TOWN OF ACTON
472 Main Street
Acton, Massachusetts, 01720
Telephone (978) 929-6630
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Engineering Department

INTERDEPARTMENTAL COMMUNICATION

To*: Board of Selectmen** ***Date: 9/2/2016

From: **Engineering Department**

Subject: **Site Plan Special Permit #11/20/15 - #459 – Concord Water – 180-182 Skyline Drive**

We have reviewed the plans titled "Nagog Pond Water Treatment Plan, Concord Massachusetts" dated August 2016 for the above mentioned special permit. The site plans and relevant sections of the application have not changed since our last review therefore our comments from our last memo dated 1/8/2016 still apply. We have attached a copy of that memo.

In particular, we stress to the applicant to provide water balance calculations which provide a quantification of the volume of infiltrated stormwater on an annual basis. The water balance calculations provided merely imply that stormwater infiltration "is expected" because stormwater runoff is reduced and a new septic system is being provided. The applicant is required to provide calculations which demonstrate this explicitly. We have given the applicant three examples from three different engineering firms for other site plan special permits to provide guidance as to what is expected.

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To*: Board of Selectmen** ***Date: 1/8/2016

From: **Engineering Department**

Subject: **Site Plan Special Permit #11/20/15 - #459 – Concord Water – 180-182 Skyline Drive**

We have reviewed the plans titled "Nagog Pond Water Treatment Plan, Concord Massachusetts" dated November 18, 2015 for the above mentioned special permit and have the following comments:

1. No change is being proposed to the driveway location at Skyline Drive. An SU-30 vehicle would be able to access the driveway coming from Acorn Park but not the newly developed Quail Ridge development. We will defer to the Fire Department regarding access to the driveway and have provided the applicant with a turning template for the Acton Fire Truck along with this memo.

2. The Fire Department should also comment on whether they would require a sign at the driveway entrance for the treatment plant. The applicant may need approval for the sign location at the driveway from the Quail Ridge development.

3. The applicant has not addressed the sidewalk requirement in the application. The frontage for this parcel is located in Littleton.

4. The vertical datum of the plans is 1988 NAVD. A conversion factor should be shown on the plans to convert elevations to 1929 NGVD. The benchmarks should be in areas that will be undisturbed during construction.

5. The property is located within a 100-year floodzone and floodway however the proposed site work takes place outside of the 100-year floodzone, therefore there is no alteration proposed to the floodzone.

6. The property is located in 4 of the Groundwater Protection District and meets the drainage requirements for the zone and the MassDEP Stormwater Standards with the following exceptions:

a. The applicant provided Water Balance calculations to address Section 4.3.6.2 of the Zoning Bylaw regarding Watershed Recharge which states:

   Watershed Recharge – The ***amount*** **[VOLUME]** ***of annual precipitation*** *being captured and recharged to the groundwater on site shall not be reduced due to development related surface runoff from the site when compared to pre-development conditions. Where a Special Permit or Subdivision Approval is required the Special Permit Granting Authority or the Planning Board shall require a hydrologic budget or water balance calculation for the site, showing pre- and post-development conditions, prepared by a Massachusetts Registered Professional Engineering experienced in hydrogeology. This Section shall also apply in Zone 4.*

The water balance calculations provided quantifies the volume for the runoff and septic volume only and not the infiltration volume. The water balance calculations should quantify the annual volume of infiltration in the pre- and post-development condition. We have attached three examples of water balance calculations for similar developments along with this memo.

b. Recognizing that the effect on stormwater runoff for solar panel installation has not been something extensively studied, the applicant should address how stormwater runoff is being handled in this area. The drainage calculations only focus on the rest of the site being developed. We were unable to find any design recommendations from MassDEP however we did find an ASCE study which states:

   Because of the benefits of solar energy, the number of solar farms is increasing; however their hydrologic impacts have not been studied. The goal of this study was to determine the hydrologic effects of solar farms and examine whether or not stormwater management is needed to control runoff volumes and rates.

   A model of a solar farm was used to simulate runoff for two conditions: the pre- and post-paneled conditions. Using sensitivity analyses, modeling showed that the solar panels themselves did not have a significant effect on the runoff volumes, peaks, or times to peak. However, if the ground cover under the panels is gravel or bare ground, owing to design decisions or lack of maintenance, the peak discharge may increase significantly with stormwater management needed.

