TITLE MC-15

DEPARTMENT OF PUBLIC WORKS AND WASTE MANAGEMENT

COUNTY OF MAUI

CHAPTER 4

RULES FOR THE DESIGN OF
STORM DRAINAGE FACILITIES
IN THE COUNTY OF MAUI

SUMMARY

1.   Chapter 4, entitled "Rules For The Design
Of Storm Drainage Facilities In The County of Maui", is
hereby adopted to read as follows:

"TITLE MC-15
DEPARTMENT OF PUBLIC WORKS AND WASTE MANAGEMENT

SUBTITLE 01

CHAPTER 4

RULES FOR THE DESIGN OF
STORM DRAINAGE FACILITIES
IN THE COUNTY OF MAUI

GENERAL PROVISIONS

§15-04-01   Title. The rules in this Title shall be known as the "Rules For The Design of Storm Drainage Facilities in the County of Maui". [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-02   Authority. The rules herein are established pursuant to the provisions of Sections 46.15(13) and 46.15(14), Hawaii Revised Statutes, and Section 18.20.130A, Maui County Code. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-03   Purpose. These rules govern the design of storm drainage facilities in the County of Maui. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-04   Definitions. For the purpose of these rules, unless it is plainly evident from the context that a different meaning is intended, certain words and phrases used herein are defined as follows:
  "Detention facilities" means temporarily impound runoff to control runoff rates.
  "Director" means the Director of Public Works and Waste Management.
  "Infiltration facilities" means facilities, such as, infiltration basins, retention basins and porous pavements, which rely on absorption of runoff.

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"Injection wells" are wells that dispose runoff into the subsurface and shall be in conformance with applicable State Department of Health Underground Injection Control (UIC) Rules.

"Sumps" mean either detention facilities or infiltration facilities. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-05   Hydrologic criteria.
Recurrence interval.

(a) For drainage areas of 100 acres or less, Tm (recurrence interval) = 10 year based on 1 hour storm, unless otherwise specified.

(b) For drainage areas of 100 acres or less with sump, or tailwater effect, Tm (recurrence interval) = 50 year based on 1 hour storm.

(c) For the design of roadway culverts and bridges with drainage areas less than 100 acres, Tm (recurrence interval) = 50 year based on 1 hour storm.

(d) For drainage areas greater than 100 acres and all streams, the Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service) hydrograph method shall be used, Tm (recurrence interval) = 100 year based on 24 hour storm.

(e) Retention and Detention Basins: Tm (recurrence interval) = 50 year based on 1 hour storm for drainage areas 100 acres or less.

Tm (recurrence interval) = 100 year based on 24 hour storm for drainage areas more than 100 acres.

(f) When a drainage area of less than 100 acres contributes to a major stream or channel with a total drainage area greater than 100 acres, the contributory drainage system shall be designed for 10 year or 50 year storm, whichever is applicable.

Runoff Quantity.

(a) **Rational Method:** For drainage areas of 100 acres or less, the rational method along with the accompanying reference tables and charts, or latest revision thereof, shall be used. The formula Q=CIA may be used to determine quantities of flow rate, in which:

Q=flow rate in cubic feet per second;
C=runoff coefficient;

I=rainfall intensity in inches per hour for a duration equal to the time of concentration; and A=drainage area in acres.

(b) Runoff Coefficient (C):

(1) For Off-site Areas - The "C" value shall be determined from Table No. 1 and based on the current use of the drainage area. For distinctive composite drainage areas, a weighted value of runoff coefficient shall be used.

(2) For On-site Areas - Composite areas shall be designated and a weighted value of runoff coefficient shall be determined using the runoff coefficient from Table 1 or 2, whichever is higher. Minimum runoff coefficients for built-up areas are noted in Table 3.

(c) **Time of Concentration (Tc)**

(1) Determine overland flow time from Plate 1 generally for paved, bare soil and g r a s s e d areas.

(2) Determine flow time over small agricultural areas with well-defined divides and drainage channels from Plate 3.

 (A) Use upper curve for well-forested areas representing:
$$Tc=0.0136K^{0.77}$$

 (B) Use lower curve for areas with little or no cover, representing:
$$Tc=0.0078 \ K^{0.77}$$

(3) To verify the time of concentration, divide the estimated longest route of runoff by the appropriate runoff velocity from Table 4.

(4) Tc for flows in uniform channels and in culverts shall be computed by length of run L/V divided by computed velocity.

(d) **Rainfall Intensity (I)** - The design rainfall intensity of a drainage area shall be determined by the following procedure:

(1) Select the appropriate 1-hour rainfall value from Plates 4 to 9 for the design recurrence interval for each individual island.

(2) Enter Plate 2 with the 1-hour rainfall value and the required time of concentration. Obtain the design rainfall intensity in inches per hour.

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Natural Resources Conservation Service (NRCS)
Method, Hydrograph Analysis

(a) For drainage areas greater than 100 acres and all streams, the Natural Resources Conservation Service method shall be used.

(b) The procedure for computing the peak flows and plotting the hydrographs shall be as outlined in the NRCS, National Engineering Handbook, Section 4, Hydrology, Supplement, or latest revision thereof or Erosion and Sediment Control Guide for Hawaii, NRCS, March 1981, or latest revision thereof.

(c) The NRCS computer program TR55 or TR20 may be used in lieu of the NRCS hydrograph analysis.

Federal Emergency Management Agency (FEMA)

Federal Emergency Management Agency (FEMA) storm flows shall be the minimum storm flow in drainage basins where flows have been determined in the "Flood Insurance Study," Maui County. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-06   Design   Standards.   (a) General Conditions: The design and capacity of a drainage system shall be based on the following conditions:

(1) The drainage system shall dispose the design storm runoff and subsurface water without damage to street facilities, structures or ground and cause no serious interruption of normal vehicular traffic, and in a manner that will not adversely affect downstream and adjoining properties.

(2) System must have maximum reliability of operation with minimum maintenance and upkeep requirements.

(3) If applicable, system must be adaptable to future expansion.

(4) Where sump conditions exist; a safety measure such as an overflow swale shall be provided to prevent flooding of adjacent lots in the event the design capacity of the closed conduit is exceeded.

(5) In general, natural gullies, waterways, streams and tributaries shall not be replaced with a closed system except at roadway crossings. For natural drainageways with contributory areas greater than 100 acres, the engineer shall determine, dimension and designate the 100 year flooded width as a drainage reserve in the drainage report and on the final subdivision map, if applicable.

