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WATER TOWER HILL PROPERTY
COLCHESTER, VERMONT
STORMWATER RUNOFF ANALYSIS

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Date: February 15, 1988

WATER TOWER HILL PROPERTY
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STORMWATER RUNOFF ANALYSIS

SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

1) Wagner, Heindel, and Noyes, Inc. has performed an extensive stormwater runoff analysis for the Water Tower Hill property in Colchester, Vermont. The purpose of the analysis has been to develop a management plan utilizing stormwater retention ponds and diversion structures to result in no increase in peak discharge rates at compliance points downgradient from the site for the design storm.

2) A total of 3 points of compliance have been located at the southern, eastern, and western periphery of the site. Within each of these regions, subwatersheds have been created for the pre-development (existing) and post-development conditions based on topographic divides and drainage structures.

3) For the post-development condition, a uniform lot coverage of 75% continuous impervious area has been assumed since the actual configuration of construction on each lot is unknown. This approach was taken as it provides the most conservative appraisal of expected runoff conditions.

4) Using the TR-20 hydrologic model, peak discharge rates for the 10-year, 24-hour design storm have been obtained, and the hydrographs for all subwatersheds have been routed to the compliance points.

5) A series of 3 stormwater retention ponds have been specified within and adjacent to the site to control the peak rate of stormwater discharge. With these ponds in place, there will be no increase in peak discharge rates at any of the compliance points.

6) To obtain adequate stormwater treatment as specified by the Vermont Agency of Natural Resources Guidelines, all retention ponds have been sized so as to provide at least the recommended ratio of surface area to peak outflow rate. In fact, all ponds provide surface area to outflow ratios considerably in excess of the recommended value.

WATER TOWER HILL PROPERTY

COLCHESTER, VERMONT

STORMWATER RUNOFF ANALYSIS

INTRODUCTION

This report presents the results of an extensive stormwater runoff analysis for Water Tower Hill property in Colchester, Vermont. The site is located to the west of U.S. Routes 2 and 7, and to the north of Interstate 89, as shown on the USGS map on page 1 of Appendix 1.

Since the site is located on a hilltop, drainage proceeds radially outward in all directions from the center. Three compliance points have been identified for the purpose of evaluation of peak stormwater discharge rates. Within each of these regions, a series of subwatersheds have been created which are based on topographic divides and existing or proposed drainage structures. Within each subwatershed, watershed area, hydrologic curve number, and time of concentration have been computed for pre-development and post-development conditions. With these data, the Soil Conservation Service TR-20 hydrologic model has been used to generate runoff hydrographs from each subwatershed. These hydrographs have been routed using the computer model through existing or proposed channel reaches, and culverts to result in a composite runoff hydrograph at each compliance point. For the post-development condition, a series of

stormwater retention/treatment basins have been proposed for the site in order to result in no increase to peak discharge at any of the compliance points, as well as to provide removal of particulate material from stormwater leaving the site.

COMPLIANCE POINTS

Three compliance points for the evaluation of peak discharge have been identified. These are shown on the USGS map on page 1 of Appendix 1. The majority of the site will drain to either the eastern or western compliance point, both of which are unnamed tributaries of Sunderland Brook. These compliance points have been located at the point of confluence of the lowest drainage way from the site. This is appropriate since the receiving streams are all quite small (<300 acres). An agreement has been obtained from the Vermont Agency of Natural Resources to use these compliance locations.

A small portion of the site near the southwest corner drains across Interstate 89 through a 3-foot diameter reinforced concrete pipe. The compliance point for this stormwater discharge has been taken as the point at which the stormwater exits the site.

As per Agency of Natural Resources Guidelines, the peak discharge at each compliance points has been evaluated for the 10-year, 24-hour storm (3.6 inches of rain in 24 hours). The pre-development peak discharge for the design storm has been computed with the TR-20 model using current coverage conditions. For the post-development condition, a peak discharge rate has also been projected. Stormwater retention structures have then been specified to result in no increase in peak discharge at any of the compliance points and to provide removal of particulate material from the stormwater.

