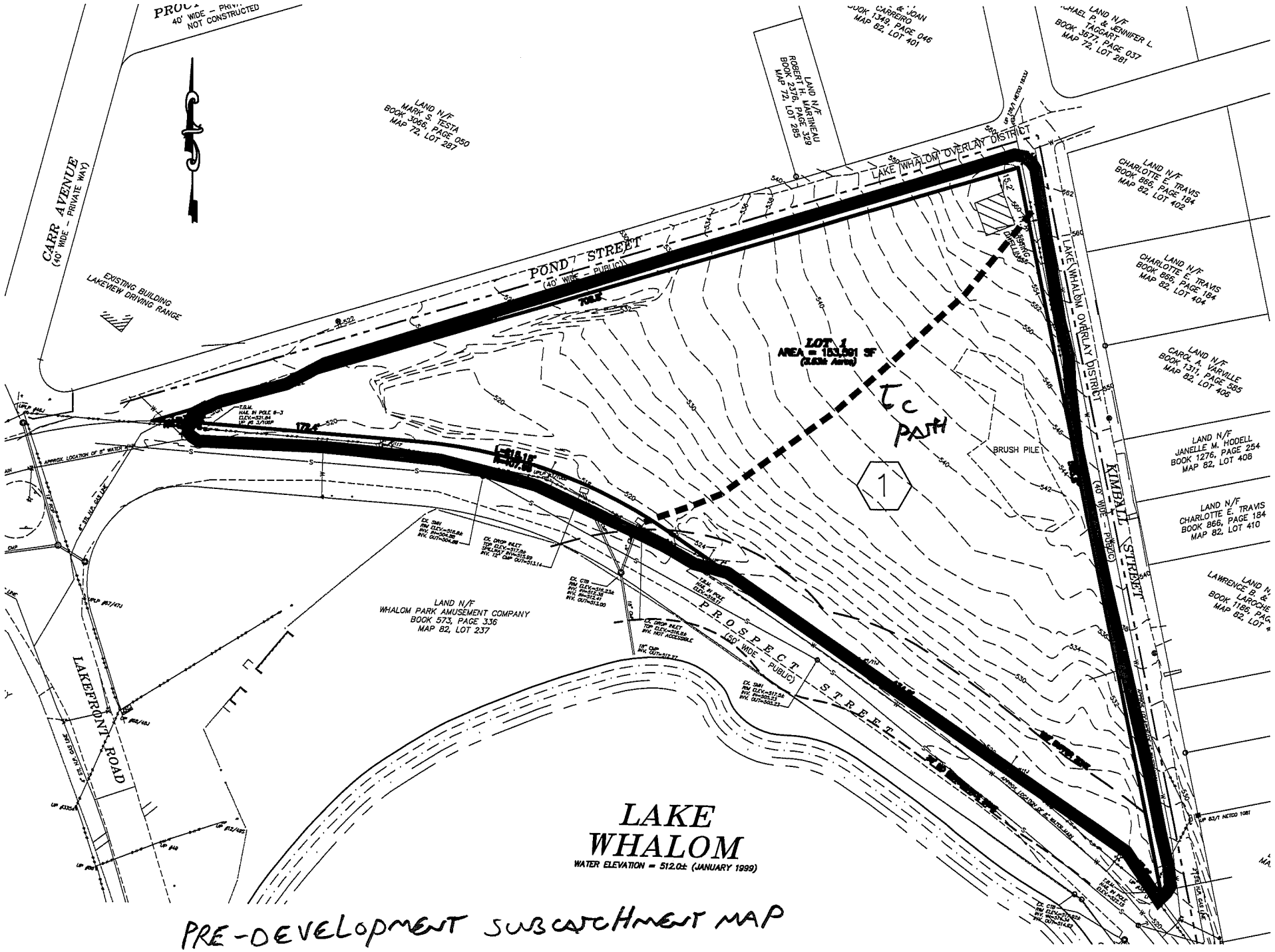
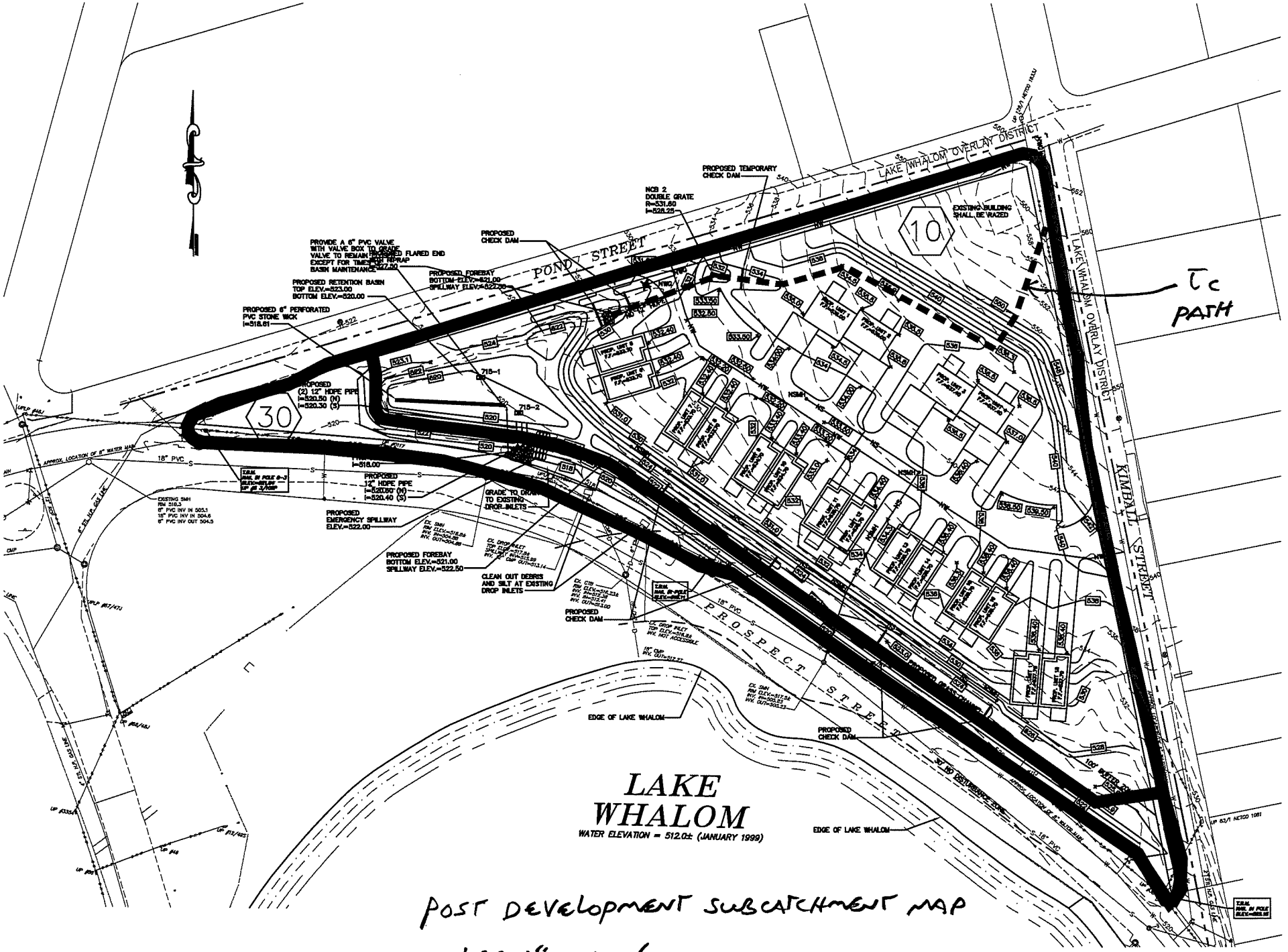
SUBCATCHMENT MAPS