(6) Roadway culverts and bridges shall be designed to pass the design flow as determined by this design criteria. Under open channel hydraulic analysis the minimum freeboard shall be as specified in the design criteria for open channels. Multiple span road crossings (bridges) shall have minimum clear spans of 30-feet, unless otherwise permitted by the Director. Where possible, the roadway shall be designed to form a sag vertical curve with a low point at the waterway crossing with minimum grades to confine and control overflow at the crossing.

(7) In general, outlets for enclosed drains emptying into open channels shall be designed to point downstream at an angle of 45 degrees. Junctions of open channels shall be designed to flow as nearly parallel as possible.

(8) Outlet velocities of storm waters leaving culverts and channels shall not exceed existing drainage velocities when entering existing drainage ways.

(9) Subsurface drains may be installed when approved by the Director, provided no ground water is encountered or will be encountered during wet weather.

(10) In areas where existing drainage systems are inadequate, the existing system shall be upgraded to handle runoff from the new project area or a new system shall be provided to connect to an adequate outlet. When there is no existing drainage system or adequate outlet to connect to, the additional runoff generated by the development may be retained on-site in a temporary retention basin with the following design conditions:

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(A) Storage volume of an infiltration basin, infiltration trench piping, or retention basin shall equal at least the total additional runoff volume for the appropriate storm intensity.

(B) Soil percolation shall not be used in satisfying required storage volumes.

(C) Fifty percent (50%) of voids within the rock envelope for subsurface drains may be used in satisfying required storage volume provided that filter fabric is installed around the subsurface pipe and at the interface of the rock envelope and soil.

(D) Sumps, detention and retention facilities will remain private.

(E) Detention or retention ponds with embankment heights equal to or in excess of 25 feet or with storage capacity equal to or in excess of 50 acre-feet shall conform to all state and federal requirements relative to dams.

(11) Flooded widths shall not be more than the following for the appropriate design storm:

(A) 8 feet for all curbed streets.

(B) No portion of the pavement shall be flooded for non-curbed streets. All storm runoff shall be confined to the roadway shoulder swale.

(12) Provide spillway or other devices that will direct overflow for design storms to an appropriate drainage channel or drainage system to assure that there will be no adverse effects on downstream or adjacent properties.

(13) Additional storm runoff from a new development shall be disposed of at an appropriate drainage outlet or drainage system so as not to create any additional adverse effects to adjacent or downstream properties.

(14) Off-site flows may be passed safely through a development provided there are no additional adverse effects resulting from the new development to adjacent and downstream properties.

(15) All new structures shall have either:

    (A) The lowest floor or lowest opening be at least one foot above the crown of the nearest street or above the highest grade adjacent to the structure; or

    (B) The site plan ensure that new structures are protected from local drainage problems.

(b) **Drainage system**

(1) Closed Conduits:

    (A) Freeboard and Hydraulic Grade Line (HGL) unless otherwise authorize by the Director:

        i. 1' freeboard within drainage structures.

        ii. HGL shall not be less than 1' below finish ground elevation.

    (B) Minimum Pipe Sizes Within County Right-of-Way:

        i. 18" diameter for lateral not exceeding 50 feet in length connecting drainage structures to main line.

        ii. 24" diameter for main trunk line

    (C) Materials and "n" Values:

i. Concrete Pipe	n=0.013
ii. *High Density Polyethylene Pipe (HDPE)	n=0.013
iii. *Corrugated Aluminum Pipe (CAP) and *Corrugated Galvanized Metal Pipe (CMP), annular (1/2 X 2 2/3 corrugation, All sizes):	
Unpaved	n=0.024
25% paved invert	n=0.021
Lower 50% Paved	n=0.018
100% Paved	n=0.013
iv. Helical *CAP and *CSP (1/2 X 2 2/3 corrugation):	
18"	n=0.014
24"	n=0.017
30"	n=0.018
36" to 48"	n=0.020
54" and larger	n=0.021
v. *Spiral Rib Pipe All sizes	n=0.011

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*Shall be allowed only upon submittal of soil test, PH value, etc. to substantiate soil/effluent/pipe material compatibility and with written approval from the Director.

(2) Open Channels

    (A) Freeboard: Freeboard shall be according to the U.S. Department of Interior Bureau of Reclamation's empirical formula,

$$\text{Freeboard in feet} = 2.000 + 0.025v^3\sqrt{d}$$

where v is the velocity in feet per second and d is the flow depth in feet. Freeboard shall be provided at bends from the superelevated water surface.

    (B) Material, "n" values and maximum velocities:

Material	Manning n	Max. v (fps)
Concrete, trowel finish	0.013	no limitation
Concrete, form finish	0.015	no limitation
Gunite, good section	0.018	20
Gunite, wavy section	0.020	20
Grouted Rubble Paving (GRP)	0.025	20
Cement Rubble Masonry (CRM)	0.025	20
Rock, smooth, uniform	0.030	10
Rock, jagged, irregular	0.045	10
Earth, fairly uniform, grassed	0.035	5

    (C) Channel rights-of-ways shall encompass the channel width and include sufficient width for maintenance.

    (D) Special considerations shall be made for guard rails and fences, debris control structures, energy dissipators, etc.

(c) Drainage report: Three copies of a drainage report, when required, shall be submitted to the Land Use and Codes Administration for approval. The drainage report shall be sealed and signed by a professional civil engineer licensed to practice in the State of Hawaii and at a minimum, include the following:

    (1) Hydrologic runoff computations
        (A) On-Site
            i. Existing Conditions
            ii. Developed Conditions
        (B) Off-Site
            i. Existing Conditions
            ii. Allowances for future conditions (if any).
    (2) Hydraulic Analysis:
        (A) Catch Basins & Inlet Capacities.
        (B) Flooded Road Width.
        (C) Hydraulic Grade Line (HGL). The HGL shall be shown on the construction plans.
    (3) Contributory drainage area maps and schematic drainage scheme.

    (b) The chairperson and vice-chairperson shall have responsibilities and duties as prescribed in this chapter. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §1.16.040 Maui County Charter

§15-04-07   <u>Severability.</u> If any portion of the foregoing rules or the applicability thereof to any person, property or circumstance is held invalid for any reason, such invalidity shall not affect other provisions or applications which can be given effect without the invalid provision or application, and to this end these are declared to be severable. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)
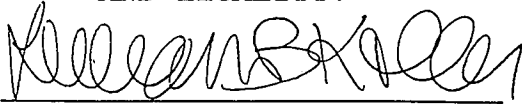

§15-04-08   <u>Appendix.</u> Reference charts and tables attached hereto and made a part hereof." [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

ADOPTED THIS __14th__ DAY OF ____July____, 19_95_,

by the Director of Public Works and Waste Management,

County of Maui, State of Hawaii.

