Final Design Report

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February 9, 2010
APPENDIX R

Flood Plain Evaluation
Westchester County Department of Public Works

Reconstruction/Replacement of Structures Carrying the Bronx River Parkway Over the Bronx River and The Metro-North Railroad

‘Crane Road Bridge Project’

Flood Plain Evaluation Report

March 2008; Revised February 2010

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ADDENDUM

Crane Road Bridge – Floodplain Analysis

Revised Alternative C

The revised Alternative C design consists of a reduction in the total number piers for the Crane Road Bridge from seven (7) piers for the existing bridge to six (6) piers for the proposed bridge. The existing Crane Road bridge piers in the Bronx River are 14 feet in diameter and are spaced approximately 42 feet apart (from center to center). The Alternative C design incorporates bridge piers with a 16 foot diameter that are spaced approximately 62 feet apart. Applying this configuration to the hydraulic model and calculating the new water surface elevations, modeling results indicate that although the pier diameter is increased by two feet, the increased spacing between piers results in a greater flow area through the floodway and floodplain. As the table below illustrates, the proposed bridge will have no adverse impact on the floodplain or floodway when compared to the existing floodplain and floodway, as water surface elevations during a 100-year storm event following construction of the proposed bridge are expected to be less than under existing conditions.

### Water Surface Elevations at Crane Road Bridge

<table>
<thead>
<tr>
<th>Proposed Conditions vs. Existing Conditions</th>
<th>WSEL (ft) at Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100-yr event</td>
</tr>
<tr>
<td>Existing Conditions</td>
<td>140.02</td>
</tr>
<tr>
<td>Proposed Conditions</td>
<td>139.98</td>
</tr>
</tbody>
</table>
Overview

Crane Road Bridge is being considered for reconstruction or replacement. Malcolm Pirnie, Inc. (Pirnie) has been tasked to perform a hydraulic analysis of the proposed bridge design alternatives. The focus of this evaluation is to identify potential impacts on the existing floodplain as a result of each design alternative. As requested in the scope, the hydraulic analysis was performed for existing conditions and each alternative using Hydrologic Engineer Center’s River Analysis System (HEC-RAS) and GeoRAS as the pre/post processor. Water surface elevations were developed for the Design Flood (Q50), the Base Flood (Q100), as well as the 10 and 500-year return periods. The hydraulic evaluation was performed in accordance with the NYSDEC Flood Plain Management Criteria for State Projects 6 NYCRR Part 502 and Federal Highway Administration FAPG 23 CFR 650A. and the NYS Green Pages to the Model Drainage Manual. These regulations have been provided as Attachment A to this report.

Bridge Design Assumptions

Pirnie’s representation of the bridge design alternatives in the hydraulic model were developed from conceptual design drawings received from Stantec. These drawings are provided as Attachment B to this report. Stantec also provided additional information regarding proposed bridge heights and bridge pier diameters. The bridge height for the design alternatives was assumed to be no less than the height of the existing bridge.

Hydraulic Model Data Collection

Upon review of the Westchester County, New York, Flood Insurance Study (FIS) with an effective data of September 28, 2007, the Bronx River has been studied by detailed methods with base flood elevations being established. A data request was submitted to FEMA for all relative data associated with the effective study. The data obtained from FEMA consisted of the following:

- Hydrologic Data: A hydrologic model (HEC-1) used to estimate peak flows generated from the 10, 50, 100, and 500-year rain events.

- GeoRas file: This file contains all geometry data used for hydraulic model development.

Two foot contour data was also collected for the Bronx River.
Hydraulic Analysis of Existing Structure and Design Alternatives

The following is a list of the modeling scenarios that were evaluated for this analysis.

- Existing Conditions
- Alternative A
- Alternative B
- Alternative C

Existing Conditions Model

The effective model data received from FEMA for the Bronx River flood study served as the basis for development of the existing conditions hydraulic model. The existing Crane Road Bridge is represented in the model. The existing bridge spans over the Bronx River for approximately 300 feet starting at an approximate elevation of 152 feet on the west end climbing to an elevation of around 164 feet on the east end. There are seven concrete bridge piers which are 14 feet in diameter. The existing bridge deck width is 43 feet.

Alternative A Model (Bridge Rehabilitation)

The existing conditions model was modified in order to represent bridge design Alternative A. This alternative consists of a rehabilitation of the existing bridge. The bridge deck would be replaced and widened from 43 feet to 53 feet. The existing concrete bridge piers would be restored and widened to a diameter of 15 feet (based on information provided by Stantec). No changes were made to the existing conditions model outside of the project area.

Alternative B Model (Bridge Replacement)

The existing conditions model was modified in order to represent bridge design Alternative B. Alternative B consists of a replacing the existing bridge. The proposed bridge deck would be 59 feet wide. As shown on the conceptual design drawing, the number of piers would be the same and located in a hydraulically similar location when compared to the existing bridge. The proposed bridge pier diameters were estimated to be 16 feet (based on information provided by Stantec). No changes were made to the existing conditions model outside of the project area.
**Alternative C Model (Bridge Replacement)**

Alternative C proposes the same bridge configuration as Alternative B though construction methods would differ due to the use of a temporary bridge. Alternative B and C would act hydraulically similar upon construction, therefore, no additional hydraulic model for Alternative C was deemed necessary.

**Regulatory Requirements**

As stated in the NYSDEC Flood Plain Management Criteria for State Projects 6 NYCRR Part 502 and Federal Highway Administration FAPG 23 CFR 650A and the NYS Green Pages to the Model Drainage Manual, “In riverine situations, no project (including fill) shall be undertaken unless it is demonstrated that the cumulative effect of the proposed project, when combined with all other existing and anticipated development, will not increase the existing water surface elevation of the base flood more than one foot at any point”.

The proposed bridge reconstruction or replacement associated with any of the design alternatives is not anticipated to increase the water surface elevation of more than one foot.

**Hydraulic Model Results and Potential Impacts of Design Alternatives**

Hydraulic models were developed representing existing conditions and the three design alternatives. Several hydraulic characteristic were analyzed but water surface elevation (base flood elevation) was the focus of this comparison. The following provides a brief summary of the modeling results.

**Existing Conditions Model**

The existing conditions model was developed and water surface elevations were generated. The water surface elevations (WSEL’s) were used to develop the existing conditions floodplain. Figure 1 illustrates the delineation of the existing 100-yr floodplain for the segment of the Bronx River upstream and downstream of Crane Road Bridge.

The hydraulic characteristics of Crane Road Bridge were evaluated with flows generated from the 10, 50, 100, and 500-year return periods. As previously mentioned, the elevation of the bridge deck ranges from 152 feet to 164 feet. The following table provides water surface elevations from the hydraulic analysis at the bridge for the 10, 50, 100, and 500-year return periods.
Table 1:  
Water Surface Elevations at Crane Road Bridge

<table>
<thead>
<tr>
<th></th>
<th>WSEL (ft) at Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-yr event</td>
</tr>
<tr>
<td>Existing Conditions</td>
<td>138.67</td>
</tr>
</tbody>
</table>

The water surface elevation generated from a 500-year storm event is 140.96 feet, which is approximately 11 feet below the lowest elevation of the bridge deck.

**Estimated Impacts of Alternative A (Bridge Rehabilitation)**

The Alternative A hydraulic model was developed and water surface elevations were generated. In order to evaluate the impact of Alternative A on the existing floodplain, WSEL’s generated in the Alternative A model were compared to the WSEL’s of the existing conditions model. As a result of the bridge modification proposed in Alternative A, there would be slight increase in WSEL’s at the structure upstream of the structure. This increase ranges from a maximum of 0.15 feet at the bridge reducing to approximately 0.10 feet about 400 feet upstream. Beyond this point the modeling results show an increase of less than 0.09 feet extending approximately 1,600 feet upstream. Figure 2 provides a floodplain delineation for Alternative A along with identifying locations of increased WSEL’s when compared to the existing conditions floodplain. There are no impacts to the floodplain downstream of the bridge as a result of this design alternative.

**Estimated Impacts of Alternative B/C (Bridge Replacement)**

The Alternative B/C hydraulic model was developed and water surface elevations were generated. In order to evaluate the impact of Alternative B/C on the existing floodplain, WSEL’s generated in the Alternative B/C model were compared to the WSEL’s of the existing conditions model. As a result of the bridge modification proposed in Alternative B/C, there would be slight increase in WSEL’s at the structure upstream of the structure. This increase ranges from a maximum of 0.20 feet at the bridge reducing to approximately 0.10 feet about 500 feet upstream. Beyond this point the modeling results show an increase of less than 0.09 feet extending approximately 1,500 feet upstream. Figure 3 provides a floodplain delineation for Alternative B/C along with identifying locations of increased WSEL’s when compared to the existing conditions floodplain. There are no impacts to the floodplain downstream of the bridge as a result of this design alternative.
Summary of Results

Potential impacts on the existing floodplain as a result of the proposed design alternatives are minimal. Though water surface elevations at the bridge and upstream of the bridge may increase slightly (0.20 feet or less), the increase is well below the regulatory threshold of 1.0 foot. Additionally, the design alternatives are hydraulically adequate to handle storm flows generated from the 10, 50, 100, and 500-year return events. As described previously in this report, the height of the bridge deck is estimated to be 11 feet above the estimated water surface elevation associated with the 500-year rain event. Therefore, the potential of bridge failure due to overtopping is highly unlikely. The bridge design alternatives have a negligible effect in terms of contributing to failure due to overtopping.

Due to the increase in water surface elevations associated with the design alternatives being relatively insignificant, the design alternatives would not have an impact on flood conditions of the surrounding floodplain.
Figure 1
EXISTING 100 YEAR EVENT
WATER SURFACE ELEVATIONS

Legend
- Existing 100-Year Flood Plain
- Bronx River
- Road
- Railroad
- Intermediate Contour
- Index Contour

CRANE ROAD BRIDGE
RECONSTRUCTION/REPLACEMENT

NOTE: MAP DATA PROVIDED BY WESTCHESTER COUNTY GEOGRAPHIC INFORMATION SYSTEMS AND FEDERAL EMERGENCY MANAGEMENT AGENCY
CRANE ROAD BRIDGE
RECONSTRUCTION/REPLACEMENT

FIGURE 2
ALTERNATE "A" VS. EXISTING
100 YEAR EVENT WATER SURFACE ELEVATIONS
Figure 3

Alternate "B/C" vs. Existing
100 Year Event Water Surface Elevations

Legend
- Existing 100-Year Flood Plain
- Impacted 100-yr Floodplain > 0.1 FT INCREASE
- Bronx River
- HEC-RAS XSCutlines
- Railroad
- Index Contour
- Intermediate Contour

W.S. Change = [ALT. "B" 100-YR W.S. ELEV.] - [EX. 100-YR W.S. ELEV.]
APPENDIX A
Part 502: Floodplain Management Criteria For State Projects

(Statutory authority: Environmental Conservation Law, §§1-0101, 3-0301, Article 36)

Historical Note


Contents:

Sec.

