DIVISION 600 – INCIDENTAL CONSTRUCTION

SECTION 603 – CULVERTS AND STORM DRAINS

603.1 – GENERAL

Culverts and storm drains are used on roadway construction projects to comprise a drainage system to channel run–off and surface water away from the roadway. Water, either directly or indirectly, is the cause of many roadway failures. Water that makes its way under pavement is subject to freezing, leading to the destruction of the roadway through the freeze–thaw cycle. Culverts and storm drains are employed based on their function in either a hydraulic or structural capacity. In planning the installation of culverts and storm drains, consideration of both factors as well as economics must be made.

Figure 600 – 1: Installing Reinforced Concrete Pipe Culvert

The installation of drainage structures is one of the first operations to occur, and any field changes should be made as soon as possible. Prior to commencing any operations to install items in this section, project personnel should check the condition of existing pipes, calculate the elevations and slopes with the finish grades of the roadway, and consult the drainage schedule for the appropriate lengths and sizes. Only the required amount of drainage materials should be ordered and costs associated with unneeded pipes, basins, or labor should be avoided.

The Contract Administrator is responsible for ensuring that the drainage system designer's requirements are fulfilled during the construction process so that a satisfactory installation is the end result. There is more to drainage than just getting water to flow away from the roadway. Project personnel will encounter unexpected field conditions and differing pay limits involved with each drainage run, so familiarization with the Plans, Standard Specifications, Special Provisions, and the Health and Safety Manual is very important. The Department and the Contractor should be pro–active in quickly resolving any conflicts that may arise with the various conditions associated with the project.

603.2 – MATERIALS

Various materials are used in the manufacture of culverts and storm drains, mainly reinforced concrete, corrugated metal, and plastic. The Standard Specifications contain the material requirements, but also refer to various governing AASHTO Specifications. The following subsections have information from various AASHTO and NHDOT Specifications that are useful in working with pipe. Certificates of Compliance must be submitted to the Contract Administrator at the time of delivery.

- Reinforced Concrete Pipe

  NHDOT's policy is to use Reinforced Concrete Pipe (RCP) for cross pipes, in lieu of plastic or metal, due to the durability and strength of RCP. Since RCP is usually precast, it should only be delivered to the project after is has properly cured. The Standard Specifications require a minimum curing age for the pipe, and the pipe's manufacturing date is marked on the pipe. This date should be checked against the delivery date to verify that the pipe has cured sufficiently to be transported without damage to the pipe.

Figure 600 – 2: Reinforced Concrete Pipe Installation

Whenever it becomes necessary to relocate a reinforced concrete culvert to a position having a greater cover height than that shown on the plans, reinforced concrete pipe cover criteria must be observed as shown in the following table.

Reinforced Concrete Pipe Cover Criteria		
Maximum Height of Fill over Pipe (ft)	Normal Construction	Imperfect Trench
13	2000–D	
20	3000–D	
35		3000–D
50		4000–D
75		5000–D

The following table list design requirements for 2000–D RCP pipe.

Design Requirements For Reinforced Concrete Pipe (1)							
		Wall Thickness (in)					
Internal Diameter		2.000 kips–ft^2 (2000–D)					
Size (in)	Max. Var. (in)	Wall Type A		Wall Type B		Wall Type C	
		Min.	Design	Min.	Design	Min,	Design
12	3/16	1 9/16	1 3/4	1 13/16	2	–	–
15	7/32	1 11/16	1 7/8	2 1/16	2 1/4	–	–
18	9/32	1 13/16	2	2 5/16	2 1/2	–	–
24	3/8	2 5/16	2 1/2	2 13/16	3	–	–
30	3/8	2 9/16	2 3/4	3 5/16	3 1/2	–	–
36	3/8	2 13/16	3	3 13/16	4	4 1/2	4 3/4
42	13/32	3 5/16	3 1/2	4 9/32	4 1/2	5	5 1/4
48	15/32	3 13/16	4	4 3/4	5	5 15/32	5 3/4
54	17/32	4 9/32	4 1/2	5 7/32	5 1/2	5 15/16	6 1/4
60	19/32	4 3/4	5	5 11/16	6	6 13/32	6 3/4
66	21/32	5 7/32	5 1/2	6 3/16	6 1/2	6 7/8	7 1/4
72	23/32	5 11/16	6	6 21/32	7	7 3/8	7 3/4

The following table list design requirements for 3000–D RCP pipe.

Design Requirements For Reinforced Concrete Pipe (2)					
		Wall Thickness (in)			
Internal Diameter		3.000 kips–ft^2 (3000–D)			
Size (in)	Max. Var. (in)	Wall Type B		Wall Type C	
		Min.	Design	Min.	Design
12	3/16	1 13/16	2	–	–
15	7/32	2 1/16	2 1/2	–	–
18	9/32	2 5/16	2 1/2	–	–
24	3/8	2 13/16	3	3 9/16	3 3/4
30	3/8	3 5/16	3 1/2	4 1/32	4 1/4
36	3/8	3 13/16	4	4 1/2	4 3/4
42	13/32	4 9/32	4 1/2	5	5 1/4
48	15/32	4 3/4	5	5 15/32	5 3/4
54	17/32	5 7/32	5 1/2	5 15/16	6 1/4
60	19/32	5 11/16	6	6 13/32	6 3/4
66	21/32	6 3/16	6 1/2	6 7/8	7 1/4
72	23/32	6 21/32	7	7 3/8	7 3/4

The following table list design requirements for 3750–D RCP pipe.