CHARLES JENCKS
Its Director
Department of Public Works &
Waste Management
County of Maui

APPROVED AS TO FORM
    AND LEGALITY:

LILLIAN B. KOLLER
Deputy Corporation Counsel
County of Maui
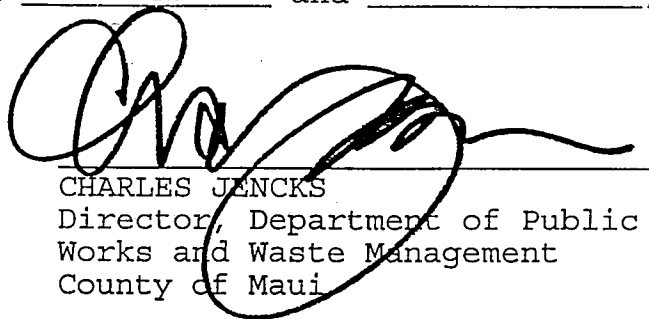c:\wp51\rules\drngstnd(pk)

APPROVED this ___14___ day of
____July____, 19_95_.

LINDA CROCKETT LINGLE
Mayor
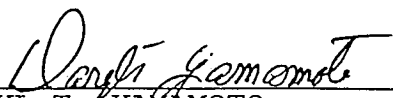County of Maui

CERTIFICATION

I, CHARLES JENCKS, in my capacity as Director of Public Works and Waste Management, County of Maui, do hereby certify:

1. That the foregoing is a full, true and correct copy of the Rules of the Department of Public Works and Waste Management relating to the Rules for the Design of Storm Drainage Facilities in the County of Maui.

2. That the notice of public hearing on the foregoing Rules, which notice included the substance of such Rules, was published in the Maui News on ___June 12___ and _____, 19 95 .

_____
CHARLES JENCKS
Director, Department of Public
Works and Waste Management
County of Maui

Received this _2nd_ day of

_____November_____, 19_95_.

_____
DARYL T. YAMAMOTO
County Clerk
County of Maui

Table 1

GUIDE FOR THE DETERMINATION OF RUNOFF COEFFICIENTS FOR BUILT-UP AREAS*

WATERSHED CHARACTERISTICS	EXTREME	HIGH	MODERATE	LOW
INFILTRATION	NEGLIGIBLE 0.20	SLOW 0.14	MEDIUM 0.07	HIGH 0.0
RELIEF	STEEP (> 25%) 0.08	HILLY (15-25%) 0.06	ROLLING (5-15%) 0.03	FLAT (0-5%) 0.0
VEGETAL COVER	NONE 0.07	POOR (< 10%) 0.05	GOOD (10-50%) 0.03	HIGH (50-90%) 0.0
DEVELOPMENT TYPE	INDUSTRIAL & BUSINESS 0.55	HOTEL-APARTMENT 0.45	RESIDENTIAL 0.40	AGRICULTURAL 0.15

NOTE: The design coefficient "c" must result from a total of the values for all four watershed characteristics of the site.

Table 2

RUNOFF COEFFICIENTS

Type of Drainage Area	Runoff Coefficient C
Business:	
Downtown areas	0.95
Neighborhood areas	0.70
Residential:	
Single-family areas	0.50
Multi-units, detached	0.60
Multi-units, attached	0.75
Suburban	0.40
Apartment dwelling areas	0.70
Industrial:	
Light areas	0.80
Heavy areas	0.90
Parks, cemeteries	0.25
Playgrounds	0.35
Railroad-yard areas	0.40
Unimproved areas	0.30
Streets:	
Asphaltic	0.95
Concrete	0.95
Brick	0.85
Drive and walks	0.85
Roofs	0.95
Lawns:	
Sandy, soil, flat, 2%	0.10
Sandy, soil, avg., 2-7%	0.15
Sandy, soil, steep, 7%	0.20
Heavy soil, flat, 2%	0.17
Heavy soil, avg., 2-7%	0.22
Heavy soil, steep, 7%	0.35

Table 3

RESIDENTIAL AREAS: C = 0.55 to 0.70

HOTEL-APARTMENT AREAS: C = 0.70 to 0.90

BUSINESS AREAS: C = 0.80 to 0.90

INDUSTRIAL AREAS: C = 0.80 to 0.90

The type of soil, the type of open space and ground cover and the slope of the ground shall be considered in arriving at reasonable and acceptable runoff coefficients.

Table 4

APPROXIMATE AVERAGE VELOCITIES OF RUNOFF
FOR CALCULATING TIME OF CONCENTRATION

TYPE OF FLOW	VELOCITY IN FPS FOR SLOPES (in percent) INDICATED			
OVERLAND FLOW:	0-3%	4-7%	8-11%	12-15%
Woodlands	1.0	2.0	3.0	3.5
Pastures	1.5	3.0	4.0	4.5
Cultivated	2.0	4.0	5.0	6.0
Pavements	5.0	12.0	15.0	18.0
OPEN CHANNEL FLOW:				
Improved Channels	Determine Velocity by Manning's Formula			
Natural Channel* (not well defined)	1.0	3.0	5.0	8.0