• 502.1 Purpose
• 502.2 Definitions
• 502.3 Determination of flood hazard area boundaries and base flood elevations
• 502.4 Floodplain management criteria for State projects in flood hazard areas
• 502.5 Acquisition of interests in lands and facilities
• 502.6 Disposition of State property
• 502.7 Coordination
• 502.8 Variance provisions for State agencies.
• 502.9 Variance provisions relating to certain facilities and lands owned or formerly owned by the State
• 502.10 References

§502.1 Purpose

(a) Recurrent flooding of large areas of the State presents serious hazards to, and causes adverse effects upon, the health, safety, welfare and property of the people of the State, both within and outside flooded areas. These adverse effects include loss of life; loss and damage to private and public property; disruption of lives and livelihoods; interruption of commerce, transportation, communication and governmental services; and unsanitary and unhealthful living and environmental conditions. Floodplain management is, therefore, a matter of State concern and the establishment of improved floodplain management practices is important to the health, safety and welfare of all of the State.
(b) The implementation of this Part by all State agencies will insure that the use of State lands and the siting, construction, administration and disposition of State-owned and State-financed facilities are conducted in ways that will minimize flood hazards and losses. The regulations are required for the State of New York to continue it's qualification as a participating community in the National Flood Insurance Program administered by the Federal Insurance Administration of the Department of Housing and Urban Development.

Historical Note


§502.2 Definitions

(a) Administrator shall mean the Federal Insurance Administrator of the Federal Insurance Administration in the Department of Housing and Urban Development.

(b) Base flood shall mean the flood having a one-percent chance of being equaled or exceeded in any given year.

(c) Base flood level or base flood elevation shall mean the computed water surface elevation at a given location resulting from a flood having a one-percent chance of being equaled or exceeded in any given year.

(d) Breakaway wall shall mean a wall designed and intended to collapse under stress without jeopardizing the structural integrity of a structure, so that the impact of abnormally high tides or wind-driven water on the structure is minimized.

(e) Coastal high hazard area shall mean any coastal area subject to high velocity waters, including but not limited to hurricanes.

(f) Commence a project shall mean the initiation of any phase of a project, including any excavation or site preparation.

(g) Commissioner shall mean the Commissioner of Environmental Conservation or his duly authorized representative.

(h) Department shall mean the Department of Environmental Conservation.

(i) Flood or flooding shall mean:
(1) a general and temporary condition of partial or complete inundation of normally dry land areas from:

(i) the overflow of inland or tidal waters;

(ii) the unusual and rapid accumulation or runoff of surface waters from any source; or

(iii) mud slides (i.e. mud flows) which are proximately caused or precipitated by accumulations of water on or under the ground;

(2) the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels, or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in subparagraph (i) of paragraph (1) of this subdivision.

(j) *Flood elevation determination* shall mean a determination by the administrator of the water surface elevations of the base flood.

(k) *Flood hazard area* shall mean the land in a floodplain within a city, town or village subject to a one-percent or greater chance of flooding in any given year.

(l) *Flood hazard boundary map* or *FHBM* shall mean an official map of a city, town or village, on which the administrator has delineated the boundaries of the flood hazard area in that municipality.

(m) *Flood insurance rate map* or *FIRM* shall mean an official map of a city, town or village, on which the administrator has delineated both the flood hazard areas and the risk premium zones applicable to that municipality.

(n) *Floodplain* shall mean any land susceptible to being inundated by water from any source (see definition of flood).

(o) *Floodproofing* shall mean any combination of structural and nonstructural additions, changes or adjustments to structures which reduce or eliminate flood
damage to real estate or improved real property, water and sanitary facilities, structures and their contents.

(p) *Habitable floor* shall mean any floor usable for living purposes, which includes working, sleeping, eating, cooking or recreation, or a combination thereof. A floor used only for storage purposes is not a habitable floor.

(q) *Levee-protected area* shall mean any land protected, or proposed to be protected, from inundation by the base flood by an earthen embankment, concrete wall, or other substantial barrier specifically designed as a flood protection project.

(r) *Mean sea level (MSL)* shall mean the arithmetic mean of hourly water elevations observed over a specific 19-year Metonic cycle (the national tidal datum epoch), as determined by the National Ocean Survey (mean sea level is synonymous with National Geodetic Vertical Datum).

(s) *Mobile home* shall mean a structure, transportable in one or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. Mobile home shall not include recreational vehicles or travel trailers.

(t) *Person* shall mean any individual, public or private corporation, political subdivision of the State, municipality, industry, copartnership, association, firm, trust, estate or any other legal entity whatsoever, except a State agency as defined in this Part.

(u) (1) *Project* shall mean any undertaking or activity (including any financing thereof at any location or the authorization of any such undertaking or activity on State-owned lands) involving any change to improved or unimproved real estate, including but not limited to:

(i) the construction, installation, expansion, substantial improvement, reconstruction or restoration of structures, highways, access roads, bridges, canals, railroads, airports, sewage disposal systems and any other waste disposal systems, water treatment works, levees, dikes and dams, sewers, gas or water mains, electrical transmission or other service lines, and solid waste disposal facilities;
(ii) any mining, dredging, filling, grading, paving, excavation or drilling operations; and

(iii) an action of a State agency resulting in a change in the use of a State-owned or leased building or facility from nonresidential to residential usage, or in any other change in usage where flood damage to the facility would pose a serious danger to life and health or widespread social or economic dislocation.

(2) The term *project* shall not include ordinary maintenance and repair of existing structures or facilities, and shall not include any repair, reconstruction, rehabilitation or improvement of any structure listed in the National Register of Historic Places or any structure which has been formally proposed by the Committee on the Registers for consideration by the New York State Board for Historic Preservation for a recommendation to the State Historic Officer for nomination for inclusion in said National Register, where the work is undertaken in a manner designed to maintain the historic character of the structure. In addition, the term *project* shall not include permits, certifications or other approvals issued by any State agency for any undertaking or activity, on lands other than those to which title is held by a state agency, unless such State agency is financing the project.

(3) When used in this Part, the term *project* shall be construed as though followed by the words "or part or parts thereof", unless the text clearly requires a different meaning.

(v) *Regulatory floodway* shall mean the channel of a river or other watercourse and the adjacent land areas that must be or have been reserved in order to discharge the base flood without cumulatively increasing the existing water surface elevation of the base flood more than one foot at any point.

(w) *Riverine* shall mean relating to, formed by or resembling a river (including tributaries), stream or brook.

(x) *Sand dunes* shall mean naturally occurring accumulations of sand in ridges or mounds landward of the beach.

(y) *Site* shall mean the entire tract, subdivision, parcel of land or structure in or on which a project is to be undertaken.
For the purposes of this Part, the boundaries of flood hazard areas and base flood elevations shall be determined as follows:

(a) Where the administrator has not provided an FHBM or FIRM or a flood insurance study designating flood hazard area boundaries and/or base flood elevations for a particular location, any State agency proposing a project at such location shall determine, in cooperation with the department, the boundaries of flood hazard areas and base flood elevations on the basis of all pertinent information available from Federal, State or other sources.

(b) Where the administrator has provided an FHBM or FIRM and/or flood insurance studies designating flood hazard area boundaries and/or base flood elevations for a particular location, flood hazard area boundaries and base flood elevations shall be as designated by the administrator. Provided, such boundaries or elevations as designated by the administrator shall be modified in such a manner as to be consistent with all pertinent additional information available from any Federal, State or other source, but any boundaries or elevations determined on the basis of such additional information shall not be smaller in area or lower in elevation than the boundaries or elevations designated by the administrator.

Historical Note


§502.4 Floodplain management criteria for State projects in flood hazard areas

(a) When the administrator has not provided data for a city, town or village to designate a regulatory floodway, or if that data has been provided and such regulatory floodway has not yet been designated, or when the administrator has not identified coastal high hazard areas in a city, town or village, any State agency proposing to commence any project within a flood hazard area in that city, town or village shall do so only if it determines such project is in compliance with the following criteria:

(1) State agencies shall consider other alternative sites on which the project could be located which would not involve a flood hazard area.
(2) All necessary permits shall be acquired from those governmental agencies from which approval is required by Federal or State law, including section 404 of the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1334).

(3) The proposed project shall:

(i) be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the project;

(ii) be constructed with materials and utility equipment resistant to flood damage; and

(iii) be constructed by methods and practices that minimize flood damage.

(4) The proposed project shall be designed and constructed so that:

(i) it is consistent with the need to minimize flood damage within the flood hazard area;

(ii) all public utilities and facilities, such as sewer, gas, electric and water systems, are located and constructed to minimize or eliminate flood damage; and

(iii) adequate drainage is provided to reduce exposure to flood hazards.

(5) New and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems.

(6) New and replacement sanitary sewage systems and any other waste disposal systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems, and discharges from the systems into floodwaters, and new and replacement onsite waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

(7) All new residential structures and substantial improvements of existing residential structures shall have the lowest floor (including basement) elevated to not less than one foot above the base flood level.

(8) All new nonresidential structures and substantial improvements of existing nonresidential structures shall have the lowest floor (including basement) elevated or flood-proofed to not less than one foot above the base flood level, so that below this elevation the structure, together with attendant utility and sanitary facilities, is watertight, with walls substantially impermeable to the passage of water and with
structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

(9) Where floodproofing is utilized for a particular structure in order to comply with this Part, a professional engineer or architect licensed to practice in New York State shall certify to said State agency that the floodproofing methods are adequate to withstand the flood depths, pressures, velocities, impact and uplift forces and other factors associated with the base flood.

(10) For the purpose of the determination of applicable flood insurance risk premium rates for structures insurable under the National Flood Insurance Program (42 U.S.C. § 4001 et seq.) (see section 503.1 of this Title), said agency shall:

(i) obtain the elevation (in relation to mean sea level) of the lowest habitable floor (including basement) of any new or substantially improved structures, and specify whether or not such structure contains a basement;

(ii) if a structure has been flood-proofed, obtain the elevation (in relation to mean sea level) to which the structure was flood-proofed; and

(iii) maintain records of such information.

(11) In riverine situations, affected cities, towns and villages and the department shall be notified in writing by said State agency prior to any alteration or relocation of a watercourse.

(12) The flood carrying capacity within any altered or relocated portion of any watercourse shall be maintained.

(13) All mobile homes shall be anchored to resist flotation, collapse or lateral movement by providing over-the-top and frame ties to ground anchors as follows:

(i) over-the-top ties shall be provided at each of the four corners of the mobile home, with two additional ties per side at intermediate locations (except that mobile homes less than 50 feet long shall require only one additional tie per side);

(ii) frame ties shall be provided at each corner of the home, with five additional ties per side at intermediate points (except that mobile homes less than 50 feet long shall require only four additional ties per side);
(z) *State agency* shall mean any department, bureau, commission, board or other agency of the State, or a public benefit corporation or public authority at least one of whose members is appointed by the Governor.

(aa) *Structure* shall mean an existing or proposed walled and roofed building, including a gas or liquid storage tank, that is or is to be affixed to a permanent site. It shall include, but shall not be limited to, a foundation, a mobile home, and any building being constructed, improved, altered, repaired, reconstructed or restored. When used in this Part, the term shall be construed as though followed by the words "or part or parts thereof", unless the context clearly requires a different meaning.

(bb) (1) *Substantial improvement* shall mean any repair, reconstruction or improvement of a structure, the cost of which equals or exceeds 50 percent of the replacement value of the structure, either:

(i) before the improvement or repair is started; or

(ii) if the structure has been damaged and is being restored, before the damage occurred.

(2) For the purposes of this definition, *substantial improvement* shall include an alteration of a wall, ceiling, floor, or other structural part of the building, whether or not the external dimensions of the structure are changed. The term shall not include minor changes to a structure to comply with existing Federal or State health, sanitary or safety code specifications which are solely necessary to assure safe living conditions, and shall not include any expansion of a structure.

(cc) *Water surface elevation* shall mean the projected height, in relation to mean sea level, reached by floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas.

**Historical Note**


§502.3 Determination of flood hazard area boundaries and base flood elevations
(iii) all components of the anchoring system shall be capable of carrying a force of 4,800 pounds; and

(iv) any additions to the mobile home shall be similarly anchored.