Design Requirements For Reinforced Concrete Pipe (3)					
		Wall Thickness (in)			
Internal Diameter		3.750 kips–ft^2 (3750–D)			
Size (in)	Max. Var. (in)	Wall Type B		Wall Type C	
		Min.	Design	Min.	Design
12	3/16	1 13/16	2	–	–
15	7/32	2 1/16	2 1/4	–	–
18	9/32	2 5/16	2 1/2	–	–
24	3/8	2 13/16	3	3 9/16	3 3/4
30	3/8	3 5/16	3 1/2	4 1/32	4 1/4
36	3/8	3 13/16	4	4 1/2	4 3/4
42	13/32	4 9/32	4 1/2	5	5 1/4
48	15/32	4 3/4	5	5 15/32	5 3/4
54	17/32	–	–	5 15/16	6 1/4
60	19/32	–	–	6 13/32	6 3/4
66	21/32	–	–	6 7/8	7 1/4
72	23/32	–	–	7 3/8	7 3/4

- Corrugated Metal Pipes and Pipe Arches

Corrugated Metal Pipe (CMP) is rated for use based on structural, hydraulic, and durability factors. The use of aluminized steel and aluminum pipes is appropriate for drive pipes. Galvanized steel pipes, however, usually perform poorly in the field due to corrosion issues. Reactions with backfill materials, acidic soil and runoff, and abrasion, due to high flow rates, are the main causes of early CMP failure.

Figure 600 – 3: Corrugated Metal Pipe

Additional causes for rejection of CMP in terms of material properties are as follows:

- Uneven laps
- Elliptical shaping
- Variation from a straight centerline
- Ragged or diagonal sheared edges
- Loose, unevenly lined, or unevenly spaced rivets
- Defective spot welds or continuous welds
- Poorly formed rivet heads or lock seams
- Unfinished ends
- Illegible brand
- Dents and bends in the metal itself
- Bruised, scaled, or broken spelter coating (Corrugated Steel Pipe)
- Lack of rigidity (Corrugated Steel Pipe)

Corrugated metal pipe arches may also be used for certain conditions. Pipe arches are made from reshaping round corrugated metal pipe, and are especially useful in low clearance situations and where low–flow hydraulic rates are required.

- Plastic Culvert Pipe

Plastic culvert pipe, usually made from HDPE (High Density Polyethylene) plastic, is primarily used for slope drains and in low groundwater ditch lines. Plastic culvert pipe should not be placed in areas where slope seepage or a high groundwater table is anticipated, as there is a risk of the relatively buoyant plastic pipe floating up and out of its installed position. Perforated plastic culvert pipe should be used in these situations, allowing the carrying pipe to also act as an underdrain.

Figure 600 – 4: Plastic Culvert Pipe

Refer to *Subsection 603.2.9 Plastic Pipe* of the Standard Specifications for plastic culvert pipe material requirements.

Note: It is NHDOT policy to use only reinforced concrete pipe (RCP) for cross pipes.

603.3 – CONSTRUCTION OPERATIONS

A. General

The proposed drainage system as shown on the Plans is usually designed from survey notes and existing ground data taken long before construction begins. The location of all drainage pipes should be verified prior to construction operations. Due to the actual conditions that may be encountered during construction, the original design may not be satisfactory and changes may be needed. Such conditions may be the presence of utilities, which should be thoroughly checked prior to making any structure excavations so any permissible adjustments in line or grade may be made.

If a drainage pipe is to be moved, added, deleted, or resized, then these modifications must be properly documented and recorded. In many cases, this documentation will in the form of a change order. In all cases, the changes should be documented on the as–built plans as well as the daily report and drainage field book.

If the changes are minor and are not likely to affect installation methods or payment, then a change order is not required. An example of a minor change could be adjusting the alignment of a pipe slightly to avoid a buried utility. It is impractical and inefficient to expect that all "minor" changes be documented via change orders since change orders, by definition, need to be written and approved prior to the commencement of work.

It is not uncommon to have to make field decisions during the installation of underground drainage structures "on the fly." However, these decisions still require thoughtful response and appropriate follow up. The Contract Administrator should not be forced by the Contractor into making an uncomfortable decision about drainage. The Contract Administrator should follow up with the District Construction Engineer or Design team for feedback or direction regarding the installation of drainage pipes.

Field conditions should be carefully evaluated and double checked against planned and adjusted locations and grades. Any necessary revisions to the drainage system must be made as early as possible to allow the Contractor to order the correct pipe and drainage structures. The Right–of–Way Bureau should also be notified of any changes in drainage flowage rights.

The Contractor may elect to use any reasonable method to install drainage pipe as long it yields acceptable results.

The use of a laser and target is the most common installation tool used to provide line and grade. The laser is usually set at the low end of the drainage run and the grade is dialed

into the laser to set the beam. As the crew digs the pipe trench, they can immediately see where the excavation lies relative to the laser beam and the target that is placed in the pipe that is being installed. When correct, the laser beam should hit the center of the target.

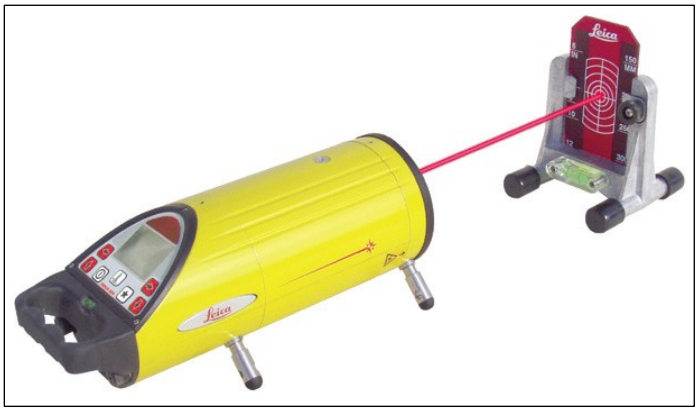

Figure 600 – 5: Typical Laser and Target

Some issues that arise with the use of a laser include distortion of the beam on longer shots and the ease by which the laser may be knocked out of alignment. Before the actual installation, the pay limits for each run should be reviewed. It is important to check the original cross–sections for accuracy. In areas not covered by sections, the existing ground data should be obtained before the area is disturbed so that quantity computations are possible.