PRE-DEVELOPMENT SUBCATCHMENT MAP

SCALE: 1" = 100'



POST DEVELOPMENT SUBCATCHMENT MAP

SCALE: 1" = 100'

TSS REMOVAL CALCULATIONS

TSS Removal Calculation Worksheet

Location: **LUNENBURG, MA**

A BMP	B TSS Removal Rate	C Starting TSS Load *	D Amount Removed (BxC)	E Remaining Load (C-D)
Sweep Parking Area	0.10	1.00	0.100	0.90
Grassed Channel	0.50	0.90	0.450	0.45
Infiltration/Retention Basin	0.70	0.45	0.315	0.14

Total TSS Removal = 0.865 = ***86.5%***

Project: **274 Prospect Street**
Prepared By: **MFP**
Date: **6/15/2015**

* Equals remaining load from previous BMP (E) which enters the BMP

RECHARGE VOLUME CALCULATIONS

RECHARGE VOLUME CALCULATION

June 15, 2015
Revised: December 7, 2015

Calculate recharge volume lost to newly developed impervious areas.

- Woodbridge and Paxton soils (C soils) –

  Total of 0.99 acres of impervious area in C soils group

  Recharge volume =

  (0.99 AC)(0.25"/12"/ft)(43,560 SF/AC) = 899 *Cubic Feet (CF)*

TOTAL RECHARGE VOLUME REQUIRED = 899 CF

Calculate the recharge volume provided.

Calculate Retention Basin sump volume (Below Elevation 520.30):

Volume from HydroCAD Calculations = 1,077 CF

TOTAL RECHARGE VOLUME PROVIDED = 1,077 CF

DRAWDOWN CALCULATION

Time (drawdown) = Rv (storage volume) / [K x(Bottom Area)]

K - Saturated Hydraulic Conductivity 0.27 Inches / Hour = 0.0225 Feet / Hour

Infiltration within Subsurface Retention Basin sump

Time = 1,077 C.F. / [(0.0225 Feet / Hour) x 3,310 S.F.]

Time = 14.46 Hours

OPERATION AND MAINTENANCE PLAN

WHITMAN & BINGHAM
ASSOCIATES

510 Mechanic Street
Leominster, Massachusetts 01453
(978) 537-5296
FAX (978) 537-1423

STORMWATER MANAGEMENT SYSTEM INSPECTION AND MAINTENANCE PLAN

Proposed Residential Development
274 Prospect Street
Lunenburg, Massachusetts

Prepared for:

Daniel Gardner
811 Chase Road
Lunenburg, MA 01462

Date: June 15, 2015

The proposed 274 Prospect Street site has been designed to function properly provided that routine maintenance is performed. Maintenance of the parking area, driveways, catch basin, stone check dams, grass channel and retention basin are required to ensure that sedimentation and pollution is controlled and storm water retention capacity is sustained. To ensure the proper functioning of these facilities the following maintenance practices will be used:

Owner and Party Responsible for Maintenance:

Mr. Daniel Gardner
811 Chase Road
Lunenburg, MA 01462
Office:
Mobile:

The owner shall develop a chart with a list of the following Best Management Practices (BMP's) with the chart listing the maintenance requirement, frequency of maintenance and the date the maintenance was performed.

PART 1 - INSPECTION AND MAINTENANCE (DURING CONSTRUCTION)

A. It shall be the responsibility of the General Contractor to ensure that the inspection, maintenance and protection of the stormwater management system (defined in Section 2a below) is performed during the construction phase of the project and up to final stabilization of the site (refer to attached plan).

B. The on-site stormwater management system shall be protected from the introduction of sediments and debris both during installation and throughout the duration of site construction in order to provide a fully functioning and long lasting system upon completion of construction.

C. The following steps shall be implemented, at a minimum, to protect the stormwater management system during construction:

1. During construction of the grass channels and retention basin, the open excavation shall be protected from on-site sediments from storm runoff and snow melt by providing a line of erosion controls consisting of haybales or silt fence or a combination of both. In the event that the excavation is compromised by sediment, the sediments shall be removed and the bottom of the excavation restored.

2. An inspection of the stormwater management system shall be conducted by the General Contractor weekly as well as during and after all rainstorms until the completion of construction. In case of any noted introduction of sediments into the system, the General Contractor shall immediately remove said sediments and take any necessary steps to limit further introduction of sediments and notify the engineer of any problems involving storm water management systems.

   a) The stormwater management system shall be defined as the catch basin, drain manhole, stone check dams, grass channel and retention basin.

   b) A rainstorm shall be defined by all or one of the following thresholds:

      i. Any storm in which rain is predicted to last for twelve consecutive hours or more.

      ii. Any storm for which a flash flood watch or warning is issued.

      iii. Any single storm predicted to have a cumulative rainfall of greater than one-half inch.

      iv. Any storm not meeting the previous three thresholds but which would mark a third consecutive day of measurable rainfall.

3. The General Contractor shall also inspect the stormwater management systems at times of significant increase in surface water runoff due to rapid thawing when the risk of sediment migration is significant.

4. All collected/removed sediments shall be removed from the site and disposed of in a legal manner.

PART 2 - INSPECTION AND MAINTENANCE (POST-CONSTRUCTION)

A. It shall be the responsibility of the Owner to ensure that the long-term inspection and maintenance of the stormwater management system on-site is performed. The on-site system shall include the following individual components of the stormwater management system: catch basin, drain manhole, stone check dams, grass channel and retention basin as shown on the approved plans. The Owner shall obtain the services of a qualified Contractor to perform the required inspections and maintenance of the individual components of the stormwater management system on-site, as listed above. All inspections and maintenance of the components of the stormwater management system.