   In addition, the kinetic energy of the flow that drains from the panels was found to be greater than that of the rainfall, which could cause erosion at the base of the panels. Thus, it is recommended that the grass beneath the panels be well maintained or that a buffer strip be placed after the most down gradient row of panels.

c. The areas shown on plans SW-1 and SW-3 do not match the areas shown on SW-2, SW-4 and the drainage calculations. For example, SW-1 had a total area of 241,436.51 SF while SW-2 and the drainage calculations had a total area of 242,195.18. Because of this, we were unable to verify the areas within the two different soil types on the site.

d. The catch basins were modeled as ponds in the calculations. If we're assuming the catch basins provide storage, the calculations should only assume storage above the invert and to the rim. The 0.25-ft of storage above the rim should only be allowed for the 100-year storm. The catch basins should be sized to adequately handle the 2- and 10-year storms without surcharging past the rim elevation.

7. An as-built plan certified by a Massachusetts Licensed Surveyor showing the buildings, pavement, drainage, utilities, etc. should be required at the conclusion of construction. A Professional Engineer should also stamp the as-built plan to certify that the site has been completed in accordance with the approved site plan and that all features required on the site by the approved plans, decisions, etc… have been field inspected by the PE and conform with the approved design. Any non-conforming features shall be clearly noted.

WATER BALANCE CALCULATIONS
RESIDENCES AT QUAIL RIDGE
JULY 2011

PRE- DEVELOPMENT RECHARGE

PREDEVELOPMENT RECHARGE CALCULATIONS REMAIN UNCHANGED FROM STAMSKI AND MCNARY WATER BALANCE CALCULATIONS DATED 6/3/08

CN=	61.9		
FROM FIGURE 1, INFILTRATION =	19.3	IN/YR	
DRAINAGE AREA =	7,567,243	SF	(INCLUDES OFFSITE AREAS)

RECHARGE = 7,567,243 X 19.30 X 1/12 = **12,170,649** CF/YR

POST- DEVELOPMENT RECHARGE

CN=	67.2		
FROM FIGURE 1, INFILTRATION =	17.9	IN/YR	
DRAINAGE AREA =	7,568,247	SF	(INCLUDES OFFSITE AREAS)

RECHARGE = 7,567,243 X 19.30 X 1/12 = CF/YR **11,289,301**

IRRIGATION FLOW

UNCHANGED - MAINTAINED FROM WATER BALANCE CALCULATIONS FROM STAMSKI AND MCNARY - 6/3/08

32.8 +/- AC TO BE IRRAGATED = 1,428768 SF X 16 WEEKS X 0.04 FT/WK 914,412 CF/YR

25% ALLOWED FOR DEEP INFILTARTION = **228603**

SEWERAGE FLOW

DESIGN FLOW = 153 UNITS X 3 BEDROOMS X 110 GPD/BR = 50,490 GPD
(50490 GPD*365 DAYS/YR)/(7.48 GAL/CF)=2,463,750 CF/YR
CONSERVATIVE ESTIMATE - 50% OF DESIGN FLOW **1231875**

BASIN 31-QUAIL RIDGE DRIVE AT UNIT #71

SUBCAT AREA		140214	sf	
SUBCAT CN		77		
INF VOLUME FROM 1 YR STORM	0.221	9626.76		
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		5.5	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA		64264.75	CF/YR	**64264.75**

WATER BALANCE CALCULATIONS
RESIDENCES AT QUAIL RIDGE
JULY 2011

BASIN #9-QUAIL RIDGE DRIVE AT TRAIL HEAD PARKING

SUBCAT AREA		93628	sf	
SUBCAT CN		77		
INF VOLUME FROM 1 YR STORM	0.147	6403.32		
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		5.5	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR	**42912.833**

BASIN #13-QUAILRIDGE DR -WEST OF CROSSING

SUBCAT AREA		269927	sf	
SUBCAT CN		80		
INF VOLUME FROM 1 YR STORM	0.504	21954.24		
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		6.8	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR	**152958.63**

BASIN #12- QUAIL RIDGE DR ADJACENT TO CONCORD WATER EASEMENT

		49627	sf	
SUBCAT CN		84		
INF VOLUME FROM 1 YR STORM	0.115	5009.4		
RAINFALL TO GENERATE RUNOFF		2.5		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		0.96		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		8.2	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR	**32555.312**

