
Appendix B

1959 Duck Lake Level Report of Special Investigation

DUCK LAKE LEVEL CONTROL

GRAND TRAVERSE COUNTY

REPORT OF SPECIAL INVESTIGATION

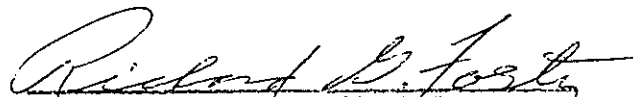
June 1959

MICHIGAN DEPARTMENT OF CONSERVATION
ENGINEERING AND ARCHITECTURE

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DUCK LAKE LEVEL CONTROL
Grand Traverse County

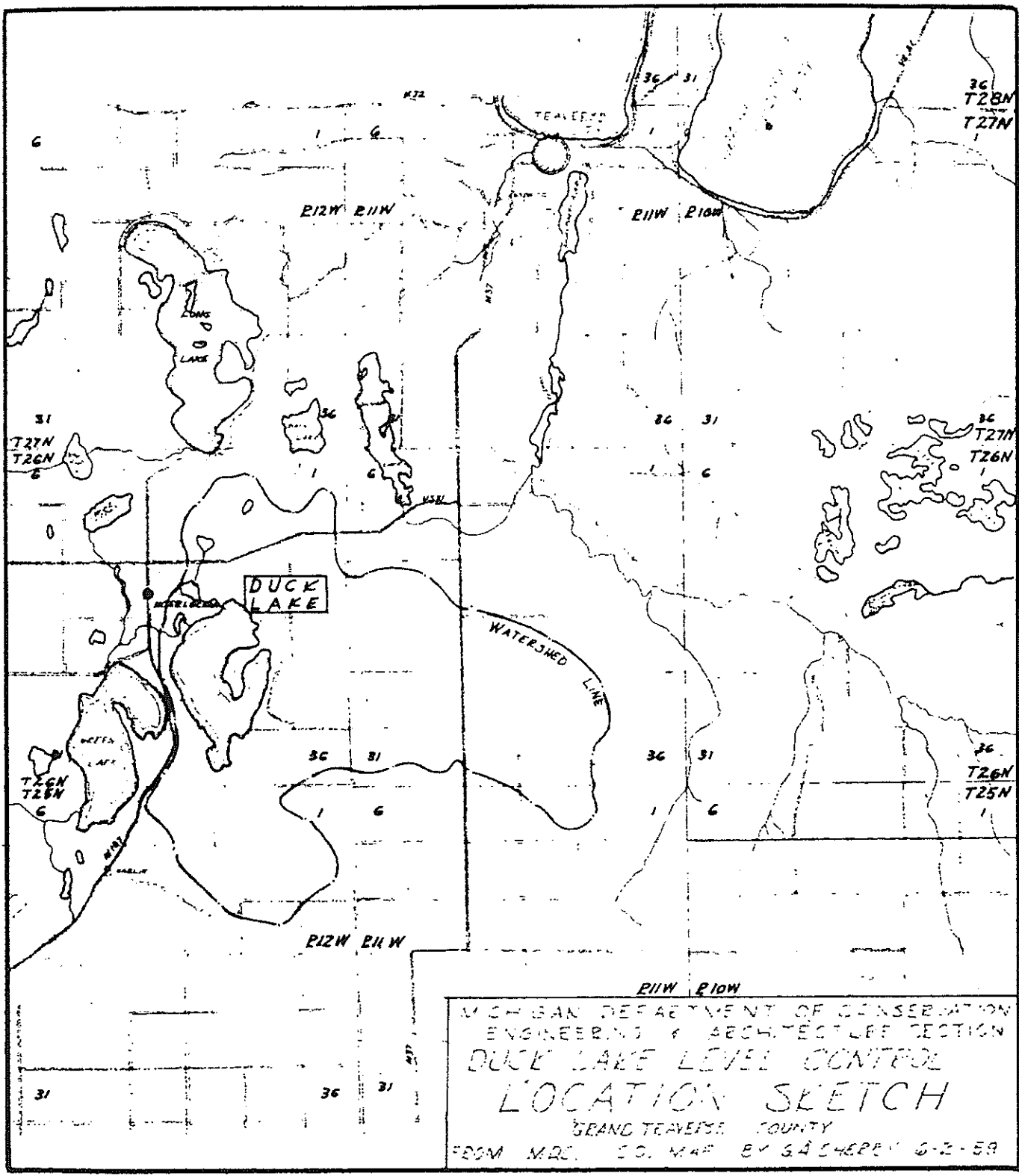
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WMP 6/4/59



DUCK LAKE LEVEL CONTROL

I - INTRODUCTION

It is a local concept that the levels of Duck Lake are influenced to some degree by the remains of an old dam about one and one-half mile downstream from the lake. There have been complaints about low lake levels during the summer season in recent years, and the inference that changes in the outlet control have been responsible. It is more logical to conclude that Duck Lake was low as a result of deficient precipitation and receding ground water levels.

Riparian owners on Duck Lake decided to organize a group to seek stabilization of Duck Lake at a level that would benefit the majority of those interested in the lake. The property owners submitted a petition to the Grand Traverse County Board of Supervisors, requesting action in this matter. The Board directed the Prosecuting Attorney to proceed and February 6, 1959 was set as a date for hearing in Circuit Court to establish the level of Duck Lake. Notice of the hearing was received by the Conservation Department December 24, 1958. An inquiry from the Department to the Prosecuting Attorney prompted a request dated January 13, 1959, for the Conservation Department to testify as to Duck Lake levels that would best suit Department interests.

Conservation Department engineers made a brief survey of the developed frontage on Duck Lake at Interlochen State Park on January 19, 1959. This was all that the work schedule would permit at that time. A telephone conference between an Assistant Attorney General and Judge Danford, Attorney for the Lake Association, led to the conclusion that the Lake level hearing should be postponed to allow time to make a more complete investigation, in order to provide the minimum amount of data needed for a lake level determination.

Interested State agencies were assured that the official hearing would be postponed, however, a brief hearing was held, as scheduled, on February 6, 1959, and we are advised that some testimony was taken from the interested local parties who appeared in Court. The hearing was then continued to June 18, 1959 to allow time for completion of the investigation reported herewith.