In general, excavations up to 9 ft are subsidiary to the pipe and any depth over 9 ft is for extra pay. There are similar limits with catch basins and drop inlets. Refer to *Section 206 Structure Excavation for Pipes and other Minor Structures* of the Standard Specifications for actual excavation pay limits If ledge is encountered then sections must be determined by plotting the top of ledge and the bottom of the pipe trench to determine the correct quantity to be paid.

These are just some of aspects of drainage that the field personnel need to be familiar with, as previously stated, the contract specifications need to be reviewed before any drainage run is started. It is impossible to review the operation after old ground is disturbed and the pipe is buried.

The Contractor shall comply with all safety regulations currently incorporated in the Contract in regard to excavation, bracing, and shoring of trenches, etc. OSHA regulations do apply and regulators have the ability to levy fines. A short list of the most relevant OSHA regulations and requirements may be found in *Section 900* of this Construction Manual. Project personnel should be familiar with safety codes and should immediately notify the Contractor if any unsafe practices are observed.

A trench can be a trap, and neglecting trench shoring to speed construction can lead to tragedy. Care shall be taken that the width of the trench shall not exceed that specified in

the Standard Specifications since loads on pipes increase when trench widths increase. Common sense should prevail; if something seems like it could be dangerous or unsafe, it probably is.

The following figures show trench widening parameters.

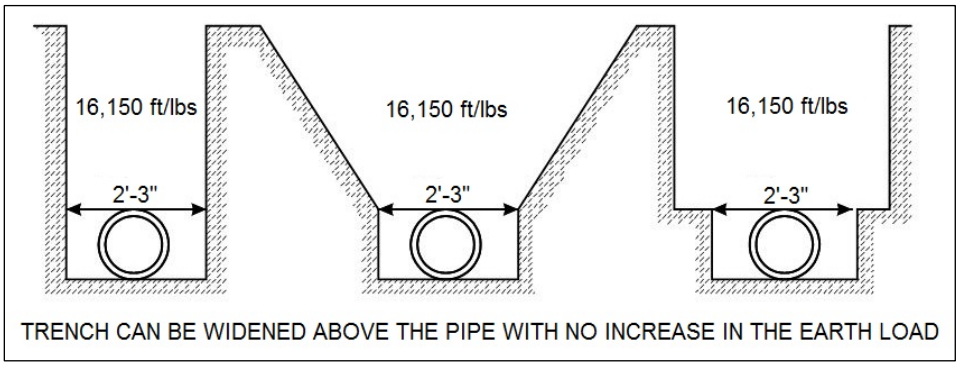

Figure 600 – 6: Trench Widening Parameters with Widening above Pipe

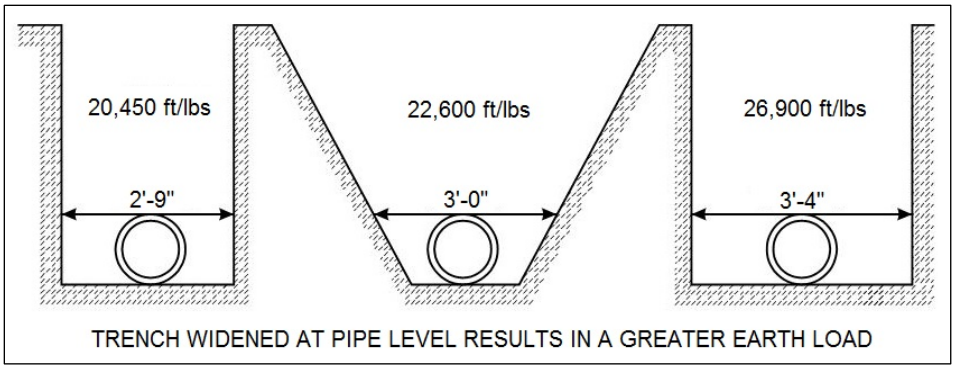

Figure 600 – 7: Trench Widening Parameters with Widening at Pipe Level

B. Bedding

The Inspector should ensure that the Contractor's personnel understand the need for proper pipe bedding. Normal construction practice involves excavating the trench to the elevation of the bottom of the pipe and then preparing and shaping the bottom of the trench to fit the lower 10% of the external diameter of the pipe.

The load imposed on a pipe from above by the weight of the overlying soil or other type of surface load must be channeled by the pipe to the underlying soil. If firm support of the pipe by underlying soil is established only over a narrow width, as with a round pipe in a flat bottom trench, the intensity of the load beneath the pipe will be large and failure is more likely. Firm support of the pipe established over a wider band will reduce the load intensity beneath the pipe.