B. It shall be the responsibility of the Owner to maintain adequate records to demonstrate conformance with this inspection and maintenance plan.

C. The inspection and maintenance plan for the on-site stormwater management system (as listed in Section A above) shall be carried out by the current owner (project applicant) and by any and all future owners of the site in perpetuity.

D. The inspection and maintenance plan shall be carried out as outlined below upon completion and final stabilization of the project site:

E. During the first six months of operation of the facility the stormwater management system shall be inspected a minimum of once per month and after every rainstorm (defined in Part 1 above). A portion of this time period must be in the growing season. As warranted by these inspections maintenance of the system shall be performed including, but not limited to the following:

   1. Visual inspection of the catch basins, stone check dams, grass channel and retention basin to ensure that the system is not backed up and is emptying properly.

F. After the six month time period above has elapsed, thorough investigations shall be conducted four times a year. Maintenance requirements may be adjusted based upon the results obtained from the first year of operation. As warranted by these inspections maintenance of the system shall be performed including, but not limited to the following:

   1. The stone check dams, grass channel and retention basin requires an annual inspection for necessary maintenance (refer to attached plan). This consists of visually inspecting for the accumulation of sediment; obstructions within the dams, channel and basin. Remove sediments from the stone check dams (replace stone as necessary), grass channel and retention basin. Sediment, which is removed, shall be legally disposed of. The retention basin shall be monitored at several intervals during and after a small and large rainfall event to ensure the basin is functional.

MAINTENANCE LOGS

Maintain a log of all operation and maintenance activities including without limitation inspections, repairs, replacement and disposal (for disposal, the log shall indicate the type of material and disposal location). A copy of the yearly maintenance logs shall be made accessible to the following agencies:

Planning Board
Ritter Memorial Building
960 Massachusetts Avenue
Lunenburg, MA 01462

Department of Environmental Protection
Central Regional Office
627 Main Street
Worcester, MA 01608

CATCH BASIN INSPECTION FORM

Daniel Gardner
811 Chase Road
Lunenburg, MA 01462

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Catch Basins Inspected (circle): 2

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

DRAIN MANHOLE INSPECTION FORM

Daniel Gardner
811 Chase Road
Lunenburg, MA 01462

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Catch Basins Inspected (circle): 4

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

STONE CHECK DAMS

Daniel Gardner
811 Chase Road
Lunenburg, MA 01462

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Stone Check Dams Inspected (Describe location of dam):

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

GRASS CHANNEL INSPECTION FORM

Daniel Gardner
811 Chase Road
Lunenburg, MA 01462

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Grass Channel Inspected (Describe location of channel):

Acceptable ☐ Needs Work ☐

Add notes below if structures need work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

RETENTION BASIN INSPECTION FORM

Daniel Gardner
811 Chase Road
Lunenburg, MA 01462

Owner:_____

Property Manager:_____

Inspected By:_____

Date of Inspection:_____

Retention Basins Inspected: Basin 52

Acceptable ☐ Needs Work ☐

Add notes below if structure needs work:

Date of cleaning:_____ By Whom:_____

Date of repair: _____ By Whom:_____

Below note any further actions that need to be taken as necessary:

AERIAL MAP

(Picture shows meadow with a few trees on perimeter)

Locus


Traffic, Bicycling, Directions
Lakeview Nurseries
Ugly Omlete
Hey Good Look'n
Harris F
Lakeview Driving Range
Presto Pizza
CVS Pharmacy - Photo
Emerald Place
Cardtronics ATM
Sean Patrick's
On the Rocks
Brian McNally Park
Lake Whalom
Leominster Rd
Google

CLOSED DRAINAGE SYSTEM

CALCULATIONS

WHITMAN & BINGHAM ASSOCIATES

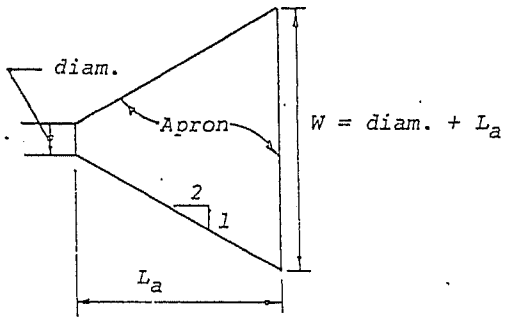
DESIGN OF STORM SEWERS

PROJECT NAME 274 Prospect Street
PROJECT NO. 13334 SHEET 1 OF 1
CALCULATED BY MAP DATE 6-16-15

A		B		C	D	E	F	G	H	I	J	K	L	M	N	O	P	
FLOW PATH		AREA (Ac)		COEFF. OF RUNOFF (c)	TIME TO INLET (min.)	DESIGN STORM (year)	INTENSITY (i)	DESIGN FLOW (Q) (cfs) (CxFxB)	PIPE SIZE (in.)	PIPE SLOPE (ft./ft.)	ROUGH. COEFF. (n)	FULL CAPACITY (cfs)	FULL VELOCITY (fps)	DESIGN VELOCITY (fps)	LENGTH OF PIPE (ft.)	TIME IN CHANNEL (min.) (N/M)	TIME TO NEXT NODE (min.) (D+O)	REMARKS
FROM	TO	SUB-AREA	TOTAL															
NCB 2	OUTLET	0.83	0.83	0.38	10	100	8	2.52	12	0.010	0.012	4.2	5.3	5.8	82	0.30	10.3	USE DOUBLE GRATE

RIPRAP PAD CALCULATIONS

DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION (Tw <0.5 diam.)



Median stone diameter, d_{50}, is the stone size which 50% of the riprap mixture, by weight, is larger than.

Velocities shown are for pipes flowing full.

OUTLET FROM CB

PAD PROPOSED IS ADEQUATE.