II - SCOPE OF FIELD INVESTIGATION

A preliminary survey of the Interlochen State Park frontage on Duck Lake in January 1959 indicated the need for more information before taking the matter to court for a lake level determination. A standard U. S. Geological Survey staff gage* was installed at the north end of the State Park to provide a lake stage record through the spring breakup. Daily lake stage observations are available since April 9, 1959. The gage was tied-in to mean sea level datum by leveling from U.S.G.S. Bench Mark TT 485 1932 and the zero* of the gage found to be 819.48 feet above mean sea level.

Field surveys completed during the week of May 11, 1959 included Beach Profiles at numerous locations around Duck Lake. The locations of these profiles are shown on the area map and are plotted on other sheets of plan No. N 28 A, which accompanies this report.

The location and description of these Beach Profiles is listed below for reference.

BEACH PROFILE LOCATIONS

<u>No.</u>	<u>Side of Lake</u>	<u>Location or Owner</u>
1	Northwest	H. Theil - Just east of outlet
2	North	Forestry property
3	East end peninsula	At culvert through road
4	Northwest side peninsula	Williamson
5	Southeast end peninsula	Thomas
6	East	1/4 mile north of Rainbow Pond
7	East	P. M. Boyd
8	West	Pennington
9	West	State Park-South Picnic Grounds
10	West	State Park-Central Bathing Beach
11	West	State Park-North of Concession Stand
12	West	Music Camp - Boat house
13	Northwest	300' Southwest of outlet

*See Appendix, Terminology

A conference with the President of the Duck Lake Improvement Association revealed that the lake level that existed during the survey was generally satisfactory to all the riparian owners who he was able to contact during the previous few days. Duck Lake level on May 12, 1959 was at 17.86 gage (added to zero elevation 819.48) which is equal to 837.34 feet above mean sea level.

The railroad spike reference mark just north of Pennington's cottage on the west shore, just south of the State Park, was found to be elevation 841.53 feet above mean sea level. This spike was set by the Institute for Fisheries Research, Michigan Department of Conservation during their inventory for mapping the lake in January 1950.

The bench mark spike set by Norton and Robbins' engineers, in the State Park, 70 feet northeast of new bath house, was included in our levels.

A stream profile and cross sections were surveyed at the outlet of the lake to provide data for determining the feasibility of locating a dam at this site.

A topographic survey was made at the existing dam site and basic information was obtained on the outlet, from the dam site to Green Lake, to provide data on outlet channel capacity.

III - DISCUSSION OF LAKE LEVELS

A. Desirable Levels for Duck Lake

The Parks and Recreation Division of the Michigan Department of Conservation arrived at a normal lake level in the summer of 1952 to be used as a guide to design elevations for bathing beach, docks, sewage disposal systems and other installations at Interlochen State Park. This design lake level is elevation 837.3 feet above mean sea level datum. This design level fits favorably with present facilities and future installations can be adapted to the same level. Any departure from this design lake level should be lower rather than higher to maintain the minimum freeboard desired at the State Park.

The sewage disposal system for the bathing beach toilet and main campground at the park has a minimum elevation of 839.7, providing 2.4 feet freeboard above the design lake level elevation of 837.3. The sewage system at the south campground is somewhat lower with a minimum elevation of 838.5, but this tile disposal field is over the divide toward Green Lake and 500 or more feet from Duck Lake, so the level of Duck Lake probably has little or no influence on operation of this disposal system.

Private riparian owners available at the time of the field survey, May 1959, were contacted by Mr. Conning, President of the Duck Lake Improvement Association. Mr. Conning found that no known damage had occurred as a result of the 1959 spring high lake level, elevation 837.73 feet above mean sea level and that all those contacted were satisfied with the lake level that existed early in the week of May 10, 1959, when Duck Lake was between elevations 837.5 and 837.4.

The lake level during the survey was near optimum for boat passage through the culvert at Beach Profile 3 near the east end of the peninsula.

The Duck Lake level at the time of survey, May 1959, was not damaging to the State owned frontage on the north end and south end of the lake. This property is in the Five Lake State Forest and the Forestry Division of the Michigan Department of Conservation advises that they do not plan to improve or develop this property, so Duck Lake levels are not a critical issue with respect to this frontage.

Field investigation and contacts with riparian owners indicate, that a normal summer level at elevation 837.3 feet above mean sea level datum should prove generally satisfactory and beneficial to all interests.

B. Past Lake Levels

Daily lake level records for Duck Lake are available for only a few months since a gage was established by the Parks Division of the Michigan Department of Conservation on April 9, 1959. Thus a resume' pointing out long term means, maximums and minimums is impossible. A

tabulation of miscellaneous lake levels is shown below, including excerpts from the above short term record.

<u>ELEVATION</u>	<u>DATE</u>
837.35	July 6, 1938
837.43	Jan. 10, 1950
837.22	Aug. 1, 1952
837.30	Aug. 5, 1952
837.40	Sept. 19, 1953
836.6	Aug. 23, 1958
836.90	Jan. 20, 1959
837.78	April 20, 1959
837.34	May 12, 1959
837.13	May 19, 1959

A very general correlation of the above data with daily lake level records on Green Lake, available since 1942, indicates that the normal August-September lake level on Duck Lake lies somewhere between elevations 836.7 and 837.4.

4/17/59 7:04 PM 9090 17.16
819.42
836.67

IV - MAINTENANCE OF FUTURE LAKE LEVELS

An analysis was made of flood runoff from the 35 square mile Duck Lake watershed and of the adequacy of the existing natural outlet. Under conditions of abnormally heavy base flows during late winter and early spring, Duck Lake can be expected to reach a level of elevation 837.5. Then, if a flood runoff follows, having a 25 year recurrence interval, the lake can be expected to reach a maximum level of elevation 838.2. Although this lake level is definitely higher than can be tolerated as a normal level, its infrequent occurrence, its short duration, and the time of year during which it will normally occur, makes this point of little importance. Field investigation indicates that this maximum level of elevation 838.2 and the high winter level of elevation 837.5 will not cause any major property damage. To lower these levels would require outlet improvements which does not appear to be economically justified.

A desirable normal summer level can be maintained by the construction of a control dam in the outlet. The most desirable dam site is that at the edge of the lake. Although a dam at the old dam site, about 6600 feet below the lake, would also satisfactorily control Duck Lake levels, the higher head at this lower site would require a more expensive structure and would also require acquisition of flooding rights along 6600 feet of the outlet.

The proposed dam would have 3 - five foot bays, a sill at elevation 835.0 and stop logs to maintain a desirable level throughout periods of varying flow. The top of the structure and adjoining dike should be placed at elevation 840.0 to prevent damage and possible destruction by overtopping. This proposed dam will maintain a normal summer level at elevation 837.3 as discussed previously or any other reasonable summer level. Normal summer inflow to the lake should be enough so that the lake will recede very little below the desired summer level if maintained by a dam.