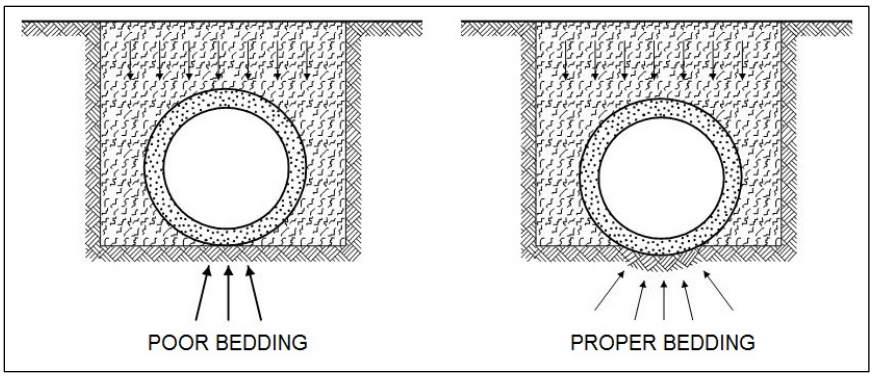

Figure 600 – 8: Pipe Bedding Parameters

Similarly, bell and spigot pipe should be installed with cutouts for the bells to avoid unnecessary stresses on the pipe.

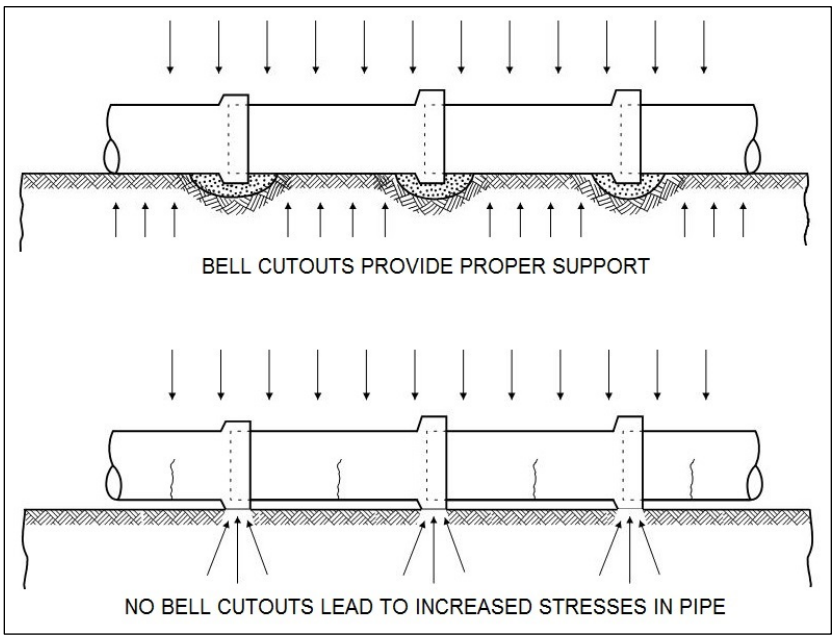

Figure 600 – 9: Bell and Spigot Pipe Installation Parameters

Culverts should not be installed partly on filled ground and partly on undisturbed natural ground because of the probability of unequal settlement, which may distort or break the culvert. When pipes are installed in embankments, the fill should be constructed to a specified height and width on each side of the culvert before installation. Unstable soils, which produce poor supporting conditions, should be removed and replaced with suitable material.

Serious cracking sometimes develops in reinforced concrete pipe when rock is closer to the bottom of the pipe than permitted by the Specifications. A coarse gravel bedding containing cobbles may also produce cracking if large cobbles are close to the pipe. The Contract Administrator has the authority to direct removal and replacement of the bedding

if the material is unsuitable, but this is not subsidiary to the pipe and accurate quantities must be obtained to enumerate the extra pay quantity.

Refer to the Standard Specifications regarding the type of bed requirements and trench dimensions for various soil or rock conditions.

C. Laying and Joining Pipe

Proper equipment is essential for installing culvert. Methods of laying pipe may differ between Contractors, but the Inspector's primary concern is to see that the finished culvert installation is in compliance with the Specifications.

Handling and lifting pipe shall be done in such a manner as to prevent damage to the pipe. Pipehooks and slings are a common method for installing pipe.

Figure 600 – 10: Pipeline Sling

The use of eyebolts with nuts and washers when lift holes are provided in the pipe is also an acceptable method for pipe installation. Pipe laying shall begin at the downstream end of the culvert with bell ends or groove ends facing upstream. The Contractor is prohibited from attempting to shape the trench bottom by raising and dropping the pipe.

Establishing tight joints between pipe segments is accomplished with the use of a pry bar with suitable blocking to protect the bell or by cable winches. Care should be exercised to prevent the moving of previously placed pipe segments when setting new pipe. Cutting a pipe where it joins a structure should be avoided.

In cases where the ground water infiltrates the pipe, the rubber gaskets used to seal the joint between pipe segments may be eliminated in an effort to collect and channel the water.

Corrugated metal pipes, when specified, shall be shop–strutted. The life of a corrugated steel culvert depends largely on the care taken to preserve the galvanizing and the asphalt coating.

The Inspector shall verify the proper grade and alignment for the pipe run after laying and joining the culvert. This is also the appropriate time to make any necessary quantity measurements.

D. Backfilling

Settlement in fill adjacent to or over culverts is one of the main causes of rough riding roadways. Another frequent cause of settlement is the use of differing material between the pipe trench and the surrounding materials. Uneven finished ground surfaces may result from frost acting on dissimilar materials, so the same material used in the backfill operation should be used as in the pipe excavation operation.

The Inspector must verify that the backfill over and adjacent to the pipe has been properly compacted. Good compaction minimizes pipe deflection in the case of flexible pipe and reduces backfill settlement in the case of rigid pipe. Uniform support for the finished pavement surface above the pipe run is the result of proper compaction.