(14) All mobile homes shall have:

(i) stands or lots that are elevated on compacted fill or on pilings or piers so that the lowest floor of the mobile home will be located not less than one foot above the base flood level;

(ii) adequate surface drainage;

(iii) lots that are large enough to permit steps from the ground into the mobile home and ready access for a hauler;

(iv) in the case of elevation on pilings or piers, pier foundations or pilings that are placed in stable soil no more than 10 feet apart; and

(v) in the case of elevation on piers, adequate reinforcement for piers that extend more than six feet above ground level.

(15) In riverine situations, no project (including fill) shall be undertaken unless it is demonstrated that the cumulative effect of the proposed project, when combined with all other existing and anticipated development, will not increase the existing water surface elevation of the base flood more than one foot at any point. Provided, the provisions of this paragraph shall not apply to any project being undertaken on a site where there is less than one square mile of drainage area for the watercourse involved above such site, and where the administrator has not provided final flood base elevations on a city, town or village's FIRM.

(16) No project (including fill) shall be undertaken unless it is demonstrated that the cumulative effect of the proposed project, when combined with all existing development, will not cause any material flood damage to such existing development.

(17) In order to prevent potential flood damage to certain facilities that would result in serious danger to life and health, or widespread social or economic dislocation, none of the following new projects shall be undertaken within any flood hazard area:
(i) facilities designed for bulk storage of chemicals, petrochemicals, hazardous or toxic substances or floatable materials;

(ii) hospitals, rest homes, correctional facilities, dormitories, patient care facilities; (iii) major power generation, transmission or substation facilities, except for hydroelectric facilities;

(iv) major communications centers, such as civil defense centers; or

(v) major emergency service facilities, such as central fire and police stations.

(b) When the administrator has provided data for a city, town or village to designate a regulatory floodway and such floodway has been designated by a city, town or village, any State agency proposing to commence any project in a flood hazard area in such city, town or village shall do so only if it determines such project is in compliance with the following criteria:

(1) The requirements of subdivision (a) of this section, except for the provisions of paragraph (15) of said subdivision.

(2) No portion of the project, including encroachments, fill, new construction or substantial improvements, shall be placed or located within the adopted regulatory floodway that would result in any increase in flood levels during the occurrence of the base flood discharge, except where the effect on flood levels, due to the loss of floodway capacity, is completely offset by the creation of equal floodway hydraulic capacity at that point.

(3) There shall be no placement of any mobile homes within the adopted regulatory floodway.

(c) When the administrator has identified coastal high hazard areas on a city, town or village's FIRM, any State agency proposing to commence any project in a coastal high hazard area in such city, town or village shall do so only if it determines such project is in compliance with the following criteria:

(1) The requirements of paragraphs (1) through (10), inclusive, and paragraph (17) of subdivision (a) of this section.

(2) All new structures shall be located landward of the reach of mean high tide.
(3) (i) All new structures and substantial improvements of existing structures shall be elevated on adequately anchored pilings or columns, and securely anchored to such pilings or columns, so that the lowest portion of the structural members of the lowest floor (excluding the pilings or columns) is elevated to not less than one foot above the base flood level;

(ii) a professional engineer or architect licensed to practice in New York State shall certify to said agency that the structure is securely anchored to adequately anchored pilings or columns in order to withstand high velocity waters and hurricane wave wash; and

(iii) the requirements of subparagraphs (i) and (ii) of this paragraph shall not be applicable to temporary structures associated with recreational uses, or to marine uses such as bridges, docks, jetties, piers, breakwaters or groins.

(4) All new structures and substantial improvements of existing structures shall have the space below the lowest floor free of obstructions or be constructed with breakaway walls intended to collapse under stress without jeopardizing the structural support of the structure, so that the impact on the structure by abnormally high tides or wind-driven water is minimized. Such temporarily enclosed space shall not be used for human habitation.

(5) There shall be no use of fill for structural support of structures.

(6) There shall be no placement of mobile homes.

(7) There shall be no alteration of sand dunes which would increase potential flood damage.

(d) In order to prevent flood damage to certain facilities that would result in serious danger to life and health, or widespread social or economic dislocation, none of the following new projects shall be undertaken by any State agency within any levee-protected area unless the entire project or, where applicable, the lowest floor of such project, is elevated to at least one foot above the base flood level:

(1) facilities designed for bulk storage of chemicals, petrochemicals, hazardous or toxic substances or floatable materials;

(2) hospitals, rest homes, correctional facilities, dormitories, patient care facilities;
(3) major power generation, transmission or substation facilities, except for hydroelectric facilities;

(4) major communications centers, such as civil defense centers;

(5) major emergency service facilities, such as central fire and police stations; or

(6) transportation facilities which provide a major access route to any facility listed in paragraphs (1) through (5) of this subdivision.

**Historical Note**


**§502.5 Acquisition of interests in lands and facilities**

(a) No State agency shall acquire any interest in, or finance the acquisition of any interest in, any land or facility without first:

(1) evaluating such land or facility in order to determine if the subject land or facility is located in a flood hazard area; and

(2) if such land or facility is located in a flood hazard area, determining that the contemplated use of the land or facility will be consistent with the provisions of this Part.

(b) Any existing structure located in a flood hazard area acquired by any State agency shall be flood-proofed by said State agency in accord with the provisions of paragraphs (8) and (9) of subdivision (a) of section 502.4 of this Part.

(c) No State agency shall acquire an existing structure located within a regulatory floodway and utilize said structure for any use involving human habitation.

**Historical Note**


**§502.6 Disposition of State property**

No State agency shall sell or otherwise transfer any State-owned land or facility located in a flood hazard area to any person, other than a State agency, without
providing in the deed or other instrument of transfer necessary covenants and use restrictions, binding on the grantee and his or her heirs, successors and assigns, which ensure that said property or facility will forever be utilized in a manner consistent with the provisions of this Part.

**Historical Note**


§502.7 Coordination

State agencies undertaking any project pursuant to this Part shall ensure that reviews thereunder are coordinated with those of appropriate environmental impact statements, project notification and review systems, and State capital construction funding requests.

**Historical Note**


§502.8 Variance provisions for State agencies.

(a) Variances to the provisions of this Part may be granted by the department in accord with this section. No project or activity which requires a variance to any provision of this Part shall be commenced unless the department grants a variance in accord with this section.

(b) Requests for variances to the provisions of this Part shall be submitted in writing to the department by the State agency requesting such variance. Any request for a variance pursuant to this section shall be filed, by the State agency requesting the variance, with the department at the earliest time practicable in the planning of the project or activity involved, and to the maximum extent possible prior to the submission of a formal budget request for the funding of said project or activity.

(c) The procedures for the submission of requests for variances under this section, time periods for department action thereon, provisions relating to minor projects, and notice and hearing requirements, shall be governed by the provisions of Part 621 of this Title. A copy of the department's decision shall be sent by mail to the State
agency requesting the subject variance and to the director of the Division of the Budget.

(d) Variances shall not be issued by the department for any project or activity within any designated regulatory floodway if any increase in flood levels would result during the base flood discharge.

(e) Variances shall be issued by the department only upon:

(1) a showing of good and sufficient cause;

(2) a determination that the project will, consistent with social, economic and other essential considerations of State policy, be undertaken in accordance with the purposes of this Part to the maximum extent possible;

(3) a determination that the granting of a variance will not result in materially increased flood damages, add additional threats to public safety, result in extraordinary public expense, or create nuisances or cause victimization of the public; and

(4) a determination that the variance granted is the minimum necessary, considering flood hazard, to afford relief.

(f) The department may attach to any variance issued, pursuant to this section, such conditions as are necessary to insure that any action taken pursuant to said variance is consistent with the purposes and limitations of sections 502.4, 502.5 and 502.6 of this Part to the maximum extent possible.

(g) The department shall maintain a record of all variances issued pursuant to this section, including justification for their issuance, and report such variances annually to the administrator.

Historical Note


§502.9 Variance provisions relating to certain facilities and lands owned or formerly owned by the State
(a) Variances to the provisions of section 502.4 of this Part may be granted by the department to any person who has acquired or who proposed to acquire lands or facilities owned or formerly owned by the State, where the deed or other instrument of transfer contains a covenant or use restriction placed upon such lands or facilities by the State at the time of disposition. Any person seeking relief from such covenant and use restrictions may submit a written request to the Commissioner of Environmental Conservation at 625 Broadway, Albany, New York 12233 and include the following information:

(1) the name and address of the petitioner;

(2) a copy of the deed or other instrument of transfer which includes the full text of the covenant or use restriction;

(3) a copy of maps or drawings, to suitable scale, which clearly identify the location of the property with existing or proposed improvements shown thereon;

(4) a description of the proposed uses for the property;

(5) a detailed text clearly indicating the basis for the petitioner's claim of unnecessary hardships and/or practical difficulties in the way of complying with the requirements imposed by the covenant and use restrictions; and

(6) any other information that the commissioner deems necessary to make a finding pursuant to subdivision (d) of this section, based upon the standards contained in subdivision (e) of this section.

(b) The procedures for the submission of requests for variances under this section, time periods for department action thereon, provisions relating to minor projects, and notice and hearing requirements, shall be governed by the provisions of Part 621 of this Title. A copy of the department's decision shall be sent by mail to the petitioner requesting the subject variance and to the chief administrative officer of each city, town or village in which the property is located. The granting of any variance pursuant to this section shall not be construed as relieving any person from obtaining any other necessary approval(s) from any Federal, State or local government body.
(c) Variances shall not be granted for any project or activity within any designated regulatory floodway, if any increase in flood levels would result during the base flood discharge.

(d) A variance may be granted or denied by the commissioner based upon information submitted by the petitioner and other resources available to the department. The granting of a variance pursuant to this section may contain such conditions or limitations as may be deemed reasonably necessary to assure that the spirit of the act shall be observed, public safety and welfare secured, and substantial justice done.

(e) Standards for the granting of a variance.

(1) The petitioner shall establish to the satisfaction of the commissioner that he will suffer an unnecessary hardship if the variance is not granted, or that there are practical difficulties in the way of carrying out the strict letter of the requirements of the covenant and use restriction. In the absence of a satisfactory showing of good and sufficient cause, no variance will be issued.

(2) The basis for the granting of a variance shall be a determination that the petitioner has established:

(i) that the proposed project or use of such lands is consistent with the findings and purposes of the New York State Legislature as expressed in section 1 of article 36 of the Environmental Conservation Law; and

(ii) that the public safety and welfare will be secured and substantial justice done.

Historical Note


§502.10 References

The following Federal statutes, regulations or publications have been referenced in Parts 500-502 of this Title:

(b) *Flood-Proofing Regulations*, U.S. Army Corps of Engineers, June 1972, Washington, DC.

(c) Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (33 USC 1334), effective October 18, 1972.

(d) *USC* means United States Code.


(f) All material referenced in Part 500 of this Title is available for copying and inspection at the Department of Environmental Conservation, Division of Water, 625 Broadway, Albany, NY 12233.

**Historical Note**

Section filed Nov. 5, 1984 effective Nov. 5, 1984. revised 7-21-04 Fran Smith
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PREFACE

The New York State Hydraulic Manual for Structures consists of the "Model Drainage Manual" of 1991 as published by AASHTO and NYSDOT revisions as indicated on the "green" pages. These pages represent specific information that describes the policy and procedures of the Structures Division that are to be used to Design the hydraulic opening of bridge structures over streams in New York.

This Manual contains more information than required for the Hydraulic Design of Bridges, such as background information for Hydrology and Hydraulics, Hydraulics of stream channels, Energy Dissipators, Storm Drainage Systems, Pump Stations, Surface Water Environment, Erosion and Sediment Control.