*These values vary with the channel size and other conditions so that the ones given are the averages of a wide range. Wherever possible, more accurate determinations should be made for particular conditions by Manning's formula.
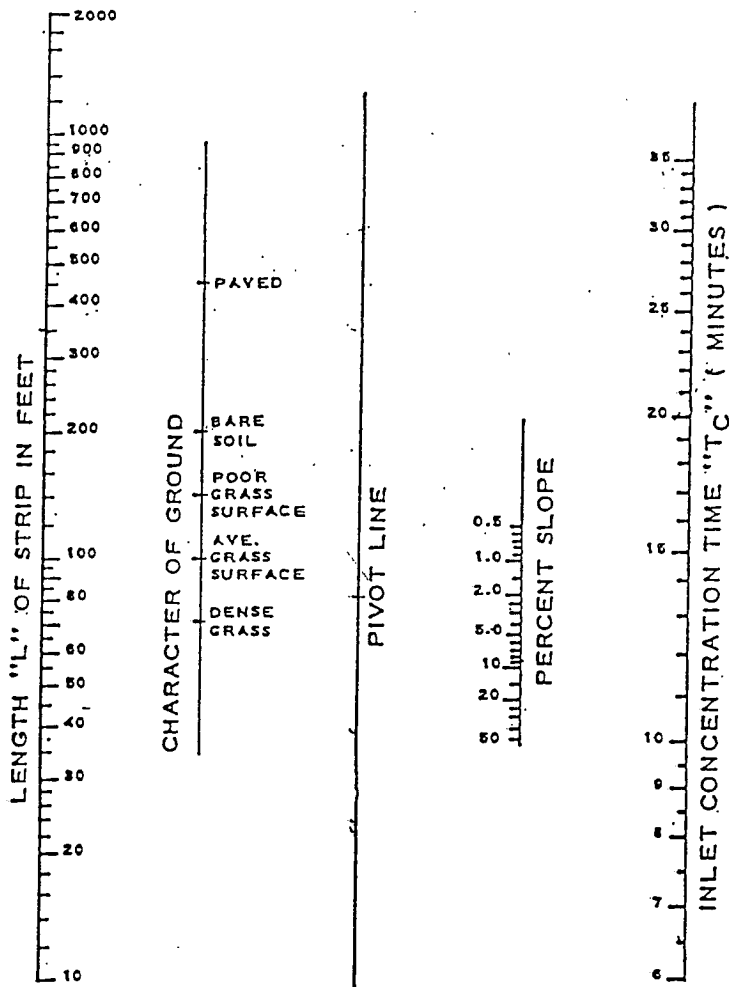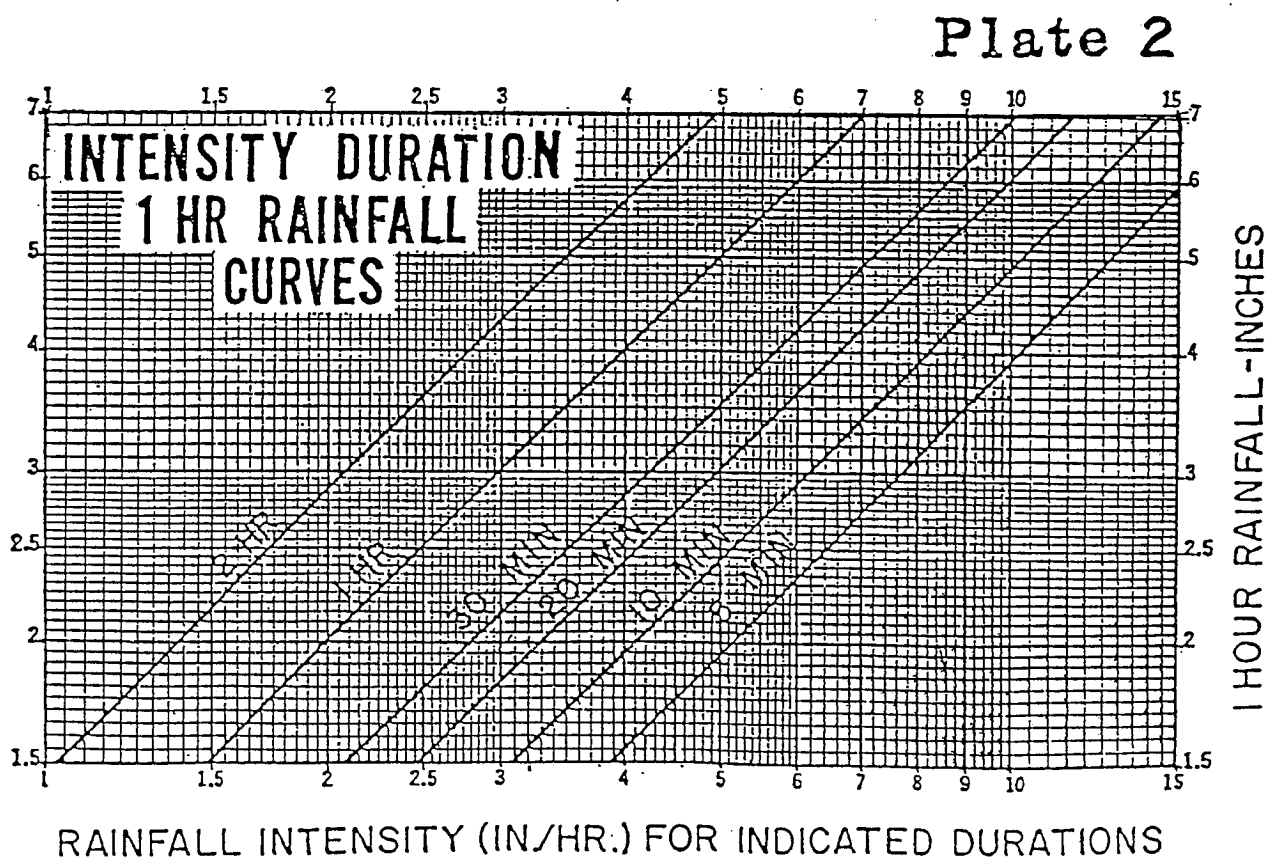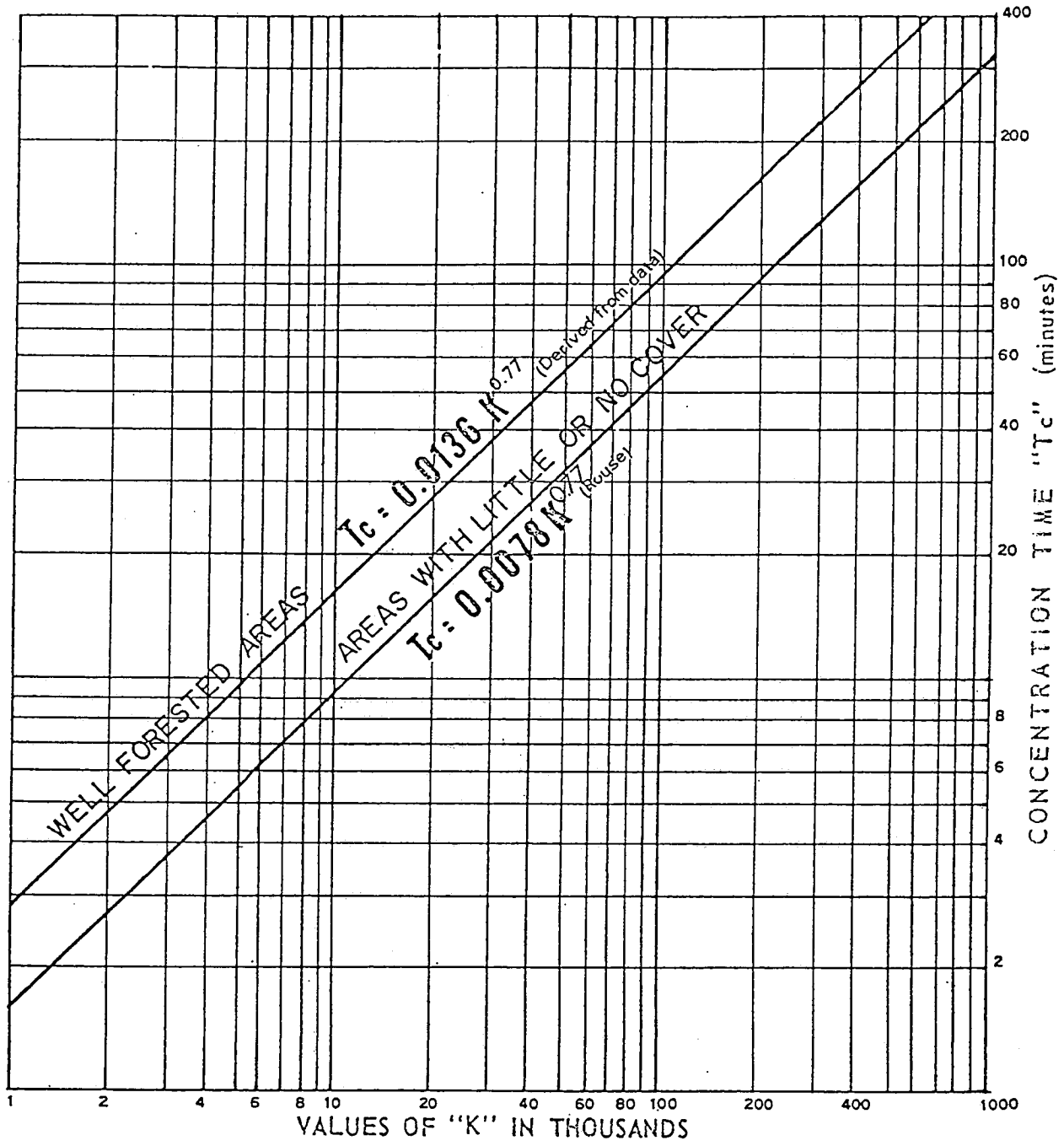
Plate 1