When backfilling a trench, the backfill material placed under the pipe haunches must be thoroughly compacted. This is referred to as “chinking” the pipe, and it is done by angling a shovel handle or spade end down – acting as a compactor rod – and under the pipe to hand–compact the fill directly beneath the pipe. This chinking should be done under the entire length of the pipe while backfilling the bottom half of the pipe.

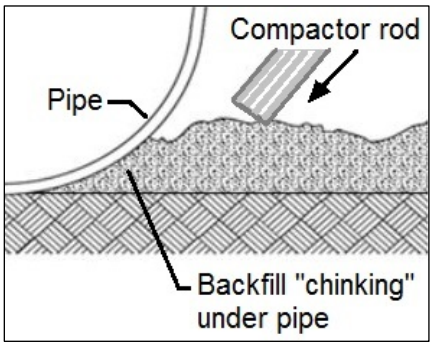

Figure 600–11: Backfill “Chinking” under a Pip

Note: Compaction requirements for narrow trenches should not be relaxed, as adequate lateral support is necessary to successfully distribute the pipe loading.

After installation, adequate fill over the top of the pipe is required to prevent damage to the installed pipe by heavy equipment. Backfill shall be compacted by air or vibratory tools.

Pipes may develop cracks on their inside top and bottom faces when backfill is improperly placed and subjected to inadequate compaction under haunches and along the sides of the

pipe. Proper compaction is important, as settlement of backfill materials and pipe failures occurring underground are not immediately obvious. These problems may arise long after construction operations have been completed, contributing to poor riding qualities in the finished paved surface and increased maintenance time and costs.

To ensure the alignment of the pipe is maintained, each lift of backfill material should be placed and compacted uniformly on each side of the pipe. As stated in the Standard Specifications, backfilling should be done in lifts not exceeding 6 in. The goal of the 6 in lift is to achieve a compacted backfill of not less than 95%. This 6 in lift thickness may be exceeded only if a 95% compaction rate is achieved.

Figure 600 – 12: Compacting Backfill with a Vibratory Rammer

Water may be used to aid in compaction and consolidation of backfill in problem areas, as well as to obtain the optimum moisture content for the material.

Proper compaction is also crucial for plastic culvert pipe installations. The weight of improperly placed backfill on plastic pipe may lead to significant internal stresses in the pipe, resulting in deflection, flattening, or premature failure, along with settlement of the backfill material. The same backfill and compaction requirements that apply to reinforced concrete pipe and corrugated metal pipe apply to plastic culvert pipe.

Important: All traffic should be prohibited from travelling over any pipe that has not yet been properly backfilled.

Refer to *Subsection 603.3.5 Backfilling* of the Standard Specifications for more information regarding proper backfill operations.

E. Video Inspection

Video inspection of drainage pipes for internal defects, improper installation, or other issues is a required tool, and is covered under *Subsection 603.3.7.1 Video Inspection* of the Standard Specifications. Video inspection of all newly installed drainage pipes that have a diameter of 36 in or less is required not less than 30 days after the backfilling has taking place, although video inspection must take place before placing pavement over the pipe run.

Figure 600 – 13: Still Image from Video Inspection with Mandrel

A YouTube video of an example video inspection, *5% Mandrel Test – Repaired Sanitary Sewer Line*, may be found at the following URL:

https://www.youtube.com/watch?feature=player_detailpage&v=ynNKwDD–5ZE

Even on projects with an apparently excellent installation and compaction of the pipe run, video inspection has proven to be a valuable double–check of actual conditions inside the pipe, especially in runs installed under massive fill volumes or in instances of construction vehicular traffic passage over a shallow culvert with incomplete backfill depth.

As stated in the Specifications, deflection of flexible pipe shall not exceed 5%. Video inspection should be conducted using a mandrel, which is a specifically sized and shaped device designed to stop in the pipe when any ovality or deflection conditions are encountered that exceed design tolerances. Also, out–of–round conditions may be readily ascertained visually, indicating at least a 5% amount of deflection.

F. Imperfect Trench

When culvert pipe is to be covered with a deep layer of backfill, the pipe must be protected from the weight of that backfill. This may be done by using the "imperfect trench" method,

which involves excavating a trench above the backfilled conduit and then filling the new trench with uncompacted fill. Since the uncompacted fill is lighter by volume than compacted fill, the overall backfill load above the pipe is thereby reduced. The remainder of the embankment work may then proceed, adding compacted backfill above this "cushion."

The compacted material over this cushion carries the load from the fill above it to the sides of the trench by arch action, which channels the load around the pipe and prevents the pipe from being crushed. In some cases, serious pipe stresses have resulted when pipes were backfilled with an imperfect trench above, but then the compacted fill to be added above was delayed. This may result in the imperfect trench backfill material being partially compacted by the combined action of construction traffic and weather, thus reducing the effectiveness of the imperfect trench method.

SECTION 604 – CATCH BASINS, DROP INLETS, AND MANHOLES

604.1 – GENERAL

Catch basins and drop inlets are the entrance structures that collect water from pavements, loam areas, and most ditch lines. Catch basins should be used where water flow is relatively slow and a sump is required to collect sediment, thus keeping pipes in the system clean. Catch basins range in size, and are generally over 6 ft tall with a 2 ½ to 3 ft deep sump.

Figure 600 – 14: Precast Concrete Catch Basin Components before Installation

Drop inlets will be used where water flow is rapid enough to make the system self–cleaning; for this reason the size of a drop inlet is approximately 4 ft, but can vary depending on the size of the outlet pipe.

Manholes will be used where a structure is required to provide entrance to a pipe due to its long length, where a number of pipes must join, and where an angle must be made in a run, all where surface water entrance at the location is not required.