BASIN #10 - PARKLAND AVE AT UNIT #102

SUBCAT AREA		95414	sf	
SUBCAT CN		71		
INF VOLUME FROM 1 YR STORM	0.103	4486.68		
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		3.5	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR	**27829.083**

WATER BALANCE CALCULATIONS
RESIDENCES AT QUAIL RIDGE
JULY 2011

BASIN #17-BASIN AT END OF GREENSIDE
NO INFILTRATION PROPOSED

BASIN #14 - VERNAL POOL
NO INFILTRATION

BASIN #15-QUIAL RIDGE DRIVE AT UNIT #7
NO INFILTRATION PROPOSED

BASIN #3 - IRRIGATION POND
NO INFILTRATION PROPSED -

BASIN #21 - EXISTING BASIN IN GOLF COURSE TO REMAIN

SUBCAT AREA		185885	sf	
SUBCAT CN		63		
INF VOLUME FROM 1 YR STORM	0.106	4617.36		
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		1.9	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR	**29431.792**

BASIN #20- EXISTING BASIN IN GOLF COURSE TO REMAIN

SUBCAT AREA		414633	sf	
SUBCAT CN		61		
INF VOLUME FROM 1 YR STORM	0.106	4617.36		
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2
FROM GRAPH 1 ANNUAL RUNOFF		1.7	IN/YR	
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR	**58739.675**

BASIN #4- EXISTING BASIN IN GOLF COURSE TO REMAIN
NO INFILTRATION PROPOSED

BASIN #5- EXISTING BASIN IN GOLF COURSE TO REMAIN
NO INFILTRATION PROPOSED

BASIN #22 -BASIN ADJACENT TO PROPSED RESTAURANT
NO INFILTRATION PROPOSED

WATER BALANCE CALCULATIONS
RESIDENCES AT QUAIL RIDGE
JULY 2011

BASIN #16-SKYLINE DRIVE AT QUAIL RIDGE ROAD

SUBCAT AREA		92508	sf		
SUBCAT CN		81			
INF VOLUME FROM 1 YR STORM	0.183	7971.48			
RAINFALL TO GENERATE RUNOFF		>2.6		from HydroCAD	
% OF ANNUAL RAINFALL INFILTRATED		1		FIGURE 2	
FROM GRAPH 1 ANNUAL RUNOFF		7	IN/YR		
ANNUAL RUNOFF X %INFILTAREATED X AREA			CF/YR		**53963**

BASIN #28 - BEHIND GOLF CART STORAGE GARAGE

NO INFILTRATION PROPOSED

TOTAL RECHARGE ON A YEARLY BASIS = CF/YR **13212434**

13212434.1 CF/YR - PROPOSED RECHARGE VOLUME

12,170,649 CF/YR - EXISTING RECHARGE VOLUME

1,041,785 CF/YR INCREASE IN RECHARGE VOLUME

OR

7.9% INCREASE IN ANNUAL RECHARGE.

WATER BALANCE CALCULATIONS
RESIDENCES AT QUAIL RIDGE
JULY 2011

PRE- DEVELOPMENT WEIGHTED CURVE NUMBER CALCULATIONS

SUBCATCHMENT	AREA (AC)	CN	PRODUCT
1	18.62	71	1322.02
2	10.69	81	865.89
3	14.69	84	1233.96
4	3.62	80	289.6
5	9.5	62	589
6	17.66	81	1430.46
7	18.74	73	1368.02
8	7.73	62	479.26
9	33.53	68	2280.04
10	10.9	65	708.5
11	25.21	77	1941.17
12	2.83	63	178.29
	173.72		12686.21
	WEIGHTED CN=		73.026767

WATER BALANCE CALCULATIONS
RESIDENCES AT QUAIL RIDGE
JULY 2011

PROPSOSED DEVELOPMENT WEIGHTED CURVE NUMBER CALCULATIONS

SUBCATCHMENT	AREA (SF)	CN	PRODUCT
10	95414	71	6774394
11	69316	81	5614596
12	49627	84	4168668
13	200611	80	16048880
14	100884	62	6254808
15	152686	81	12367566
17	99640	73	7273720
18A	63597	62	3943014
18B	159310	68	10833080
2	480105	65	31206825
31	140214	77	10796478
6	147160	63	9271080
7	56057	73	4092161
8	185538	73	13544274
9	93628	77	7209356
1S	137403	84	11541852
1	1678786	66	110799876
16	92508	81	7493148
19	612322	63	38576286
20	414633	61	25292613
21	185885	63	11710755
22	84050	70	5883500
23	969892	62	60133304
24	106597	74	7888178
26	215921	79	17057759
27	44868	75	3365100
28	62728	75	4704600
29	97538	87	8485806
3	373203	59	22018977
4	314904	58	18264432
5	83222	70	5825540
	7568247		508440626