SUBWATERSHED CHARACTERISTICS

In order to evaluate the runoff rates from the subwatersheds identified for the pre- and post-development conditions, it is necessary to compute three watershed parameters. These are as follows:

Area

Curve Number

Time of Concentration

For the pre-development condition, the site has been subdivided into a total of 10 subwatersheds, with an additional 5 subwatersheds located off site. Division of subwatersheds on site has been based on in-field mapping of topographic divides, and drainage patterns created by existing swales along the roadways bordering the site. For each subwatershed, the area

has been computed by planimeter, the curve number has been computed from published SCS soil types (see Appendix 1, page 2) and land use patterns. A standard S.C.S. table indicating the curve numbers assigned for differing land uses is included on pp. 3A-3B of Appendix 1. The time of concentration has been computed as the time necessary for flow to reach the base of each subwatershed from the most hydraulically remote point. Graphs of flow velocity versus slope are included on pp. 3C and 3D of Appendix 1 for overland flow and channel flow respectively, these velocities are used to compute this travel time. Off site subwatersheds have been included where necessary in order to enable generation of a complete runoff hydrograph at the compliance points. These are subwatersheds 10A, 10B, 11, 12, 13 and 14 as indicated on the location map on p. 1 of Appendix 1. The watershed characteristics for all pre-development subwatersheds are summarized on page 3 of Appendix 1, with backup calculations included on pages 4 through 17 of Appendix 1.

For the post-development condition, 75% connected, impervious cover has been assumed on all lots on site with the exception of Lot B 28 (Hotel site) which has been assigned a coverage of 65%. The 75% coverage figure has been chosen since it is the maximum allowable under Colchester zoning rules, and since the actual configuration of the construction on each lot is unknown, it provides the most conservative projection possible of peak discharge rates. To evaluate the effect of 75% coverage on each

lot, an impervious surface equidistant from property lines has been assumed with a greenbelt left at the perimeter. Calculations showing the 75% area for each lot are included on page 18 of Appendix 1.

For the post-development condition, a total of 22 subwatersheds have been created on the site. The hydrologic characteristics of these are summarized on page 19 of Appendix 1, with the backup calculations of area, hydrologic curve number, and time of concentration included on pages 20 through 41 of Appendix 1.

COMPOSITE RUNOFF HYDROGRAPHS

Once the runoff hydrograph for a subwatershed has been generated, it is necessary to route the hydrograph through existing or proposed downstream channel sections, swales, or drainage structures and combine it in sequence with all other subwatersheds. To do this using the TR-20 model, rating tables of area versus elevation and discharge versus elevation are computed for the applicable stream cross-sections. The locations of stream cross-sections included in the TR-20 model for the pre- and post-development conditions are included on Drawings 1 and 2, respectively (see map pocket). For the eastern region, watershed schematics showing each of the subwatersheds, cross-sections and structures as well as the routing relationships between these are included on pages 1 (pre-development) and 2 (post-development) of Appendix 2. The discharge and area

rating tables for each section are included on pages 3 through 13 of Appendix 2. The rates of discharge through swales and natural stream cross-sections have been computed using the Manning equation based on existing or proposed channel slopes, and computed geometric elements. In the case of culverts, the type of hydraulic control prevailing (inlet versus outlet) has been established, and the appropriate Bureau of Public Roads nomographs have been used to determine flow rates for various water surface elevations. (See Appendix 2, pp. 2A-2B.)

For the western and southern compliance points, the subwatershed routing relationships are as shown in the watershed schematics on pages 14 and 15 of Appendix 2 for pre- and post-development conditions, respectively. The discharge computations for these cross-sections are included on pages 16 through 25 of Appendix 2.

RETENTION BASINS

In addition to stream cross-sections and culverts, a total of 3 stormwater retention basins have been specified for the post development condition. Within the eastern region, a basin referred to as Pond A is specified just north of the access road to the site. The volume vs. elevation rating for this pond is included on page 26 of Appendix 2. This configuration is the result of numerous trials to optimize the size of the basin, and maintain a peak discharge rate equal to or less than

pre-development level for the eastern compliance point. Pond A is proposed to be a "wet pond" which will have water in it at all times, as an aesthetic enhancement to the development. During storm periods, there is a 4 foot freeboard in the pond which will allow the water surface to build up, to retain storm-water temporarily and reduce the peak discharge rate.