604.2 – MATERIALS

The Inspector should verify that all catch basin, drop inlet, and manhole materials are inspected and approved for use prior to being incorporated into the work, and that all of the required Certificates of Compliance for these materials have been received. Refer to *Subsection 604.3.1 Construction Requirements* of the Standard Specifications and the Standard Plans for more information regarding catch basin, drop inlet, and manhole installation requirements.

Based on concrete structure manufacturers' data, the following table lists the standard hole sizes cored into catch basins for RCP and plastic pipe. This information should be used to help select the proper diameter for a catch basin or manhole that has multiple pipe runs set in and out of the structure. The recommended minimum inside diameter spacing between two cored holes is 12 in; 7 in if one of the pipes is underdrain.

Determining Catch Basin Size						
	RCP			Plastic Pipe		
Pipe Size (I.D.) (in)	Wall Thick. (in)	Core Hole Size (in, ft)		Wall Thick. (in)	Core Hole Size (in, ft)	
12	2	18	1.50	—	18	1.50
15	2 ¼	22	1.83	—	20	1.67
18	2 ½	26	2.17	—	24	2.00
24	3	34	2.83	—	32	2.67
30	3 ½	42	3.50	—	42	3.50
36	4	48	4.00	—	48	4.00
42	4 ½	54	4.50	—	54	4.50
48	5	64	5.33	—	64	5.33
54	5 ½	72	6.00	—		
60	6	78	6.50	—		

This minimum spacing is important in order to maintain the structural integrity of the basin. This is especially true when three or more pipes penetrate the structure or where a larger diameter pipe requires a cored hole with a diameter that is 6 in greater than the size of the pipe. If the basin only has one inlet pipe and one outlet pipe, the 12 in minimum spacing between holes may be reduced since there will only be one potential weak spot in the structure which may be reinforced with a proper brick and mortar application between the two pipes.

604.3 – CONSTRUCTION OPERATIONS

Careful attention to grades and positioning during layout of catch basins, drop inlets, and manholes is essential; otherwise the structure may not fit the curb or the ditch alignment. Improperly positioned structures make maintenance and cleaning operations difficult or impossible. This is especially true when locating a basin within a curb radius. The curb radius layout must be accurate so that the basin location will be correct. If a basin is positioned at a low point, it should be verified by plotting a profile of the pavement as it joins the curb, with adjustments made to the basin's elevation if necessary.

Figure 600 – 15: Installed Catch Basin with Inlet Grate at Curb

If a structure is improperly located during construction operations, the situation must be corrected before any curbing and paving are placed. Where grades are generally flat, even a properly positioned basin at the low point may result in water collecting on either side of the grate, so the grates should be set 2 in lower than the pavement grade instead of the usual 1 or 1½ in depending on the thickness of the wearing course pavement.

Good engineering practice dictates setting the frame and grate at their final elevation flush with the intermediate, or binder, layer of pavement. The finish pavement layer should then be applied to taper evenly to the grate so that water will flow from the pavement into the basin uninterrupted.

For most basins set in pavement, the addition of a plastic liner, Item 604.0007, between the frame of the grate and the basin is required. The liner should be placed when the frame is set to grade. Concrete should then be poured around the basin and finished to within 2 to 3 in of the top of the

grate, locking the basin, liner, and frame together as one. The specific details for this work are found on Standard Plan *Detail DR–4*.

Note: The Contractor must use concrete around the basin, and they are prohibited from using any other materials, such as gravel or hot top.

Manholes should be carefully positioned to accommodate curb lines. When laying out sanitary sewer structures, the center of the sewer is not necessarily the center of the top opening in the structure. The final grade of the manhole cover should be flush with the top course of pavement, not set at a lower grade like catch basins, especially if it will be located directly in or near the wheel paths. It is preferable to place manholes out of the path of vehicular traffic. Manholes should be located in the center of the travel lane if they must be located within the roadway, avoiding wheel paths as much as possible.

Figure 600 – 16: Manhole Installed in Pavement

The methods of installation for these structures differ, but for the ease of setting catch basin sumps and manhole bases, the structures should be set before laying the last length of pipe. During installation, the Inspector should verify all takeoff measurements made by project personnel. Structure walls should be constructed plumb and the dimensions of the structures should reasonably conform to those required.

Careful attention should be paid to the backfilling operations ensure that the backfill is properly compacted and no damage occurs to the structure. Finished grades of all structures should be verified prior to locking in the basins with concrete or final paving operations.

SECTION 605 – UNDERDRAINS

605.1 – GENERAL

Underdrains are used to lower a high water table, and to intercept and dispose of water seeping into the roadbed. Underdrain consists of perforated pipe and granular backfill that will readily pick up and carry off water from the roadway, thus creating a more stable roadbed and minimizing differential frost action.

Figure 600 – 17: Installing Perforated Underdrain Pipe

The sand granular backfill for the underdrain must meet the required gradation, and generally be uncompacted for the first 1 ft over the pipe to allow for water filtration. If a spring or other natural flow erupts from the subgrade and is not drained by the normal underdrain pipe run, the source should be located and a special pipe run to it should be installed.

605.3 – CONSTRUCTION OPERATIONS

Except for special conditions, it is preferable to lay out underdrain runs with the flow line parallel to the pavement. The typical roadway section sheet and the Standard Sheet in the Plans indicate the minimum distance below subgrade to the top of the pipe and also the minimum distance below pavement to the bottom of the trench. This distance is usually 2 ft 6 in below subgrade and 15 ft left or right of centerline. In guardrail areas, there must enough room to install the guardrail posts without interfering with the underdrain run.

