT MARENISCOS, MICH.	1,710 1,050	2,090 2,210	2,608 2,710	3,000 3,090	3,420 3,500	1,490 1,370	895 859
04032000	PRESCUE ISLE RIVER NEAR TULA, MICH.	3,240 2,510	3,780 2,970	4,480 3,600	4,868 4,090	5,310 4,600	2,870 2,130	1,630 1,330
04033000	MIDDLE BRANCH ONTONAGON RIVER NEAR PAULSING, MICH.	1,240 1,280	1,480 1,500	1,790 1,880	2,020 2,040	2,260 2,290	1,180 999	657 649
04035000	EAST BRANCH ONTONAGON RIVER NEAR MASS, MICH.	3,560 2,860	4,070 3,460	4,680 4,240	5,110 4,890	5,510 5,460	1,970 1,920	1,130 1,120
04039500	SOUTH BRANCH ONTONAGON RIVER AT EWEH, MICH.	5,510 5,090	6,710 6,180	8,310 7,680	9,560 8,850	10,900 10,100	3,850 3,260	2,160 1,840
04040500	STURGEON RIVER NEAR SIDMAN, MICH.	3,040 3,300	3,540 3,890	4,120 4,680	4,540 5,300	4,930 5,930	2,470 3,120	1,350 1,740
04041000	PERCH RIVER NEAR SIDMAN, MICH.	634 446	757 533	916 648	1,040 736	1,160 826	- -	- -
04041500	STURGEON RIVER NEAR ALSTON, MICH.	4,580 4,930	5,240 5,820	6,010 6,980	6,550 7,890	7,070 8,810	3,480 4,740	2,050 2,650
04042300	STURGEON RIVER NEAR PELKE, MICH.	5,830 8,140	6,870 9,820	8,210 12,000	9,250 13,700	10,300 15,500	- -	- -
04042500	OTTER RIVER NEAR ELO, MICH.	3,660 3,620	4,240 4,500	4,920 5,680	5,410 6,600	5,880 7,540	2,500 2,000	1,350 1,030
04043000	STURGEON RIVER NEAR ARNHEIM, MICH.	8,680 10,500	10,600 12,800	13,380 15,800	15,580 18,100	17,700 20,480	- -	- -
04043050	TRAP ROCK RIVER NEAR LAKE LINDER, MICH.	1,030 896	1,208 582	1,430 893	1,680 779	1,770 864	608 415	315 240
04045500	TAMQUANESON RIVER NEAR TAM- QUANESON PARADISE, MICH.	5,510 5,150	6,100 5,820	6,780 6,620	7,250 7,170	7,690 7,710	5,810 6,220	4,680 4,300
04046000	BLACK RIVER NEAR GARNEY, MICH.	366 522	454 616	582 738	689 832	809 930	264 297	166 173
04049500	MANISTIQUE RIVER AT GERMFAKE, MICH.	1,530 2,318	1,710 2,630	1,940 3,020	2,110 3,320	2,290 3,610	1,470 2,320	1,170 1,590
04050000	MANISTIQUE RIVER NEAR BLANEY, MICH.	5,040 4,380	5,950 4,940	7,160 5,640	8,110 6,160	9,090 6,660	4,790 4,620	3,350 3,140
04056000	WEST BRANCH MANISTIQUE RIVER NEAR MANISTIQUE MICH.	3,540 3,200	4,300 3,750	5,050 4,460	5,690 4,990	6,350 5,550	3,470 2,820	2,120 1,770
04057510	STURGEON RIVER NEAR SANNA JUNCTION, MICH.	1,370 1,170	1,520 1,350	1,700 1,570	1,840 1,750	1,970 1,920	1,330 1,080	873 743
04057800	MIDDLE BRANCH ESCANABA RIVER AT HUMBOLT, MICH.	921 544	1,110 634	1,350 753	1,550 845	1,760 935	701 496	399 318





Water Resources

Data Category:

Surface Water

Geographic Area:

Michigan

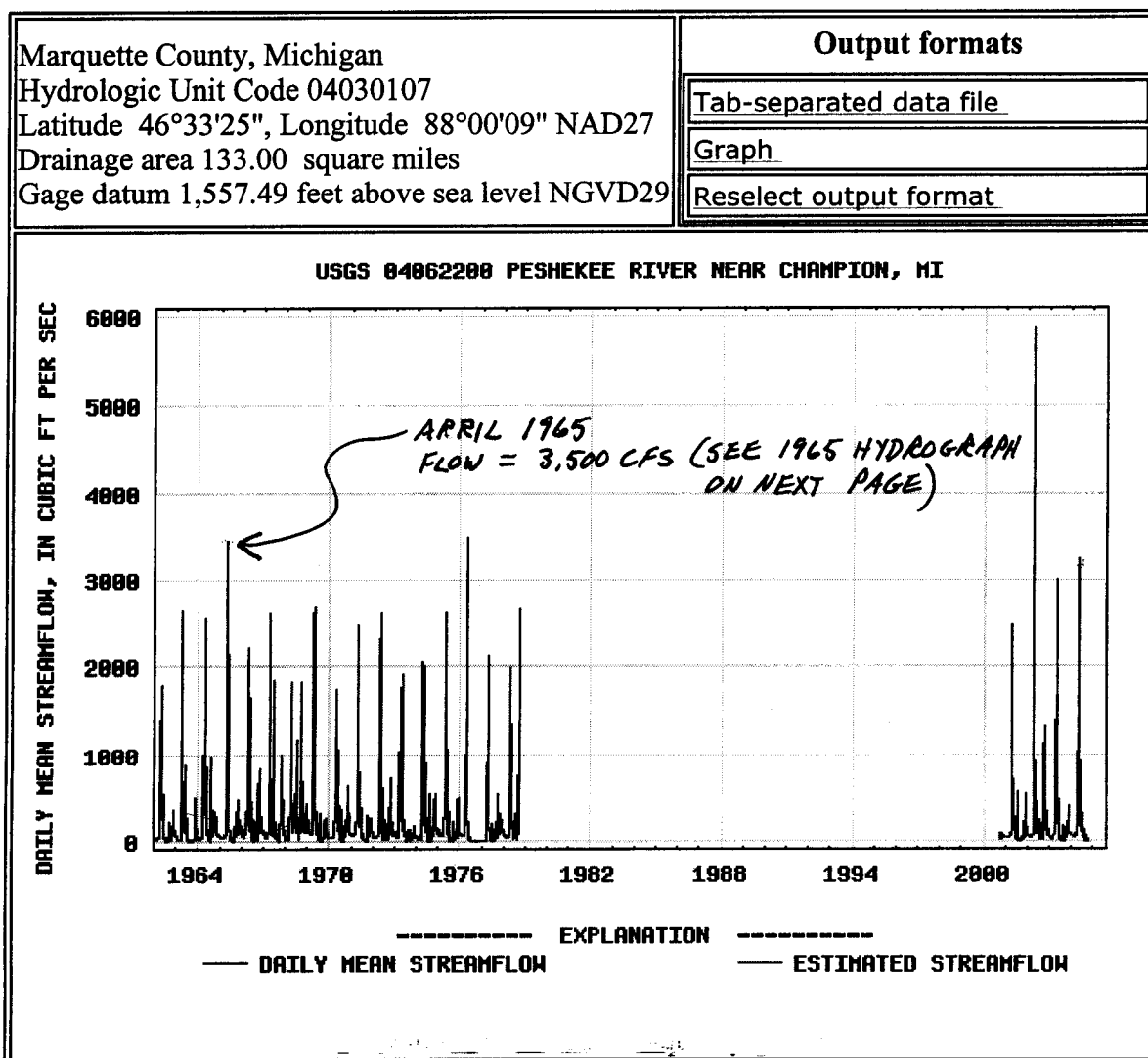
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Daily Streamflow for Michigan

USGS 04062200 PESHEKEE RIVER NEAR CHAMPION, MI

Available data for this site

Surface-water: Daily streamflow



Questions about data [Michigan NWISWeb Data Inquiries](#)
 Feedback on this website [Michigan NWISWeb Maintainer](#)
 Surface Water for Michigan: Daily Streamflow
<http://waterdata.usgs.gov/mi/nwis/discharge?>

[Top](#)
[Explanation of terms](#)

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 Department of the Interior, U.S. Geological Survey



Water Resources

Data Category:

Surface Water

Geographic Area:

Michigan

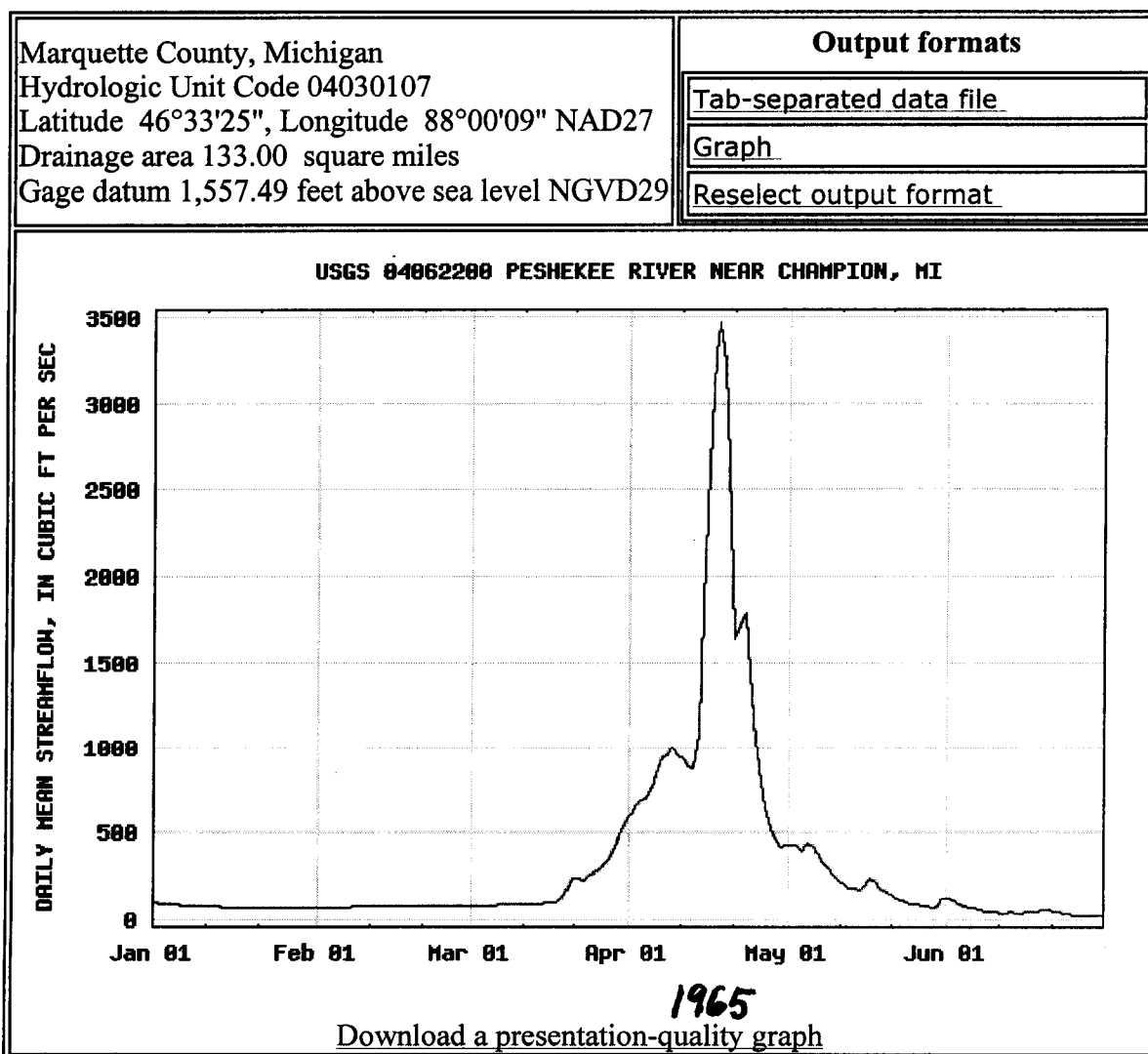
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Daily Streamflow for Michigan