WEIGHTED CN= 67.180765

Water Balance Calculations

JOB: BVS
LOCATION: 400 Massachusetts Avenue, Acton, MA
BY: KBS

P = DRO + ET + I

P = Mean Annual Precipiation (Attached) = 44" / year
ET = Evapotranspiration Potential (Attached) = 21" / year
DRO = Direct Runoff
I = Infiltration

Existing Condition:
DRO = Direct Runoff - Calculated with Hydrocad Output - 2 yr storm frequency - Acre-feet
1.213 Af

Express DRO as % of total P for Watershed - Total Existing Drainage Area

Total runoff (Af) / {Exist. Drain Area x 2 yr rainfall, 24 hour storm (3.1")} = 1.213 / (10.8 Ac x 3.1 inch / 12)

= 0.44 Therefore 44% of rainfall will become direct runoff in existing condition

DRO = Total rainfall (44") x 43% Total P which becomes runoff
DRO = 19.36 in / yr Therefore 18.9" of direct runoff per year for existing site
ET = 21.0 in / yr Therefore 21" of evapotranspiration per year for existing site
P = 44.0 in / yr Therefore 44" per year of precipitation for existing site

I = P - DRO - ET 3.6 inches infiltrated per year in existing condition

Proposed Condition:
DRO = Direct Runoff - Calculated with Hydrocad Output - 2 yr storm frequency - Acre-feet
1.292 Af

Express DRO as % of total P for Watershed - Total Existing Drainage Area

= Total runoff (Af) / {Exist. Drain Area x 2 yr rainfall, 24 hour storm (3.1")} = 0.925 / (10.8 Ac x 3.1 inch /12)

= 0.33 Therefore 47% of rainfall will become direct runoff in proposed condition

DRO = Total rainfall (44") x 33% Total P which becomes runoff
DRO = 16 in / yr
ET = 21.0 in / yr Therefore 21" of evapotranspiration per year for proposed site
P = 44.0 in / yr Therefore 44" per year of precipitation for proposed site

I = P - DRO - ET 7.5 inches infiltrated per year in proposed condition

Greater Infiltration in Proposed Condition due to : - Improved landcover
- Runoff collected underground detention basin