V - CONCLUSIONS AND RECOMMENDATIONS

1. Local people have expressed the opinion that the existing dam $1\frac{1}{4}$ miles below Duck Lake has a pronounced influence on lake levels, and that disturbance of the dam and outlet channel has resulted in receding lake levels in recent years. It is more logical to conclude that Duck Lake, like many other Michigan lakes, was low during the summer of 1958 as a result of deficient precipitation and receding ground water levels.
2. Riparian owners on Duck Lake organized an association and prevailed on the Board of Supervisors to start proceedings for establishment of a desirable legal level for Duck Lake. The Board directed the Prosecuting Attorney to proceed and a hearing date was set for February 6, 1959.
3. On notice to the Conservation Department of the hearing, a brief field investigation was made at the Interlochen State Park property on Duck Lake. It became apparent that available data was not sufficient to serve as a basis for a legal level determination, so a postponement was requested by the Attorney General's Department to allow time for the Conservation Department to complete an investigation. The Court ordered proceedings to be continued on June 18, 1959.
4. A gage was installed at the State Park and Duck Lake stage records are available since April 9, 1959 and include the spring break-up and high water period.
5. Based on field observations and local contacts, the lake level that existed the week of May 10, 1959 appears to be near optimum for a summer level.
6. The 1959 spring high water did not adversely affect any septic tank disposal systems nor cause any noticeable shoreline damage, as far as could be determined.
7. Contacts with available riparian owners revealed that they considered the lake level that existed the week of May 10, 1959 to be desirable for a summer level for Duck Lake. The lake varied from gage 18.0 (elevation 837.48 ft. m.s.l.d.) to gage 17.74 (elevation 837.22 ft. m.s.l.d.) during that week.
8. The Parks and Recreation Division of the Department of Conservation has used a Duck Lake elevation of 837.3 as a design level for park facilities and they are agreeable to establishment of this elevation as a summer level.
9. The Duck Lake level during the survey of May 1959, elevation 837.4, was not damaging the State owned frontage in Fife Lake State Forest, and the Forestry Division of the Department of Conservation has no objection to this level.

10. The Fish Division of the Conservation Department advises that a stabilized normal high water level would be most advantageous to fish life in the lake.

11. The Game Division does not consider Duck Lake to have a high game value and therefore their interest is very minor.

12. Occasional field checks on Duck Lake levels, from 1938 to 1959, show that the lake ranged from elevation 836.6 and 837.78.

13. A dam site on Duck Lake at the outlet has limited free-board but is desirable for close control of lake levels. From an engineering standpoint, it is feasible to construct the control dam at this site.

14. Based on limited information, the normal level of Duck Lake is between elevation 836.7 and 837.4.

The maximum level expected to result from a 25-year storm runoff is elevation 838.2 and will cause no serious damage to existing installations.

15. A control structure consisting of a dike with top elevation 840.0 and a spillway having 3 bays each five feet wide and sill elevation at elevation 835.0 will maintain the lake at or near elevation 837.3 or any other reasonable summer level.

16. After establishment of a legal level by the Circuit Court the Grand Traverse County Board of Supervisors is responsible for maintaining the legal level.

17. The Board of Supervisors should engage a registered professional engineer to prepare plans and supervise construction of a dam to maintain the legal level.

18. The cost of construction can be spread on the basis of benefits in a special assessment district.

From 7017 Development
Report

Design Flood elev 838.2

- 837.4

840.0

VI APPENDIX
DUCK LAKE LEVEL CONTROL
Grand Traverse County

- I N D E X -

Lake Inventory Map

Terminology

Sea Level Datum
Staff Gages
Hydrographs
Beach Profiles

Outline of Procedures - Act 194, Public Acts 1939

Inland Lake Levels - Act 194, Public Acts 1939

SUPPLEMENTAL DATA - NOT INCLUDED

(Available in Engineering and Architecture Files)

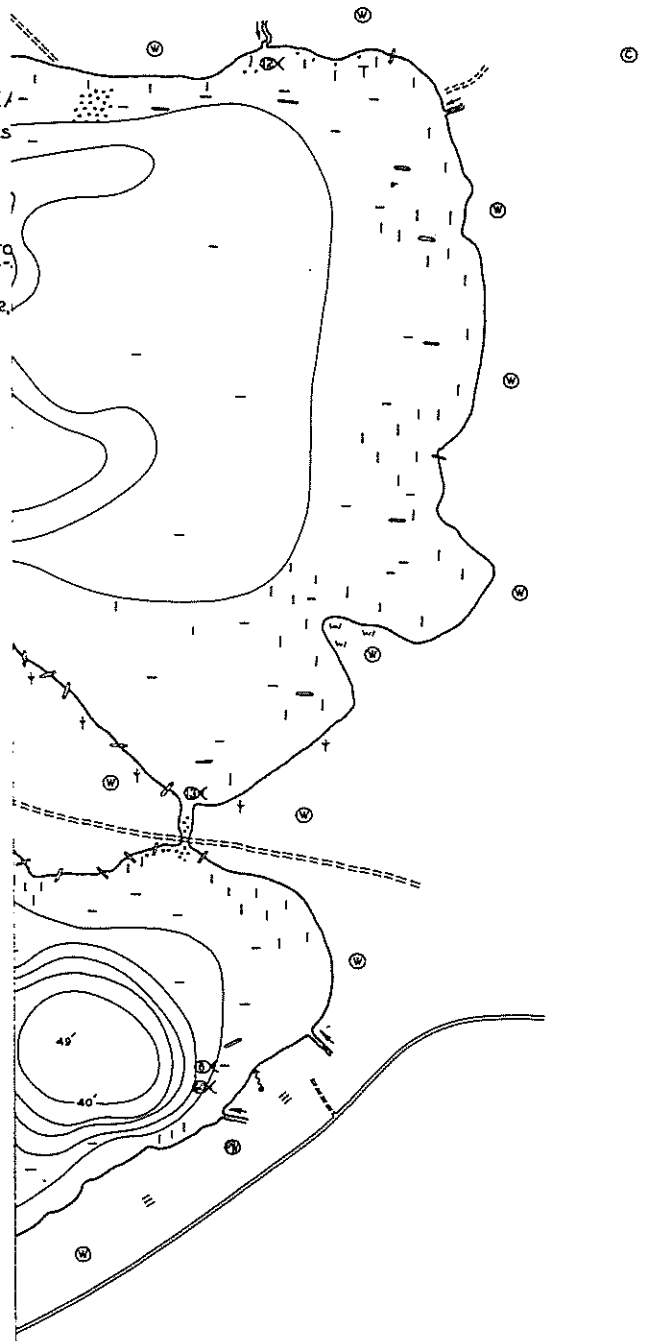
A. Symbols and Formulas

B. Computations

1. Existing Outlet Capacity
2. Hydrology
3. Flood Routing
4. Proposed Dam

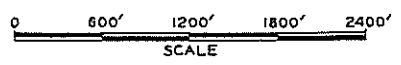
C. Hydrographs - Duck Lake
Hydrographs - Green Lake