USGS 04062200 PESHEKEE RIVER NEAR CHAMPION, MI

Available data for this site

Surface-water: Daily streamflow

[Questions about data](#) [Michigan NWISWeb Data Inquiries](#)[Feedback on this website](#) [Michigan NWISWeb Maintainer](#)

Surface Water for Michigan: Daily Streamflow

<http://waterdata.usgs.gov/mi/nwis/discharge?>[Top](#)[Explanation of terms](#)

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Water Resources

Data Category:

Surface Water

Geographic Area:

Michigan

go

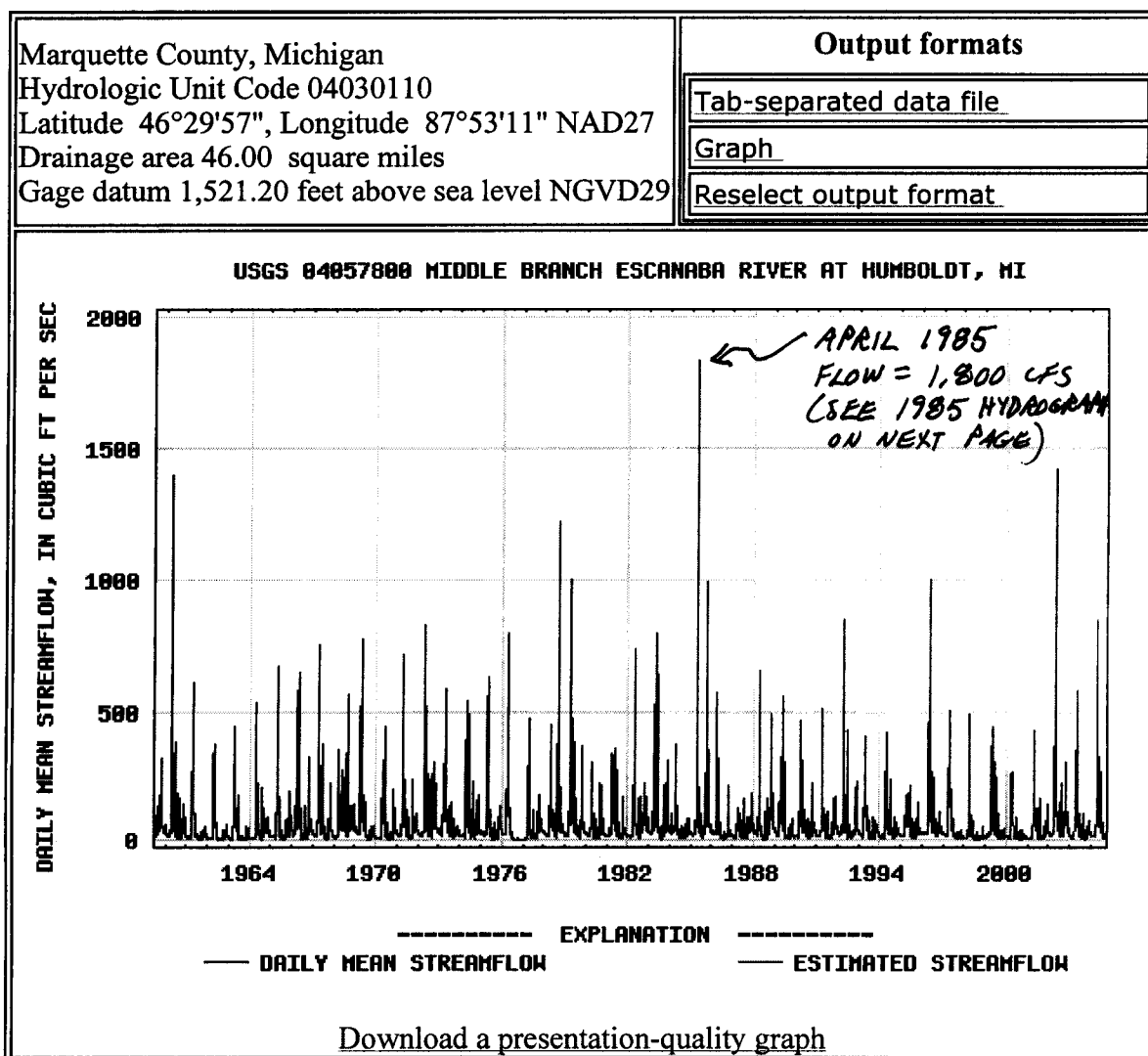
Daily Streamflow for Michigan

USGS 04057800 MIDDLE BRANCH ESCANABA RIVER AT HUMBOLDT, MI

Available data for this site

Surface-water: Daily streamflow

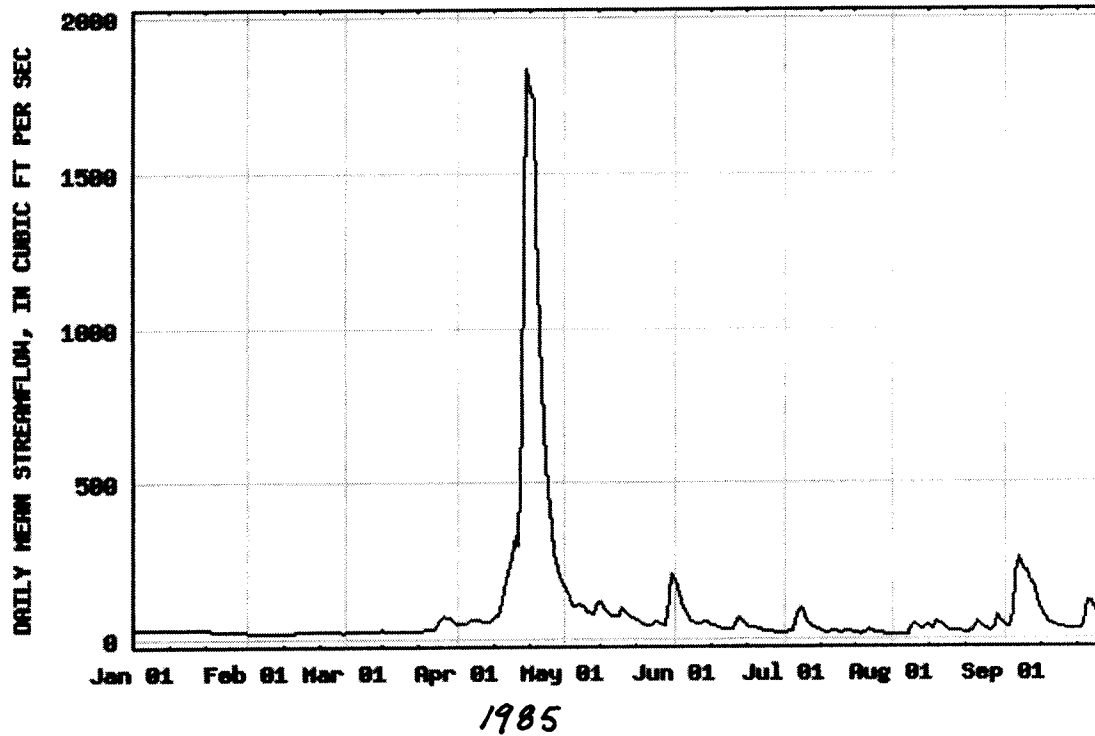
GO



Questions about data [Michigan NWISWeb Data Inquiries](#)
 Feedback on this website [Michigan NWISWeb Maintainer](#)
 Surface Water for Michigan: Daily Streamflow
<http://waterdata.usgs.gov/mi/nwis/discharge?>

[Top](#)
[Explanation of terms](#)

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 Department of the Interior, U.S. Geological Survey