↖ BASIN OUTLET

SOIL TESTING DATA

715-1

0-48" FILL

48"-96" C L.S. 2.5Y 6/4

weep 72" NO REF mottles

obs none ESHGW 48" 7.5YR 4/6

2.5Y 5/1

715-2

0-48" FILL

48"-96" C

weep 72" NO REF

obs none ESHGW 48" mottles

7.5YR 4/6

2.5Y 5/1

7-7-15

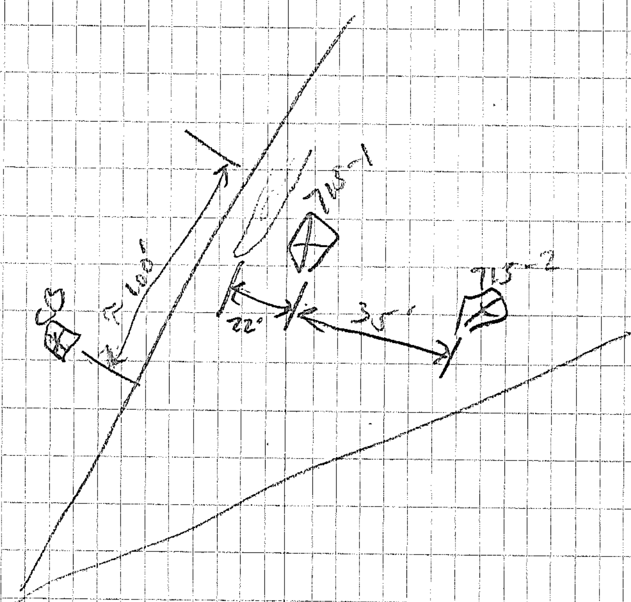
274 Prospect Street

Lunenburg

MFP — WSA

BOH Agent - Dan Gardner Excavating

FOR STORMWATER



NRCS SOIL MAP

Soil Map—Worcester County, Massachusetts, Northeastern Part
(274 Prospect Street)

Map Scale: 1:3,260 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

Map Unit Legend

Worcester County, Massachusetts, Northeastern Part (MA613)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Water	6.4	12.8%
305D	Paxton fine sandy loam, 15 to 25 percent slopes	7.4	14.7%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	20.8	41.5%
310C	Woodbridge fine sandy loam, 8 to 15 percent slopes	6.4	12.8%
602	Urban land	0.1	0.2%
622C	Paxton-Urban land complex, 8 to 15 percent slopes	9.0	18.0%
Totals for Area of Interest		**50.2**	**100.0%**

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

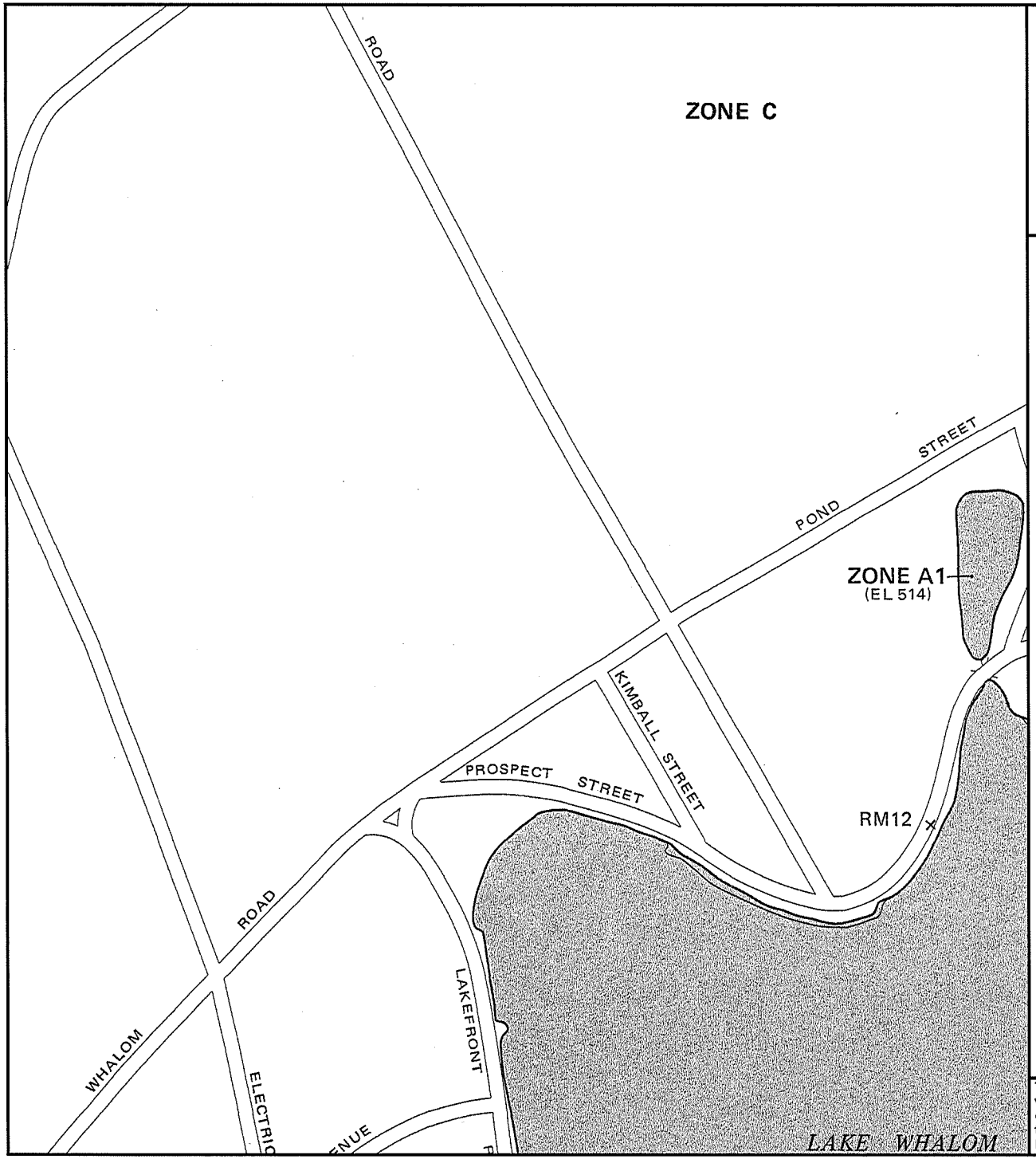
Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 9, Sep 19, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 8, 2011—Apr 9, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

FEMA MAP



N

APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

TOWN OF
LUNENBURG,
MASSACHUSETTS
WORCESTER COUNTY

PANEL 4 OF 6
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
250315 0004 B

EFFECTIVE DATE:
JUNE 15, 1982

Federal Emergency Management Agency

TABLES AND CHARTS

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.