When collecting water, the underdrain pipe should be laid with the perforations oriented down, which results in a self–cleaning system. Entering water agitates the fine materials in the pipe and carries them to the outlet. When the only requirement is to channel water, such as through a fill section to the outlet, the underdrain pipe should be installed with the perforations oriented up.

In deep roadway cuts where sidestakes are far from the underdrain, the Contractor should run and grade an additional control line from the original ties as a reference for the underdrain run and any other related structures. With proper planning, the same stakes may be used for other drainage runs, as well as subgrade shaping and checking.

SECTION 606 – GUARDRAIL

606.1 – GENERAL

Guardrail work includes the initial installation or resetting of guardrail, which usually consists of galvanized steel beams, box beams, post markers, and anchorages. Guardrail is an expensive construction item and has high maintenance costs throughout its working life. Safer highway mandates have caused redesign and experimentation with different types of guardrail. The Contract Administrator shall be thoroughly familiar with the type, location, and quantity of guardrail to be installed on each project.

Guardrail and median barrier installations are formidable roadside hazards and provide errant vehicles with only a relative degree of protection. Guardrail should only be used where the result of striking an object or leaving the roadway would be more severe than the consequences of striking the guardrail.

Figure 600 – 18: Highway Guardrail Installation

Where the installation of guardrail is indicated, the roadway and the adjacent area should be evaluated to determine whether flattening an embankment slope or adjusting other site features might eliminate the need for the guardrail installation. The design criteria for placing guardrail vary depending upon the geometry of the roadway, that is, along a tangent, curve, shoulder, or

sideslope. The design specifications and roadway hazards should be fully understood before changing any guardrail run.

Portable concrete barriers (PCB) are used to shield motorists as well as workers within the construction zone. Like guardrail, PCB should only be installed where the protective benefits of the barrier outweigh the potential damages if struck. Common uses of PCB are for channeling traffic through roadway and bridge widening or narrowing areas, shielding of roadside structures, protecting from pavement edge drop off, and for separating two–way traffic on one roadway lane.

Figure 600 – 19: Portable Concrete Barrier Segments

606.2 – MATERIALS

The Inspector should review the required material Certificates of Compliance for the steel guardrail prior to installation. All materials should be inspected for any damage that may have occurred during transit and handling. Steel Guardrail posts are either 6 ft or 7 ft in length, depending on the roadway back slope. The 7 ft posts, especially from a liability stand point, must be installed at the proper locations. The post shall be set such that the top of the metal rail is 31 in above the grade at edge of pavement. End units and special rails may have a different height.

Portable concrete barriers (PCBs) must meet the requirements of the National Cooperative Highway Research Program's (NCHRP) *Report No. 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features*. In order to achieve crashworthy effectiveness, PCB sections must be properly connected to one another and in some cases, anchored to the underlying surface to prevent lateral movement, with the exception of phase bridge deck construction.

606.3 – CONSTRUCTION OPERATIONS

A. Guardrail Locations

The Contract Administrator should verify each guardrail location as shown on the Plans. It is difficult for a designer to accurately determine the final locations, so field personnel should become familiar with current NHDOT policy on the location of guardrail, and then field check the locations prior to staking, thus allowing for adjustments in lengths and locations. If large differences are anticipated, the Contract Administrator should obtain authorization from the District Construction Engineer before proceeding with the layout.

Portable concrete barrier should be placed at a minimum offset of 2 ft from the traveled lane wherever possible. Refer to *Subsection 9.2.1.1.2 Offset* of the currently adopted AASHTO *Roadside Design Guide* for more information regarding PCBs. The MUTCD also recommends that PCB not be placed more than 12 to 15 ft from the edge of the roadway to reduce the potential of high–angle impacts.

B. Guardrail Layout

Once the guardrail has been laid out by the Contractor, project personnel should review the layout prior to guardrail installation. This will help to visualize the rail lengths relative to the hazard. The pavement centerline should be established to align the guardrail posts. A careful check should be made to see that the guardrail is located at the proper distance from the shoulder or pavement. Proposed locations should also be checked for conflict with underground utilities.

The Contractor may use one or more of several different staking techniques, which range from offset stakes to offset tacks indicating line and grade. A check with the Contractor to determine their method of operation will often prevent a conflict between the layout location and the necessary positioning of the construction equipment and excavated material. The Contractor should also be thoroughly informed as to the meaning and method of layout.

Guardrail should be properly positioned to minimize the possibility of a vehicle running behind the installation into the hazard zone. Although the Plans indicate the location of guardrail by station number, the Contract Administrator should review the Contractor's layout at the location and adjust it to the actual field location that will afford passing vehicles the most coverage.

The Contract Administrator should extend the guardrail end points so that the approach end is not a hazard to oncoming vehicles. Regarding liability, it is easier to add lengths to a guardrail run than it is to take lengths away.

In some instances, field conditions may require that the designed guardrail layout be changed due to unforeseen obstacles in the planning phase. One method used to minimize

the length of rail needed, or to reduce the amount of grading required to build a flat approach to the terminal, is to flare the rail. This means installing the rail that tapers away from the edge of the road or shoulder so that it no longer runs parallel with the road.

The greater the flare rate, the higher the angle of impact and severity of a crash. Flared sections also increase the chance that a vehicle will be redirected back into or across the roadway. This situation is especially undesirable on two–way roadways where the impacting vehicle could be directed onto oncoming traffic. Refer to *Subsection 5.6.3 Flare Rate* of the currently adopted AASHTO *Roadside Design Guide* for more information. The advantages and disadvantages of flaring the rail must be seriously considered before any change is made.