**USGS 04057800 MIDDLE BRANCH ESCANABA RIVER AT HUMBOLDT, MI**

U. S. DEPARTMENT OF COMMERCE
JOHN T. CONNOR, Secretary
WEATHER BUREAU
ROBERT M. WHITE, Chief

CLIMATOLOGICAL DATA

MICHIGAN

APRIL 1965
Volume 80 No. 4



ASHEVILLE: 1965

DAILY PRECIPITATION

NICHIGAN
APRIL 1968

Station	Total	Day of Month																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
WEST UPPER 01																																
ALBERTA FORD FOR CNTR	2.24	.17					.44	.26			.25	.14			.08	.41	.01					.27	.22									
BEECHWOOD T MNR	2.48	.64	T	.04			.24	.14					.03		.13	.03	.01				T		.27	.22								
BERGLAND DAM	2.28	.41				.02	.06	.15					.28	.05		.34	.14	.01					.02	.31								
CHANDLER VAN RIVER PK	2.28	.41					.19	.15					.34	.05	T								.24	.24								
CRYSTAL FALLS & NE	2.31	.57	.01				.11	.25	.02				.47										.25	.24								
EAGLE HARBOR COAST GO	1.44	.11					.42	.14				.50	T			.02	T	T					.02	.03								
MOUNTAIN FFA AIRPORT	1.70	.08					.03	.22				.01	T			.03	.20	T	T				.02	.04								
THOMAS HUNTER 100 WNS	2.09	.08					.13	.14				.28	.04			.11	.25	.02	T				.10	.44								
INDWOOD	2.23	.54			.09	T	.13	.14				.22	.04			.11	.25	.02	T				.10	.44								
INDWOOD	2.07	.34					.21	.19				.27	T										.10	.23								
KEWTON U S FOREST	1.73						.03	.03				.23	.10			.33	.03						.23	.28								
L ARSE 2 S	1.48	.13					.27	.10				.10	.10			.34							.20	.22								
MARQUETTE W CITY	1.43	.17				.01	.19	.04				.18	.03			.14	.19	.01	T	T			.10	.16	.20							
MARQUETTE FFA AIRPORT	1.30	.14	T				.34	.02				.22	.01			.20	.09	T	T	T			.19	.14	.19							
MOTY ISLAND ISLE ROYAL																																
ONTONAGON	2.32	.18				.01	.44	.20				.32	.02			.04	.42						.12	.35								
SPALDING	3.01	.48	T				.20					.37	.11			.34							.07	.37								
STANBACH 1 S	3.04	.21				T	.07	.07				.48	.03			.01	.48	.02	T	.08			.37	.39								
STEPHENSON 3 W	2.04	.09					.21					.43				.05	.32			.08	.04		.05	.15			.06	.02				
WATERSMEET																																
EAST UPPER 02																																
BREVORT	1.89	.14					.44	T				.23	.13			.32	T						.10	.30								
CHATHAM EXP FARM	1.97	.20					.14					.29	.08			.34	.04						.10	.30								
CORNELL	2.44	.40					.26	.05				.48												.10	.30							
DE TOUR 1 N	1.69	.12					.20	.04	.30			.15	.03			.13							.03	.19								
DURHAM FOREST EXP STA	1.69	.12					.20	.04	.30			.15	.03			.13							.03	.19								
ESCANABA																																
FAVETTE	2.00	.30	.03				.02					.39	.37			.34		T	T				.11	.34								
GRAND MARAIS	1.20	.04					.13		.20	.25		.15				.34	.04	.01	T			.01	.03	.07	.10							
KINCHELOE A F BASE	1.30	.04					.30	.03				.32	.06			.19	.08	.02	.04				.03	.10								
MARISTONE WATERWORKS	2.09	.21					.06	.12				.19				.19	.08	.02	.04				.03	.10								
MUNISING	1.73	.13					.19	.20				.35				.34	.07	T	T				.10	.34	T							
NEWBERRY STATE HOSP	1.61	.11					.09	.09				.35				.34	.02	.02	T				.10	.34	T							
PORT INLAND	2.78	.38					.02	.11	T			.34				.32	.02	.14					.14	.35								
ROCK	2.62	.43	.04				.24	.03				.39	.03			.19	.02						.14	.35								
SAULT STE MARIE W AP	1.32	.11					.23	.14				.20	.04			.01	.38	T	T				.09	.17								
SENEY NATL WLR		.14					.09					.25				.02			.04	T												
STEVENS 2 WNW																																
WHITEFISH POINT																																
NORTHWEST LOWER 03																																
BOYNE FALLS	3.37	.09					.10	.05				.12	1.10			.43	.12	.23					.04	.23								
CADILLAC	4.70	.88	T									1.22	.24			.61	T	.01					.01	.18								
CHARLEVOIX	3.08	.04					.24					.14	.70			.23	.10	.11					.10	.09								
CROSS VILLAGE	3.25	.04					.24	.03	T			.16	.70			.23	.10	.11					.10	.09								
EAST JORDAN																																
PIPE LAKE 4 SW	3.16	.28					.50					.24	1.30			.45	.10	.30	.40				.10	.03	.01	.01	.09	.70				
FRANKFORT 2 NE	3.30	1.10					T					.41	1.07			.36	.04	.44					.07	.10	.09	T	.01	.67				
KALKASKA	3.31	.19					.10	T				.17	.35			.43	.11	.44					.02	.10	.17		.09	.67				
LAKE CITY EXP FARM	3.01	.30					.04		.01			.32	.33			.44	.12	.38					.04	.10			.09	.69				
MARISTE																																
MARLE CITY	3.04	.31					.18	T				.26	.74			.34	.10	.39					.27	.11			.62					
NORTH MARISTE 15 NO 2																																
PELLAYON FFA AIRPORT	2.98	.17					.28	.07				.44	.63			.47	T	.07				.01	.09	T	.12		.42	.11				
PETOSKEY	3.43	.08					.07	.04				.21	.98			.79	.12	.14					.01	.10			.42	.11				
ST JAMES BEAVER ISLAND	2.27	.10					.06	T				.75				.42	.09						.30									
SUTTONS BAY 4 NW	4.05	.29	.18				.09	.20	.03			.21	1.04			.44	.23	.16					.10	.30			.03	.30				
THOMPSONVILLE	3.64	.31					.10	.01				.32	.63			.44	.23	.16					.10	.30			.03	.30				
TRAVERSE CITY FFA AP	3.02	.27					.10	.01				.32	.63			.44	.23	.16					.10	.30			.03	.30				
WELLSTON TIMPES DAM	3.17	.22					.01	T				.32	.63			.44	.23	.16					.10	.30			.03	.30				
NORTHEAST LOWER 04																																
ALPENA W AIRPORT	3.42	.27					.23	T				1.12	.10			.77	.01	.17					.24	.21			.04	.23				
ALPENA SEWAGE PLANT	3.42	.27					.23	T				1.12	.10			.77	.01	.17					.24	.21			.04	.23				
ATLANTA 3 WSW	3.42	.27					.23	T				1.12	.10			.77	.01	.17					.24	.21			.04	.23				
CHEBOYGAN RR LIGHT STA	1.39	.08					.12	.01				.10	.73			.33	.24	.24					.10	.09								
EAST TANDU 1 S FOREST	2.28	.41					.19	.15				.34	.05			.47																
BAYLORD CON DEP	3.28	.12	T				.14	.06				.01	1.03	T		.38	.10	.22					.03	.22								
GRAYLINE MILITARY RES	3.44	.27					.14	.01				.01	.72	.02		.44	.09	.22					.03	.22						</		

SNOWFALL AND SNOW ON GROUND

MICHIGAN
APRIL 1965

Station		Day of month																															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
* * *																																	
WEST UPPER 01																																	
BERGLAND DAM	SNOWFALL SN ON GND	-	-	-	26	27	25	T	24	23	22	20	-	-	-	-	-	-	12	11	11	9	7	6	4	3	2	T	T				
HOUGHTON FAA AIRPORT	SNOWFALL SN ON GND	1.9 39	39	39	38	34	1.4 30	2.4 30	28	25	24	20	T	T	10	10	1.0 16	T	15	14	12	6	4	0.3 3	2	2	2	2	T	T			
IRON MOUNTAIN WTR WKS	SNOWFALL SN ON GND	7.0 17	14	11	10	9	T	6	5	4	4	2	2	T	T	T	T	T	T	T	T	T				0.9 1	7.0 T						
IRONWOOD	SNOWFALL SN ON GND	5.2 32	31	29	29	27	24	1.3 24	22	20	17	13	11	10	10	0.1 9	0.3 9	0.8 6	5	4	3	2	2	1	T	T	T	0.5 T	T				
KENTON U S FOREST	SNOWFALL SN ON GND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MARQUETTE WB CITY	SNOWFALL SN ON GND WTR EQUIV	1.7 33 -	32	31	29	27	27	24	22	20	19	14	12	12	11	9	0.4 8	0.7 7	6	4	4	2	1	0.2 T	0.4 T	T	T	T	T	T			
ONTONAGON	SNOWFALL SN ON GND	1.8 23	22	21	21	19	14	11	10	9	7	3	2	1																			
STANBAUGH I S	SNOWFALL SN ON GND	8.5 20	18	16	16	15	T	14	13	13	12	10	10	9	3	T	1	T	T	T	T	T	T	T	T	T	T	2.0 T	T				
STEPHENSON S W	SNOWFALL SN ON GND	8.1 21	15	12	10	8	6	6	4	2	2						0.7 T	0.4 T									0.9 T						
* * *																																	
EAST UPPER 02																																	
DUNBAR FOREST EXP STA	SNOWFALL SN ON GND	1.1 20	-	10	-	17	14	13	13	-	-	-	T	6	5	2	3.5 3	T	2	1	T	T	T	T	0.8 T	T	T	T	T	T			
HANISTIQUE WATERWORKS	SNOWFALL SN ON GND	5.4 16	14	12	11	10	9	T	9	8	7	6	5	4	3	2	0.3 2	T	T	T	T												
MUNISING	SNOWFALL SN ON GND	3.0 30	28	26	18	-	-	16	-	-	12	10	-	-	-	T	T	T	T														
NEWBERRY STATE HOSP	SNOWFALL SN ON GND	1.2 23	23	21	20	20	19	17	13	13	13	8	6	3	2	1	1	1	1														
SAULT STE MARIE WB AP	SNOWFALL SN ON GND WTR EQUIV	1.1 10 2.8	10	8	6	5	5	0.3 3	0.3 3	1	1	1	1	0.6 T	0.6 T	0.2 T	3.8 1	T	T	T	T	T	0.1 T	T	1.8 T	T	T						
* * *																																	
NORTHWEST LOWER 03																																	
HANISTEE	SNOWFALL SN ON GND	3.0 3	1															3.0 T															
PELLSTON FAA AIRPORT	SNOWFALL SN ON GND	1.9 15	15	15	11	9	7	6	4	2	2	1	T	T	T	1.0 T	T	1.0 1	1	1	T	T	T										
TRAVERSE CITY FAA AP	SNOWFALL SN ON GND	4.5 5	5	4	2	1	T	T	T							0.1 T	3.3 1																
* * *																																	
NORTHEAST LOWER 04																																	
ALPENA WB AIRPORT	SNOWFALL SN ON GND WTR EQUIV	4.4 5 0.5	4	3	3	2	1	T	T	T	T	T	T			0.4 T	T	1.8 T	T														
GRAYLING MILITARY RES	SNOWFALL SN ON GND	5.0 15	12	11	10	10	9	T	6	5	3	2	T	T	T	T	1.0 T	7.0 3	T	T	T	T	T	T	T	T	T	T	T	T			
HALE LOUD DAM	SNOWFALL SN ON GND	7 12	3.0 13	13	9	7	6	6	5	5	4	4	3	3	2	1	T	2.0 T	2	T	T	T	T										
HOUGHTON LAKE WB AP	SNOWFALL SN ON GND WTR EQUIV	4.9 5 0.9	T	6	4	4	3	1	T	T	T	T				T	T	5.7 T	3 1	0.2 T													
MIO HYDRO PLANT	SNOWFALL SN ON GND	4.0 12	T	14	14	13	12	10	8	7	6	6	5	4	3	2	1	T	4.0 1	3	1	T	T	T	T								
ONAWAY STATE PARK	SNOWFALL SN ON GND	2.3 14	15	18	11	8	6	6	4							2.2 T	1.3 T	1.5 T															
VANDERBILT TROUT STA	SNOWFALL SN ON GND	3.0 24	23	22	19	18	17	16	15	15	13	12	9	8	8	0.3 T	1.3 T	4.0 12	9	7	5	3	3	2	2	2	1						
WEST BRANCH 2 H	SNOWFALL SN ON GND	2.0 7	1.5 8	6	4	3	2	1	1									4.3 6	2														
* * *																																	
WEST CENTRAL LOWER 05																																	
LUDINGTON 4 SE	SNOWFALL SN ON GND	4.6 5																3.8 4															
MUSKEGON WB AIRPORT	SNOWFALL SN ON GND WTR EQUIV	5.9 1 0.3	5	8	1	1	T										T	0.2 T															
NEWAYGO HARDY DAM	SNOWFALL SN ON GND	9.0 17	15	14	13	12	10	8	6	5	5	2	1	T	T	T	T	4.0 1	T	T	T	T	T										
* * *																																	
CENTRAL LOWER 06																																	
ALMA	SNOWFALL SN ON GND	0.6 3	3.4 7	4	3	2	1	T	T									2.0 2	1.0 1														
BIG RAPIDS WATERWORKS	SNOWFALL SN ON GND	3.1 7	6	5	5	4	2	1	T	T	T							3.5 2															
GLADWIN	SNOWFALL SN ON GND	6.0 -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	4.0 -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

See Reference Notes Following Station Index

CLIMATOLOGICAL DATA

MICHIGAN

APRIL 1985

VOLUME 100 NUMBER 4



"I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF
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28801

Kenneth D. Haden

DIRECTOR
NATIONAL CLIMATIC DATA CENTER

noaa

NATIONAL
OCEANIC AND
ATMOSPHERIC ADMINISTRATION

NATIONAL
ENVIRONMENTAL SATELLITE, DATA
AND INFORMATION SERVICE

NATIONAL
CLIMATIC DATA CENTER
ASHEVILLE NORTH CAROLINA

DAILY PRECIPITATION (INCHES)