INSTITUTE FOR FISHERIES RESEARCH
 DIVISION OF FISHERIES MICHIGAN CONSERVATION
 LAKE INVENTORY MAP
DUCK LAKE
 AREA 1930 ACRES
 MARGINAL SURVEY AND SOUNDINGS
 INVENTORY 1/1 TO 7/24/57
 GRAND TRAVERSE COUNTY T. 26 N., R. 12 W., SEC'S. 14, 15, 21, 22.



LEGEND

- BOTTOM
- ⊙ x Trash
 - ⊙ Deadheads
- OUTLINE & CONTOURS
- Shoreline
 - s- Contours
- SHORE FEATURES
- ≡ Slope
 - == Improved road
 - Unimproved road
 - ⊙ Spring
 - ~ Marsh
 - + Brush
 - ⊙ Wooded
 - ⊙ Partly wooded
 - ⊙ Cultivated
 - ⊙ Inlet
 - ⊙ Outlet
 - Trail
- VEGETATION
- | Emergent
 - Submergent
 - T Floating
- STATIONS
- ⊙ Vegetation
 - △ Temp, chem. analysis
 - ⊙ x Fish sample



INLAND LAKE LEVELS

Act 194, P.A. 1939

AN ACT to provide for the determination and maintenance of the normal height and level of the waters in inland lakes of this state, for the protection of the public health, safety and welfare and the conservation of the natural resources of this state; to authorize the building and maintenance of dams and embankments and the installation, maintenance and operation of pumps, weirs, locks, gates, tubes, ditches or any other devices or construction to accomplish such purposes; to authorize the acquisition of lands and other property by gift, grant, purchase or condemnation proceedings; to authorize the acceptance of gifts and grants of funds for the construction and maintenance of such dams and embankments and the installation, maintenance and operation of pumps, weirs, locks, gates, tubes, ditches, or any other devices or construction; to authorize the raising of money by taxation and by special assessments for the purposes of this act; to authorize the issuance of special assessment bonds; to prescribe the duties and powers of boards of supervisors, the conservation commission of Michigan and county drain commissioners with reference hereto; and to repeal certain acts and parts of acts.

The People of the State of Michigan enact:

NORMAL WATER LEVEL OF INLAND LAKES; DEFINITIONS. Section 1. For the purposes of this act:

(a) The normal water level of any inland lake, natural or artificial, is defined to be such a level as, considering the height above sea level, established by government surveys; the high water line as disclosed by old surveys; testimony of old inhabitants; the extent to which drainage and other artificial causes have decreased the natural ground water table of the areas; the extent to which natural causes have either decreased or increased the natural ground water table; and all other pertinent surrounding facts and circumstances, will provide the most benefit to the public and best protect the public health, welfare and safety and which will best preserve the natural resources of the state, and preserve and protect the values of properties developed around said lake as a result of the creation of the same: Provided, however, No "normal water level" as defined in this act, shall be established under this act for an artificial lake which has been or may be created for the purpose of providing a reservoir for a municipal water supply system unless petitioned for by the governing body of the municipality.

(b) A public inland lake is defined to be such an inland lake as is available and accessible to the general public for navigation, fishing, hunting, and other lawful purposes, and such as is reasonably capable of supporting a beneficial public interest.

(c) Whenever in this act authority is granted to acquire, construct or maintain dams or embankments, such authority shall be deemed to include authority to acquire or construct and to install, operate and maintain pumps, weirs, locks, gates, tubes, ditches or any other devices or construction to keep and maintain the waters in lakes at normal height and level: Provided, That the conservation department may require the installation of fish ladders or other devices to permit the free passage of fish whenever the department deems such installation to be necessary or desirable.

SAME: AUTHORITY OF BOARD OF SUPERVISORS AND/OR STATE CONSERVATION COMMISSION TO DETERMINE AND MAINTAIN. Section 2. The board of supervisors of any county in which the whole or any part of the waters of any inland lake is situated, and/or

the state conservation commission may, for the protection of the public health, welfare and safety and the conservation of natural resources of this state, determine and cause to be determined the normal height and level of the waters in such inland lake, and construct and maintain sufficient dams or embankments upon and along the shores and across and through any such lake to keep and maintain the water in such lake at its normal height and level.

SAME: DETERMINATION, PROCEDURE, PETITION IN CIRCUIT COURT, HEARING, NOTICE, ORDER, FILING, APPEAL: DRAIN COMMISSIONER. Section 3. Whenever in the judgment of the board of supervisors of any county, or in the judgment of the conservation commission, or in the judgment of such board of supervisors and the conservation commission, acting jointly, it shall be deemed expedient to have determined and established the normal height and level of the waters in any inland lake situated in said county for the purpose of promoting the public health, welfare or safety and the conservation of the natural resources of this state, such determination shall be arrived at in the following manner: In the event the board of supervisors takes action alone under the provisions of this act, such board shall by resolution, duly adopted, determine the expediency at any regular or special meeting thereof and shall direct the prosecuting attorney of the county to institute by proper petition in the circuit court of said county a proceeding for such determination. Such prosecuting attorney shall thereupon prepare and file in said court a petition on behalf of the board of supervisors of said county, addressed to said court, in which said petition shall be set forth the description of the lake and the reasons why the normal height and level of the waters thereof should be determined and established: Provided, That when the waters of any inland lake are situated in 2 or more counties, the normal height and level of the waters of such lake may be determined in the same manner and with the same effect as the waters of any lake lying wholly within 1 county, if the several boards of supervisors of all the said counties determine such expedient and by resolution direct the prosecuting attorney of any 1 or more of said counties to institute such proceedings for such determination.