For the western region, 2 retention basins have been specified. Pond B is located in an existing depression, adjacent to Rathe Road. It is proposed that no modification of the shape of this depression be made, but only that a riser pipe be installed to enable the temporary storage of stormwater during major rainfall events. Volume and outflow data for Pond B are included on pages 29 and 30 of Appendix 2. During non-storm periods, the pond will be dry. As shown on Drawing 2 (see map pocket) runoff from subwatersheds 13, 14, 16, and 18 will be directed into this pond.

Pond C, will be located adjacent to the southwest corner of the site and Interstate 89. To create proper storage conditions, it it will be necessary to build a short berm along the downstream end of the proposed pond site. A riser pipe will be installed to temporarily retain and convey the outflow from the pond. Volume and outflow data for Pond C are included on pages 31 and 32 of Appendix 2. This pond will be dry during non-storm periods.

To maintain the current level of peak discharge at the southern compliance point, a diversion structure is proposed at the location of cross-section 9. A schematic of the diversion structure is shown on page 33 of Appendix 2. The purpose of the diversion structure will be to allow passage of a maximum flow which is equivalent to the pre-development peak discharge rate at the this compliance point. The remainder of the stormwater flow from this portion of the site (subwatershed 5) would be directed to Pond C via a swale along the southern property line. A similar diversion structure is proposed at cross-section 2 which will result in a splitting of runoff between the existing culvert crossing Rathe Road at this location and a swale sloped to the west toward Pond B.

MODEL SET UP AND RESULTS

TR-20 data files including the cross-sections and structures, watershed runoff commands, as well as the watershed routing are included on pages 1 through 13 of Appendix 3. The TR-20 simulations have been performed for the projected 10-year, 24-hour storm of 3.6" of rainfall (see Appendix 1, p. 42). A standard S.C.S. Type II rainfall distribution has been assumed, as well as average antecedent moisture conditions (AMC=2). Summary output tables reporting the peak discharge rates for the design storm at each section and structure are included on pages 14 through 19 of Appendix 3. Tabular runoff hydrographs at selected locations are included on pp. 20-24 of Appendix 3. The

peak discharge rates at the three compliance points are shown below. It should be noted that the post-development peak discharge rates are those with the stormwater retention ponds and diversion structures in place.

COMPLIANCE POINT	PRE-DEVELOPMENT PEAK Q	POST-DEVELOPMENT PEAK Q
Eastern	237.66 cfs	237.67 cfs
Western	41.73 cfs	40.76 cfs
Southern	11.41 cfs	11.41 cfs

Thus, it can be seen that the proposed retention ponds and diversion structures will result in no increase in the pre-development peak discharge rates for the design storm at each of the compliance points.