MICHIGAN
APRIL 1985

STATION	TOTAL	DAY OF MONTH														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MICHIGAN																
NORTH UPPER FOR CNTR	4.77	.54	.05	.33		.02										
ALBERTA FORD 7 WNW	2.83	.18	.16	.04		.01										
BERGLAND DAM	2.40	.72	.04	.03		.01										
BIG BAY 1 S	M															
CHAMPION VAM RIVER PK	7.42	.37	.23	.28		.36										
COPPER HARBOR FORT WILKIN	2.95	.36	.18	.27		.02										
CRYSTAL FALLS 6 NE	3.44	.61	.23	.38		.03										
HERMAN	5.64	.26	.13	.36		.03										
HOUGHTON FAA AP	2.91	.25	.03	.09		.07										
IRON MTN-KINGSFORD WMTF	3.79	.68	.16	.11		.07										
IRONWOOD	4.01	.75	.11	.19		.40										
ISHPEMING	6.17	.33	.04	.19		.40										
KENTON	1.92	.60	.18	.18		.07										
MARQUETTE MSD	4.27	.12	.05	.15		.77										
MOTT ISLAND ISLE ROYAL	6 M	.34	.20	.15		.08										
MONTAING 6 SSE	3.70	.22	.03	.31		.29										
ONTONAGON 1 S	2.33	.03	.13	.05		.01										
SPALDING 1 S	3.86	.82	.03	.16		.06										
STAMBAUGH 8 WNW	1.72	.72	.03	.03		.10										
WATERSMEET	4.47	.11	.15	.15		.06										
EAST UPPER FARM	4.19	.19	.02	.19		.26										
CHATHAM EXP FARM	2.22	.15	.11	.16		.41										
CORNELL 4 WSW	3.52	.50	.37	.06		.52										
DE TOUR VILLAGE	3.62	.06	.20	.06		.70										
DUNBAR FOREST EXP STN	1.53	.20	.06	.11		.48										
ESCANABA 3 SH	2.11	.20	.20	.15		.11										
FAYETTE MARIS 2 E	3.06	.04	.02	.02		.05										
GRAND MARIS 2 E	3.21	.04	.02	.02		.05										
MANISTIQUE	M															
MUNISING	4.58	.16	.16	.15		.28										
NEPORT 1 NE	5.93	.16	.16	.15		.85										
ROCKY HILL	3.41	.50	.60	.19		.30										
RUDYARD 4 N MACKINAC BR	4.23	.29	.18	.05		.45										
ST IGNACE MARIE WSO	3.34	.13	.01	.38		.27										
SAULEY NATL WLR	M					.15										
SELEBENHON FALLS PARK	5.42	.86	.48	.35		.08										
TRAVELER LAKE	M					.92										
WHITEFISH POINT	4.18	.35	.15	.15		.88										
NORTHWEST LOWER	3.45	.09	.01	.37		.44										
BOYNE FALLS	M					.63										
CADILLAC	3.66	.20	.09	.23		.79										
CARLEVOIX	4.94	.15	.15	.42		.60										
CROSS VILLAGE	3.60	.08	.12	.43		.74										
EAST JORDAN NE	2.24	.12	.10	.06		.42										
FRANKFORD 6 WSW	1.08	.15	.04	.14		.09										
HOUGHTON LAKE 6 WSW	3.99	.10	.06	.34		.16										
KALKASKA	3.35	.18	.04	.23		.47										
LAKE CITY EXP FARM	M					.85										
LAKE STEE 3 SE	4.69	.10	.19	.15		.58										
HAPLE CITY	2.79	.01	.50	.22		.26										
OLD MISSION 3 SSW	3.75	.01	.35	.01		.54										
PELLSTON FAA AP	3.00	.03	.43	.01		.92										
TRAVERSE CITY FAA AP	4.68	.11	.34	.10		.59										
WELLSTON TIPPY DAM						.04										

SEE REFERENCE NOTES FOLLOWING STATION INDEX

DAILY PRECIPITATION (CONT)

MICHIGAN
APRIL 1985

STATION	DAY OF MONTH															
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MICHIGAN																
WEST UPPER 01																
ALBERTA FORD FOR CNTR																
BEECHWOOD 7 MNW																
BIG BAY 1 S																
CHAMPION VAN RIPER PK																
COPPER HARBOR FORT WILKIN																
CRYSTAL FALLS 6 NE																
HERMAN																
HUGHES FARM AP																
IRON MTN-KINGSFORD MNTP																
IRONWOOD																
ISHPEMING																
KENTON																
KARQUETTE WSO																
MOTT ISLAND 6 ROYAL																
ONTONAGON 1 SE																
SPALDING 1 SSE																
STAMBAUGH 1 S																
STEPHENS 8 MNW																
WATERSHEET																
EAST UPPER 02																
CHATHAM FARM																
CORNELL 4 WSM																
DE TOUR VILLAGE																
DUNBAR FOREST EXP STN																
ESCANABA 3 SH																
FAYETTE 2 E																
GRAND MARAIS 2 E																
HANISTIQUE																
HENBERRY STATE HOSP																
PORT INLAND																
ROCK 1																
RODY ARD 4 NACKINAC BR																
SAULY STEEL MARIE WSO																
SENEY NATL WLR																
STAGBENNON FALLS PARK																
TROUT LAKE																
WHITEFISH POINT																
NORTHWEST LOWER 03																
BOYNE FALLS																
CADILLAC																
CHARLES VILLAGE																
CROST JORDAN 2																
FRANKFORD LAKE 6 NSH																
HOUGHTON LAKE 6 NSH																
KALKASKA EXP FARM																
LAKE STEE CITY																
MAPLE CITY																
OLD MISSION 3 SSH																
PELLSTON FARM AP																
PETOSKEY																
TRAVERSE CITY FARM AP																
WELLSTON TIPPY DAM																

SEE REFERENCE NOTES FOLLOWING STATION INDEX

SNOWFALL AND SNOW ON GROUND (INCHES)

MICHIGAN
APRIL 1985

STATION

DAY OF MONTH

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MICHIGAN																															
WEST UPPER																															
ALBERTA FORD FOR CNTR																															
BECKHOOD 7 MNH																															
BERGLAND DAN																															
CHAMPION VAN RIPER PK																															
CRYSTAL FALLS 6 NE																															
HOUGHTON FAA AP																															
IRON MTN-KINGSFORD HMTF																															
IRONWOOD																															
MARQUETTE																															
STEPHENSON 8 MNH																															
EAST UPPER																															
CHATHAM EXP FARM																															
DE TOUR VILLAGE																															
ESCANABA																															
GRAND MARAIS 2 E																															
MEMBERRY STATE HOSP																															
SAULT-STE MARIE NSO																															
TAHOUEMONG FALLS PARK																															
NORTHWEST LOMER																															
BOYNE FALLS																															
CHARLEVOIX																															
FRANKFORT 2 NE																															
LAKE CITY EXP FARM																															

SNOWFALL INCLUDES SNOW AND ICE
SNOW ON GROUND INCLUDES SNOW, SLEET, ICE AND HAIL
WATER EQUIVALENT GIVEN FOR HWS STATIONS ONLY, WHEN SNOW DEPTH IS 2 INCHES OR MORE
SEE REFERENCE NOTES FOLLOWING STATION INDEX

Spring 2002 Flood Across Western and Central Upper Michigan

Jim Sieveking and James LaRosa
NOAA/WFO Marquette
Negaunee Township

1. Introduction

The late winter season record setting snowfall in February and March set the stage for spring floods in 2002. During February and March of 2002 north-central and western parts of Upper Michigan observed over 100 inches of snowfall. At the National Weather Service (NWS) Office, located in Negaunee Township, 175 inches of snow fell during those 59 days. That was an average of nearly 3 inches of snow per day. The maximum snow depth during this two month period at the NWS office was 41 inches. This year's snow pack held over 11 inches of water in north central and western Upper Michigan.

NOTE
WATER
FRACTION

Daily Maximum (red) and Minimum (blue) Temperature (F),
Precipitation (green) (in.), and Snow Depth (light blue) (in.) for 1-19 April 2002

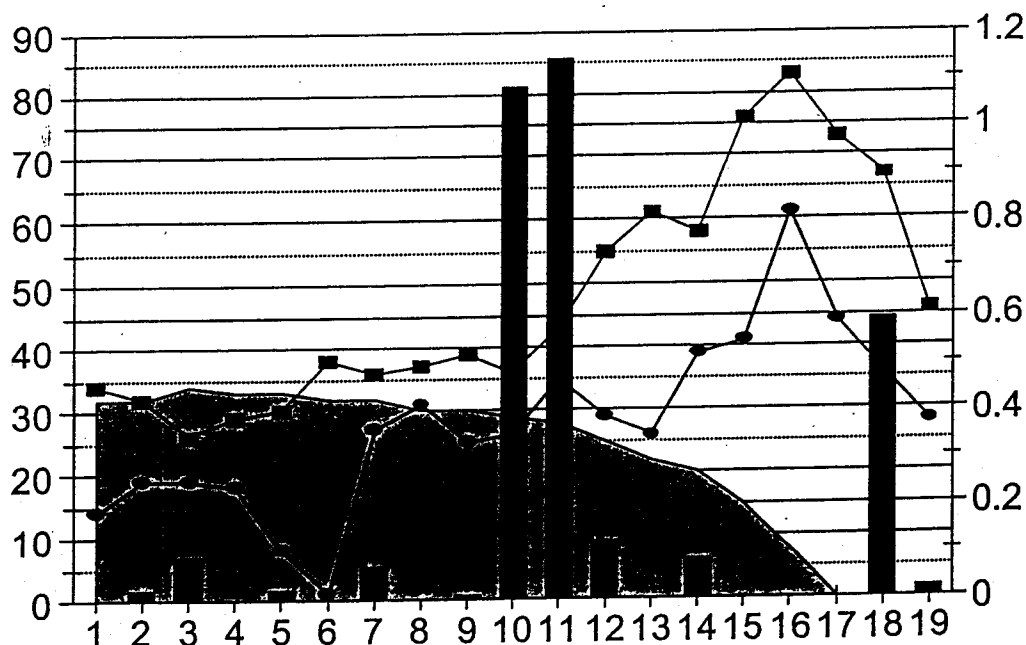
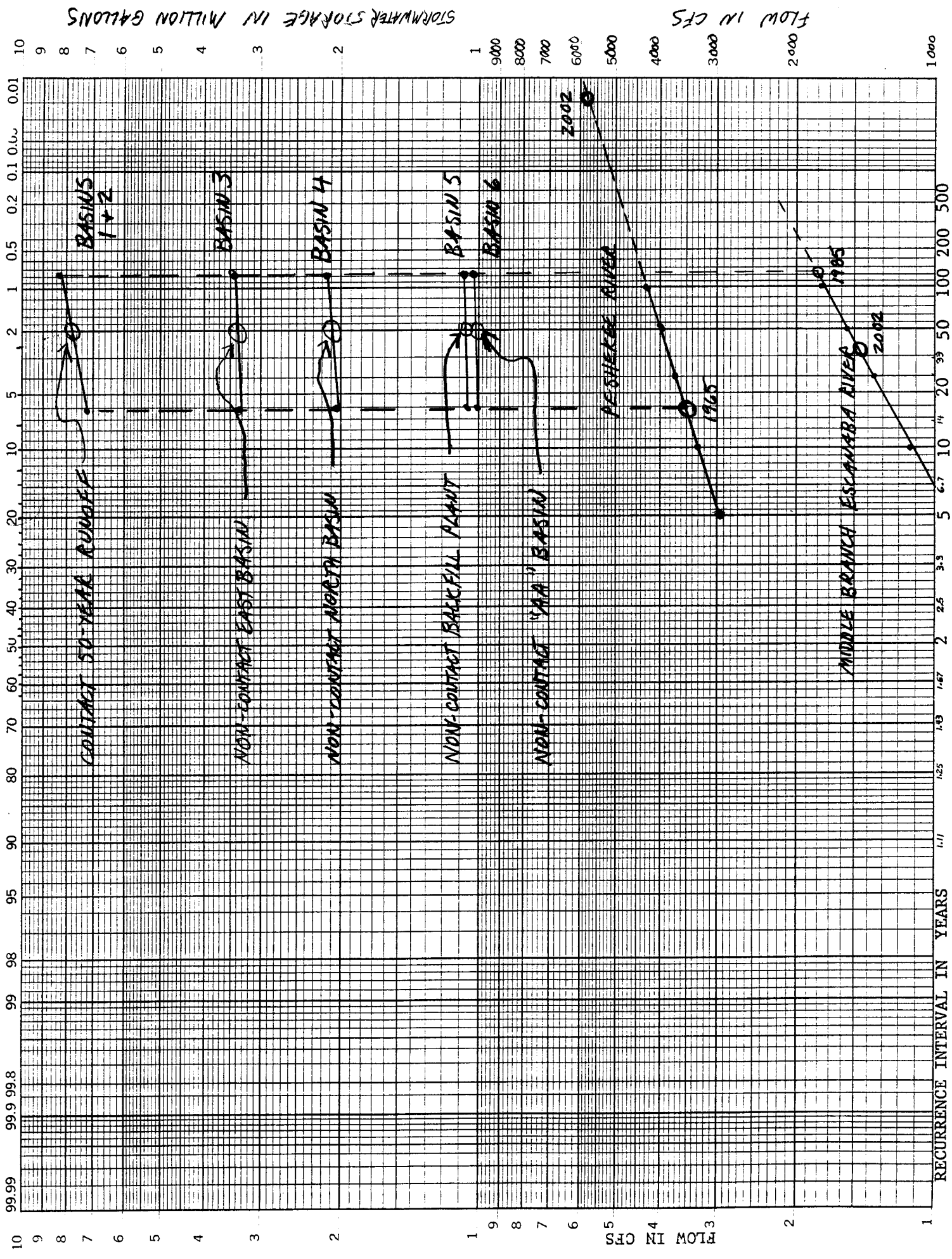


Figure 1. The above graph illustrates the maximum temperature (Red) and minimum temperature (Blue), snow depth in inches (light blue) (y-axis left), and precipitation in inches (green) (y-axis right) for the first 19 days of April 2002 (x-axis) at the National Weather Service Office located in Negaunee Township in Marquette County.