We also recommend that each Region obtain a copy of the "Highway Drainage Guidelines" Manual of 1992 prepared by AASHTO, because it also contains valuable background information for the Hydraulic Engineer.

For Policy decisions as well as for everyday design determinations the Engineer should refer to the "Model Drainage Manual" with the "green" pages revising some of the Chapters pertaining to the Hydraulic analyses of bridges to the New York State design requirements.

The following "green" pages amending the Model Drainage Manual have been prepared:

Chapter 2 under Legal Aspects we added a note on p. 2-16 to use in the Project Reports or Design reports whenever there is Construction in the Floodplains, or to discuss the proposed bridge size during the Phase 1 or 2 before any Hydraulic Analysis has occurred.

In the same Chapter we have included the 6NYCRR 502 regulations for FEMA requirements in New York State as well as the most updated requirements of the Coast Guard.

Chapter 3 under Policy we added General Policy requirements for designing highway bridges as well as the requirements for Hydraulic Evaluation for Rehab Bridges.

Chapter 6 under Data Collection we added our requirements for obtaining Hydraulic cross-sections for bridge replacements over streams, Bridge Data sheets 1 & 2, and the NYSDOT Structures Field Trip Photographic sheet record.

Chapter 7 under Hydrology we added the Structures Hydrologic Methods, a copy of the USGS Regression Equations developed for Rural Watersheds in NYS (WRI 90-4197), and the addition of the three parameter equations for Urban watersheds by Sauer et al.
Chapter 9 under Culverts we added a short page describing the Hydraulic Definition of Culverts, and the difference between a culvert and a structure sized culvert.

Chapter 10 under Bridges we added Definitions for Ordinary High Water, Ordinary Water and Low Water and defined that these Elevations should be obtained in the field rather than by computation.

In this Chapter we included under Hydraulic Analysis a discussion about Freeboard, the requirement of founding the bridge substructures on rock or piles to safeguard them from scour and the latest Division policy on Detour Structures.

Appendices: We added an example of HEC-2 for an actual bridge computed both for Special Bridge as well as for Normal Bridge, and at the end of the chapter we included the requirements for the Hydraulic Data Table included in the Preliminary Plans along with requirements for other details.
Federal Agencies

Basically four Federal agencies carry out existing Federal regulations.

* Coast Guard - the Coast Guard (USCG) has regulatory authority over bridges and causeways under the General Bridge Act of 1946, 33 USC 525 (delegated through the Secretary of Transportation in accordance with 49 USC 1655(g)) to approve and issue permits for the location and plans for bridges and causeways across navigable waterways of the U.S. (Prior to the General Bridge Act of 1946, authority was exercised under Section 9 of the River and Harbor Act of 1899 and the Bridge Act of 1906).

Certain bridge actions funded by the Federal Highway Administration may not require a USCG bridge permit. Under 23 USC 144(h), FHWA may exempt a bridge from the provisions of 33 USC 525 if such bridge is over (1) waters which are not used and are not susceptible to use in their natural condition or by reasonable improvement as a means to transport interstate or foreign commerce and (2) which are (a) not tidal, or (b) if tidal, used only by recreational boating, fishing, and other small vessels less than 21’ in length. For projects exempted under Section 144(h), the FHWA shall notify the USCG of same if FHWA believes that sufficient navigation exists to require the establishment, maintenance, and operation of lights and signals under 14 USC 685 (Reference USCG/FHWA MOU, #1IV, B. 8, July 17, 1981).

The USCG has the responsibility:

(1) to determine whether or not a USCG bridge permit is required for the rehabilitation or replacement of an existing bridge and/or construction of a new bridge over navigable waters of the U.S. except for the exemption exercised under Section 144(h) by the FHWA and

(2) to approve the bridge location, alignment, plans, aids to navigation and appropriate navigational clearances in all bridge permit applications.

For more information related to navigational clearances for bridges, see the Federal-Aid Highway Program Manual 6-7-1-1. For guidance on USCG regulations and procedures, consult the Coast Guard Compliance Unit at the Structures Division.
Corps of Engineers - the Corps of Engineers has regulatory authority over the construction of dams, dikes or other obstructions (which are not bridges and causeways across navigable waters of the U.S.) under Section 9 of the River and Harbor Act of 1899. The Corps also has authority under:

a) Section 10 of the River and Harbor Act of 1899 which prohibits the unauthorized obstruction or alteration (includes structures in or over, excavation from or depositing of material) of any navigable water of the United States unless the work has been authorized by the Corps.

b) Section 11 of the River and Harbor Act of 1899 which authorizes the Corps to establish harbor lines channelward of which no piers, wharves, bulkheads, or other works may be extended or deposits made without approval of the corps of Engineers. Work shoreward of those lines is subject to Section 10 permit approval.

c) Section 404 of the Federal Water Pollution Control Act (33 USC 1344) prohibits the unauthorized discharge of dredged or fill material into waters of the U.S., including navigable waters. Such discharges require a permit from the Corps of Engineers. The term “discharges of fill material” means the addition of rock, sand, dirt, concrete or other material into waters of the United States, including navigable waters, incidental to the construction of any structure. The Corps of Engineers has issued Nationwide General Permits for thirty-six categories of certain minor activities involving discharge of fill material. Under the provisions of 33 CFR 330.5(a)(15), fill associated with the construction of bridges across navigable waters of the U.S., including cofferdams, abutments, foundation seals, piers, temporary construction and access fills are authorized under this Nationwide Section 404 Permit provided such fill has been permitted by the U.S. Coast Guard as part of the bridge permit. Therefore, formal application to the Corps of Engineers for a Section 404 Permit in a USCG bridge permit action is not required unless the bridge approach embankment is located in a wetland area contiguous to said navigable waterway. This regulation may also apply to excavation activities as defined by the Corps of Engineers in Special Public Notice No. 93-07 dated September 17, 1993.

Section 401(a)(1) of the Federal Water Pollution Control Act requires any applicant for a Federal license or permit for any activity that may affect the quality of waters of the U.S., including navigable waters, to obtain a water quality certification from the State certifying Agency that the activity will comply with the applicable provisions of Sections 301, 302, 303, 306 and 307 of the Act.
STANDARD DESIGN NOTE FOR CONSTRUCTION IN THE FLOODPLAIN

To satisfy the FHWA requirements, and unless a detailed hydraulic analysis is warranted at an early stage, all Federal Aid projects that will construct or replace stream bridges, or that could conceivably have an impact on a flood plain, should have the following statement included in the appropriate environmental document. If a categorical exclusion is being sought, the statement should appear in the Design Report.

"In accordance with the provisions of Executive Order 11988, Flood Plain Management, as implemented in the Federal Aid Policy Guide 23CFR 650, sub-part A, Location and Hydraulic Design of Encroachments on Flood Plains and 6NYCRR 502 Flood Plain Management Criteria for State Projects, this action has considered and evaluated the practicability of alternatives to any significant encroachments, or any support of incompatible flood plain development. As a result of this evaluation, it is concluded that (1) a significant encroachment does not exist, (2) there is no significant potential for interruption or termination of a transportation facility which is needed for emergency vehicles, (3) there is no significant risk and (4) there are no significant impacts on natural and beneficial flood plain values."

However, if it becomes necessary to discuss the proposed replacement structure size over a stream, (which is normally sized during Final Design) the following or similar paragraph should be included in the Project Report or Design Report:

"The waterway opening for this structure will be evaluated considering Risk Analysis, as described in FHWA Federal Aid Policy Guide 23CFR 650, sub-part A. The Overtopping Flood will be identified if it occurs at a recurrence interval of less than 100 years. It is intended that the structure will provide a minimum freeboard of 2 feet for the 50 year storm, (if possible) with somewhat lesser freeboard for the 100 year storm. However, the actual minimum freeboard will be determined during Final Design."
INTRODUCTION
FLOOD PLAIN MANAGEMENT CRITERIA FOR STATE PROJECTS
6 NYCRR 502

In New York State the Flood Plain Management Criteria for the Flood Emergency Management Agency (FEMA) is administered by the New York State Department of Environmental Conservation (NYSDEC) Flood Protection Bureau. NYSDEC through their Statutory authority have created the following document for State projects as it applies to Bridge (and to a lesser extent Highway) projects when they impact the Floodplains in New York State.

Copies of all the Flood Insurance Studies for New York State are kept in the New York State Department of Transportation's Central Office Hydraulic Unit along with many of the background computations. Each NYS DOT Region also has copies of the Flood Insurance Studies for their own Region. If a Region requires any copies of the Flood Insurance Studies or copies of the computations associated with these studies they should go through the Central Office that may already have them.

All questions and design disputes involving established Floodways in New York State with the Department of Environmental Conservation are handled through the Central Office Hydraulic Unit.
STATE OF NEW YORK

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Flood Plain Management Criteria for State Projects

6 NYCRR 502

Statutory authority: Environmental Conservation Law, §§1-0101, 3-0301 and Article 36
PART 502

FLOOD PLAIN MANAGEMENT CRITERIA FOR STATE PROJECTS
(Statutory Authority: Environmental Conservation Law,
§1-0101, 3-0301 and Article 36)

Sec.

502.1  Purpose.
502.2  Definitions.
502.3  Determination of flood hazard area boundaries and base flood elevations.
502.4  Flood plain management criteria for state projects in flood hazard areas.
502.5  Acquisition of interests in lands and facilities.
502.6  Disposition of state property.
502.7  Coordination.
502.8  Variance provisions for state agencies.
502.9  Variance provisions relating to certain facilities and lands owned or formerly owned by the state.

Section 502.1 Purpose.

Recurrent flooding of large areas of the State presents serious hazards to and causes adverse effects upon the health, safety, welfare and property of the people of the State, both within and outside flooded areas. These adverse effects include loss of life; loss and damage to private and public property; disruption of lives and livelihoods; interruption of commerce, transportation, communication and governmental services; and unsanitary and unhealthful living and environmental conditions. Flood plain management is, therefore, a matter of State concern and the establishment of improved flood plain management practices is important to the health, safety and welfare of all of the State.

The implementation of these regulations - Flood Plain Management Criteria for State Projects (6 NYCRR Part 502) - by all state agencies will insure that the use of State lands and the siting, construction, administration and disposition of State-owned and State-financed facilities are conducted in ways that will minimize flood hazards and losses. The regulations are required for the State of New York to continue its qualification as a participating community in the National Flood Insurance Program administered by the Federal Insurance Administration of the Department of Housing and Urban Development.
502.2. Definitions.

(a) "Administrator" shall mean the federal insurance administrator of the federal insurance administration in the department of housing and urban development.

(b) "Base flood" shall mean the flood having a one percent chance of being equalled or exceeded in any given year.

(c) "Base flood level" or "base flood elevation" shall mean the computer water surface elevation at a given location resulting from a flood having a one percent chance of being equalled or exceeded in any given year.

(d) "Breakaway wall" shall mean a wall designed and intended to collapse under stress without jeopardizing the structural integrity of a structure so that the impact of abnormally high tides or wind-driven water on the structure is minimized.

(e) "Coastal high hazard area" shall mean any coastal area subject to high velocity waters, including but not limited to hurricanes.

(f) "Commence a project" shall mean the initiation of any phase of a project, including any excavation or site preparation.

(g) "Commissioner" shall mean the commissioner of environmental conservation or his duly authorized representative.

(h) "Department" shall mean the department of environmental conservation.

(i) "Flood" or "flooding" shall mean:

1. A general and temporary condition of partial or complete inundation of normally dry land areas from:

   (i) the overflow of inland or tidal waters.

   (ii) the unusual and rapid accumulation or runoff of surface waters from any source.