STORMWATER TREATMENT

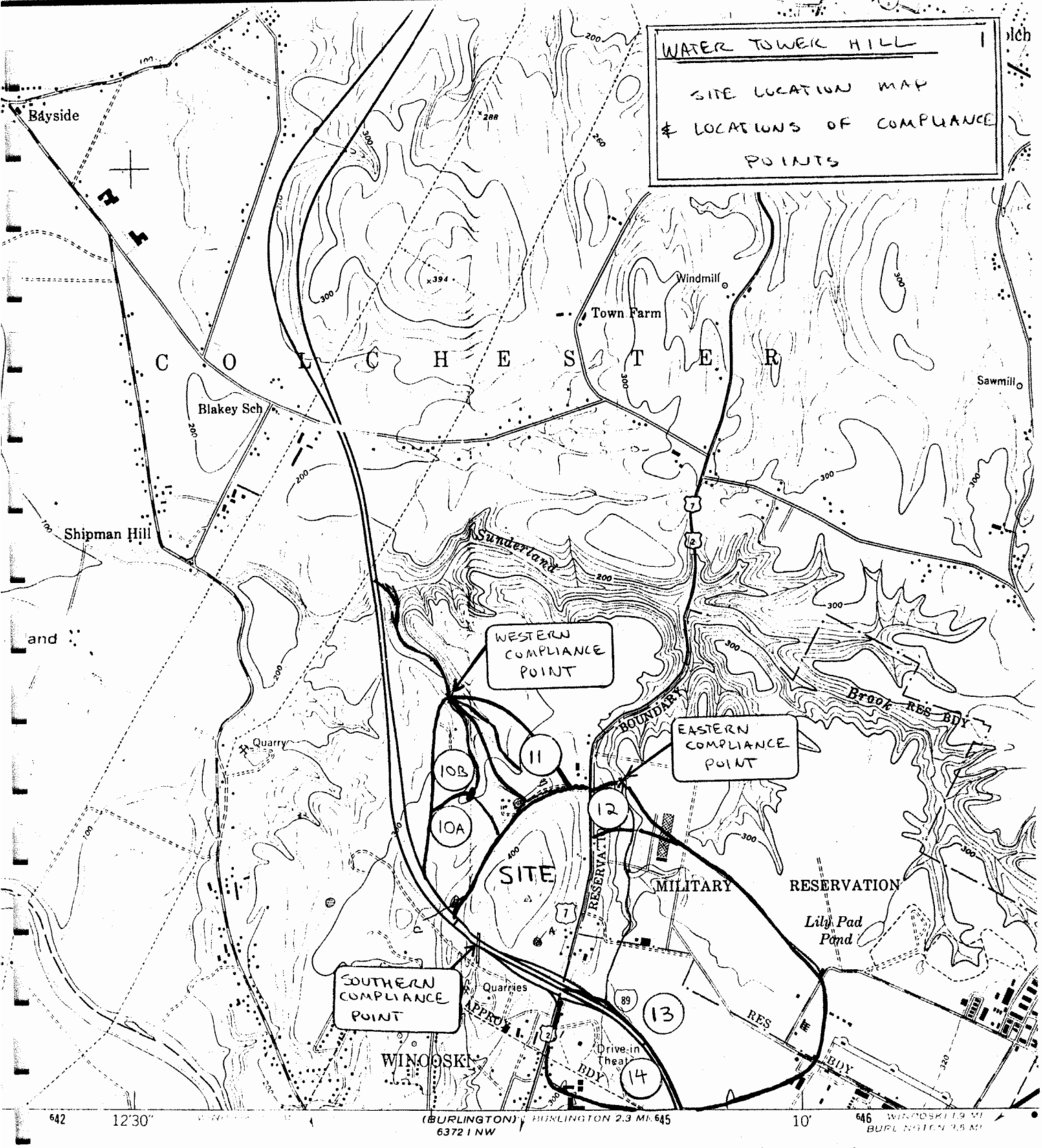
The retention ponds have been sized with adequate surface area to provide particle settlement in accordance with the Guidelines of the Vermont Agency of Natural Resources. These Guidelines specify a surface area of 145 ft^2/cfs of outflow. The actual surface areas provided at each pond (at the elevation of the top of the riser pipe) are considerably in excess of the state guidelines, as shown below:

Pond A 2377 ft^2/cfs

Pond B 481 ft^2/cfs

Pond C 3110 ft^2/cfs

Given the fact that the modeling techniques (assumption of 75% continuous impervious area) have resulted in significant overestimation of peak discharge, it is likely that the ratio of surface area to peak basin outflow will be even greater than that specified in the table above, thus providing additional opportunity for particle settlement.