If the conservation commission shall by resolution deem it expedient to have the normal height and level of any such inland lake determined, whether wholly situated in 1 county or situated in 2 or more counties, such commission shall authorize the director thereof to institute by proper petition on behalf of the state, in the circuit court of any county in which the whole or any part of said lake shall be situated, a proceeding for such determination. Said petition shall contain the allegations and the reasons therefor as hereinabove set forth. The conservation commission may likewise join with the board or boards of supervisors of any counties of the state in instituting proceedings as herein set forth for such determination.

Upon receipt of any such petition, the court shall fix a day of hearing, shall direct the prosecuting attorney and/or the conservation commission, or both, in the event of joint action, to give notice thereof by publication in 1 or more newspapers of general circulation in said county, and in the event the waters of such inland lake are situated in 2 or more counties, in 1 or more newspapers in general circulation in each of the counties in which said lake or any part thereof is situated. Said notice shall be published at least once each week for 6 successive weeks prior to the date fixed for such hearing. Said court shall also direct the copies of the published notice of hearing shall be served by registered mail upon all the owners of record of lands abutting or touching on said lake, said notices to be mailed at least 3 weeks prior to the date set for hearing.

SAME; BY BOARD OF SUPERVISORS, PROCEDURE, GENERAL COUNTY STATUTES. Section 8. Whenever the board of supervisors of any county in this state shall determine by proper resolution that it is necessary to condemn private property for the purpose of this act, such condemnation proceedings shall be commenced and conducted in accordance with the provisions of law applicable to the condemnation of private property for public use by counties.

SAME; BY CONSERVATION COMMISSION, PROCEDURE, GENERAL STATE STATUTE. Section 9. Whenever the conservation commission shall by proper resolution determine that it is necessary to take private property for public use for the purposes of this act by condemnation proceedings, such condemnation proceedings shall be commenced and conducted in accordance with the provisions of law applicable to the taking of private property for public use by the state.

GIFTS, GRANTS IN AID, AUTHORITY OF BOARD OF SUPERVISORS TO ACCEPT. Section 10. The board of supervisors of any county of this state in which is situated, wholly or in part, the waters of any inland lake is hereby authorized to receive and accept in the name of such county, gifts or grants in aid, for the purpose of carrying out the provisions of this act, from persons and from other governmental units: Provided, That in the event the waters of such inland lake shall be situated in 2 or more counties, such gifts and grants in aid shall be apportioned to the respective counties as the facts may require and as determined by the donor or grantor.

SAME; AUTHORITY OF CONSERVATION COMMISSION TO ACCEPT. Section 11. The conservation commission in carrying out the purposes of this act is hereby authorized to receive and accept, on behalf of the state of Michigan, gifts and grants in aid from persons and other governmental units.

DAMS; CONTRACT FOR CONSTRUCTION OF; BIDS; RIGHT TO REJECT ALL BIDS. Section 12. Whenever the board or boards of supervisors shall cause to be constructed and maintained a dam and embankment as may have been determined to be necessary, as herein provided, plans and specifications therefor shall be prepared under the direction of the board or boards and bids may be advertised for the doing of the work in such manner as the board shall by resolution direct. The contract shall be let to the lowest responsible bidder giving adequate security for the performance of his contract but the board may reserve the right to reject any and all bids and said board or boards may erect and cause to be erected and maintained such dam and embankment as a work relief project, in accordance with the provisions of the law applicable thereto.

SAME; EXPENSE OF CONSTRUCTION BY BOARD TO BE BORNE BY COUNTY; ASSESSMENT; PUBLIC LAKE. Section 13. In the event the board or boards of supervisors alone conduct the proceedings hereunder, the expense of determining the normal height and water level of any inland lake, the expense of constructing and maintaining any dam or embankment, as herein provided, together with the cost and expense of acquiring lands and other property by condemnation necessary thereto, shall be assessed, levied and collected upon the taxable real estate of the county, the same as other general taxes are assessed, levied and collected in such county or counties, whenever such inland lake shall be a public lake.

SAME; SPECIAL ASSESSMENT DISTRICTS TO BE DETERMINED BY BOARD OF SUPERVISORS; LEVY AND COLLECTION OF TAXES. Section 14. If such inland lake shall not be a public lake, or if the board or boards of supervisors believe that a portion of the area in the vicinity of the proposed improvement will be benefited by such improvement, they shall, by an entry in their minutes, determine that the whole or any just proportion of the compensation awarded by the jury or commissioners,

in the event of condemnation proceedings, as hereinabove provided, and the estimated cost of the dam or embankment shall be assessed upon the owners or occupants of real estate deemed to be thus benefited: Provided, That in the event a special assessment district has been created and a dam or embankment constructed, then said board of supervisors may, upon petition of at least 55 per cent of the taxable property owners of said district, assess the cost of operation, repair and maintenance of said dam or embankment against or upon the owners or occupants of real estate subject to taxation in the original special assessment district. Such board or boards may include therein the cost and expense of the condemnation proceedings and the estimated cost of the proceedings for assessments of benefits or such part thereof as they may deem just, and they shall by resolution fix and determine the district or portion of the county benefited and specify the amount to be assessed upon the owners or occupants of the taxable real estate therein. The resolution may also provide for the issuance and sale of special assessment bonds in anticipation of the collection of said special assessment taxes. The amount of the benefit thus estimated shall be assessed upon the owner or occupants of such taxable real estate in proportion as nearly as may be to the advantage which such lot, parcel, or subdivision is deemed to acquire by the improvement.

All proceedings relating to the making, levying and collection of special assessments herein authorized and the issuance of bonds in anticipation of the collection thereof shall conform as near as may be to the proceedings for levying special assessments and issuing special assessment bonds of villages, as set forth in Act No. 3 of the Public Acts of 1895, as amended, being sections 67.24 to 67.34, inclusive, of the Compiled Laws of 1948. The provisions herein contained for the levying and collection of taxes for the purpose of paying for the improvement and its maintenance, shall be applicable only to proceedings commenced under the provisions of this act by the board or boards of supervisors of the respective counties of the state. In the determination of taxes necessary to be raised for the purposes herein contained, such board or boards of supervisors shall make proper allowances for any gifts or grants in aid received and accepted by said county for such purpose.

SAME; PUBLIC LAKE; EXPENSE OF PROCEEDINGS BY CONSERVATION COMMISSION TO BE BORNE BY STATE. Section 15. Whenever proceedings are commenced under the provisions of this act by the conservation commission, the cost and expense thereof, including the maintenance of such dam or embankment, shall be wholly borne by the state, less any grants in aid received by the state for such purposes: Provided, That such lake is a public inland lake.