Overland Flow Chart

LENGTH "L" OF STRIP IN FEET

2000
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10

CHARACTER OF GROUND

PAVED

BARE SOIL
POOR GRASS SURFACE
AVE. GRASS SURFACE
DENSE GRASS

PIVOT LINE

PERCENT SLOPE

0.5
1.0
2.0
5.0
10
20
50

INLET CONCENTRATION TIME "T$_C$" (MINUTES)

35
30
25
20
15
10
9
8
7
6

Plate 2

INTENSITY DURATION 1 HR RAINFALL CURVES

1 HOUR RAINFALL-INCHES

RAINFALL INTENSITY (IN./HR.) FOR INDICATED DURATIONS

400

200

100
80
60

40

CONCENTRATION TIME "Tc" (minutes)

20

8

6

4

2

$Tc = 0.0136 \, K^{0.77}$ (Derived from data)

AREAS WITH LITTLE OR NO COVER

$Tc = 0.0078 \, K^{0.77}$ (Rouse)

WELL FORESTED AREAS

1   2   4   6   8 10   20   40   60 80 100   200   400   1000

VALUES OF "K" IN THOUSANDS

L = Maximum length of travel in feet
H = Difference in elevation between most
    remote point and outlet in feet.
S = Slope   H/L

$$K = \frac{L}{\sqrt{S}} = \sqrt{\frac{L^3}{H}}$$

Use upper curve for well forested areas.
Use lower curve for areas with little or no cover.

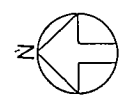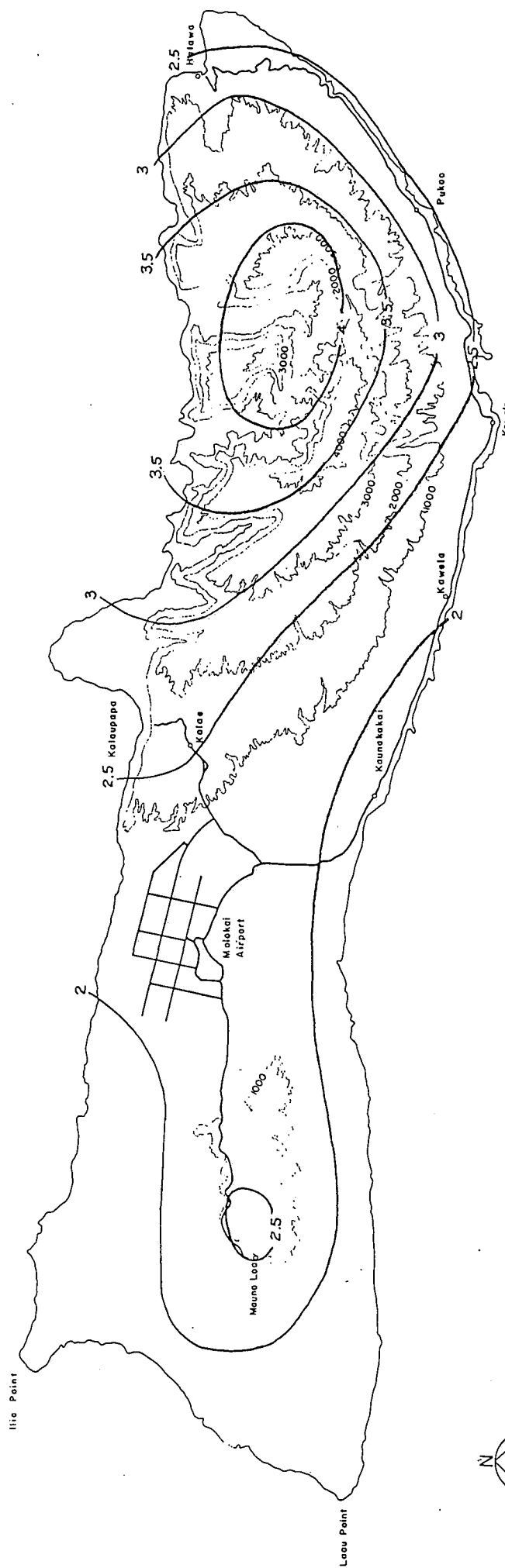Plate 3
Time of Concentration
(OF SMALL AGRICULTURAL DRAINAGE BASIN)
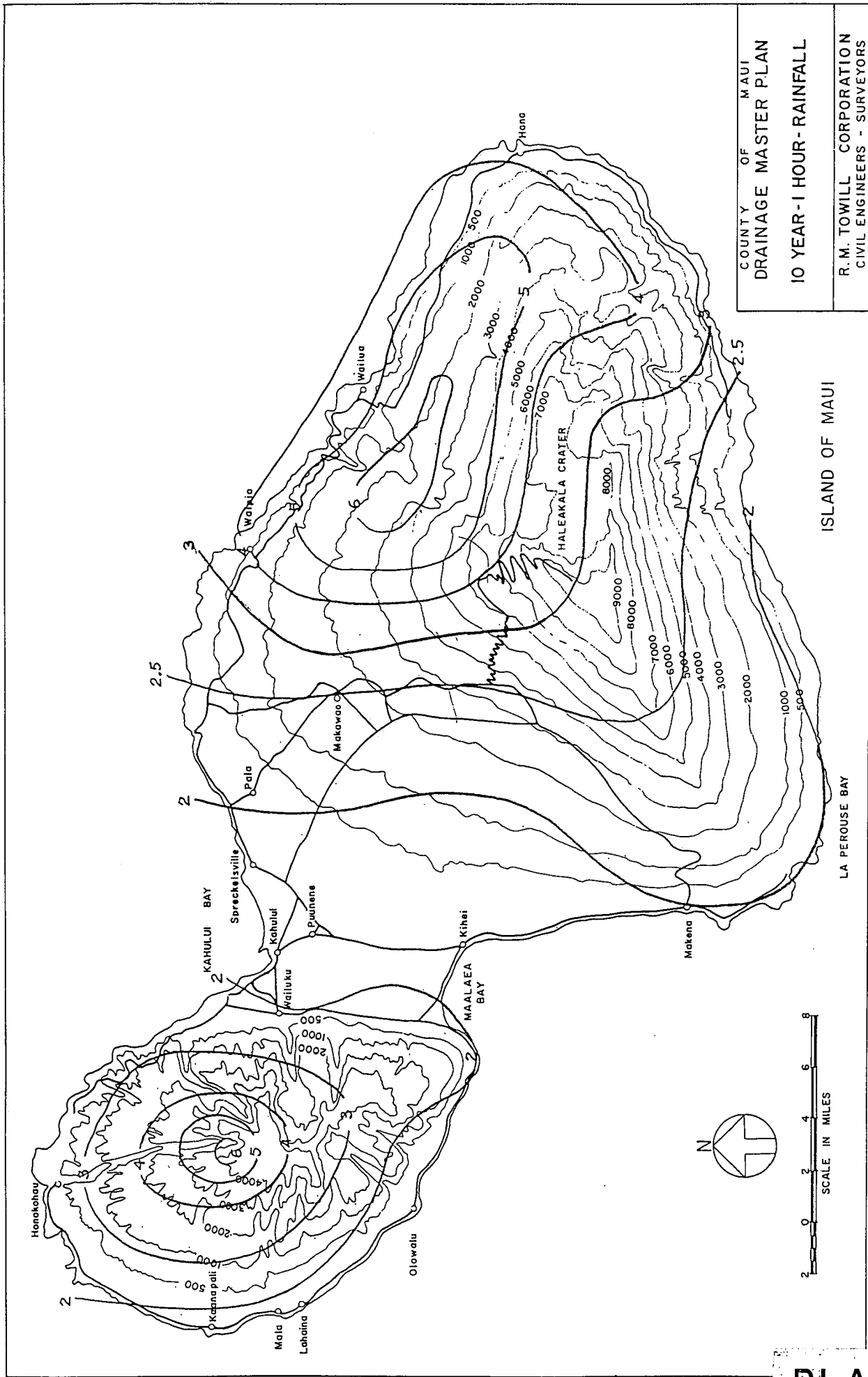
COUNTY OF MAUI
DRAINAGE MASTER PLAN