SCALE 1:24 000

1 0 1 MILE

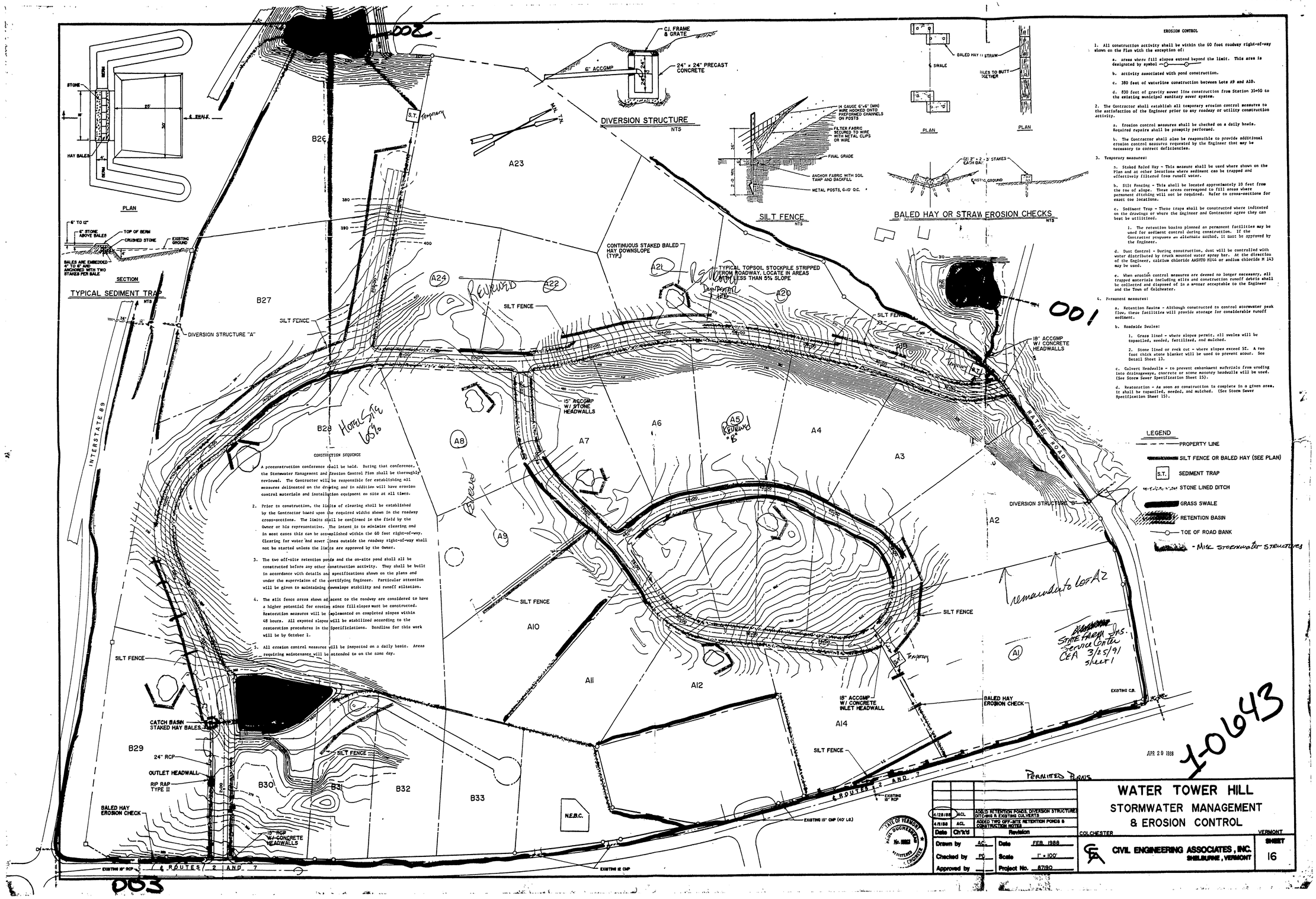
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

VT.

QUADRANGLE LOCATION



CONSTRUCTION SEQUENCE

1. A preconstruction conference shall be held. During that conference, the Stormwater Management and Erosion Control Plan shall be thoroughly reviewed. The Contractor will be responsible for establishing all measures delineated on the drawing and in addition will have erosion control materials and installation equipment on site at all times.

2. Prior to construction, the limits of clearing shall be established by the Contractor based upon the required widths shown in the roadway cross-sections. The limits shall be confirmed in the field by the Owner or his representative. The intent is to minimize clearing and in most cases this can be accomplished within the 60 foot right-of-way. Clearing for water and sewer lines outside the roadway right-of-way shall not be started unless the limits are approved by the Owner.

3. The two off-site retention ponds and the on-site pond shall all be constructed before any other construction activity. They shall be built in accordance with details and specifications shown on the plans and under the supervision of the certifying Engineer. Particular attention will be given to maintaining downslope stability and runoff siltation.