SAME; PETITION UNNECESSARY; PROCEEDINGS MUST BE INSTITUTED UPON FILING OF PETITION: DISCONTINUANCE OF PROCEEDINGS. Section 16. The conservation commission and/or the board or boards of supervisors may commence and conduct proceedings under the provisions of this act without petition therefor. Whenever a petition is filed with the board of supervisors of any county in which an inland lake is situated, wholly or in part, signed by the owners of not less than 51 per cent of the land abutting any such lake, praying for a determination of the normal height and level of such lake and for the construction and maintenance of a dam and embankment for the purpose of maintaining the water level at such normal height, such board of supervisors, upon receipt of said petition, shall commence proceedings under the provisions of this act: Provided, however, That when such lake shall be situated in 2 or more counties, executed petitions shall be filed with the board of supervisors in each of such counties. Proceedings commenced under the provisions of this act shall not be dismissed or discontinued except by consent of all parties interested therein or by order of the court having jurisdiction thereof.

SAME; NOTICE OF INSTITUTION OF PROCEEDINGS TO BE SERVED UPON CONSERVATION COMMISSION. Section 17. Whenever the board or boards of supervisors of any county commence proceedings for the determination and maintenance of the normal height and level of the waters of any inland lake, whether by voluntary action or upon petition, such board of supervisors shall serve or cause to be served a notice of the commencement of such proceedings upon the conservation commission of the state. Service of such notice upon such commission may be had by mailing to the secretary of such commission a certified copy of the resolution adopted by said board, determining the expediency of establishing and maintaining the normal height and level of the waters of any such inland lake. Such notice so served upon the conservation commission shall be accompanied by a description and the location of the inland lake in question.

SAME; PUBLIC WATERS; RIGHT OF CONSERVATION COMMISSION TO JOIN OR INTERVENE IN PROCEEDINGS; DUTY TO ASSIST. Section 18. If the waters of such inland lake are public waters, such conservation commission may join with such board of supervisors in the proceedings thereafter taken and may intervene for the protection and conservation of the natural resources of the state. Whenever the waters of any inland lake are public waters and proceedings are commenced for the purpose of determination and maintenance of the normal height and level thereof by the board of supervisors of any county, the conservation commission shall aid and assist in the preparation and presentation of the information, facts and data necessary under the provisions of this act.

COUNTY DRAIN COMMISSIONER; DELEGATION OF DUTIES TO, BY BOARD OF SUPERVISORS, REPORTS. Section 19. Whenever the board of supervisors of any county of this state shall commence and conduct proceedings under the provisions of this act and/or shall construct and maintain a dam, as herein provided, said board in its discretion may delegate ministerial duties germane to the purposes of this act to the county drain commissioner. Such duties so delegated may include the preparation, assembling, and computation of statistical data for the use of said board, superintending the construction of any dam, and superintending the maintenance thereof. Such drain commissioner shall make such reports and submit such information as the board of supervisors shall from time to time request in carrying out the purposes of this act.

CONNECTING WATERS OF GREAT LAKES EXEMPT FROM ACT. Section 20. The term "inland lake" as herein used, shall not be deemed to include any of the connecting waters of the great lakes; Provided, That this act shall apply to lakes which are connected with waters of the great lakes under any conditions in which there is no conflict with established authority of the Federal Government or any of its agencies or when such conflict does exist, consent of the Federal Government or its agencies has been granted.

ACT NO. 39 OF THE PUBLIC ACTS OF 1937 INAPPLICABLE TO FUTURE PROJECTS. Section 21. After the effective date of this act the provisions of Act No. 39 of the Public Acts of 1937 shall be applicable only in such cases in which proceedings have been theretofore commenced with respect to the determination of the normal height and level of the waters in inland lakes of this state.

REPEAL. Section 22. All acts and parts of acts inconsistent with the provisions of this act are hereby repealed.

SUPPLEMENT - A

SYMBOLS AND FORMULAS

King's "Handbook of Hydraulics" - Third Edition
by H.W. King.

I - Channel Flow - General.

$Q = AV =$ Discharge or Quantity.

$A =$ area of cross-section of water
in channel = waterway area.

$V =$ velocity = $\frac{1.486}{n} r^{2/3} s^{1/2}$ - Manning

Formula for flow in open channels.

$S = \frac{(nv)^2}{2.2082 \cdot r^{14/3}}$ = slope of energy gradient.
assumed parallel to slope of water
surface.

$n =$ coefficient of roughness of channel.

$w.p. =$ wetted perimeter.

$r = \frac{A}{w.p.} =$ Hydraulic Radius.

$Q = \frac{K}{n} D^{8/3} s^{1/2}$ Simplification of Manning
Formula from "King's" table 112.

$Q, n,$ and $s,$ as above.

$K =$ coefficient dependent upon, bottom
width - $b,$ side slopes of the channel,
and depth of water - $D.$ Table 112.

$Q = \frac{K'}{n} b^{8/3} s^{1/2}$ simplification of Manning
Formula from King's. table 113.

$Q, n, b,$ and D as above.

Values for K' found in table 113.

$S = \left(\frac{Qn}{K' b^{8/3}} \right)^2$; $Q, n, b,$ and $s,$ as above.

Values for $\frac{1}{K'}$ from King's table 114.

II Discharge Over Dams and Weirs

$Q = cL\sqrt{Z} (H + \frac{D}{2})$ Fteley Sterns Formula
for submerged weirs.

$C =$ coefficient depending on the ratio $\frac{D}{H},$

Values for c from Kings page 98.

$H =$ head in feet = difference between
headwater and crest elevation.

$D =$ difference between crest elevation
and tailwater elevation.

$Z = H - D.$

$Q = C_1 C L H^{3/2}$ Formula for flow over sub-
merged low head dams.

Values for " c_1 " - table 1, page 64 "Low Dams"

National Resources Committee 1939 Printing.

Values for " C " from "Kings" page 98.

$Q = CLH^{3/2}$ flow over weir.

"C" from "Kings" page 98.

L = effective weir length.

$L = L' - 0.1 NH$ for Broad Crested weirs under low heads.

L' = Total weir length.

N = Number of end contractions.

H = effective head in feet.

$L = L' - 0.05 NH$ for Narrow Crested weirs under high heads.

All factors same as preceding formula.

III Change in channel cross-section.

$$h = \left(\frac{V^2}{2g} - \frac{V_1^2}{2g} \right) + K_3 \left(\frac{V^2}{2g} - \frac{V_1^2}{2g} \right)$$

h = drop in water surface caused by a reduction in channel cross-section measured in feet.