[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	[4]36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

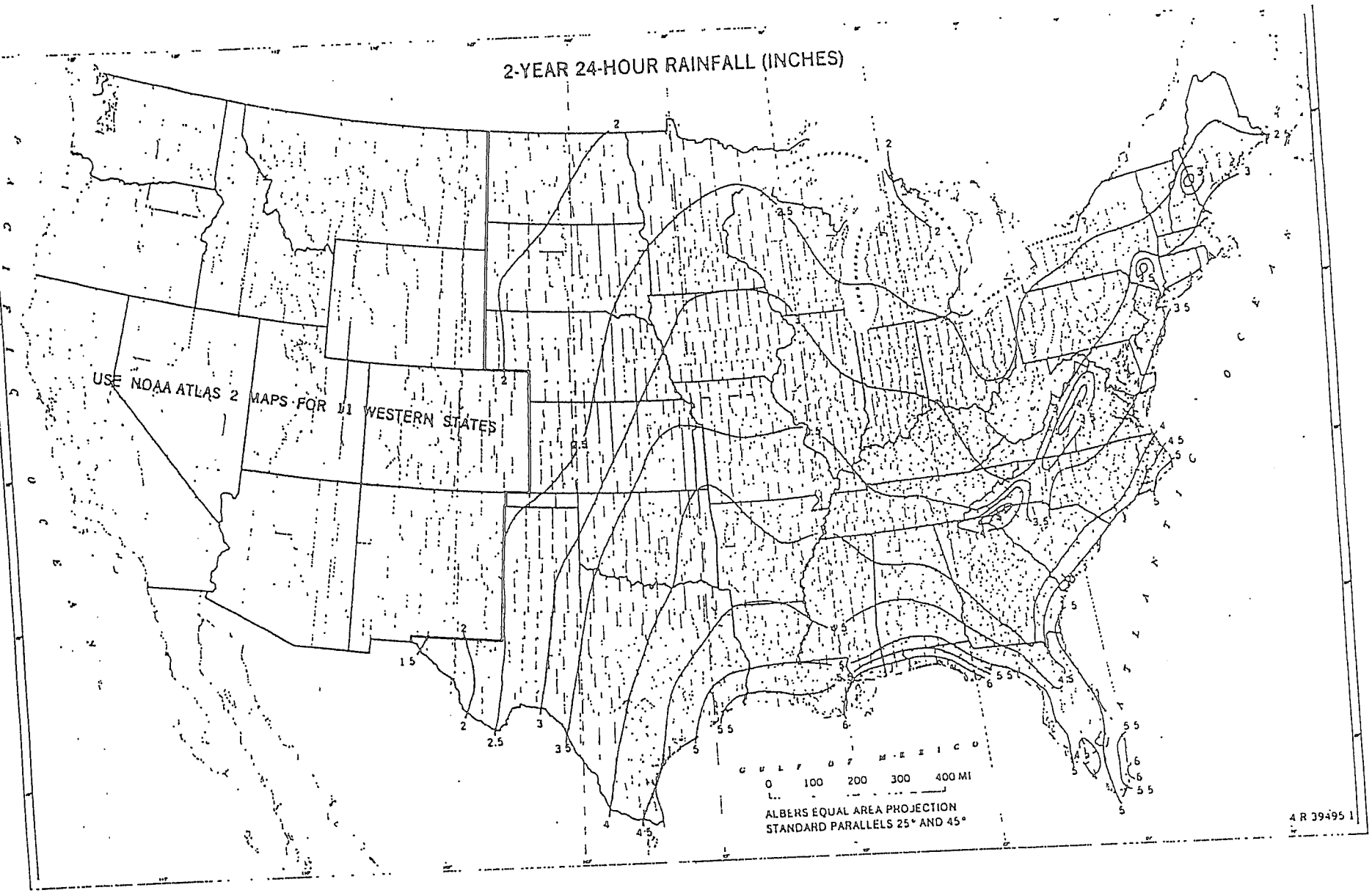


Figure B-3.—Two-year, 24-hour rainfall.

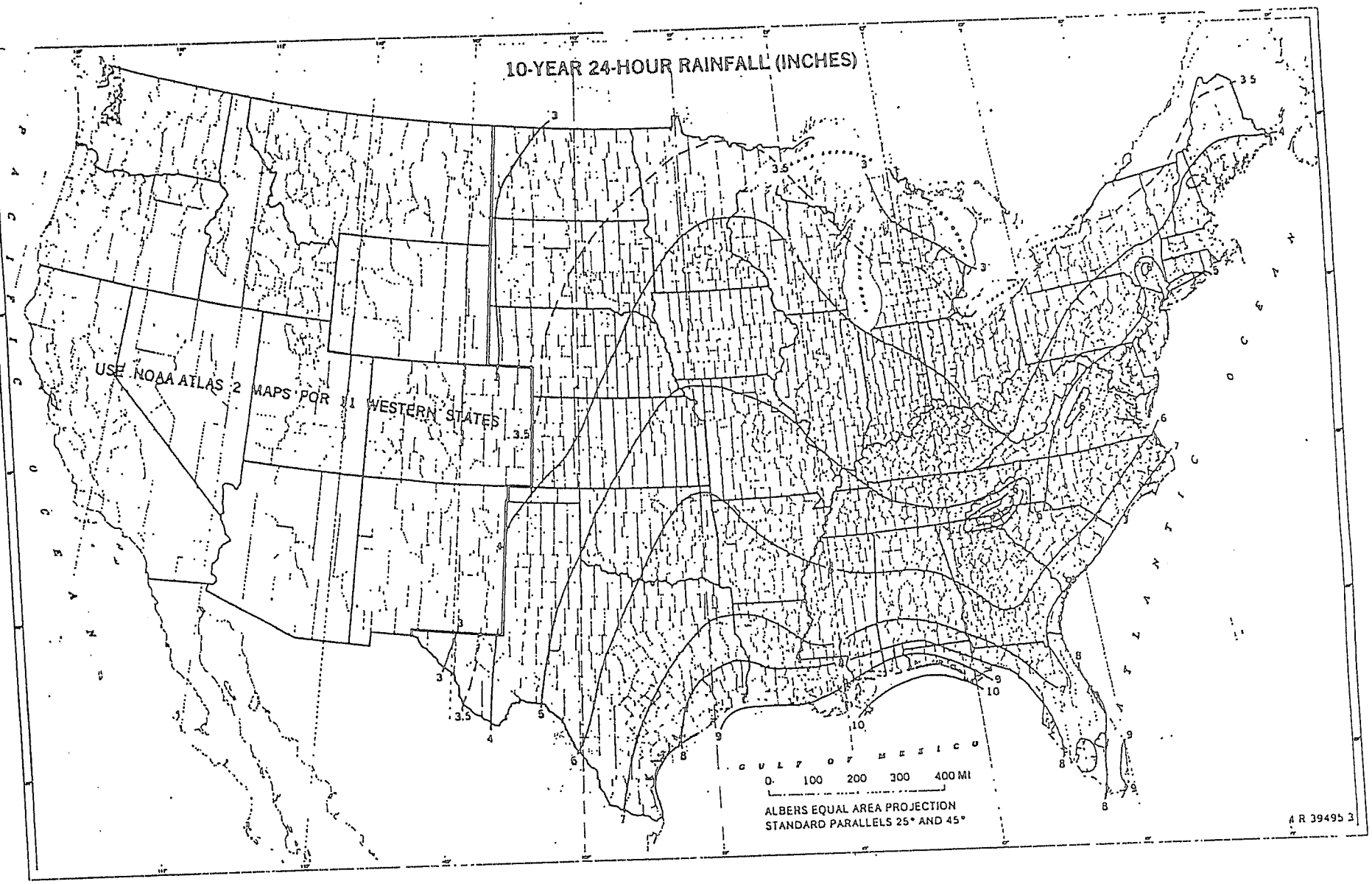


Figure B-5.—Ten-year, 24-hour rainfall.