U.S. DEPARTMENT OF INTERIOR
U.S. GEOLOGICAL SURVEY

MEAN ANNUAL RUNOFF, PRECIPITATION, AND EVAPOTRANSPIRATION IN THE GLACIATED NORTHEASTERN UNITED STATES, 1951-80

by Allan D. Randall

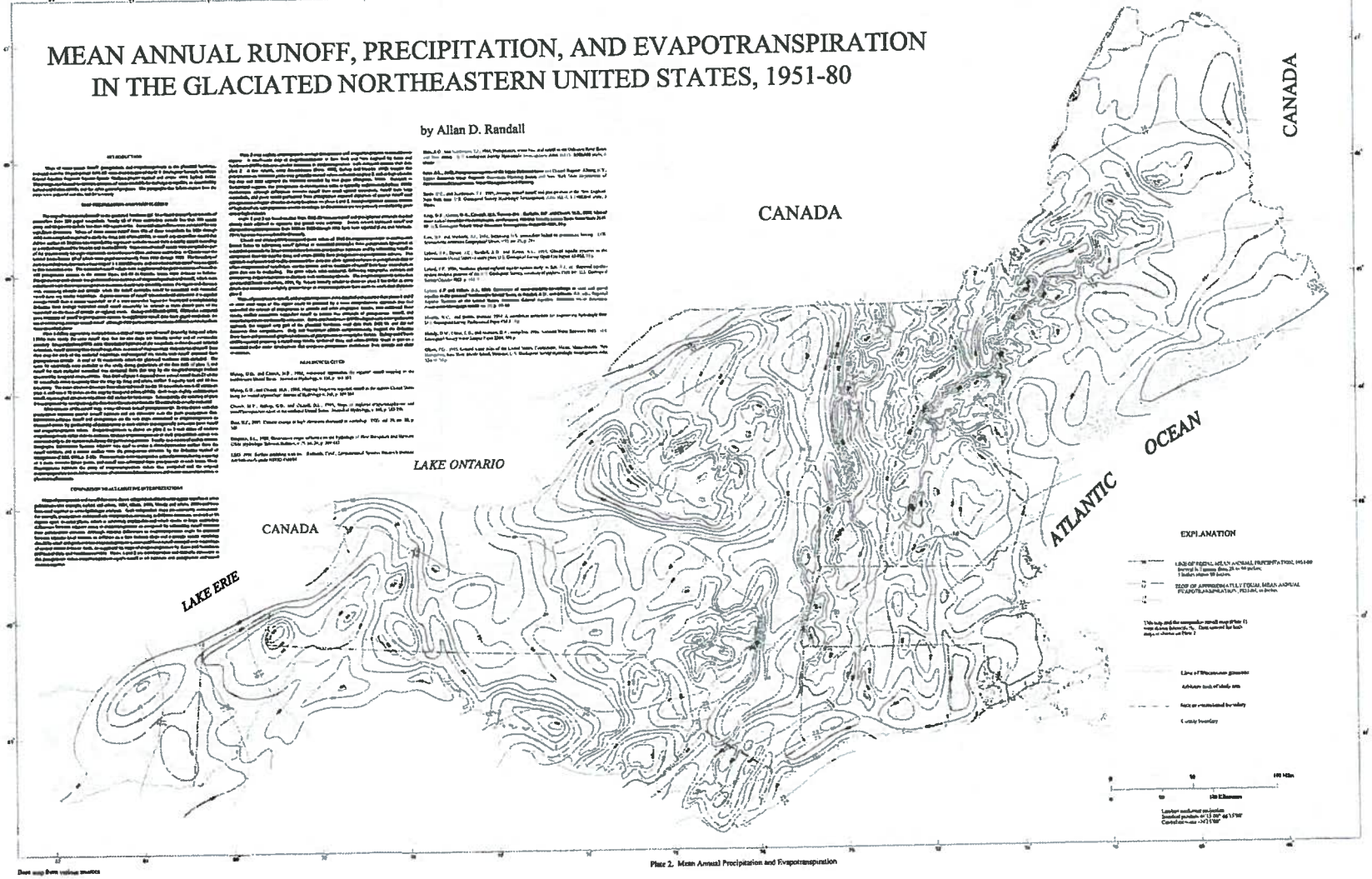


Plate 2. Mean Annual Precipitation and Evapotranspiration

Water Balance Calculations

Water Balance Calculations

SM-4993

Project: 27 Jackson Drive By: JTM Date: 3/4/2013

Location: Acton MA Checked: RJH Date: 3/4/2013

Pre-Development Recharge

CN=	62.7					
From Figure 1, infiltration=	18.2	in/year				
Drainage Area=	158,558	s.f.				
Recharge=	158,558	x	18.2	/12 in/ft	240,480	c.f./year

Post-Development Recharge

CN=	69.8					
From Figure 1, infiltration=	17.4	in/year				
Drainage area=	158,558	s.f.				
Recharge=	158,558	x	17.4	/12 in/ft	229,910	c.f./year

Post-Development Drywell Infiltration

CN=	98					
From Figure 1, runoff=	30.6	in/year (directed to drywells)				
Roof Area =	10,454	s.f.				
* Recharge=	10,454	x	30.6	/12 in/ft	26,658	c.f./year

Post-Development	Vs.	Pre-Development
256,567	>	240,480
c.f./year		c.f./year

*Additional recharge provided by SMA-1 and SMA-2 but not included in infiltration calcs

Total CN

PRE				Post			
Subcatchm	Area	CN	Sum		Area	CN	Sum
1	3.38	63.3	213.95	P1	1.57	68.3	107.23
2	0.26	55	14.30	P2	0.13	57.3	7.45
3	0	0	0.00	P3	0.41	60.7	24.89
4	0	0	0.00	P4	0.59	75.4	44.49
5	0	0	0.00	P5	0.52	65.3	33.96
				P6	0.04	98	3.92
				P7	0.06	98	5.88
				P8	0.06	98	5.88
				P9	0.06	98	5.88
				P10	0.02	98	1.96
				P11	0.02	98	1.96
				P12	0.02	98	1.96
				P13	0.07	61	4.27
				P14	0.07	61	4.27
Total	3.64		228.25	Total	3.64		253.99
	Average	62.7			Average	69.8	