4. The silt fence areas shown adjacent to the roadway are considered to have a higher potential for erosion since fill slopes must be constructed. Restoration measures will be implemented on completed slopes within 48 hours. All exposed slopes will be stabilized according to the restoration procedures in the Specifications. Deadline for this work will be by October 1.

5. All erosion control measures will be inspected on a daily basis. Areas requiring maintenance will be attended to on the same day.

EROSION CONTROL

1. All construction activity shall be within the 60 foot roadway right-of-way shown on the Plan with the exception of:

   a. areas where fill slopes extend beyond the limit. This area is designated by symbol —○—○—

   b. activity associated with pond construction.

   c. 380 feet of waterline construction between Lots A9 and A10.

   d. 830 feet of gravity sewer line construction from Station 35+50 to the existing municipal sanitary sewer system.

2. The Contractor shall establish all temporary erosion control measures to the satisfaction of the Engineer prior to any roadway or utility construction activity.

   a. Erosion control measures shall be checked on a daily basis. Required repairs shall be promptly performed.

   b. The Contractor shall also be responsible to provide additional erosion control measures requested by the Engineer that may be necessary to correct deficiencies.

3. Temporary measures:

   a. Staked Baled Hay - This measure shall be used where shown on the Plan and at other locations where sediment can be trapped and effectively filtered from runoff water.

   b. Silt Fencing - This shall be located approximately 10 feet from the toe of slope. These areas correspond to fill areas where permanent ditching will not be required. Refer to cross-sections for exact toe locations.

   c. Sediment Trap - These traps shall be constructed where indicated on the drawings or where the Engineer and Contractor agree they can best be utilitized.

      1. The retention basins planned as permanent facilities may be used for sediment control during construction. If the Contractor proposes an alternate method, it must be approved by the Engineer.

   d. Dust Control - During construction, dust will be controlled with water distributed by truck mounted water spray bar. At the direction of the Engineer, calcium chloride AASHTO M144 or sodium chloride M 143 may be used.

   e. When erosion control measures are deemed no longer necessary, all trapped materials including silts and construction runoff debris shall be collected and disposed of in a manner acceptable to the Engineer and the Town of Colchester.

4. Permanent measures:

   a. Retention Basins - Although constructed to control stormwater peak flow, these facilities will provide storage for considerable runoff sediment.

   b. Roadside Swales:

      1. Grass lined - where slopes permit, all swales will be topsoiled, seeded, fertilized, and mulched.

      2. Stone lined or rock cut - where slopes exceed 5%. A two foot thick stone blanket will be used to prevent scour. See Detail Sheet 13.

   c. Culvert Headwalls - to prevent embankment materials from eroding into drainageways, concrete or stone masonry headwalls will be used. (See Storm Sewer Specification Sheet 15).

   d. Restoration - As soon as construction is complete in a given area, it shall be topsoiled, seeded, and mulched. (See Storm Sewer Specification Sheet 15).

LEGEND

- PROPERTY LINE
- SILT FENCE OR BALED HAY (SEE PLAN)
- S.T. SEDIMENT TRAP
- STONE LINED DITCH
- GRASS SWALE
- RETENTION BASIN
- TOE OF ROAD BANK
- MISC. STORMWATER STRUCTURES

Remainder to Lot A2

Reviewed by State Farm Ins. Service Center CEA 3/25/91 sheet 1

Date	Ck'd	Revision
4/29/88	ACL	ADDED RETENTION PONDS, DIVERSION STRUCTURE, DITCHING & EXISTING CULVERTS
4/1/88	ACL	ADDED TWO OFF-SITE RETENTION PONDS & CONSTRUCTION NOTES

Drawn by AC | Date FEB. 1988
Checked by PG | Scale 1" = 100'
Approved by | Project No. 87190

STATE OF VERMONT — PAUL G. DUCHESNEAU — No. 5883 — REGISTERED ENGINEER

WATER TOWER HILL
STORMWATER MANAGEMENT & EROSION CONTROL

COLCHESTER, VERMONT

CIVIL ENGINEERING ASSOCIATES, INC. SHELBURNE, VERMONT

SHEET 16

Permitted Plans

APR 20 1988

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