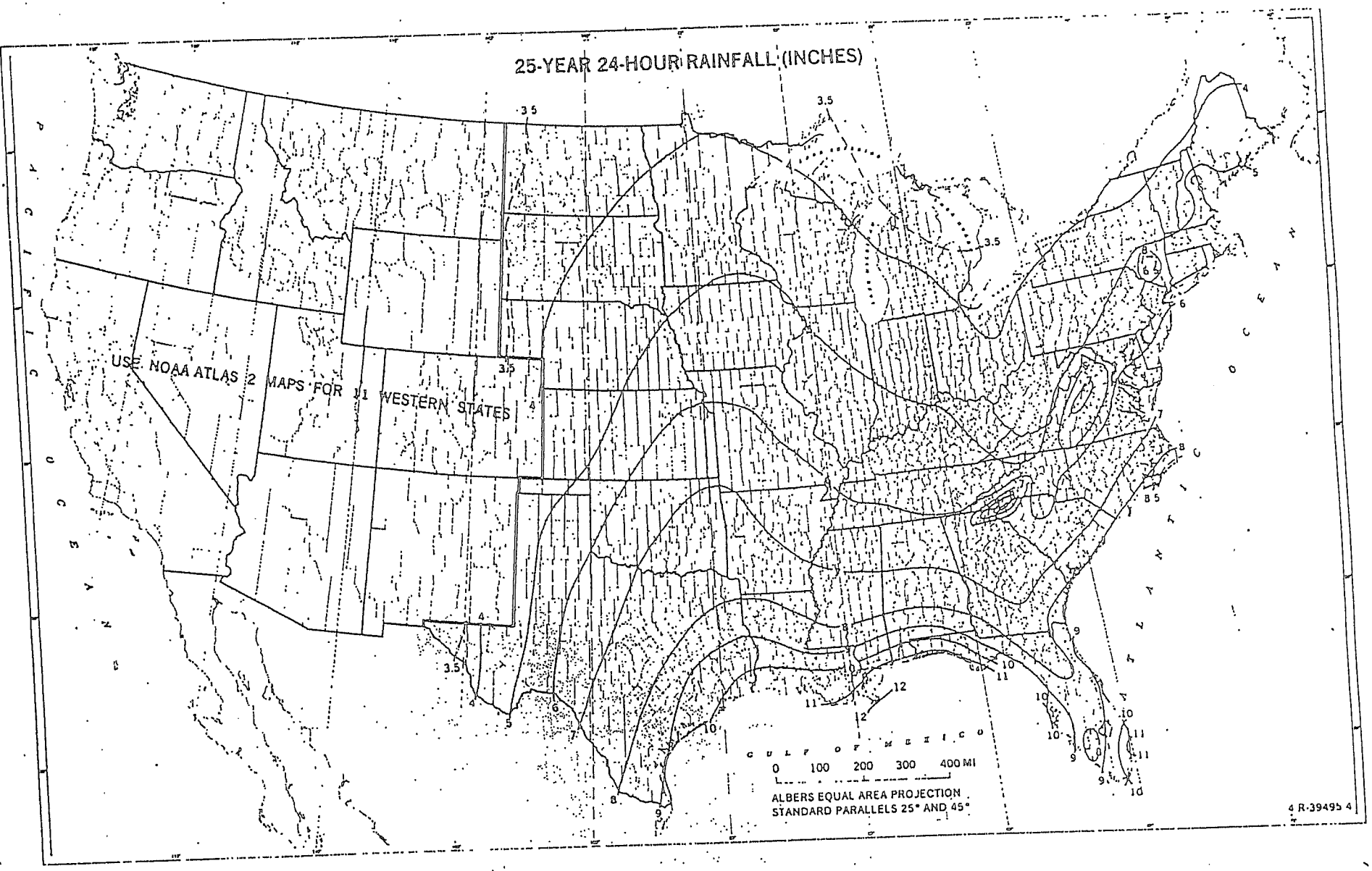


Figure B-6.—Twenty-five-year, 24-hour rainfall.