V = velocity in smaller cross-section in feet per second.

V_1 = velocity in larger cross-section in feet per second

g = acceleration due to gravity = 32 ft./sec./sec.

K_3 = coefficient depending on shape of transition.

Values for K_3 from King's page 413.

$$h = \left(\frac{V^2}{2g} - \frac{V_1^2}{2g} \right) - K_2 \left(\frac{V^2}{2g} - \frac{V_1^2}{2g} \right)$$

h = rise in water surface caused by an enlargement in channel cross-section measured in feet.

V, V_1, g as above.

K_2 = coefficient depending on shape of transition.

Values for K_2 from "Kings" page 413.

Supplement B

1. Existing Outlet Capacity 2B-7B
2. Hydrology 8B-9B
3. Flood Routing 10B-11B
4. Proposed Dam 12B

1. Existing Outlet Capacity

Sta 0+00 to 66+00 (left to old dam)

on 5/14/59, W.S. @ 0+00 = 837.3

$$\frac{66+00 = 832.1}{6600' \quad 5.2'}$$

Assume $\approx 800'$ thru 1/4 mi L. with no slope
 $S = \frac{5.2}{6600 - 800} = 9.0 \times 10^{-4}$, $S^{1/2} = 3.0 \times 10^{-2}$

A.1. x-section: x-section #2 (Sta 3+00)

main channel: $b = 20'$, $b^2 S = 2950$
 $SS = 3:1$, $n = 0.045$
av. bottom = 835.5

Flood plain: 2.0' above main
channel bottom = 837.5
 $b = 200'$, $SS = \text{vertical}$
 $n = 0.075$

Q in Main Channel:

$$Q = \frac{K'}{n} b^{5/3} S^{1/2} = K' \frac{2950 \times 3.0 \times 10^{-2}}{0.045}$$

$$= 1970 K'$$

(Lake)	(x-section #2) ①	②	D ₁ /b	K'	Q
W.S. @ 0+00	W.S. @ 3+00	D			
836.2	(central rim of lake)				0
836.8	836.5	1.0	0.05	0.0103	20
837.3	837.0	1.5	0.075	0.0207	41
837.8	837.5	2.0	0.100	0.0339	67
838.3	838.0	2.5	0.125	0.0501	99
838.8	838.5	3.0	0.150	0.0692	136

① W.S. @ 0+00 - 300.5 = W.S. @ 0+00 - 300 × 9.0 × 10⁻⁴
 = W.S. @ 0+00 - 0.3

② W.S. @ 3+00 - av. bottom @ 3+00
 = W.S. @ 3+00 - 835.5

Q in Flood Plain

$$Q = A \frac{1.486}{n} r^{2/3} S^{1/2} = A r^{2/3} \frac{1.486}{0.075 \times 3.0 \times 10^3}$$

$$= A r^{2/3} \times 0.59$$

(1) (100%) W.S. @ 0+00	(2) (x-section #2) W.S. @ 3+00	(3) D+r	r ^{2/3}	A ⁽³⁾	Q
836.2	(control rim of levee)				0
836.8	836.5	0			0
837.3	837.0	0			0
837.8	837.5	0			0
838.3	838.0	0.5	0.63	100	37 ₉
838.8	838.5	1.0	1.00	200	118

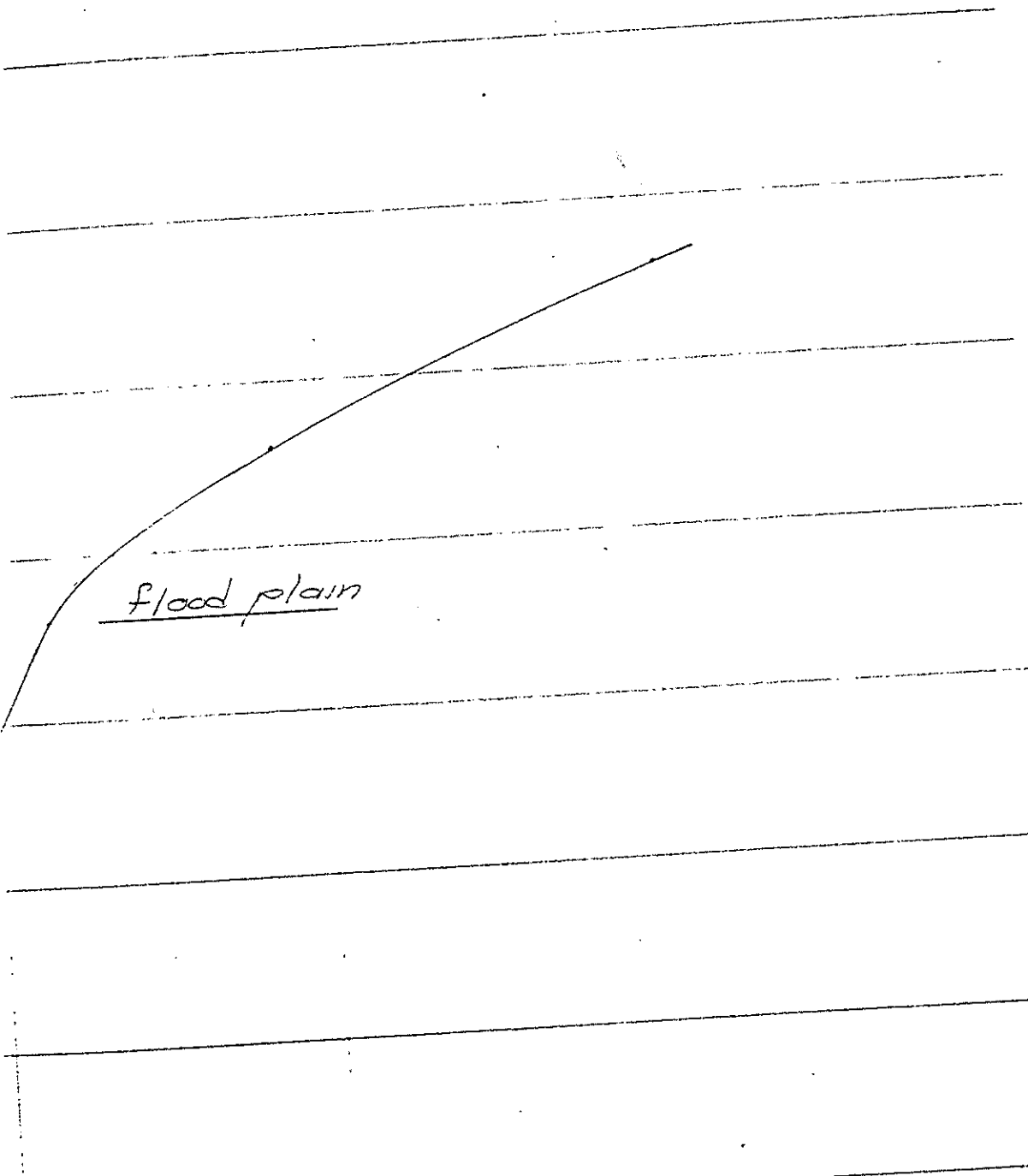
- ① W.S. @ 0+00 - 300 S = W.S. @ 0+00 - 300 × 9.0 × 10⁻³
 = W.S. @ 0+00 - 0.3
- ② W.S. @ 3+00 - elev. flood plain
 = W.S. @ 3+00 - 837.5
- ③ A = 200 D