   (iii) mudslides (i.e., mudflows) which are proximately caused or precipitated by accumulations of water on or under the ground.

2. The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in subparagraph (i) of paragraph (1) of subdivision (i) of this section.
(j) "Flood elevation determination" shall mean a determination by the administrator of the water surface elevations of the base flood.

(k) "Flood hazard area" shall mean the land in a flood plain within a city, town or village subject to a one percent or greater chance of flooding in any given year.

(l) "Flood hazard boundary map" or "FHBM" shall mean an official map of a city, town or village, on which the administrator has delineated the boundaries of the flood hazard area in that municipality.

(m) "Flood insurance rate map" or "FIRM" shall mean an official map of a city, town or village, on which the administrator has delineated both the flood hazard areas and the risk premium zones applicable to that municipality.

(n) "Flood plain" shall mean any land susceptible to being inundated by water from any source (see definition of "flood").

(o) "Floodproofing" shall mean any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents.

(p) "Habitable floor" shall mean any floor usable for living purposes, which includes working, sleeping, eating, cooking or recreation, or a combination thereof. A floor used only for storage purposes is not a "habitable floor."

(q) "Levee protected area" shall mean any land protected, or proposed to be protected, from inundation by the base flood by an earthen embankment, concrete wall, or other substantial barrier specifically designed as a flood protection project.

(r) "Mean sea level" (MSL) shall mean the arithmetic mean of hourly water elevations observed over a specific nineteen year metonic cycle (the national tidal datum epoch) as determined by the national ocean survey ("mean sea level" is synonymous with "National Geodetic Vertical Datum").

(s) "Mobile home" shall mean a structure transportable in one or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. "Mobile home" shall not include recreational vehicles or travel trailers.
(t) "Person" shall mean any individual, public or private corporation, political subdivision of the state, municipality, industry, co-partnership, association, firm, trust, estate or any other legal entity whatsoever except a "state agency" as defined in this Part.

(u) "Project" shall mean any undertaking or activity (including any financing thereof at any location or the authorization of any such undertaking or activity on state-owned land(s) involving any change to improved or unimproved real estate, including but not limited to:

1. the construction, installation, expansion, substantial improvement, reconstruction or restoration of structures, highways, access roads, bridges, canals, railroads, airports, sewage disposal systems and any other waste disposal systems, water treatment works, levees, dikes and dams, sewers, gas or water mains, electrical transmission or other service lines, and solid waste disposal facilities;

2. any mining, dredging, filling, grading, paving, excavation or drilling operations; and

3. an action of a state agency resulting in a change in the use of a state-owned or leased building or facility from non-residential to residential usage or in any other change in usage where flood damage to the facility would pose a serious danger to life and health or widespread social or economic dislocation.

The term "project" shall not include ordinary maintenance and repair of existing structures or facilities and shall not include any repair, reconstruction, rehabilitation, or improvement of any structure listed in the national register of historic places or any structure which has been formally proposed by the Committee on the Registers for consideration by the New York State Board for Historic Preservation for a recommendation to the State Historic Officer for nomination for inclusion in said National Register where the work is undertaken in a manner designed to maintain the historic character of the structure. In addition, the term "project" shall not include permits, certifications or other approvals issued by any state agency for any undertaking or activity on lands other than those to which title is held by a state agency unless such state agency is financing the project.

When used in this Part, the term "project" shall be construed as though followed by the words "or part or parts thereof," unless the text clearly requires a different meaning.
(v) "Regulatory floodway" shall mean the channel of a river or other watercourse and the adjacent land areas that must be or have been reserved in order to discharge the base flood without cumulatively increasing the existing water surface elevation of the base flood more than one foot at any point.

(w) "Riverine" shall mean relating to, formed by, or resembling a river (including tributaries), stream, or brook.

(x) "Sand dunes" shall mean naturally occurring accumulations of sand in ridges or mounds landward of the beach.

(y) "Site" shall mean the entire tract, subdivision, parcel of land or structure in or on which a project is to be undertaken.

(z) "State agency" shall mean any department, bureau, commission, board or other agency of the state, or public benefit corporation or public authority at least one of whose members is appointed by the Governor.

(aa) "Structure" shall mean an existing or proposed walled and roofed building, including a gas or liquid storage tank, that is or is to be affixed to a permanent site. It shall include, but shall not be limited to, a foundation, a mobile home, and any building being constructed, improved, altered, repaired, reconstructed or restored. When used in this Part, the term shall be construed as though followed by the words "or part or parts thereof," unless the context clearly requires a different meaning.

(bb) "Substantial improvement" shall mean any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds fifty percent of the replacement value of the structure either,

(1) before the improvement or repair is started, or

(2) if the structure has been damaged, and is being restored, before the damage occurred.

For the purposes of this definition "substantial improvement" shall include an alteration of a wall, ceiling, floor, or other structural part of the building whether or not the external dimensions of the structure are changed. The term shall not include minor changes to a structure to comply with existing federal or state health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions and shall not include any expansion of a structure.
(cc) "Water surface elevation" shall mean the projected height in relation to mean sea level reached by floods of various magnitudes and frequencies in the flood plains of coastal or riverine areas.

502.3 Determination of flood hazard area boundaries and base flood elevations.
For the purposes of this Part, the boundaries of flood hazard areas and base flood elevations shall be determined as follows:

(a) Where the administrator has not provided an FHBM or FIRM or a flood insurance study designating flood hazard area boundaries and/or base flood elevations for a particular location, any state agency proposing a project at such location shall determine, in cooperation with the department, the boundaries of flood hazard areas and base flood elevations on the basis of all pertinent information available from federal, state or other sources.

(b) Where the administrator has provided an FHBM or FIRM and/or flood insurance studies designating flood hazard area boundaries and/or base flood elevations for a particular location, flood hazard area boundaries and base flood elevations shall be as designated by the administrator. Provided, such boundaries or elevations as designated by the administrator shall be modified in such a manner as to be consistent with all pertinent additional information available from any federal, state or other source, but any boundaries or elevations determined on the basis of such additional information shall be smaller in area or lower in elevation than the boundaries or elevations designated by the administrator.

502.4 Flood plain management criteria for state projects in flood hazard areas.
(a) When the administrator has not provided data for a city, town or village to designate a regulatory floodway or, if that data has been provided and such regulatory floodway has not yet been designated, or when the administrator has not identified coastal high hazard areas in a city, town or village, any state agency proposing to commence any project within a flood hazard area in that city, town or village shall do so only if it determines such project is in compliance with the following criteria:

(1) State agencies shall consider other alternatives sites on which the project could be located which would not involve a flood hazard area.
(2) All necessary permits shall be acquired from those governmental agencies from which approval is required by federal or state law, including section 404 of the federal water pollution control act amendments of 1972, 33 U.S.C. 1334.

(3) The proposed project shall
   (i) be designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the project,
   (ii) be constructed with materials and utility equipment resistant to flood damage, and
   (iii) be constructed by methods and practices that minimize flood damage.

(4) The proposed project shall be designed and constructed so that
   (i) it is consistent with the need to minimize flood damage within the flood hazard area,
   (ii) all public utilities and facilities, such as sewer, gas, electric and water systems, are located and constructed to minimize or eliminate flood damage, and
   (iii) adequate drainage is provided to reduce exposure to flood hazards.

(5) New and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the systems.

(6) New and replacement sanitary sewage systems and any other waste disposal systems shall be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters, and new and replacement on-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

(7) All new residential structures and substantial improvements of existing residential structures shall have the lowest floor (including basement) elevated to not less than one foot above the base flood level.

(8) All new nonresidential structures and substantial improvements of existing nonresidential structures shall have the lowest floor (including basement) elevated or floodproofed to not less than one foot above the base flood level so that below this elevation the structure, together with attendant utility and sanitary facilities, is watertight.
with walls substantially impermeable to the passage of water and with structural
components having the capability of resisting hydrostatic and hydrodynamic loads and
effects of buoyancy.

(9) Where floodproofing is utilized for a particular structure in order to
comply with these regulations, a professional engineer or architect licensed to practice in
New York state shall certify to said state agency that the floodproofing methods are
adequate to withstand the flood depths, pressures, velocities, impact and uplift forces and
other factors associated with the base flood.

(10) For the purpose of the determination of applicable flood insurance risk
premium rates for structures insurable under the national flood insurance program (42
U.S.C. §4001 et seq.), said agency shall

(i) obtain the elevation (in relation to mean sea level) of the
lowest habitable floor (including basement) of any new or substantially improved
structures, and specify whether or not such structure contains a basement,

(ii) if a structure has been flood-proofed, obtain the elevation (in
relation to mean sea level) to which the structure was flood-proofed; and

(iii) maintain records of such information.

(11) In riverine situations, affected cities, towns and villages and the
department shall be notified in writing by said state agency prior to any alteration or
relocation of a watercourse.

(12) The flood carrying capacity within any altered or relocated portion of
any watercourse shall be maintained.

(13) All mobile homes shall be anchored to resist flotation, collapse, or
lateral movement by providing over-the-top and frame ties to ground anchors as follows:

(i) over-the-top ties shall be provided at each of the four corners
of the mobile home, with two additional ties per side at intermediate locations (except that
mobile homes less than 50 feet long shall require only one additional tie per side);

(ii) frame ties shall be provided at each corner of the home, with
five additional ties per side at intermediate points (except that mobile homes less than 50
feet long shall require only four additional ties per side);

(iii) all components of the anchoring system shall be capable of
carrying a force of 4,800 pounds; and

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(iv) any additions to the mobile home shall be similarly anchored.

(14) All mobile homes shall have

(i) stands or lots that are elevated on compacted fill or on pilings or piers so that the lowest floor of the mobile home will be located not less than one foot above the base flood level,

(ii) adequate surface drainage,

(iii) lots that are large enough to permit steps from the ground into the mobile home and ready access for a hauler,

(iv) in the case of elevation on pilings or piers, pier foundations or pilings that are placed in stable soil no more than 10 feet apart, and

(v) in the case of elevation on piers, adequate reinforcement for piers that extend more than six feet above ground level.

(15) In riverine situations, no project (including fill) shall be undertaken unless it is demonstrated that the cumulative effect of the proposed project when combined with all other existing and anticipated development, will not increase the existing water surface elevation of the base flood more than one foot at any point. Provided, the provisions of this paragraph shall not apply to any project being undertaken on a site where there is less than one square mile of drainage area for the water course involved above such site and where the administrator has not provided final flood base elevations on a city, town or village’s FIRM.

(16) No project (including fill) shall be undertaken unless it is demonstrated that the cumulative effect of the proposed project, when combined with all existing development, will not cause any material flood damage to such existing development.

(17) In order to prevent potential flood damage to certain facilities that would result in serious danger to life and health or widespread social or economic dislocation, none of the following new projects shall be undertaken within any flood hazard area:

(i) facilities designed for bulk storage of chemicals, petrochemicals, hazardous or toxic substances or floatable materials;

(ii) hospitals, rest homes, correctional facilities, dormitories, patient care facilities;
(iii) major power generation, transmission or substation facilities, except for hydroelectric facilities;
(iv) major communications centers, such as civil defense centers;
(v) major emergency service facilities, such as central fire and police stations.

(b) When the administrator has provided data for a city, town or village to designate a regulatory floodway and such floodway has been designated by a city, town or village, any state agency proposing to commence any project in a flood hazard area in such city, town or village shall do so only if it determines such project is in compliance with the following criteria:

1. the requirements of subdivision (a) of this section, except for the provisions of paragraph (15) of said subdivision.
2. No portion of the project, including encroachments, fill, new construction, or substantial improvements, shall be placed or located within the adopted regulatory floodway that would result in any increase in flood levels during the occurrence of the base flood discharge, except where the effect on flood levels, due to the loss of floodway capacity, is completely offset by the creation of equal floodway hydraulic capacity at that point.
3. There shall be no placement of any mobile homes within the adopted regulatory floodway.