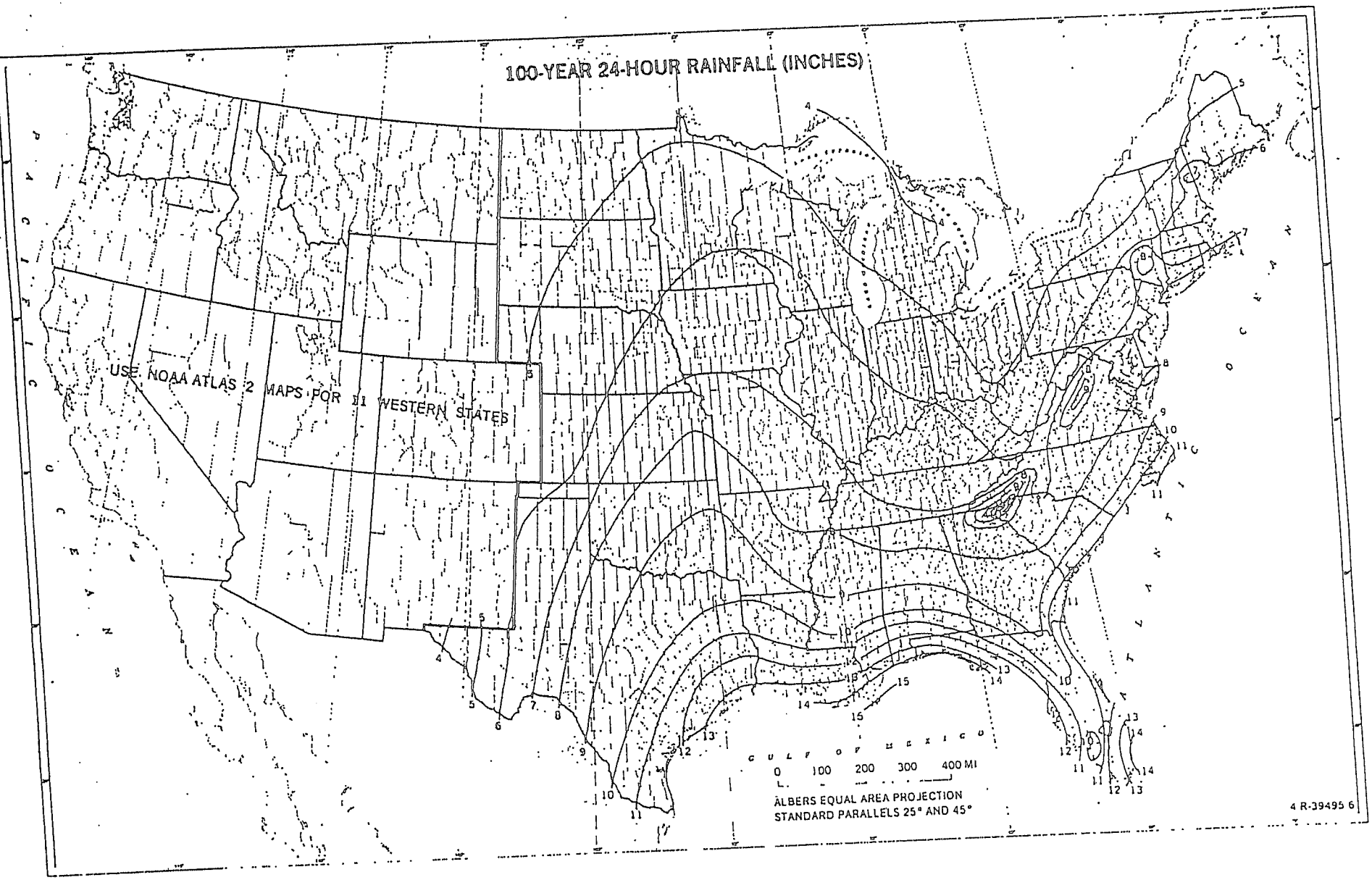
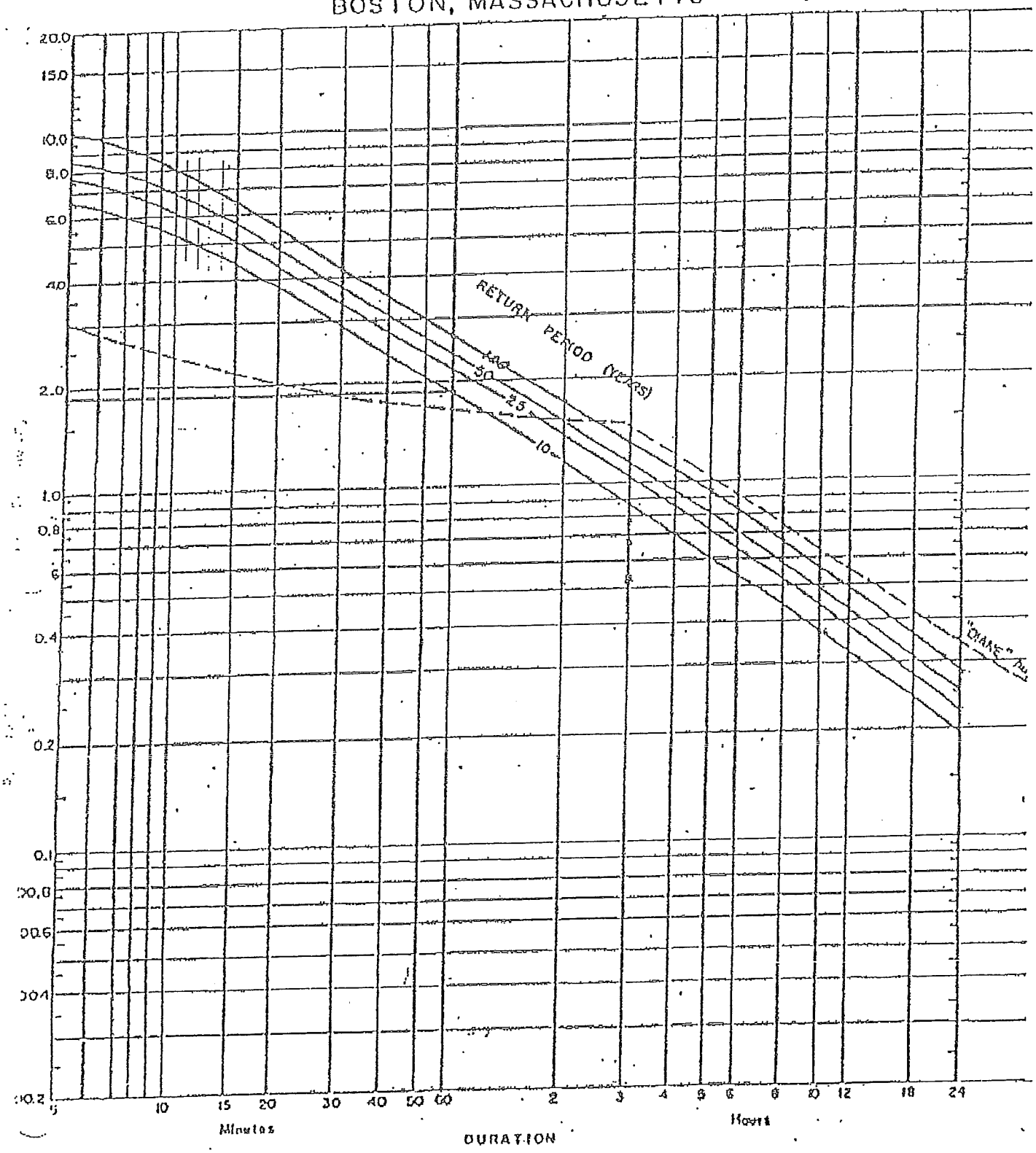


Figure B-8.—One-hundred-year, 24-hour rainfall.