10 YEAR - 1 HOUR - RAINFALL

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

ISLAND OF MAUI

SCALE IN MILES

PLATE 4

COUNTY OF MAUI
DRAINAGE MASTER PLAN
10 YEAR - 1 HOUR - RAINFALL

R. M. TOWILL CORPORATION
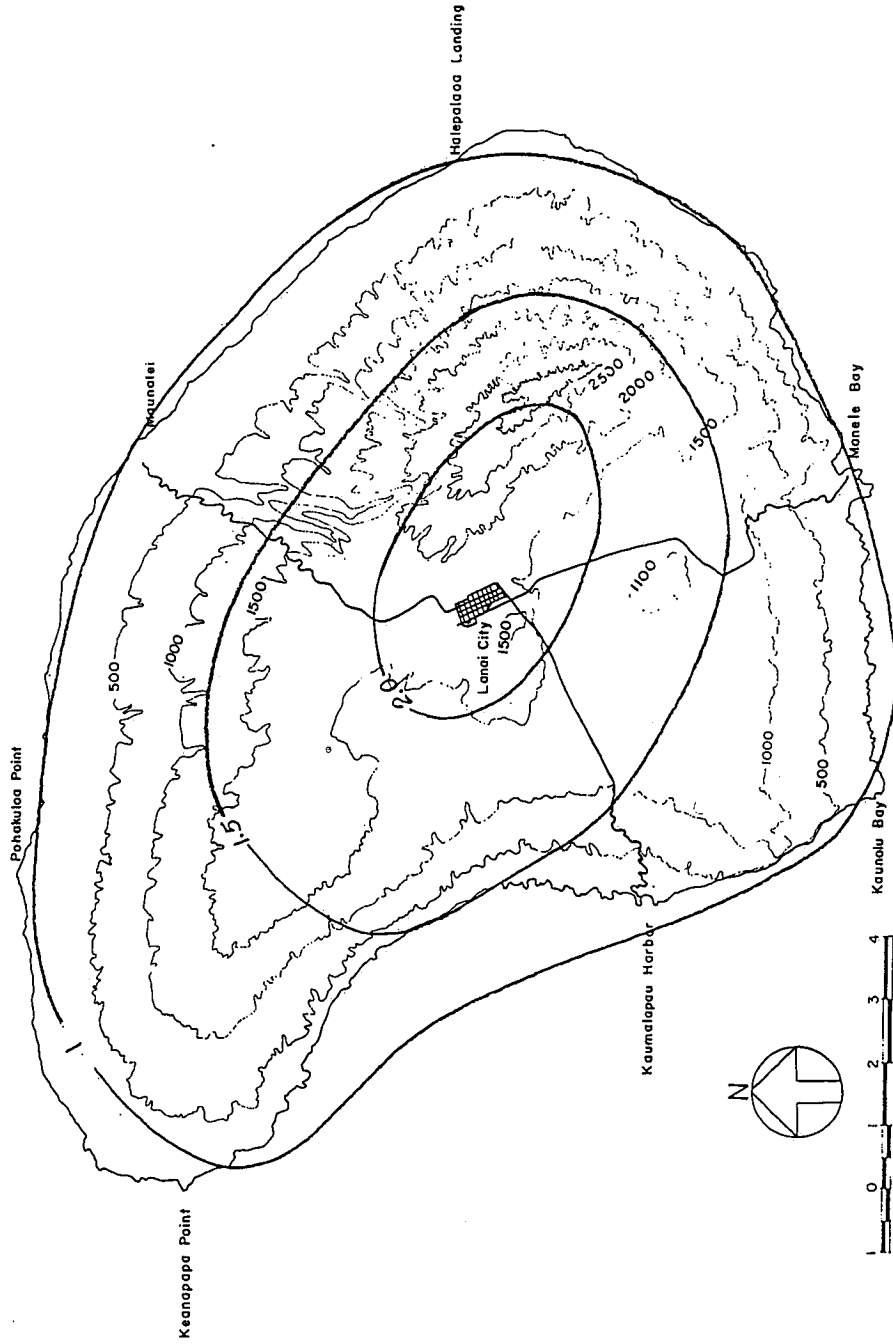CIVIL ENGINEERS – SURVEYORS
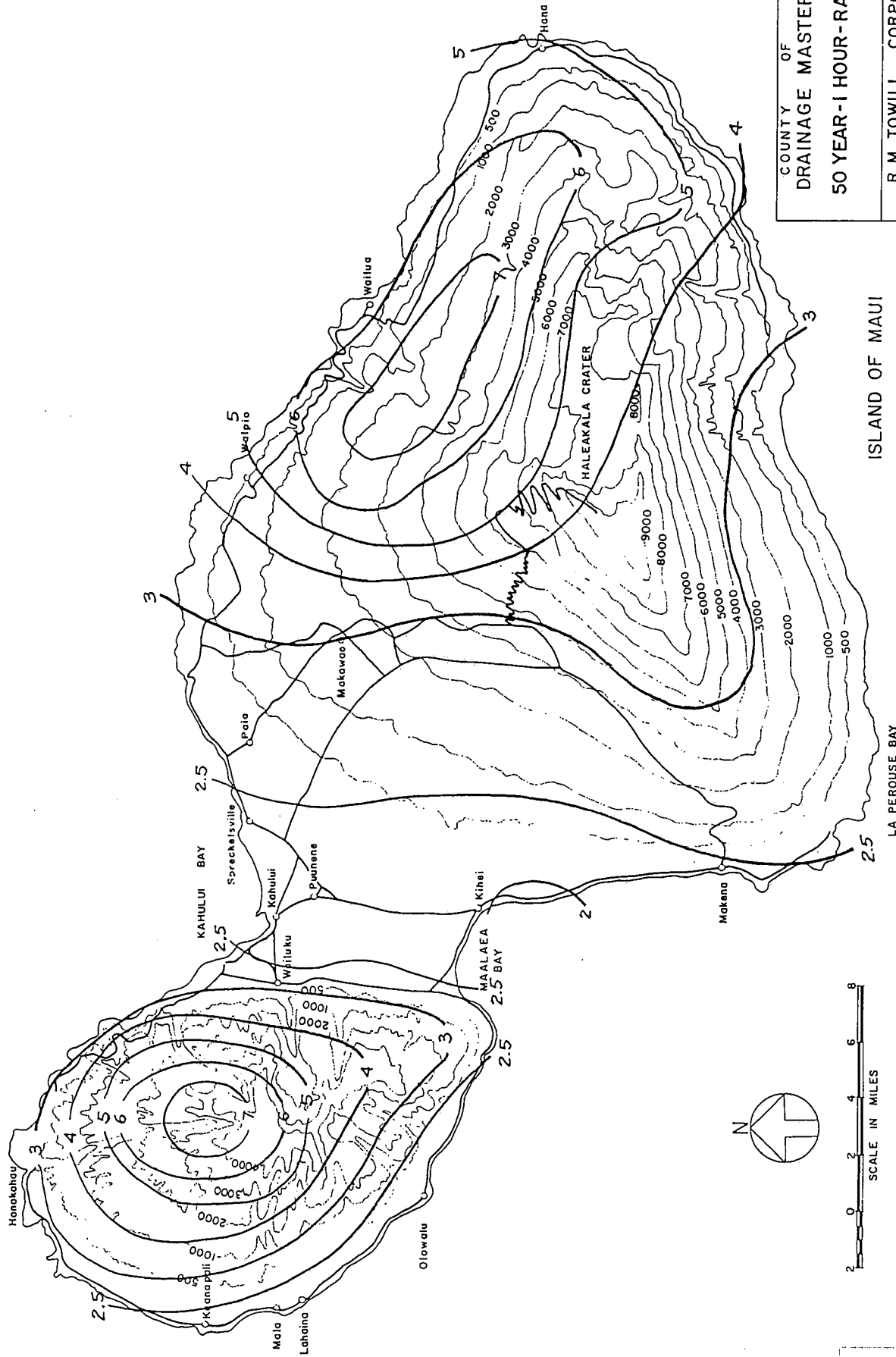
ISLAND OF MOLOKAI

N