(c) When the administrator has identified coastal high hazard areas on a city, town or village's FIRM, any state agency proposing to commence any project in a coastal high hazard area in such city, town or village shall do so only if it determines such project is in compliance with the following criteria:

1. The requirements of paragraphs (1) through (10), inclusively, and paragraph (17) of subdivision (a) of this section.
2. All new structures shall be located landward of the reach of mean high tide.
3. (i) All new structures and substantial improvements of existing structures shall be elevated on adequately anchored pilings or columns, and securely anchored to such pilings or columns, so that the lowest portion of the structural members of the lowest floor (excluding the pilings or columns) is elevated to not less than one foot above the base flood level;
(ii) a professional engineer or architect licensed to practice in New York state shall certify to said agency that the structure is securely anchored to adequately anchored pilings or columns in order to withstand high velocity waters and hurricane wave wash; and

(iii) the requirements of subparagraphs (i) and (ii) of this paragraph shall not be applicable to temporary structures associated with recreational uses or to marine uses such as bridges, docks, jetties, piers, breakwaters or groins.

(4) All new structures and substantial improvements of existing structures shall have the space below the lowest floor free of obstructions or be constructed with breakaway walls intended to collapse under stress without jeopardizing the structural support of the structure so that the impact on the structure by abnormally high tides or wind-driven water is minimized. Such temporarily enclosed space shall not be used for human habitation.

(5) There shall be no use of fill for structural support of structures.

(6) There shall be no placement of mobile homes.

(7) There shall be no alteration of sand dunes which would increase potential flood damage.

(d) In order to prevent flood damage to certain facilities that would result in serious danger to life and health or widespread social or economic dislocation, none of the following new projects shall be undertaken by any state agency within any levee protected area unless the entire project or, where applicable, the lowest floor of such project, is elevated to at least one foot above the base flood level:

(1) facilities designed for bulk storage of chemicals, petrochemicals, hazardous or toxic substances of floatable materials;

(2) hospitals, rest homes, correctional facilities, dormitories, patient care facilities;

(3) major power generation, transmission or substation facilities, except for hydroelectric facilities;

(4) major communications centers, such as civil defense centers;

(5) major emergency service facilities, such as central fire and police stations;

(6) transportation facilities which provide a major access route to any facility listed in paragraphs (1) through (5) of this subdivision.
502.5 Acquisition of interests in lands and facilities.

(a) No state agency shall acquire any interest in, or finance the acquisition of any interest in, any land or facility without first

   (1) evaluating such land or facility in order to determine if the subject land or facility is located in a flood hazard area and

   (2) if such land or facility is located in a flood hazard area, determining that the contemplated use of the land or facility will be consistent with the provisions of this Part.

(b) Any existing structure located in a flood hazard area acquired by any state agency shall be floodproofed by said state agency in accord with the provisions of paragraphs (8) and (9) of subdivision (a) of section 502.4.

(c) No state agency shall acquire an existing structure located within a regulatory floodway and utilize said structure for any use involving human habitation.

502.6 Disposition of state property

No state agency shall sell or otherwise transfer any state-owned land or facility located in a flood hazard area to any person other than a state agency without providing in the deed or other instrument of transfer necessary covenants and use restrictions, binding on the grantee and his or her heirs, successors and assigns, which ensure that said property or facility will forever be utilized in a manner consistent with the provisions of this Part.

502.7 Coordination.

State agencies undertaking any project pursuant to this Part shall ensure that reviews thereunder are coordinated with those of appropriate environmental impact statements, project notification and review systems and state capital construction funding requests.
502.8 Various provisions for state agencies.

(a) Variances to the provisions of this Part may be granted by the department in accord with this section. No project or activity which requires a variance to any provision of this Part shall be commenced unless the department grants a variance in accord with this section.

(b) Requests for variances to the provisions of this Part shall be submitted in writing to the department by the state agency requesting such variance. Any request for a variance pursuant to this section shall be filed by the state agency requesting the variance with the department at the earliest time practicable in the planning of the project or activity involved and to the maximum extent possible prior to the submission of a formal budget request for the funding of said project or activity.

(c) The procedures for the submission of requests for variances under this section, time periods for department action thereon, provisions relating to minor projects, and notice and hearing requirements shall be governed by the provisions of Part 621 of Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York. A copy of the department's decision shall be sent by mail to the state agency requesting the subject variance and to the director of the division of the budget.

(d) Variances shall not be issued by the department for any project or activity within any designated regulatory floodway if any increase in flood levels would result during the base flood discharge.

(e) Variances shall be issued by the department only upon

(1) a showing of good and sufficient cause;

(2) a determination that the project will, consistent with social, economic and other essential considerations of state policy, be undertaken in accordance with the purposes of this Part to the maximum extent possible;

(3) a determination that the granting of a variance will not result in materially increased flood damages, add additional threats to public safety, result in extraordinary public expense, or create nuisances or cause victimization of the public; and

(4) a determination that the variance granted is the minimum necessary, considering flood hazard, to afford relief.
(f) The department may attach to any variance issued pursuant to this section such conditions as are necessary to insure that any action taken pursuant to said variance is consistent with the purpose and limitations of sections 502.4, 502.5 and 502.6 to the maximum extent possible.

(g) The department shall maintain a record of all variances issued pursuant to this section, including justification for their issuance, and report such variances annually to the administrator.

502.9 Variance provisions relating to certain facilities and lands owned or formerly owned by the state.

(a) Variances to the provisions of section 502.4 may be granted by the department to any person who has acquired or who proposed to acquire lands or facilities owned or formerly owned by the state where the deed or other instrument of transfer contains a covenant or use restriction placed upon such lands or facilities by the state at the time of disposition. Any person seeking relief from such covenant and use restrictions may submit a written request to the commissioner of environmental conservation at 50 Wolf Road, Albany, New York 12233, and include the following information:

1. the name and address of the petitioner;
2. a copy of the deed or other instrument of transfer which includes the full text of the covenant or use restriction;
3. a copy of maps or drawings, to suitable scale, which clearly identifies the location of the property with existing or proposed improvements shown thereon;
4. a description of the proposed uses for the property;
5. a detailed text clearly indicating the basis for the petitioner's claim of unnecessary hardships and/or practical difficulties in the way of complying with the requirements imposed by the covenant and use restrictions; and
6. any other information as the commissioner deems necessary to make a finding pursuant to subdivision (d) of this section, based upon the standards contained in subdivision (e) of this section.

(b) The procedures for the submission of requests for variances under this section, time periods for department action thereon, provisions relating to minor projects, and notice and hearing requirements shall be governed by the provisions of Part 621 of...
Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York. A copy of the department's decision shall be sent by mail to the petitioner requesting the subject variance and to the Chief Administrative Officer of each city, town or village in which the property is located. The granting of any variance pursuant to this section shall not be construed as relieving any person from obtaining any other necessary approval(s) from any federal, state or local government body.

(c) Variances shall not be granted for any project or activity within any designated regulatory floodway, if any increase in flood levels would result during the base flood discharge.

(d) A variance may be granted or denied by the commissioner based upon information submitted by the petitioner and other resources available to the department. The granting of a variance pursuant to this section may contain such conditions or limitations as may be deemed reasonably necessary to assure that the spirit of the act shall be observed, public safety and welfare secured and substantial justice done.

(e) Standards for the granting of a variance:

(1) the petitioner shall establish to the satisfaction of the commissioner that he will suffer an unnecessary hardship if the variance is not granted or that there are practical difficulties in the way of carrying out the strict letter of the requirements of the covenant and use restriction. In the absence of a satisfactory showing of good and sufficient cause, no variance will be issued.

(2) The basis for the granting of a variance shall be a determination that the petitioner has established:

(i) that the proposed project or use of such lands is consistent with the findings and purposes of the New York state legislature as expressed in section 1 of article 36 of the environmental conservation law, and

(ii) that the public safety and welfare will be secured and substantial justice done.
GENERAL HYDRAULIC DESIGN POLICY

The New York State Department of Transportation Structures Division Policy for Hydraulic Design of Replacement Structures is to Design the Proposed Bridge to pass the Design Flood (Q50) with 2' Freeboard whenever possible (see discussion of Freeboard under "Hydraulic Analysis" pages 10-8A) and convey the Basic Flood (Q100) (or Base Flood as defined in FEMA studies) with reduced freeboard. Because of site limitations it is not always possible to achieve this goal and either reduced freeboard or submergence is sometimes allowed. However, the absolute minimum requirement is to assure that the replacement bridge will not raise the water surface profile upstream of the bridge for both the Design (Q50) and the Basic Flood (Q100) or make conditions worse than those at the existing bridge.

Computations will be performed using the Hydrology obtained from the latest USGS Regression Equations and procedures and the stream cross-sections obtained by NYSDOT survey crews or their agents. The results of these computations will be shown in the Hydraulic Data Table on the Preliminary Plan of each Structure.

In addition to the above Procedure, the Hydraulic Engineer will determine if there is a Flood Insurance Study for that stream. If there is a FEMA study and if the computations for that stream exist, the Hydraulic Engineer will also analyze the proposed structure using the Flood Insurance Study computations, utilizing their flows and cross-sections to assure compliance with 6NYCRR 502 regulations (as shown in pages 2-26A to 2-26AB). If any errors are found in these computations the Hydraulic Engineer will advise the New York State Department of Environmental Conservation Flood Protection Bureau (which is the New York State Administrator for FEMA) through the Central Office Hydraulic Unit, so that the erroneous computations can be revised.
HYDRAULIC EVALUATIONS OF BRIDGES PROGRAMMED FOR REHABILITATION

To ensure that all rehabilitation projects involving bridges over streams are progressed with the proper scope and cost estimates it is important that hydraulic evaluations be made as part of the project preparation process. A Hydraulic evaluation is a 1 or 2 page memorandum, prepared by a trained Hydraulic Engineer, which describes the hydraulic conditions and hydraulic adequacy of the existing structure and other related facts at a bridge site. The Hydraulic Engineer offers opinions as to their significance and recommends the preferred alternative countermeasure, if any, to safeguard the structure.

Hydraulic evaluations early in the project's development provide an opportunity to address bridge vulnerability concerns in conjunction with capital program work, and will minimize potentially disruptive project scope or cost changes in the later design phases. Early decisions on scour protection installations will also allow time for securing any permits or DEC water quality certificates necessary for this work. Furthermore, hydraulic considerations may be an overriding factor in choosing the rehabilitation versus replacement alternatives.

During the pre-EPP phase, those responsible for regional project initiations shall request the Regional Hydraulics Engineer to perform hydraulic evaluations for all bridges over streams being considered for rehabilitation. The primary emphasis of the hydraulic evaluation is to assess the hydraulic adequacy of the existing structure and its vulnerability to hydraulic effects, such as scour, ice, and debris. The results of these evaluations shall be recommendations for countermeasures to correct any hydraulic deficiencies and/or vulnerability reduction measures which can be incorporated into the rehabilitation project. The evaluation should also assess the effectiveness of proposed countermeasures and comment if rehabilitation is practical from a hydraulic standpoint, or whether a replacement project should be considered.