TECH. PAPER # 40
BOSTON, MASSACHUSETTS



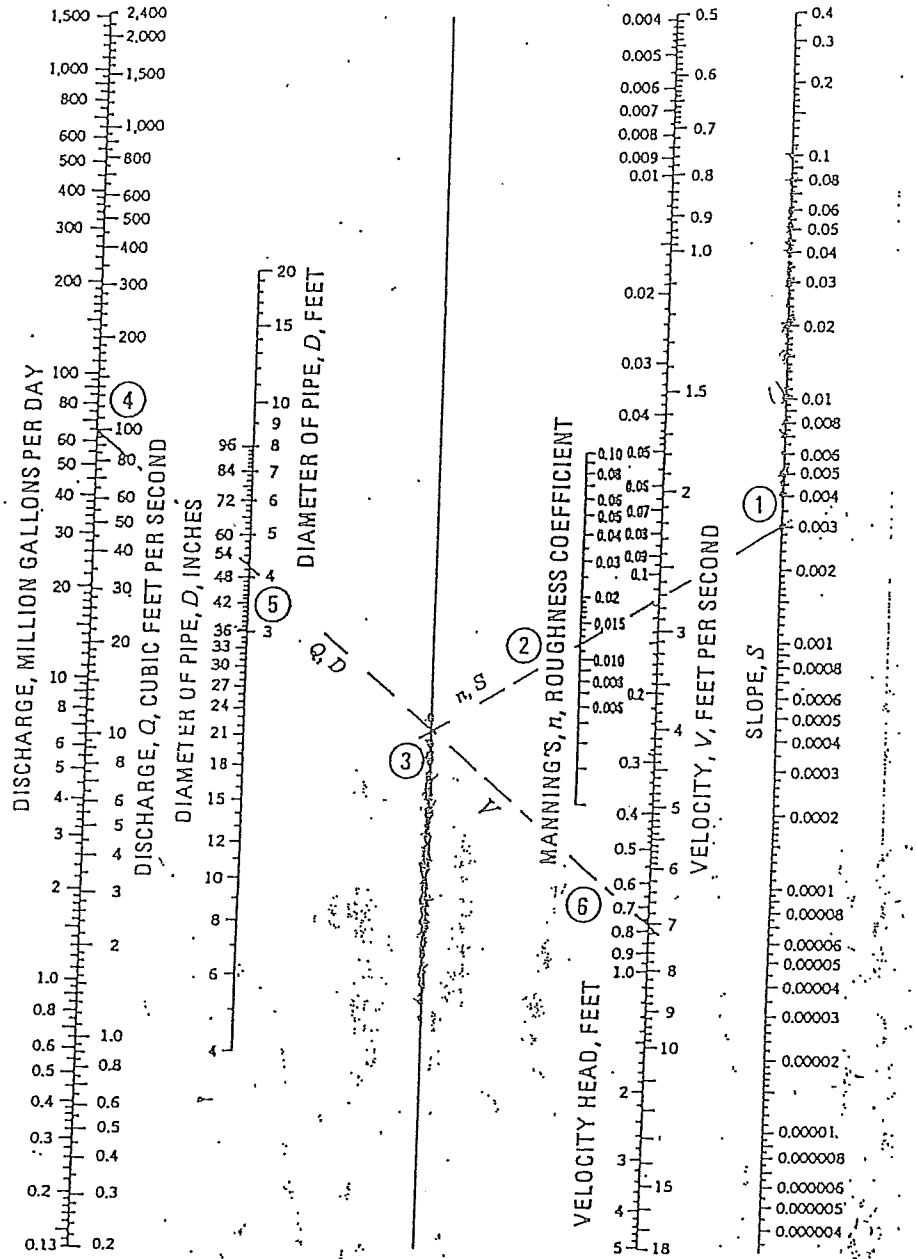
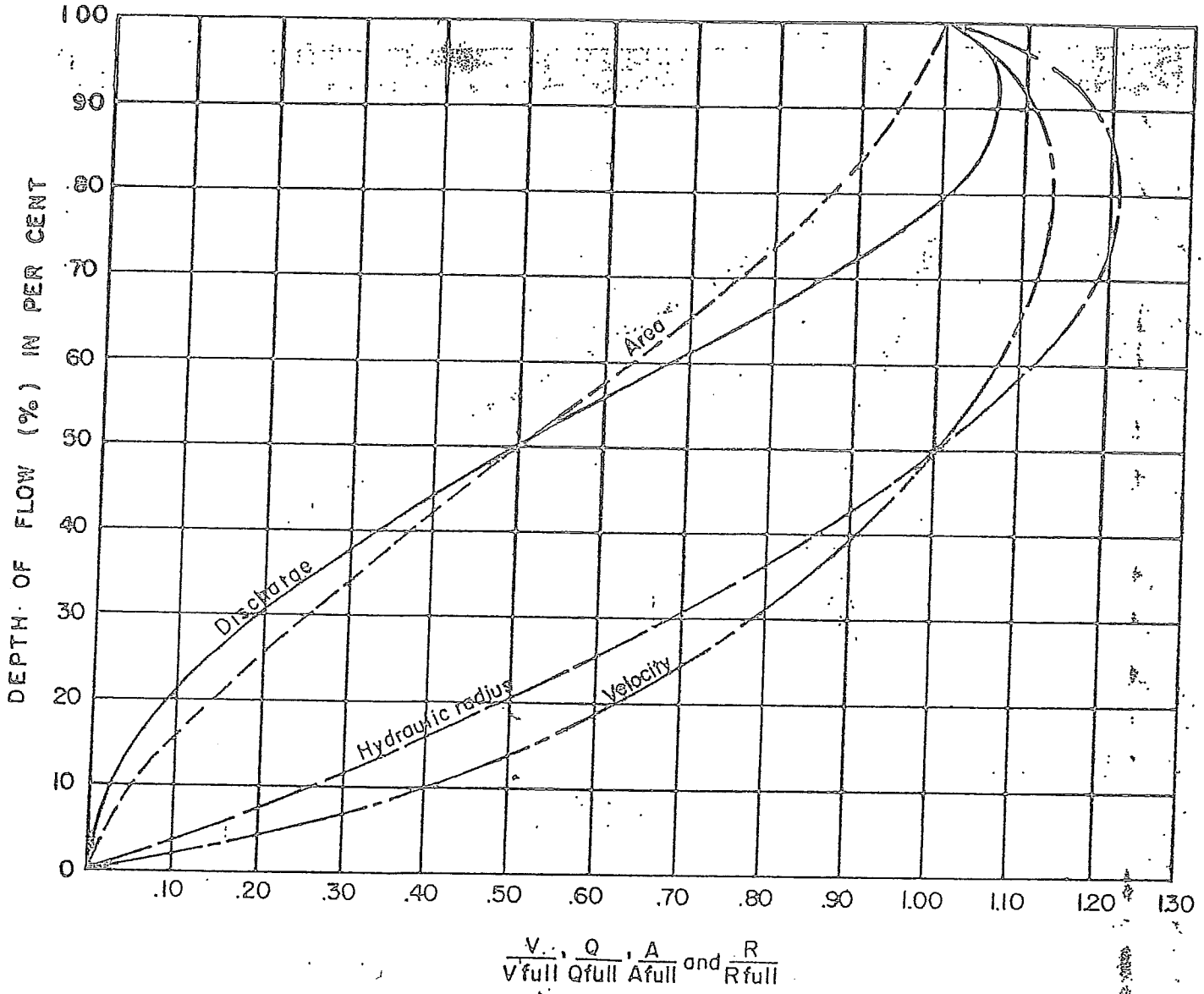


Figure 3.10. Nomograph for Manning's Equation.



HYDRAULIC ELEMENTS CHART