Attachment 2

Basin Sizing Calculations Contact Basin 1 & 2

**Foth & Van Dyke**

Client:	<u>KMC</u>	Scope ID.: <u>04W018</u>
Project:	<u>Eagle Project - Contact Snow Melt Calculations</u>	
Prepared by:	<u>ZXB</u>	Date: <u>10/17/05</u>
Checked by:	<u>MDL</u>	Date: <u>10/17/05</u>

Estimate Storm Water Runoff, 50-year runoff event quantities for the MAIN OPERATIONS AREA of the Eagle Project.
Estimate amount of excess water (to be stored for removal by WWTP) after end of 50-year event.

Basis:

4062200	Closest stream gaging station to mining site (Peshekee River near Champion).
3,970 cfs	50-year stream flow of nearby Peshekee River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1965	Peshekee River flow (3,500 cfs) approximating less than 25-year event (USGS Surface Water for Michigan).
100 gpm	Available flow rate through WWTP for main operations area runoff
1.7 inches	Precipitation during April, 1965 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau).
39 inches	Highest of measured depths of snow at beginning of 4/65 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau).
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
26 days	Snowmelt duration ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau).
32 acres	Main Operations Area

Less than 25-year Runoff (Snowmelt and Precipitation) Calculation:

10,965,225 gallons	Volume of water from main operations area = [depth snow (39 in) x water fraction (0.28)] + Precipitation (1.7 in) x 1 (ft) / 12 (in) x area (32 ac) x 43560 (sf/ac) x 7.48 (gal/cf).
3,744,000 gallons	Volume of water removed to WWTP during 25-year event = WWTP flow (100 gpm) x event duration (26 days) x 1440 min./day.
7,221,225 gallons	Net volume of water to be stored for WWTP treatment = Volume of snowmelt and precipitation from main operations area - volume of snowmelt treated during snowmelt period

**Foth & Van Dyke**

Client:	<u>KMC</u>	Scope ID.: <u>04W018</u>
Project:	<u>Eagle Project - Contact Snow Melt Calculations</u>	
Prepared by:	<u>ZXB</u>	Date: <u>10/17/05</u>
Checked by:	<u>MDL</u>	Date: <u>10/17/05</u>

Estimate Storm Water Runoff, 50-year runoff event quantities for the MAIN OPERATIONS AREA of the Eagle Project.
Estimate amount of excess water (to be stored for removal by WWTP) after end of 50-year event.

Basis:

4057800	Nearby stream gaging station (Middle Branch Escanaba River at Humboldt).
1,760 cfs	100-year stream flow of nearby Middle Branch Escanaba River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1985	Middle Branch Escanaba River flow (1,,800 cfs) approximating greater than 100-year event (USGS Surface Water for Michigan).
100 gpm	Available flow rate through WWTP for main operations area runoff
5.64 inches	Precipitation during April, 1985 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
26 inches	Highest of measured depths of snow at beginning of 4/85 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
20 days	Snowmelt duration ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
32 acres	Main operations area

Greater than 100-year Runoff (Snowmelt and Precipitation) Calculation:

11,225,888 gallons	Volume of water from main operations area = [depth snow (26 in) x water fraction (0.28)] + Precipitation (5.64 in) x 1 (ft) / 12 (in) x area (32 ac) x 43560 (sf/ac) x 7.48 (gal/cf).
2,880,000 gallons	Volume of water removed to WWTP during 100-year event = WWTP flow (100 gpm) x event duration (20 days) x 1440 min./day.
8,345,888 gallons	Net volume of water to be stored for WWTP treatment = Volume of snowmelt and precipitation from main operations area - volume of snowmelt treated during snowmelt period

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KennecottR

Return Event	Total Depth in	Rainfall Type	RNF ID
Dev 2	2.4000	Synthetic Curve	TypeII 24hr
Dev 5	2.8200	Synthetic Curve	TypeII 24hr
Dev 10	3.1500	Synthetic Curve	TypeII 24hr
Dev 25	3.6200	Synthetic Curve	TypeII 24hr
Dev 50	4.0000	Synthetic Curve	TypeII 24hr
Dev100	4.5000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
 (Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Pond Storage ac-ft
*BASIN # 1/ 2 IN	POND	2	5.736	LR	12.0000	70.76		
*BASIN # 1/ 2 IN	POND	5	6.817	LR	12.0000	86.49		
*BASIN # 1/ 2 IN	POND	10	7.677	LR	12.0000	98.83		
*BASIN # 1/ 2 IN	POND	25	8.913	LR	12.0000	116.35		
*BASIN # 1/ 2 IN	POND	50	9.918	LR	12.0000	130.46		
*BASIN # 1/ 2 IN	POND	100	11.249	LR	12.0000	148.95		
*BASIN # 1/ 2 OUT	POND	2	.000		.0500	.00	1448.09	8.986
*BASIN # 1/ 2 OUT	POND	5	.000		.0500	.00	1448.75	10.062
*BASIN # 1/ 2 OUT	POND	10	.000		.0500	.00	1449.26	10.922
*BASIN # 1/ 2 OUT	POND	25	.000		.0500	.00	1449.97	12.165
*BASIN # 1/ 2 OUT	POND	50	.000		.0500	.00	1450.52	13.159
*BASIN # 1/ 2 OUT	POND	100	.000		.0500	.00	1451.22	14.493

TOTAL RUNOFF VOLUME = 14.493 AC-FT
 = 631,315 CU.FT.
 = 4.72 MILLION
 GALLONS

MASTER NETWORK SUMMARY
 SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
 (Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
CONTACT 1 AND 2	AREA	2	5.736	LR	12.0000	70.76		
CONTACT 1 AND 2	AREA	5	6.817	LR	12.0000	86.49		
CONTACT 1 AND 2	AREA	10	7.677	LR	12.0000	98.83		
CONTACT 1 AND 2	AREA	25	8.913	LR	12.0000	116.35		
CONTACT 1 AND 2	AREA	50	9.918	LR	12.0000	130.46		
CONTACT 1 AND 2	AREA	100	11.249	LR	12.0000	148.95		

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTCONTACT1&2REV.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1441.00	-----	.9600	.0000	.000	.000
1442.00	-----	1.0400	2.9992	1.000	1.000
1443.00	-----	1.1300	3.2541	1.085	2.084
1444.00	-----	1.2100	3.5093	1.170	3.254
1445.00	-----	1.3000	3.7642	1.255	4.509
1446.00	-----	1.4000	4.0491	1.350	5.859
1447.00	-----	1.4900	4.3343	1.445	7.303
1448.00	-----	1.5900	4.6192	1.540	8.843
1449.00	-----	1.6900	4.9192	1.640	10.483
1450.00	-----	1.7900	5.2193	1.740	12.223
1451.00	-----	1.9000	5.5342	1.845	14.067
1452.00	-----	2.0100	5.8642	1.955	16.022
1453.00	-----	2.1200	6.1943	2.065	18.087
1454.00	-----	2.2400	6.5392	2.180	20.267
1455.00	-----	2.3600	6.8992	2.300	22.566
1456.00	-----	2.4800	7.2593	2.420	24.986

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Area1} + \text{Area2} + \text{sq.rt.}(\text{Area1}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Area1,Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

LEVEL POOL ROUTING SUMMARY

HYG Dir = C:\Program Files\Haestad\PPKW\Sample\
 Inflow HYG file = NONE STORED - BASIN # 1/ 2 IN Dev100
 Outflow HYG file = NONE STORED - BASIN # 1/ 2 OUT Dev100

Pond Node Data = BASIN # 1/ 2
 Pond Volume Data = BASIN # 1/ 2
 Pond Outlet Data = NONE (retention pond)

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 1444.00 ft
 Starting Volume = 3.254 ac-ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout= .00 cfs
 Time Increment = .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

=====

Peak Inflow	=	148.95 cfs	at	12.0000 hrs
Peak Outflow	=	.00 cfs	at	.0500 hrs

Peak Elevation	=	1451.22 ft
Peak Storage	=	14.493 ac-ft

=====

MASS BALANCE (ac-ft)

+ Initial Vol	=	3.254
+ HYG Vol IN	=	11.249
- Infiltration	=	.000
- HYG Vol OUT	=	.000
- Retained Vol	=	14.493

Unrouted Vol = -.009 ac-ft (.084% of Inflow Volume)

WARNING: Inflow hydrograph truncated on left side.
 WARNING: Inflow hydrograph truncated on right side.

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTCONTACT1&2REV.PPW

.....
TIME OF CONCENTRATION CALCULATOR
.....

Segment #1: Tc: TR-55 Sheet

Mannings n .0160
Hydraulic Length 300.00 ft
2yr, 24hr P 2.4000 in
Slope .010900 ft/ft

Avg.Velocity .86 ft/sec

Segment #1 Time: .0966 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length 620.00 ft
Slope .010600 ft/ft
Unpaved

Avg.Velocity 1.66 ft/sec

Segment #2 Time: .1037 hrs

=====
Total Tc: .2003 hrs
=====

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTCONTACT1&2REV.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow =====

$$Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))$$

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, %

==== SCS TR-55 Shallow Concentrated Flow =====

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved surface:
V = 20.3282 * (Sf**0.5)

$$Tc = (Lf / V) / (3600sec/hr)$$

Where: V = Velocity, ft/sec
Sf = Slope, ft/ft
Tc = Time of concentration, hrs
Lf = Flow length, ft

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTCONTACT1&2REV.PPW

RUNOFF CURVE NUMBER DATA

.....

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C %UC	Adjusted CN
Impervious Areas - Paved parking lo	98	15.150		98.00
Urban Districts - Industrial (avera	88	17.570		88.00

COMPOSITE AREA & WEIGHTED CN ---> 32.720 92.63 (93)

.....

Attachment 3

Basin Sizing Calculations Non-Contact Basin #3

**Foth & Van Dyke**

Client:	KMC	Scope ID.: 04W018
Project:	Eagle Project - NON CONTACT # 3, Storm Water Runoff Calculator	
Prepared by:	ZXB	Date: 10/17/05
Checked by:	MDL	Date: 10/17/05

Estimate Storm Water Runoff, 50-year runoff event quantities for the Non Contact Area # 3 of the Eagle Project.
Assume Infiltration at the rate of 0.52 inch / hr. over the bottom of the basin.