To accomplish this the Hydraulic Engineer shall contact all Operations and Maintenance Agencies in charge of the structure and obtain information about the structure's hydraulic performance during its life, whether it was the cause of flooding in the past and whether it has had problems with ice or debris. In addition the Hydraulic Engineer should evaluate the scour susceptibility of the structure using the procedures adopted by the Department's bridge safety assurance (BSA) program for hydraulic and scour vulnerability evaluations. If deemed necessary, a hydraulic analysis shall also be performed to estimate scour depths and evaluate scour countermeasures. The
detail of the hydraulic analysis should be consistent with those being made to determine existing bridge hydraulic vulnerability under the BSA program. The Hydraulic Engineer may use the Flood Insurance studies whose computations are available through the Main Office Hydraulic Unit or any other studies performed by the Corps of Engineers or any other Agency.

The evaluation data and results shall also be sent to the Main Office Hydraulic Unit so that they may be reviewed and filed in the hydraulic files. A summary of the evaluation shall also be prepared for incorporation into the BSA scour vulnerability rating system and database that is now being implemented for all existing bridges. A copy of the evaluation summary and project recommendation shall also be included in the EPP documentation package.

The Regional hydraulic engineer should be provided with current listings of all rehab projects and schedules so that the hydraulic evaluation workload can be arranged to accommodate these capital program needs and schedules. These evaluations and analyses should be prioritized based on program schedules as well as the potential for hydraulics or scour concerns determined from preliminary screens or assessments of all bridges on the program.
WATERWAYS

Site Data

The research required to collect the site information necessary to complete the Bridge Data sheets 1 & 2 should be performed and incorporated into the bridge data sheets BD 124-1a and BD 124-2a and submitted along with any hydraulic information obtained from the bridge inspection report. Photographs of the structure during floods, and/or periods of high water should be included if available.

Sections should be taken perpendicular to the direction of flow at design high water and at low flow. This may require a dog-leg shape section where the low flow channel meanders thru the flood plain. The cross sections required for the hydraulic analysis of each structure should be taken as follows:

1. For bridge replacement projects, sections should be taken at both the upstream and downstream faces of the existing bridge, including elevations of the low chord top of road, faces of piers and abutments.

2. For all stream bridges, sections should be taken downstream from the proposed bridge location at the following approximate distances: 100'; 200'; 300'; 400'; 500'; 1000'; 2000'. For streams with slopes flatter than 1 foot in 1000 feet, an additional section should be taken 4000' downstream.

3. For all stream bridges, sections should be taken upstream from the proposed bridge location at the following approximate distances: a distance equal to the length of the proposed bridge; that length plus 100'; that length plus 200' and one at a bridge length plus 500'. In cases where the bridge length exceeds 1000' the bridge hydraulic design unit shall be contacted for a recommendation for the locations of the sections.

4. Additional cross sections should be taken at points where the characteristics of the terrain change radically, where the flow is constricted, where the shape of the channel changes, at sharp bends in the stream, etc.

5. Sections should be at least 7 times the width of the low flow channel, and if possible, as wide as the 100 year flood plain. In cases where the flood plain is very wide, shots should be taken as far away from the stream bank as practical.

6. If a special feature such as a lake or dam exists within 26 miles downstream from the bridge site, this should be brought to the attention of the Structures Division to see whether additional sections may be required.
7. Cross sections should be plotted from left to right looking downstream, on 8-1/2 in. by 11 in. computation paper (or multiples of 8-1/2 by 11 in, starting with the farthest downstream section. The breakpoints of slope should be labeled with the station and elevation (starting from the leftmost point, which should have a positive number).
HYDROLOGIC ANALYSIS

The following methods may be used to compute the discharge at various sites, depending on the drainage area:

1. Under 100 acres the Rational method should be used.

2. The USGS Report WRI 90-4197 "Regionalization of Flood Discharges for Rural Unregulated Streams in New York State Excluding Long Island." should be used for rural unregulated streams for areas shown in table 6, page 38 of the same report. (Excerpts of this report are shown on pages 7-321 through 7-32P. Table 6 is represented on page 7-32R.

3. From 100 acres to the smallest areas shown for each hydrologic Region described in Table 6 p.38 of the USGS Report WRI 90-4197 the SCS method TR #55 should be used.

4. If the bridge is located over a stream in an urban setting, then the USGS Report 84-4350 should be used to amend the discharges obtained from the USGS Report WRI 90-4197.

If regulations exist on the stream every effort should be made to obtain records of flows and if that is not possible an acceptable routing procedure should be used or a special Hydrologic study of that stream should be requested from USGS.

All flow computations should be checked for reasonableness by using the actual flows of the various USGS Stations for different streams in the vicinity of the bridge, in the USGS Water Resources Investigations Report 92-4042 "Maximum Known Stages and Discharges of New York Streams, 1865-1989, with Descriptions of Five Selected Floods, 1913-85". The Designer should compare the CSM (Cubic Feet per second per square mile of Drainage Area) obtained from the USGS Regression Equations with the CSM of the various streams in the vicinity of the bridge. If there is a large discrepancy then a special investigation should be instituted probably by USGS through contact of the Central office.

5. Other Agencies such as the Corps of Engineers have studied various rivers and streams in New York State and developed flows for them. Their flows tend to be rather conservative therefore they should be used with caution.

The Federal Emergency Management Agency (FEMA) has studied a large percentage of the rivers and streams in the various communities in the State and has developed flows for those rivers and streams in their Flood Insurance Studies. These flows should be closely scrutinized because they were developed by different consultants, over several decades when the Science of Hydrology was in different stages of development.
When the Designer checks the water surface profiles for FEMA compliance of the proposed structure, he should use the computations, cross-sectional data and the flows from the Flood Insurance Study.
NEW YORK STATE RURAL REGRESSION EQUATIONS

The New York State Department of Transportation has financed the United States Geological Survey (USGS) twice to date (once in 1979 and once in 1990) to develop Rural Regression Equations for New York. Since 1979 the USGS has instrumented several small streams to develop equations for streams with smaller watersheds. This was published under the Water Resources Investigation Report 90-4197, excerpts of which are attached. We also include a copy of an actual hydrologic analysis at the end of the report.
URBAN REGRESSION EQUATIONS

The Structures Division of the New York State Department of Transportation recognizes both the "three variable" equations as well as the "seven variable" equations developed by Sauer et al. (1983), to transform the Rural flood frequency flows to Urban flows. The standard error of regression for the three variable equations ranges from 43% to 46% while the standard error of regression for the seven variable equations ranges from 38% to 43%. We believe that the difference is rather small and we will leave it up to the Engineer to use whatever method he prefers depending on the information he has and the degree of accuracy he desires in translating the flow from the rural regression equations into urban flows.

Attached is the set of the three variable equations that use as independent variables the Drainage Area, Basin Development Factor and Rural Peak Discharge.

\[
(Q_1)_u = 13.2A^{0.21} (13-BDF)^{0.43} (Q_2)_r^{0.73}
\]

\[
(Q_5)_u = 10.6A^{0.17} (13-BDF)^{0.19} (Q_5)_r^{0.78}
\]

\[
(Q_6)_u = 9.51A^{0.16} (13-BDF)^{0.36} (Q_6)_r^{0.79}
\]

\[
(Q_7)_u = 8.68A^{0.15} (13-BDF)^{-0.34} (Q_7)_r^{0.80}
\]

\[
(Q_8)_u = 8.04A^{0.15} (13-BDF)^{-0.34} (Q_8)_r^{0.81}
\]

\[
(Q_{100})_u = 7.70A^{0.15} (13-BDF)^{0.34} (Q_{100})_r^{0.82}
\]
CULVERTS

In this Structures Division Hydraulic Manual only bridge sized culverts are considered. A bridge sized culvert is a structure which measures in excess of 20' along the centerline of the road from face to face of support whether single or multiple span as long as the distance between the culverts does not exceed half the diameter of each pipe. These bridge sized culverts can be concrete or metal pipes, metal rigid frame culverts, and three or four sided concrete culverts if they behave hydraulically as culverts. A structure is considered to act hydraulically as a culvert, when the length of the structure perpendicular along the flow is equal or more than twice its length perpendicular to flow, irrespective of the skew. In Structural design the culvert is not usually designed to flow under a head or be submerged during the Design flow (Q50) but rather have the same freeboard that other structures are designed for as referred to in pages 10-8A.

Even though in the past the Structures Division has not designed many structure sized culverts with improved inlets as described in pages 9-67 to 9-72, the Engineer should consider this possibility and evaluate the benefits versus the cost when sizing these structure sized culverts.
DEFINITIONS FOR WATER ELEVATIONS

ORDINARY HIGH WATER ELEVATION

This is defined as the water surface elevation for the Mean Annual Flood which is the Flood that normally has a recurrence interval of 2.33 years. This elevation is usually an elevation observed in the field and reported in the Bridge Data sheet (part 2) and is used to estimate the cost of cofferdams.

ORDINARY WATER ELEVATION

This is defined as the highest surface elevation likely to be encountered during one construction season (other than major floods). It is always less than the Ordinary High Water Elevation, and it is usually an observed elevation rather than a computed one. Tremie seal designs are based on water achieving Ordinary Water Elevation during construction.

LOW WATER ELEVATION

This water elevation is the normal low water elevation prevalent during one construction season for more than 25% of the time. It is an observed elevation rather than a computed one and can be used by the contractor for crossing the stream or getting necessary permits from ENCON.
HYDRAULIC ANALYSIS

After the hydrology is completed the designer should model the existing stream conditions using the Corps of Engineers Program HEC-2, or the FHWA program WSPRO, for Design (Q50) or Basic discharges (Q100). Information from the Regional Offices, such as water elevation during a certain flood event should be used to verify this model. After this is complete a stage discharge curve may be computed using multiple runs of the HEC-2 program. Other backwater programs may be used instead of HEC-2 to obtain flood profiles for the Q50 and Q100 discharges such as the FHWA Bridge backwater program WSPRO.

At this time this office prefers the use of the Corps of Engineers program HEC-2 but it does not prohibit the use of other available programs. Flood Insurance Studies tend to use the HEC-2 backwater programs therefore when there is a Flood Insurance study at a bridge location the Engineer should also use the HEC-2 program so that he can compare his results with those of the Flood Insurance Study. On the other hand WSPRO is preferable for multiple openings.

Waterways Openings

Freeboard is defined as the vertical clearance measured between the lowest point of the superstructure of a stream bridge and the surface of the water below normally for the Design Flood (Q50).

Minimum Freeboard of any structure is generally calculated for the Design flood (Q50) and defined as that absolute minimum vertical clearance that occurs anyplace beneath the upstream or downstream fascia stringer of the bridge. This may be influenced by large skew angles, severe superelevation, or flat stream gradients. It may be necessary to investigate several locations before the absolute minimum freeboard can be determined for any particular structure.

Minimum Allowable Freeboard is that vertical clearance which has been determined to be acceptable at a particular stream bridge, for a particular flow, usually the design flood. The final bridge design must satisfy the minimum allowable freeboard requirement. Except at flood control projects, any structure that provides at least 2' minimum freeboard for the Design flood (Q50) shall be considered as satisfying normal hydraulic clearance requirements to protect against substantial reduction in waterway opening due to clogging at the structure by drift, debris, or ice.

10-8A
When a minimum freeboard of two feet is provided, no special investigation of potential debris clogging problems need be made. However, where that two foot minimum freeboard is difficult or costly to provide, an analysis and evaluation should be accomplished to determine whether a minimum allowable freeboard of less than two feet may be appropriate. Items to be investigated may include (but should not be limited to) the following:

a. History of debris clogging at the existing and/or adjacent structures.

b. Any change in water surface elevations caused by the proposed structure.

c. Characteristics of the underside of the proposed structure that might impede debris.

d. Recommendations by the Regional Office.

e. Consequence of debris clogging:
   1. Potential damage to the structure or highway.
   2. Potential damage to the upstream community.
   3. Potential effect on vehicular or pedestrian traffic.

f. The degree of difficulty or the amount of extra cost necessary to provide the full two foot freeboard.