WUST LDC (3K)
NIF 5/4/27
✓ 2.12

Total Q - Main Channel + Flood Plain

(Lake)	Q main channel	Q flood plain	Q total
W.S. @ 0700			
836.2	0	0	0
836.8	20	0	20
837.3	41	0	41
837.8	67	0	67
838.3	97	37	136
838.8	136	118	254 ⁵

DUCK LAKE
DISCHARGE CURVE



Outflow - cfs

KRJ 6/1/59

WICK 222
KRW 6/5/59
✓ 495

(12)

A Check on Discharge Curve

sta 72+00 to 83+00

on 5/14/59, $W.S @ 83+00 = 230.1$

72+00 = 230.2

$$S = \frac{0.7}{1100} = 6.4 \times 10^{-4}, \quad S^{1/2} = 2.5 \times 10^{-2}$$

Av. x-sect : x-sect = 4 (sta 83+00)

$k = 27'$, $b^{813} = 6560$

SS = 3:1, $n = 0.045$

Dev. on 5/14/59 = 1.6'

$$Q = \frac{K'}{n} b^{813} S^{1/2}$$

$$D/b = \frac{1.6}{27} = 0.059, \quad K' = 0.0141$$

$$Q = \frac{0.0141}{0.045} \times 6560 \times 2.5 \times 10^{-2}$$

$$= 51 \text{ cfs}$$

Lake level on 5/14/59 = 837.3

From discharge curve, $Q = 41$

DUCK LAKE
KRSJ 6/4/59
✓ HGS

2. Hydrology

A. Design Inflow

Duck Lake watershed - 35 sq. mi.

Painy R near Onaway - 79 sq. mi.

25 yr. flow = 650 cfs

$$650 \times \left(\frac{35}{79}\right)^{.8} = 340 \text{ cfs}$$

$$= 9.7 \text{ cfs/sq. mi.}$$

Pigeon R. near Afton - 159 sq. mi.

25 yr. flow = 1120 cfs

$$1120 \times \left(\frac{35}{159}\right)^{.8} = 340 \text{ cfs}$$

$$= 9.7 \text{ cfs/sq. mi.} \quad \times$$

Big Sable R. near Free Soil - 127 sq. mi.

25 yr. flow = 550 cfs

$$550 \times \left(\frac{35}{127}\right)^{.8} = 200 \text{ cfs}$$

$$= 5.7 \text{ cfs/sq. mi.}$$

Duck Lake - use 10 cfs/sq. mi. or 350 cfs
estimated to have a 25 yr.
recurrence interval

B. Spring Base Flow

Green L. levels prior to spring rise vary from gage 4.8 to 5.2. From Green L. discharge curve, outflow varies from 50 cfs to 80 cfs. With a drainage area of 55 sq. mi., including Duck Lake, the unit base flow varies from 0.9 cfs/sq. mi. to 1.5 cfs/sq. mi.

At outlet of basin

From flood routing curve for Sturgeon R. near Waverline, base flow = 1.5 cfs/sq. mi.

From flood routing curve for Big Sable R. near Free Soil, base flow = 1.5 cfs/sq. mi.

For Duck Lake - use 1.5 cfs/sq. mi.
or 50 cfs

Base flow
for
3/4 sq. mi.
Use 3.5 T.D.

3. Flood Routing

Flood routing curves from Farmer's Cr. near Lapeer.

Assume storage = $0.8^{.17}$

Duct late a.c. = 1400 a.c. cc

Storage = 1520^{1330} A-ft

Inflow = 350 cfs

Base flow = 50

Peak = 300 cfs

$F_1 = \frac{1330}{300} = 4.4$, $F_2 = 0.24^{.34}$

Outflow (less base flow) = $0.24^{.34} \times 300$
 = 70^{100} cfs

Base flow = 50

Total outflow = 120^{150} cfs

Stage prior to runoff, with base flow at 50 cfs, = 837.5 (see pg. #)

Storage = $0.8^{.17}$

Peak stage = $838.3^{838.2}$

Outflow @ 838.3 = $140^{120} \times 150^{120}$ cfs

Peak stage = 838.3, outflow = 140 cfs

Flood routing curves from Jordan Lake
at Lake Odessa.

Inflow = 350 cfs

Base flow = 50

Runoff = 300 cfs

Duck Lake area = 1900 ac. ft

Assume outflow (less base flow) = 40 cfs

$R = \frac{40}{300} = 13\%$

$T_0 = 2.1$, $TI = 2.2$

Mass inflow = $300 \times 2.2 = 660$ ds⁺

Mass outflow = $40 \times 2.2 = 88$ ds⁻

Storage = 1190 A-ft = 0.6

Outflow = $40 + 50 = 90$ cfs

Stage prior to runoff = 837.5 (see pg 4)
Storage = 0.6

Peak stage = 838.1

Outflow @ 838.1 = 100 cfs

Peak stage = 838.1, outflow = 100 cfs

For Duck Lake, use peak stage = 838.2
max outflow = 120 cfs
Is this correct?

4. Proposed Dam

Diameter at rim of lake, sta 0+00.

Design outflow = 120 cfs

Design max. stage = 838.2

Set crest at 835.0

$$D = 3.2'$$

$$h = \frac{1}{2} = 0.1' \text{ (H.W. - T.W.)}$$

$$V = 2.5' / \text{sec.}$$

$$A = \frac{Q}{V} = \frac{120}{2.5} = 48 \text{ sq. ft.}$$

$$L = \frac{A}{D} = \frac{48}{3.2} = 15'$$

1-2 3-5' base, crest @ 835.0