STAMSKI AND McNARY, INC.
80 Harris Street
ACTON, MASSACHUSETTS 01720
(508) 263-8585

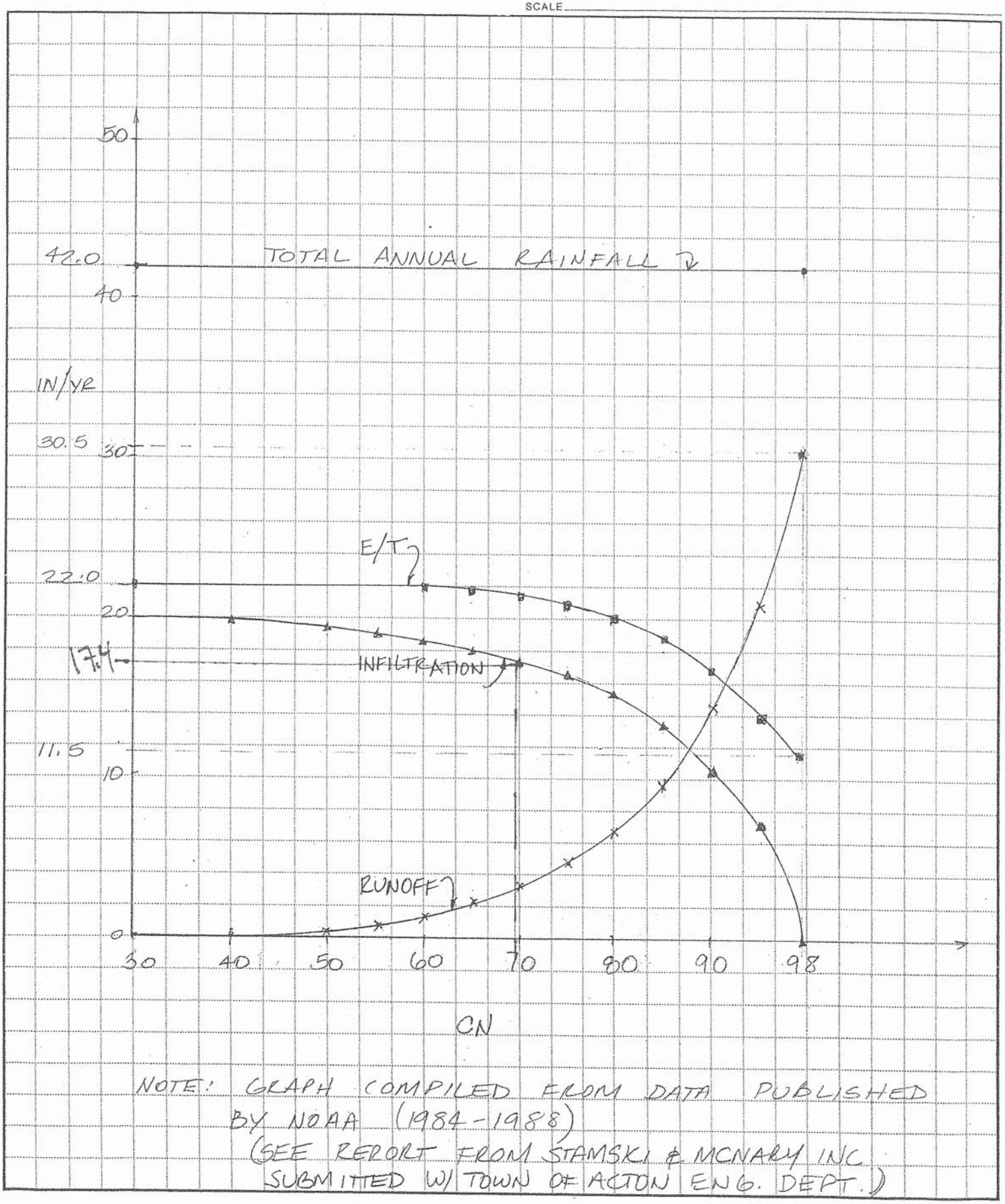
JOB 64 JACKSON DRIVE

SHEET NO. 76 OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE



NOTE: GRAPH COMPILED FROM DATA PUBLISHED BY NOAA (1984-1988)
(SEE REPORT FROM STAMSKI & MCNARY INC. SUBMITTED W/ TOWN OF ACTON ENG. DEPT.)