In an extreme situation, negative freeboard could be accepted as permissible for a replacement of an existing bridge that is already inundated by the design flood, but in no case shall the proposed negative freeboard exceed the existing negative freeboard.

To protect the Department against potential damage claims, no freeboard less than two feet shall be permitted at a bridge replacement project unless the proposed bridge will provide a greater waterway opening than the existing bridge and unless the proposed minimum allowable freeboard for the design flood will exceed the existing minimum freeboard. Similarly, no freeboard less than two feet shall be permitted at a new bridge on new location, unless careful studies and analysis indicate that the potential advantages outweigh the potential risks. In the case of a bridge spanning a waterway greater than 300 feet wide, it is permissible that the minimum allowable freeboard can be reduced below two feet, regardless of other considerations, at one or both edges of the waterway, if the average freeboard over the full width of the waterway exceeds two feet.

It is important to understand that, other than at flood control projects, there is no absolute minimum freeboard requirement or standard which must be met to satisfy a specification or regulation. Whatever minimum allowable freeboard is finally chosen by the hydraulic designer, in
accordance with accepted practice and application of relevant recommendations and instructions, should be considered as meeting all State requirements and standards.

A summary of the analysis and evaluation, and the final determination of minimum allowable freeboard, shall be placed into the hydraulic design folder for the permanent record.

The minimum allowable freeboard finally selected shall be indicated on the Preliminary Structure Plan, on or near the Elevation View. The Preliminary Structure Plan shall also include an "Available depth of beam" dimension, derived from the minimum allowable freeboard and other parameters. After final structural design, the contract plans should be revised to indicate the actual minimum freeboard, and its location.

Flood control projects, whether in service or under design or still in planning, usually require a minimum freeboard of three feet, or as determined by the Corps of Engineers.

Each project should be checked to ascertain if a Flood Insurance Study has been completed or is being developed for that particular location by the Federal Emergency Management Agency. Requirements enumerated in the Flood Insurance Study will amplify or supersede NYSDOT Requirements. Provisions of 6 NYCRR 502 Regulations will also apply.

As described in FHWA Federal Aid Policy Guide Title 23 Code of Federal Regulations Subchapter G Part 650 entitled "Location and Hydraulic Design of Encroachments on Flood Plains," Risk Analysis procedures may be appropriate.

Relief openings, spur-dikes, debris deflectors and channel training works should be used where needed to minimize the effect of adverse flood conditions. Where scour is likely to occur, protection against damage from scour should be provided for in the design of bridge piers and abutments. Embankment slopes adjacent to structures subject to erosion should be adequately protected by rip-rap, flexible mattresses, retards, spur-dikes or other appropriate construction. Borrow pits should not be located in areas which would increase velocities and the possibility of scour at bridges.
DEPTH OF FOUNDATIONS IN WATER

All footings of piers and abutments of bridges in streams or in the floodplains shall be founded either on piles or rock.

For all foundations of piers and abutments in water the depths of footings shall be determined with respect to the character of the foundation materials and the possibility of undermining due to scour. Except where solid non-scourable rock is encountered or in other special cases, the footings of all structures, which are exposed to the erosive action of stream currents, (other than culverts with bottom slabs) shall be founded at a depth of not less than 4 feet below the stream bed and supported on piles. The above minimum depths shall be increased as conditions may require, or by the amount of long term degradation or Contraction Scour as determined by the Hydraulic Unit. Long term degradation of the stream bed shall also be taken into account when setting the depth of footings. The depth of footings can also be adjusted if caissons are used during construction.

Consideration shall be given to the possible scour of the footings, for substructures that are usually in the dry during normal flows but can be underwater during a large flood (Q100), such as piers or abutments in a panhandle. Anticipated scour depths shall be computed using the prevalent scour formula with reasonable modifications based on the probability of any adverse effects due to debris or ice. The length of piles shall be determined by the Soils Bureau based on the computed length of scour in each instance for each substructure. For erodible rock the foundation shall be set into the rock an amount equal to the projected depth of rock erosion for the life of the structure as determined by the Soils Bureau.
DETOUR STRUCTURES

The Engineer can downsize a detour structure to reflect a smaller opening than the replacement bridge if it meets the conditions determined jointly between the New York State Department of Transportation Structures Division and the New York State Department of Environmental Conservation Flood Protection Bureau. If the Design Flood (Q500) or the Basic Flood (Q100) happens during the life of the structure the smaller Detour structure may be overtopped and fail. The Department of Transportation is willing to take that chance of using a smaller Detour structure than the replacement bridge (and therefore saving money an Temporary structures) because of the short life duration of the Detour structure and because few major storms take place during the construction (summer) months.

If the Detour structure is slated to be in place for more than one construction season (over the summer months) then the Engineer will consider the possible effects of spring floods and debris, winter ice accumulation, additional possibility of flooding etc. and design the Detour structure accordingly.

A Detour structure or a Temporary construction condition will be sized to pass the Basic Flood (Q100) without violating Floodway elevations, (if such elevations are published) or in the absence of a Flood Insurance Study state no more than 1' rise. If these limits are exceeded then the occurrence of the NYSDEC Flood Protection Bureau is required. In addition, if there are insurable properties upstream of the Detour structure, or the temporary construction condition the property owners of these insurable properties must be notified. A sample letter of notification is shown on Page 10-35B.

The above discussion assumes of course that the existing structure will be removed as soon as possible after the Detour structure is erected, and furthermore the Detour structure is removed as soon as practicable after the Proposed structure is erected.
June 9, 1992

Mr. & Mrs. John Doe
Anywhere Road
Anyplace, NY 12065

Dear Mr. and Mrs. John Doe,

We wish to provide you with information about a construction project we are beginning in your area.

Due to wear and tear over many years, it has become necessary to repair the dam and tainter gate system at Lock C-1 on the Hudson River between the Town of Halfmoon in Saratoga County and the Town of Schaghticoke in Rensselaer County. As part of the construction work, our contractor will build temporary cofferdams; these could have an effect on your property if the Hudson River has a serious flood at the same time construction is underway.

A flood that could be expected to occur only once in every one hundred years would be predicted to result in water encroaching to within two inches of entering your building. If this same "100 year flood" were to occur at the same time the cofferdams are in place, the flood level would be expected to be 12 inches higher. Thus, instead of being two inches below your lowest building entrance, it would be ten inches above your entrance.

We have reviewed the construction plans to decrease the flood potential as much as practical; however, this flood possibility, although remote, does exist and we want you to be aware of the consequences should it occur. The work we have scheduled is necessary to keep the dam in good repair for many years to come.

Shortly after you receive this letter, you will be visited by a New York State Department of Transportation representative, familiar with this project, who will answer any questions you may have. Should you wish to contact us directly, please call 474-6715 and ask for Mr. Charles Flewelling or Mr. David Cox.

Very truly yours,

John E. Taylor, P.E.
Regional Director of Transportation

10-35B
POLICY ON ESTABLISHING WATER ELEVATIONS
FOR THE DESIGN FLOODS THRU A BRIDGE

1. The point of maximum backwater for the 50 and 100 year floods should be taken at the point in the profile that the slope changes from flat (upstream of the point for maximum backwater) to rather steep (which is the drawdown thru the bridge). This point usually happens one bridge length (or more) upstream of the upstream bridge fascia but it could vary due to other conditions.

2. In case maximum backwater elevations for existing and proposed structures are being compared and the existing structure is located at a different location along the stream than the proposed structure, the same point along the stream should be used to compare the backwater for both structures (so that the comparison would be true). This should usually be the point of maximum backwater for the structure furthest upstream, whether it is the existing or the proposed structure.

3. To establish the water elevation and slope of water profile thru the bridge (for establishing freeboard) the following procedure should be followed. Go to the point of maximum backwater and using the slope of the water from that point to 100' - 200' upstream project it forward to the center line of the bridge. (Doing this, we eliminate the effects of drawdown, which is an unstable condition and could move up and downstream during actual conditions). Check to see if the line falls between the water line and the energy grade and looks satisfactory. If not, repeat the procedure using an average water grade from beginning to end of program (at least 500 downstream to the end of the program).

If this does not yield reasonable answers, then any other reasonable method may be used as long as it is fully documented on the hydraulic file.
WATERWAY CROSSINGS

HYDRAULIC DATA

The Preliminary Structure Plan for bridges spanning waterways shall generally contain the following tabular information for the "Basic", or 100 year, Flood as well as for the "Design", or 50 year, Flood:

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Sq. mi.</th>
<th>Basic Flood</th>
<th>Design Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrence Interval (yrs)</td>
<td></td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Peak Discharge (cfs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Water Elevation Exist.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ pt. max Backwater Prop.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Avg. Velocity thru structure @ Design Flood = f.p.s.

If reliable information pertaining to the flood of record is available which indicates that it exceeded the Basic flood, the Preliminary Structure Plan shall also include the peak discharge, high water elevation and date of occurrence of that flood of record.

The table and flood of record data shall generally also appear on the Final Contract Plans. For those structures not requiring a traditional hydraulic design, such as structures over deep gorges, or over fully controlled navigable waterways, or over tidal waters or over still waters, the tabular information of Hydraulic Data is not required.
HYDRAULIC DETAILS

1. The Preliminary Structure Plan and the Final Contract Plans shall generally indicate the Design High Water Elevation at the Bridge (usually in the Elevation A-A detail) and shall show the Minimum Allowable Freeboard that has been selected for that particular structure (usually in the same detail). This information is not required where a traditional hydraulic design is unnecessary.

2. When channel realignment or improvement is proposed, the Preliminary Structure Plan and the Final Contract Plan shall generally indicate the width of the theoretical or actual bottom angle and the elevation and/or profile that controls that bottom angle. The specific configuration and location of the proposed channel should also be shown, as well as the existing stream bed. The Preliminary Plan may indicate an exact span length and bearing station.

3. When no channel realignment nor improvement, other than bank modification, is proposed, the Preliminary Structure Plan should indicate and locate the theoretical bottom angle, with appropriate elevation and/or plan views, unless an exact span length is shown, with a specific bearing station for one or both abutments. When modifications of the existing stream banks are necessary or unavoidable, sufficient information should be shown on the Preliminary Structure Plan to allow the final designer to properly detail and estimate the Stream Bank Protection item. The final Contract Plans should indicate the theoretical bottom angle.

4. The Plan detail should also indicate the direction of stream flow, the name of the waterway, and the location of the edges of the stream at ordinary water stage, or at the time of survey.

5. For canal crossings, the Preliminary Structure Plan and the Final Contract Plans must indicate the normal pool elevation and the maximum navigable water surface elevation. The required vertical and horizontal clearances should also be shown.

6. For bridges requiring Coast Guard Bridge Permits, the preliminary and final plans must indicate all the water elevations and channel clearances shown on the Coast Guard permit application.
ALLOWABLE FREEBOARD CLEARANCES

Freeboard is defined as the vertical clearance measured between the lowest point of the superstructure of a stream bridge and the surface of the water normally for the Design Flood (Q50).

A summary of the analysis and evaluation, and the final determination of minimum allowable freeboard, shall be entered into the hydraulic design folder for the permanent record.

The minimum allowable freeboard finally selected shall be indicated on the Preliminary Structure Plan, on or near the Elevation View. The Preliminary Structure Plan shall also include an "Available depth of beam" dimension, derived from the minimum allowable freeboard and other parameters. After final structural design, the contract plans should be revised to indicate the actual minimum freeboard, and its location.