SCALE IN MILES
0 1 2 3 4
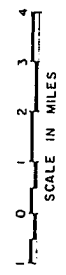
PLATE 5

COUNTY OF MAUI
DRAINAGE MASTER PLAN
10 YEAR - 1 HOUR - RAINFALL

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

ISLAND OF LANAI

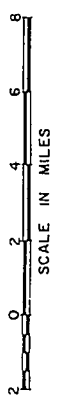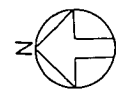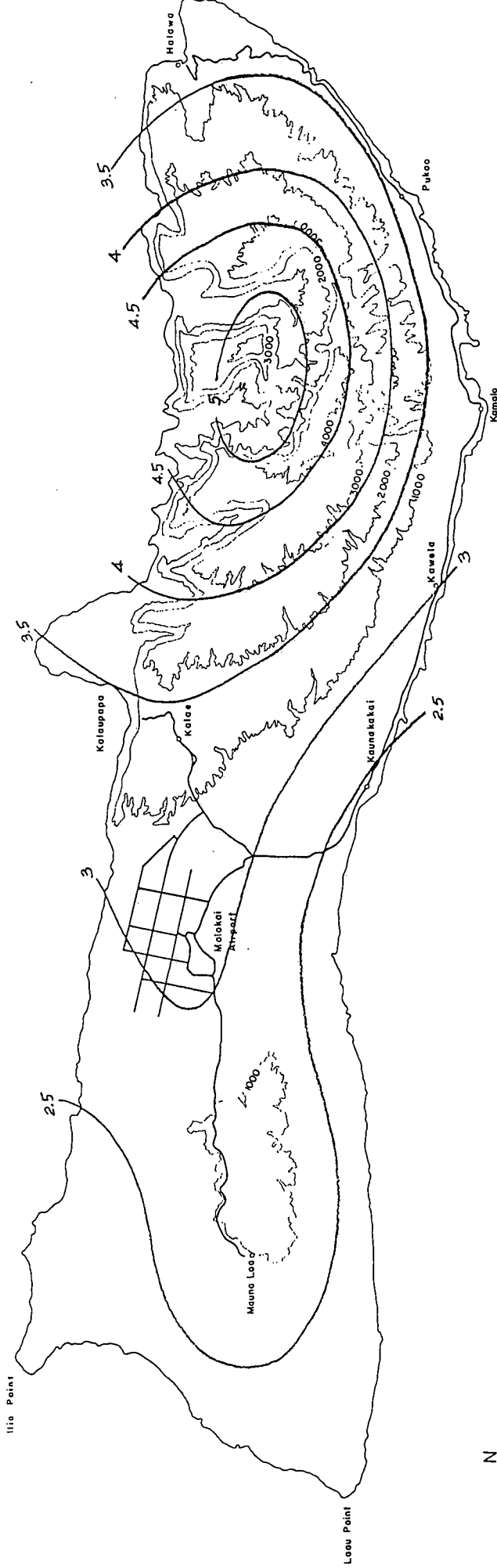Halepalaoa Landing