Basis:

4062200 3,970 cfs	Closest Stream gaging Station to Mining Site (Peshkee River near Champion) 50-year stream flow of nearby Peshkee River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1965	Peshkee River Flow (3500 cfs) approximating less than a 25-year event (USGS Surface Water for Michigan).
88 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 in./hr.
1.7 inches	Precipitation during April, 1965 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
39 inches	Highest of measured depths of snow at beginning of 4/65 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5")
26 days	Snowmelt duration ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Water Bureau)
9.85 acres	Non Contact Area # 3

Less than 25-year Runoff (Snowmelt and Precipitation) Calculation:

3,375,233 gallons	Volume of water from non-contact area = [depth snow (39 in) x water fraction (0.28)] + Precipitation (1.7 in) x 1 (ft) / 12 (in) x area (9.85 ac) x 43560 sf/ac x 7.48 (gal/cf).
3,294,720 gallons	Volume of water removed as Infiltration into the Basin during 25-year event
80,513 gallons	Net volume of water to be stored at the basin. Volume of snow melt and precipitation from Non Contact area, volume of snowmelt treated during snowmelt period.

**Foth & Van Dyke**

Client:	<u>KMC</u>	Scope ID:	<u>04W018</u>
Project:	<u>Eagle Project - NON-CONTACT # 3, Storm Water Runoff Calculation</u>		
Prepared by:	<u>ZXB</u>	Date:	<u>10/17/05</u>
Checked by:	<u>MDL</u>	Date:	<u>10/17/05</u>

Estimate Storm Water Runoff, 50-year runoff event quantities for the Non-Contact Area # 3 of the Eagle Project.
Assume Infiltration at the rate of 0.52 inch / hr. over the bottom of the basin.

Basis:

4057800	Nearby stream gaging station (Middle Branch Escanaba River at Humboldt).
1,760 cfs	100-year stream flow of nearby Middle Branch Escanaba River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1985	Middle Branch Escanaba River flow (1,800 cfs) approximating greater than a 100-year event (USGS Surface Water for Michigan).
88 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 inches / hr. (50%)
5.64 inches	Precipitation during April, 1985 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
26 inches	Highest of measured depths of snow at beginning of 4/85 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
20 days	Snowmelt duration ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
9.85 acres	Non-Contact Area # 3

Greater than 100-year Runoff (Snowmelt and Precipitation) Calculation:

3,455,469 gallons	Volume of water from non-contact area = [depth snow (26 in) x water fraction (0.28)] + Precipitation (5.64 in) x 1 (ft) / 12 (in) x area (9.85 ac) x 43560 (sf/ac) x 7.48 (gal/cf).
2,534,400 gallons	Volume of water removed as Infiltration into the basin during 100-year event = Infiltration at the rate of 0.52 inches per hour
921,069 gallons	Net volume of water to be stored at the basin = Volume of snowmelt and precipitation from Non Contact area - volume of snowmelt treated during snowmelt period

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KennecottR

Return Event	Total Depth in	Rainfall Type	RNF ID
Dev 2	2.4000	Synthetic Curve	TypeII 24hr
Dev 5	2.8200	Synthetic Curve	TypeII 24hr
Dev 10	3.1500	Synthetic Curve	TypeII 24hr
Dev 25	3.6200	Synthetic Curve	TypeII 24hr
Dev 50	4.0000	Synthetic Curve	TypeII 24hr
Dev100	4.5000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
 SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
 (Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*BASIN # 3RR IN POND		2	1.314		12.0500	18.85		
*BASIN # 3RR IN POND		5	1.635		12.0500	23.23		
*BASIN # 3RR IN POND		10	1.891		12.0500	26.68		
*BASIN # 3RR IN POND		25	2.259		12.0500	31.57		
*BASIN # 3RR IN POND		50	2.559		12.0500	35.52		
*BASIN # 3RR IN POND		100	2.957		12.0500	40.69		
*BASIN # 3RR OUT POND		2	.000		5.7500	.00	1451.46	1.146
*BASIN # 3RR OUT POND		5	.000		5.1000	.00	1451.82	1.446
*BASIN # 3RR OUT POND		10	.000		4.6500	.00	1452.10	1.691
*BASIN # 3RR OUT POND		25	.000		4.1500	.00	1452.51	2.053
*BASIN # 3RR OUT POND		50	.000		3.8500	.00	1452.84	2.356
*BASIN # 3RR OUT POND		100	.000		3.4500	.00	1453.29	2.770

total runoff = 2.77 acre-feet
 = 120,661 ft³
 = 902,546 gal.

MASTER NETWORK SUMMARY
 SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
 (Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
NON CONTACT 3RR	AREA	2	1.314		12.0500	18.85		
NON CONTACT 3RR	AREA	5	1.635		12.0500	23.23		
NON CONTACT 3RR	AREA	10	1.891		12.0500	26.68		
NON CONTACT 3RR	AREA	25	2.259		12.0500	31.57		
NON CONTACT 3RR	AREA	50	2.559		12.0500	35.52		
NON CONTACT 3RR	AREA	100	2.957		12.0500	40.69		

Page 12.49
Type.... Pond Routing Summary
Name.... BASIN # 3RR OUT Tag: Dev100 Event: 100 yr
File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT3RR.PPW
Storm... TypeII 24hr Tag: Dev100

LEVEL POOL ROUTING SUMMARY

HYG Dir = C:\Program Files\Haestad\PPKW\Sample\
Inflow HYG file = NONE STORED - BASIN # 3RR IN Dev100
Outflow HYG file = NONE STORED - BASIN # 3RR OUT Dev100

Pond Node Data = BASIN # 3RR
Pond Volume Data = BASIN # 3RR
Pond Outlet Data = NONE (retention pond)

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 1450.00 ft
Starting Volume = .000 ac-ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout = .00 cfs
Time Increment = .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

=====

Peak Inflow	=	40.69 cfs	at	12.0500 hrs
Peak Outflow	=	.00 cfs	at	3.4500 hrs

Peak Elevation = 1453.29 ft
Peak Storage = 2.770 ac-ft
=====

MASS BALANCE (ac-ft)

+ Initial Vol = .000
+ HYG Vol IN = 2.957
- Infiltration = .000
- HYG Vol OUT = .000
- Retained Vol = 2.770

Unrouted Vol = -.188 ac-ft (6.346% of Inflow Volume)

WARNING: Mass balance for routing volumes vary by more than .5%

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT3RR.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1450.00	-----	.7400	.0000	.000	.000
1455.00	-----	1.0700	2.6998	4.500	4.500
1460.00	-----	1.4500	3.7656	6.276	10.776

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Areal} + \text{Area2} + \text{sq.rt.}(\text{Areal}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Areal,Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

Type.... Runoff CN-Area
Name.... NON CONTACT 3RR

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT3RR.PPW

RUNOFF CURVE NUMBER DATA

.....

Soil/Surface Description	CN	Area acres	Impervious Adjustment		Adjusted CN
			%C	%UC	
Impervious Areas - Paved parking lo 98		3.540			98.00
Urban Districts - Industrial (avera 88		6.310			88.00

COMPOSITE AREA & WEIGHTED CN ---> 9.850 91.59 (92)

.....

Type.... Tc Calcs
Name.... NON CONTACT 3RR

Page 6.01

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT3RR.PPW

.....
TIME OF CONCENTRATION CALCULATOR
.....

Segment #1: Tc: TR-55 Sheet

Mannings n .0160
Hydraulic Length 300.00 ft
2yr, 24hr P 2.4000 in
Slope .004500 ft/ft

Avg.Velocity .61 ft/sec

Segment #1 Time: .1376 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length 422.00 ft
Slope .004500 ft/ft
Unpaved

Avg.Velocity 1.08 ft/sec

Segment #2 Time: .1083 hrs

=====

Total Tc:	.2459 hrs
-----------	-----------

=====

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT3RR.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow =====

$$Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))$$

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, %

==== SCS TR-55 Shallow Concentrated Flow =====

Unpaved surface:
 $V = 16.1345 * (Sf**.5)$

Paved surface:
 $V = 20.3282 * (Sf**.5)$

$$Tc = (Lf / V) / (3600sec/hr)$$

Where: V = Velocity, ft/sec
Sf = Slope, ft/ft
Tc = Time of concentration, hrs
Lf = Flow length, ft

Attachment 4

Basin Sizing Calculations Non-Contact Basin #4

**Foth & Van Dyke**

Client:	<u>KMC</u>	Scope ID.: <u>04W018</u>
Project:	<u>Eagle Project - NON CONTACT # 4, Storm Water Runoff Calculation</u>	
Prepared by:	<u>ZXB</u>	Date: <u>10/17/05</u>
Checked by:	<u>MDL</u>	Date: <u>10/17/05</u>

Estimate Storm Water Runoff, 50-year runoff event quantities for the Non Contact Area # 4 of the Eagle Project.
Assume Infiltration rate of 0.52 in./hr over the bottom of the basin.

Basis:

4062200	Closest Stream gaging Station to Mining Site (Peshkee River near Champion)
3,970 cfs	50-year stream flow of nearby Peshkee River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1965	Peshkee River Flow (3500 cfs) approximating less than a 25-year event (USGS Surface Water for Michigan).
53 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 in./hr.
1.7 inches	Precipitation during April, 1965 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
39 inches	Highest of measured depths of snow at beginning of 4/65 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
26 days	Snowmelt duration ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Water Bureau)
6.03 acres	Non Contact Area # 4

Less than 25-year Runoff (Snowmelt and Precipitation) Calculation:

2,066,260 gallons	Volume of water from non-contact area = [depth snow (39 in) x water fraction (0.28)] + Precipitation (1.7 in) x 1 (ft) / 12 (in) x area (6.03 ac) x 43560 sf/ac x 7.48 (gal/cf).
1,984,320 gallons	Volume of water removed as Infiltration into the Basin during 25-year event.
81,940 gallons	Net volume of water to be stored at the basin. Volume of snow melt and precipitation from Non Contact area, volume of snowmelt treated during snowmelt period.

**Foth & Van Dyke**

Client:	<u>KMC</u>	Scope ID.: <u>04W018</u>
Project:	<u>Eagle Project - NON-CONTACT # 4, Storm Water Runoff Calculation</u>	
Prepared by:	<u>ZXB</u>	Date: <u>10/17/05</u>
Checked by:	<u>MDL</u>	Date: <u>10/17/05</u>

Estimate Storm Water Runoff, 50-year runoff event quantities for the Non-Contact Area # 4 of the Eagle Project.
Assume Infiltration at the rate of 0.52 inch / hr. over the bottom of the basin.