Maunalei

2500
2000
1500

Manele Bay

1500

1100

1000

1500

Lanai City

500

1000

500

Pohakuloa Point

Kaunolu Bay

Kaumalapau Harbor

Keanapapa Point

N

0   1   2   3   4
SCALE IN MILES

PLATE 6

PLATE 7

COUNTY OF MAUI
DRAINAGE MASTER PLAN
50 YEAR-1 HOUR-RAINFALL

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

ISLAND OF MAUI

SCALE IN MILES

N

Hana

Wailua

Waipio

Makawao

Paia

Spreckelsville

Kahului

KAHULUI BAY

Wailuku

Puunene

Kihei

MAALAEA BAY

Makena

LA PEROUSE BAY
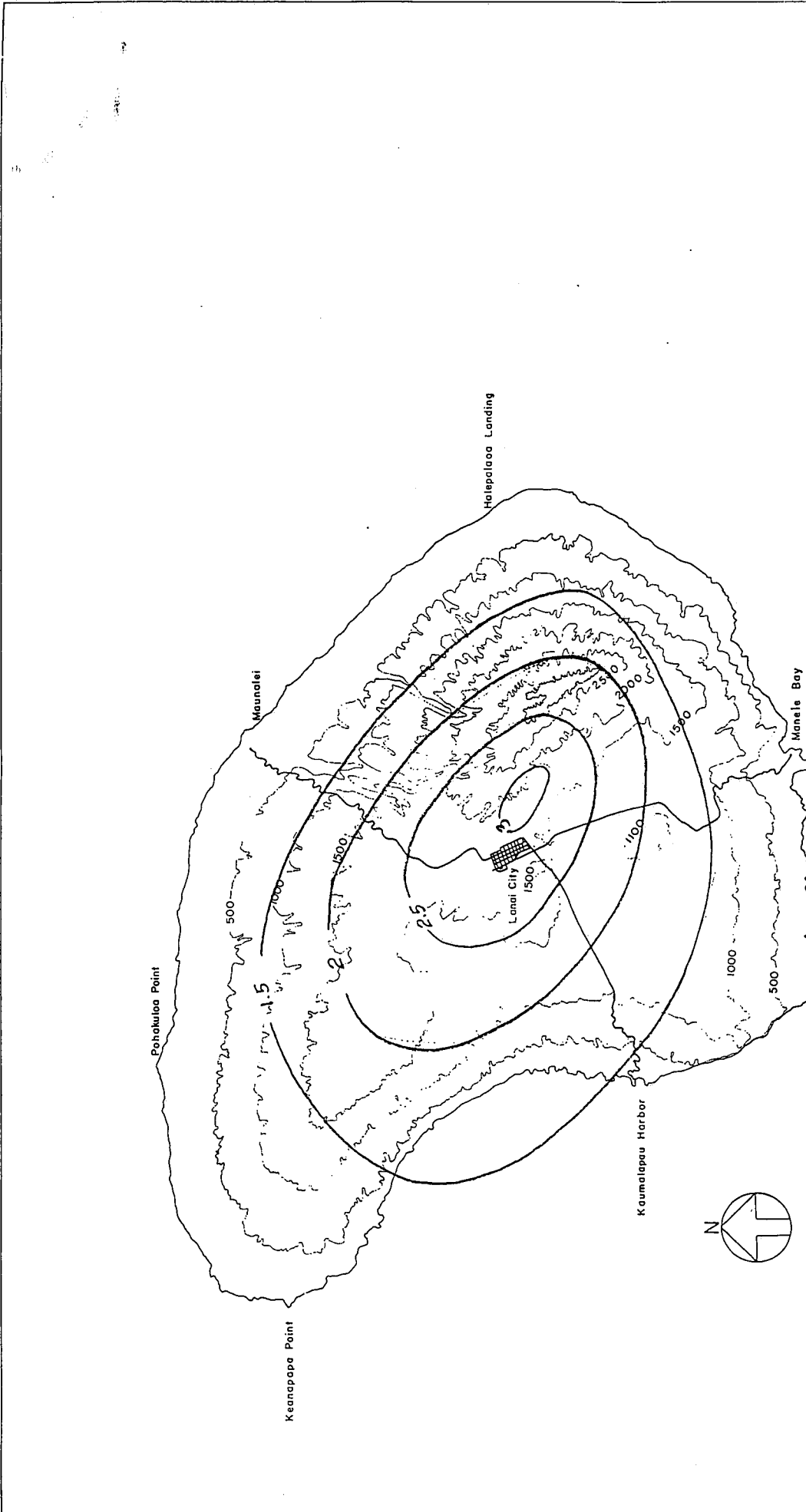
HALEAKALA CRATER

Honokohau

Kaanapali

Mala

Lahaina

Olowalu

COUNTY OF MAUI
DRAINAGE MASTER PLAN
50 YEAR-1 HOUR-RAINFALL

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

ISLAND OF MOLOKAI

Halawa

Pukoo

Kamalo

Kawela

Kalaupapa

Kalae

Kaunakakai

Molokai Airport

Mauna Loa

Ilio Point

Laau Point

3.5
4
4.5
5
4.5
4
3.5
3
2.5
3
2.5
1000
2000
3000
3000
2000
1000
1000

N

SCALE IN MILES
0 1 2 3 4

PLATE 8

ISLAND OF LANAI

Halepalaoa Landing

Maunalei

Manele Bay

Pohakuloa Point

Lanai City

Keanapapa Point

Kaumalapau Harbor

Kaunolu Bay

500
1000
1500
1.5
2
2.5
3
1100
500
1000
1500
2000
2500

N

SCALE IN MILES
0   1   2   3   4

PLATE 9