Basis:

4057800	Nearby stream gaging station (Middle Branch Escanaba River at Humboldt).
1,760 cfs	100-year stream flow of nearby Middle Branch Escanaba River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1985	Middle Branch Escanaba River flow (1,800 cfs) approximating greater than a 100-year event (USGS Surface Water for Michigan).
53 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 inches / hr. (50%)
5.64 inches	Precipitation during April, 1985 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
26 inches	Highest of measured depths of snow at beginning of 4/85 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
20 days	Snowmelt duration ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
6.03 acres	Non Contact Area # 4

Greater than 100-year Runoff (Snowmelt and Precipitation) Calculation:

2,115,378 gallons	Volume of water from non-contact area = [depth snow (26 in) x water fraction (0.28)] + Precipitation (5.64 in) x 1 (ft) / 12 (in) x area (6.03 ac) x 43560 (sf/ac) x 7.48 (gal/cf).
1,526,400 gallons	Volume of water removed as Infiltration into the basin during 100-year event = Infiltration at the rate of 0.52 inches per hour
588,978 gallons	Net volume of water to be stored at the basin = Volume of snowmelt and precipitation from Non Contact area - volume of snowmelt treated during snowmelt period

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KennecottR

Return Event	Total Depth in	Rainfall Type	RNF ID
Dev 2	2.4000	Synthetic Curve	TypeII 24hr
Dev 5	2.8200	Synthetic Curve	TypeII 24hr
Dev 10	3.1500	Synthetic Curve	TypeII 24hr
Dev 25	3.6200	Synthetic Curve	TypeII 24hr
Dev 50	4.0000	Synthetic Curve	TypeII 24hr
Dev100	4.5000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
 SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
 (Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*BASIN # 4R	IN	POND 2	.552		12.0500	8.29		
*BASIN # 4R	IN	POND 5	.723		12.0500	10.83		
*BASIN # 4R	IN	POND 10	.862		12.0000	12.90		
*BASIN # 4R	IN	POND 25	1.066		12.0000	15.96		
*BASIN # 4R	IN	POND 50	1.235		12.0000	18.47		
*BASIN # 4R	IN	POND 100	1.462		12.0000	21.80		
*BASIN # 4R	OUT	POND 2	.000		9.2000	.00	1451.00	.470
*BASIN # 4R	OUT	POND 5	.000		8.4000	.00	1451.31	.623
*BASIN # 4R	OUT	POND 10	.000		7.8000	.00	1451.56	.750
*BASIN # 4R	OUT	POND 25	.000		7.1000	.00	1451.93	.942
*BASIN # 4R	OUT	POND 50	.000		6.6000	.00	1452.24	1.106
*BASIN # 4R	OUT	POND 100	.000		6.1000	.00	1452.65	1.331

total runoff = 1.331 acre-feet
 = 57,978 ft³
 = 433,678 gal

Name.... Watershed

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT4R.PPW

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
NON CONTACT 4R	AREA	2	.552		12.0500	8.29		
NON CONTACT 4R	AREA	5	.723		12.0500	10.83		
NON CONTACT 4R	AREA	10	.862		12.0000	12.90		
NON CONTACT 4R	AREA	25	1.066		12.0000	15.96		
NON CONTACT 4R	AREA	50	1.235		12.0000	18.47		
NON CONTACT 4R	AREA	100	1.462		12.0000	21.80		

LEVEL POOL ROUTING SUMMARY

HYG Dir = C:\Program Files\Haestad\PPKW\Sample\
Inflow HYG file = NONE STORED - BASIN # 4R IN Dev100
Outflow HYG file = NONE STORED - BASIN # 4R OUT Dev100

Pond Node Data = BASIN # 4R
Pond Volume Data = BASIN # 4R
Pond Outlet Data = NONE (retention pond)

No Infiltration

INITIAL CONDITIONS

Starting WS Elev = 1450.00 ft
Starting Volume = .000 ac-ft
Starting Outflow = .00 cfs
Starting Infiltr. = .00 cfs
Starting Total Qout= .00 cfs
Time Increment = .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

=====

Peak Inflow	=	21.80 cfs	at	12.0000 hrs
Peak Outflow	=	.00 cfs	at	6.1000 hrs

Peak Elevation = 1452.65 ft
Peak Storage = 1.331 ac-ft

MASS BALANCE (ac-ft)

+ Initial Vol = .000
+ HYG Vol IN = 1.462
- Infiltration = .000
- HYG Vol OUT = .000
- Retained Vol = 1.331

Unrouted Vol = -.131 ac-ft (8.964% of Inflow Volume)

WARNING: Mass balance for routing volumes vary by more than .5%

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT4R.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1450.00	-----	.4500	.0000	.000	.000
1455.00	-----	.6600	1.6550	2.758	2.758
1460.00	-----	.9200	2.3592	3.932	6.690

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Area1} + \text{Area2} + \text{sq.rt.}(\text{Area1}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Area1,Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT4R.PPW

.....
TIME OF CONCENTRATION CALCULATOR
.....

Segment #1: Tc: TR-55 Sheet

Mannings n .0160
Hydraulic Length 300.00 ft
2yr, 24hr P 2.4000 in
Slope .005000 ft/ft

Avg.Velocity .63 ft/sec

Segment #1 Time: .1319 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length 360.00 ft
Slope .005000 ft/ft
Unpaved

Avg.Velocity 1.14 ft/sec

Segment #2 Time: .0877 hrs

=====
Total Tc: .2196 hrs
=====

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT4R.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow =====

$$Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))$$

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, %

==== SCS TR-55 Shallow Concentrated Flow =====

Unpaved surface:
 $V = 16.1345 * (Sf**.5)$

Paved surface:
 $V = 20.3282 * (Sf**.5)$

$$Tc = (Lf / V) / (3600sec/hr)$$

Where: V = Velocity, ft/sec
Sf = Slope, ft/ft
Tc = Time of concentration, hrs
Lf = Flow length, ft

Type.... Runoff CN-Area
Name.... NON CONTACT 4R

Page 7.01

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT4R.PPW

RUNOFF CURVE NUMBER DATA

.....

Soil/Surface Description	CN	Area acres	Impervious Adjustment		Adjusted CN
			%C	%UC	
Gravel Storage Area	85	5.210			85.00
Dirt Retention Basin	82	.820			82.00

COMPOSITE AREA & WEIGHTED CN ---> 6.030 84.59 (85)

.....

Attachment 5

Basin Sizing Calculations Non-Contact Basin #5

**Foth & Van Dyke**

Client:	KMC	Scope ID.: 04W018
Project:	Eagle Project - NON CONTACT # 5, Storm Water Runoff Calculation	
Prepared by:	ZXB	Date: 10/17/05
Checked by:	MDL	Date: 10/17/05

Estimate Storm Water Runoff, 50-year runoff event quantities for the Non Contact Area # 5 of the Eagle Project.
Assume Infiltration rate of 0.52 in./hr over the bottom of the basin.

Basis:

4062200	Closest Stream gaging Station to Mining Site (Peshkee River near Champion)
3,970 cfs	50-year stream flow of nearby Peshkee River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1965	Peshkee River Flow (3500 cfs) approximating less than a 25-year event (USGS Surface Water for Michigan).
40 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 in./hr.
1.7 inches	Precipitation during April, 1965 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
39 inches	Highest of measured depths of snow at beginning of 4/65 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5").
26 days	Snowmelt duration ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Water Bureau)
3.05 acres	Non Contact Area # 5

Less than 25-year Runoff (Snowmelt and Precipitation) Calculation:

1,045,123 gallons	Volume of water from non-contact area = [depth snow (39 in) x water fraction (0.28)] + Precipitation (1.7 in) x 1 (ft) / 12 (in) x area (3.05 ac) x 43560 sf/ac x 7.48 (gal/cf).
1,497,600 gallons	Volume of water removed as Infiltration into the Basin during 25-year event
(452,477) gallons	Net volume of water to be stored at the basin. Volume of snow melt and precipitation from Non Contact area, volume of snowmelt treated during snowmelt period.



Client:	KMC	Scope ID.:	04W018
Project:	Eagle Project - NON-CONTACT # 5, Storm Water Runoff Calculation		
Prepared by:	ZXB	Date:	10/17/05
Checked by:	MDL	Date:	10/17/05

Estimate Storm Water Runoff, 50-year runoff event quantities for the Non-Contact Area # 5 of the Eagle Project.
Assume Infiltration at the rate of 0.52 inch / hr. over the bottom of the basin.

Basis:

4057800	Nearby stream gaging station (Middle Branch Escanaba River at Humboldt).
1,760 cfs	100-year stream flow of nearby Middle Branch Escanaba River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1985	Middle Branch Escanaba River flow (1,800 cfs) approximating greater than a 100-year event (USGS Surface Water for Michigan).
40 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 inches / hr. (50%)
5.64 inches	Precipitation during April, 1985 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
26 inches	Highest of measured depths of snow at beginning of 4/85 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
20 days	Snowmelt duration ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
3.05 acres	Non Contact Area # 5

Greater than 100-year Runoff (Snowmelt and Precipitation) Calculation:

1,069,967 gallons	Volume of water from non-contact area = [depth snow (26 in) x water fraction (0.28)] + Precipitation (5.64 in) x 1 (ft) / 12 (in) x area (3.05 ac) x 43560 (sf/ac) x 7.48 (gal/cf).
1,152,000 gallons	Volume of water removed as Infiltration into the basin during 100-year event = Infiltration at the rate of 0.52 inches per hour
(82,033) gallons	Net volume of water to be stored at the basin = Volume of snowmelt and precipitation from Non Contact area - volume of snowmelt treated during snowmelt period

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KennecottR

Return Event	Total Depth in	Rainfall Type	RNF ID
Dev 2	2.4000	Synthetic Curve	TypeII 24hr
Dev 5	2.8200	Synthetic Curve	TypeII 24hr
Dev 10	3.1500	Synthetic Curve	TypeII 24hr
Dev 25	3.6200	Synthetic Curve	TypeII 24hr
Dev 50	4.0000	Synthetic Curve	TypeII 24hr
Dev100	4.5000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*BASIN # 5R	IN	POND 2	.295		11.9500	5.33		
*BASIN # 5R	IN	POND 5	.384		11.9000	6.92		
*BASIN # 5R	IN	POND 10	.455		11.9000	8.24		
*BASIN # 5R	IN	POND 25	.560		11.9000	10.14		
*BASIN # 5R	IN	POND 50	.647		11.9000	11.69		
*BASIN # 5R	IN	POND 100	.763		11.9000	13.75		
*BASIN # 5R	OUT	POND 2	.000		8.7500	.00	1446.82	.292
*BASIN # 5R	OUT	POND 5	.000		7.9500	.00	1447.06	.383
*BASIN # 5R	OUT	POND 10	.000		7.3500	.00	1447.24	.453
*BASIN # 5R	OUT	POND 25	.000		6.7000	.00	1447.51	.557
*BASIN # 5R	OUT	POND 50	.000		6.2000	.00	1447.73	.644
*BASIN # 5R	OUT	POND 100	.000		5.7000	.00	1448.02	.763

total runoff = 0.763 acre-feet
 = 33,236 ft³
 = 248,607 gal

Name.... Watershed

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT5R.PPW

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Return Type Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
NON CONTACT 5R	AREA 2	.295		11.9500	5.33		
NON CONTACT 5R	AREA 5	.384		11.9000	6.92		
NON CONTACT 5R	AREA 10	.455		11.9000	8.24		
NON CONTACT 5R	AREA 25	.560		11.9000	10.14		
NON CONTACT 5R	AREA 50	.647		11.9000	11.69		
NON CONTACT 5R	AREA 100	.763		11.9000	13.75		

LEVEL POOL ROUTING SUMMARY

HYG Dir = C:\Program Files\Haestad\PPKW\Sample\
 Inflow HYG file = NONE STORED - BASIN # 5R IN Dev100
 Outflow HYG file = NONE STORED - BASIN # 5R OUT Dev100

Pond Node Data = BASIN # 5R
 Pond Volume Data = BASIN # 5R
 Pond Outlet Data = NONE (retention pond)

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 1446.00 ft
 Starting Volume = .000 ac-ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout= .00 cfs
 Time Increment = .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

=====

Peak Inflow	=	13.75 cfs	at	11.9000 hrs
Peak Outflow	=	.00 cfs	at	5.7000 hrs

Peak Elevation	=	1448.02 ft
Peak Storage	=	.763 ac-ft

=====

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	.763
- Infiltration	=	.000
- HYG Vol OUT	=	.000
- Retained Vol	=	.763

Unrouted Vol = -.000 ac-ft (.049% of Inflow Volume)

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT5R.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1446.00	-----	.3400	.0000	.000	.000
1447.00	-----	.3800	1.0794	.360	.360
1448.00	-----	.4100	1.1847	.395	.755
1449.00	-----	.4500	1.2895	.430	1.185
1450.00	-----	.4900	1.4096	.470	1.654
1451.00	-----	.5300	1.5296	.510	2.164
1452.00	-----	.5700	1.6496	.550	2.714
1453.00	-----	.6200	1.7845	.595	3.309
1454.00	-----	.6600	1.9197	.640	3.949

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Areal} + \text{Area2} + \text{sq.rt.}(\text{Areal}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Areal,Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT5R.PPW

.....
TIME OF CONCENTRATION CALCULATOR
.....

Segment #1: Tc: TR-55 Sheet

Mannings n .0160
Hydraulic Length 150.00 ft
2yr, 24hr P 2.4000 in
Slope .010900 ft/ft

Avg.Velocity .75 ft/sec

Segment #1 Time: .0555 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length 150.00 ft
Slope .010900 ft/ft
Unpaved

Avg.Velocity 1.68 ft/sec

Segment #2 Time: .0247 hrs

=====
Total Tc: .0802 hrs

Calculated Tc < Min.Tc:
Use Minimum Tc...
Use Tc = .0833 hrs
=====

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT5R.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow =====

$$Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))$$

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, %

==== SCS TR-55 Shallow Concentrated Flow =====

Unpaved surface:

$$V = 16.1345 * (Sf**0.5)$$

Paved surface:

$$V = 20.3282 * (Sf**0.5)$$

$$Tc = (Lf / V) / (3600sec/hr)$$

Where: V = Velocity, ft/sec
Sf = Slope, ft/ft
Tc = Time of concentration, hrs
Lf = Flow length, ft

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACT5R.PPW

RUNOFF CURVE NUMBER DATA

.....

Soil/Surface Description	CN	Area acres	Impervious Adjustment		Adjusted CN
			%C	%UC	
Impervious Area	98	.350			98.00
Pervious Gravel	85	2.700			85.00

COMPOSITE AREA & WEIGHTED CN ---> 3.050 86.49 (86)

.....

Attachment 6

Basin Sizing Calculations Non-Contact Basin #6

**Foth & Van Dyke**

Client:	KMC	Scope ID: 04W018
Project:	Eagle Project - Non Contact Basin @ CTH"AAA"	Storm Runoff Calc.
Prepared by:	ZXB	Date: 10/17/05
Checked by:	MDL	Date: 10/17/05

Estimate Storm Water Runoff, 50-year runoff event quantities for Non-Contact Area of the Basin @ CTH"AAA" of the Eagle Project.
Assume Infiltration rate of 0.52 in./hr over the bottom of the basin.

Basis:

4062200	Closest Stream gaging Station to Mining Site (Peshkee River near Champion)
3,970 cfs	50-year stream flow of nearby Peshkee River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1965	Peshkee River Flow (3500 cfs) approximating less than a 25-year event (USGS Surface Water for Michigan).
34 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 in./hr.
1.7 inches	Precipitation during April, 1965 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
39 inches	Highest of measured depths of snow at beginning of 4/65 event ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Weather Bureau)
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
26 days	Snowmelt duration ("Climatological Data - Michigan", April 1965, Volume 80 No.4, U.S. Dept. of Commerce, Water Bureau)
3.03 acres	Non Contact Area for Basin At CTH AAA

Less than 25-year Runoff (Snowmelt and Precipitation) Calculation:

1,038,270 gallons	Volume of water from non-contact area = [depth snow (39 in) x water fraction (0.28)] + Precipitation (1.7 in) x 1 (ft) / 12 (in) x area (3.03 ac) x 43560 sf/ac x 7.48 (gal/cf).
1,272,960 gallons	Volume of water removed as Infiltration into the Basin during 25-year event
(234,690) gallons	Net volume of water to be stored at the basin. Volume of snow melt and precipitation from Non-Contact area, volume of snowmelt treated during snowmelt period.

**Foth & Van Dyke**

Client:	<u>KMC</u>	Scope ID.: <u>04W018</u>
Project:	<u>Eagle Project - Non Contact Basin @ CTH AAA Storm Runoff Calc.</u>	
Prepared by:	<u>ZXB</u>	Date: <u>10/17/05</u>
Checked by:	<u>MDL</u>	Date: <u>10/17/05</u>

Estimate Storm Water Runoff, 100+ year runoff event quantities for Non-Contact Area of the Basin @ CTH AAA of the Eagle Project
Assume Infiltration at the rate of 0.52 inch / hr. over the bottom of the basin.

Basis:

4057800	Nearby stream gaging station (Middle Branch Escanaba River at Humboldt).
1,760 cfs	100-year stream flow of nearby Middle Branch Escanaba River from gaging and statistical modeling ("Statistical Models for Estimating Flow Characteristic of Michigan Streams", USGS, Water Resources Investigations Report 84-4207).
April 1985	Middle Branch Escanaba River flow (1,800 cfs) approximating greater than a 100-year event (USGS Surface Water for Michigan).
34 gpm	Infiltration Rate obtained from the Soil Bore data is 0.52 inches / hr. (50%)
5.64 inches	Precipitation during April, 1985 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
26 inches	Highest of measured depths of snow at beginning of 4/85 event ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
0.28	Water fraction of snow pack (conservative estimate based on NOAA, Sieveking and LaRosa, estimate for 2002 ~over 11" of water in 41 inches of snow - used 11.5".)
20 days	Snowmelt duration ("Climatological Data - Michigan", April 1985, Volume 100 No.4, NOAA).
3.03 acres	Non Contact Area for Basin at CTH AAA

Greater than 100-year Runoff (Snowmelt and Precipitation) Calculation:

1,062,951 gallons	Volume of water from non-contact area = [depth snow (26 in) x water fraction (0.28)] + Precipitation (5.64 in) x 1 (ft) / 12 (in) x area (3.03 ac) x 43560 (sf/ac) x 7.48 (gal/cf).
979,200 gallons	Volume of water removed as Infiltration into the basin during 100-year event = Infiltration at the rate of 0.52 inches per hour
83,751 gallons	Net volume of water to be stored at the basin = Volume of snowmelt and precipitation from Non-Contact area - volume of snowmelt treated during snowmelt period

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KennecottR

Return Event	Total Depth in	Rainfall Type	RNF ID	
Dev 2	2.4000	Synthetic Curve	TypeII	24hr
Dev 5	2.8200	Synthetic Curve	TypeII	24hr
Dev 10	3.1500	Synthetic Curve	TypeII	24hr
Dev 25	3.6200	Synthetic Curve	TypeII	24hr
Dev 50	4.0000	Synthetic Curve	TypeII	24hr
Dev100	4.5000	Synthetic Curve	TypeII	24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
ACCESS ROAD	AREA	2	.278		12.1000	3.49		
ACCESS ROAD	AREA	5	.363		12.1000	4.59		
ACCESS ROAD	AREA	10	.433		12.1000	5.48		
ACCESS ROAD	AREA	25	.536		12.1000	6.77		
ACCESS ROAD	AREA	50	.621		12.1000	7.83		
ACCESS ROAD	AREA	100	.735		12.1000	9.23		
*BASIN # AAAR IN	POND	2	.278		12.1000	3.49		
*BASIN # AAAR IN	POND	5	.363		12.1000	4.59		
*BASIN # AAAR IN	POND	10	.433		12.1000	5.48		
*BASIN # AAAR IN	POND	25	.536		12.1000	6.77		
*BASIN # AAAR IN	POND	50	.621		12.1000	7.83		
*BASIN # AAAR IN	POND	100	.735		12.1000	9.23		

Name.... Watershed

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACTAAAR.PPW

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*BASIN # AAAR OUT POND		2	.000		9.3000	.00	1412.79	.238
*BASIN # AAAR OUT POND		5	.000		8.5000	.00	1413.03	.315
*BASIN # AAAR OUT POND		10	.000		7.9500	.00	1413.23	.379
*BASIN # AAAR OUT POND		25	.000		7.2000	.00	1413.52	.475
*BASIN # AAAR OUT POND		50	.000		6.7500	.00	1413.76	.557
*BASIN # AAAR OUT POND		100	.000		6.2000	.00	1414.08	.670

LEVEL POOL ROUTING SUMMARY

HYG Dir = C:\Program Files\Haestad\PPKW\Sample\
 Inflow HYG file = NONE STORED - BASIN # AAAR IN Dev100
 Outflow HYG file = NONE STORED - BASIN # AAAR OUT Dev100

Pond Node Data = BASIN # AAAR
 Pond Volume Data = BASIN # AAAR
 Pond Outlet Data = NONE (retention pond)

No Infiltration

INITIAL CONDITIONS

 Starting WS Elev = 1412.00 ft
 Starting Volume = .000 ac-ft
 Starting Outflow = .00 cfs
 Starting Infiltr. = .00 cfs
 Starting Total Qout = .00 cfs
 Time Increment = .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

=====

Peak Inflow	=	9.23 cfs	at	12.1000 hrs
Peak Outflow	=	.00 cfs	at	6.2000 hrs

Peak Elevation	=	1414.08 ft
Peak Storage	=	.670 ac-ft

=====

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	.735
- Infiltration	=	.000
- HYG Vol OUT	=	.000
- Retained Vol	=	.670

Unrouted Vol = -.065 ac-ft (8.836% of Inflow Volume)

WARNING: Mass balance for routing volumes vary by more than .5%

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACTAAAR.PPW

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1412.00	-----	.2900	.0000	.000	.000
1416.00	-----	.4200	1.0590	1.412	1.412
1420.00	-----	.5900	1.5078	2.010	3.422

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2} - \text{EL1}) * (\text{Areal} + \text{Area2} + \text{sq.rt.}(\text{Areal} * \text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment
 Areal, Area2 = Areas computed for EL1, EL2, respectively
 Volume = Incremental volume between EL1 and EL2

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACTAAAR.PPW

.....
TIME OF CONCENTRATION CALCULATOR
.....

Segment #1: Tc: TR-55 Sheet

Mannings n .0880
Hydraulic Length 50.00 ft
2yr, 24hr P 2.4000 in
Slope .010000 ft/ft

Avg.Velocity .15 ft/sec

Segment #1 Time: .0933 hrs

Segment #2: Tc: TR-55 Channel

Flow Area 18.0000 sq.ft
Wetted Perimeter 15.65 ft
Hydraulic Radius 1.15 ft
Slope .003800 ft/ft
Mannings n .0450
Hydraulic Length 2000.00 ft

Avg.Velocity 2.24 ft/sec

Segment #2 Time: .2479 hrs

=====
Total Tc: .3412 hrs
=====

File.... C:\Program Files\Haestad\PPKW\Sample\KENNECOTTNONCONTACTAAAR.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow =====

$$Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))$$

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, %

==== SCS Channel Flow =====

$$R = Aq / Wp$$
$$V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n$$

$$Tc = (Lf / V) / (3600sec/hr)$$

Where: R = Hydraulic radius
Aq = Flow area, sq.ft.
Wp = Wetted perimeter, ft
V = Velocity, ft/sec
Sf = Slope, ft/ft
n = Mannings n
Tc = Time of concentration, hrs
Lf = Flow length, ft

Type.... Runoff CN-Area
Name.... ACCESS ROAD

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RUNOFF CURVE NUMBER DATA

.....

Soil/Surface Description CN Area Impervious Adjusted
 acres Adjustment CN
 %C %UC -----
Pervious Gravel 85 3.030 85.00

COMPOSITE AREA & WEIGHTED CN ---> 3.030 85.00 (85)
.....