The following table lists the maximum recommended guardrail flare rates at a range of speeds and shy line offsets. The shy line offset is the distance beyond which a roadside object will be perceived as non–hazardous and does not result in motorists reducing speed or changing vehicle positions on the roadway.

Maximum Recommended Guardrail Flare Rate			
Speed (mph)	Shy Line Offset (ft)	Flare Rate Inside Shy Line	Flare Rate Outside Shy Line
70	9	30:1	20:1
60	8	26:1	18:1
55	7	24:1	16:1
50	6.5	21:	14:1
45	6	18:1	12:1
40	5	16:1	10:1
30	4	13:1	8:1

Source: Tables 5.7 and 5.9 of AASHTO Roadside Design Guide

There are other variables to consider if the designed guardrail is not going to fit the existing conditions. ELT terminal units installed at the ends of guardrail runs are designed to absorb energy when hit. This means that there must be a sufficient run–out length behind the rail so that if a vehicle runs through the terminal unit it will still have time to come to a stop. The run–out length is the theoretical distance required for a vehicle that has left the roadway to stop. This run–out length can be anywhere between 130 ft and 475 ft depending on design speed and traffic volume.

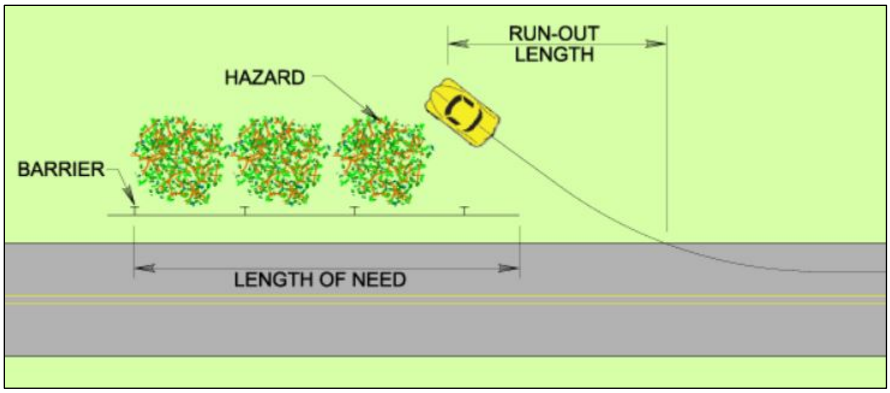

Figure 600 – 20: Runout Length for Guardrail Parameters

Suggested run–out lengths at various speeds for guardrail design are shown in the following table.

Suggested Runout Lengths for Guardrail Design				
	Runout Length (L_R) Given Traffic Volume (ADT)			
Design Speed (mph)	Greater than 10,000 vpd (ft)	5,000–10,000 vpd (ft)	1,000–5,000 vpd (ft)	Less than 1,000 vpd (ft)
80	470	430	380	330
70	360	330	290	250
60	300	250	210	200
50	230	190	160	150
40	160	130	110	100
30	110	90	80	70

Source: Table 5.10 of AASHTO Roadside Design Guide

Flare rates and run–out lengths are given as guidance only in order to formulate a solution to an on–site problem. The Highway Design Project Engineer must be consulted before any proposed changes are implemented.

The above information refers to permanent guardrail or other permanent barrier installations. The design requirements for temporary portable concrete barriers (PCBs) are less stringent than permanent installations primarily because of their temporary nature. The exposed ends of PCB should be treated to one of the following conditions:

- Connection to another in–place PBC
- Attachment to a crash cushion
- Flaring away to the edge of the clear zone
- Buried in the back slope

Flaring away the PCB end away to the edge of the clear zone is most common. The flare rates for temporary barriers should be selected to provide the most cost beneficial safety treatments possible. Low flare rates lead to longer flared sections and increase the number of impacts with the temporary barrier, while higher flare rates lead to shorter flared sections and fewer impacts.

Although these impacts increase the severity of redirection crashes and the number of barrier penetration crashes, the benefit/cost analysis of temporary concrete barriers indicate that total accident costs appear to be minimized for flare rates ranging from 4:1 to 8:1. A flare rate of 5:1 or 6:1 may be slightly more favorable for urban streets with high traffic volumes where speeds are lower and impact angles are higher.

Refer to *Subsection 9.2.1.2 Portable Concrete Barriers* of the AASHTO *Roadside Design Guide* for more information. Once a flare rate is determined, the PCB must be placed beyond the clear zone. The required clear zone is typically specified in the Prosecution of Work in the project proposal and contract.

The following table shows example clear zone widths for work zones.

Example Clear Zone Widths for Work Zones	
Speed (mph)	Width from T.W. (ft)
> 60	30
45 – 55	20
40	15
> 35	10

Source: Table 9.1 of AASHTO Roadside Design Guide

C. Guardrail Construction

Construction details relating to post spacing and locations, dimensions, and other pertinent information are shown on standard detailed drawings which are included in the Contract documents for the project. The detail sheet should be checked for conformity to project requirements as guardrail details and installation procedures change.

Holes for the guardrail posts are generally excavated by auger or hand labor. Posts may be placed by a driving machine provided that they are driven plumb to the required depth and alignment with adequate lateral stability. The post–driving operations must be closely monitored to ensure that existing posts, shoulders, and adjacent slopes are not damaged, as issues may arise with post placement by this method.

Figure 600 – 21: Installing Guardrail Posts with a Driving Machine

Larger boulders, drainage structures, or other underground obstructions may be encountered in the intended post location. In some cases, the only way to continue is to get around or remove the obstruction by hand digging, but project personnel must be realistic in their decisions. Double nesting the guardrail or pouring concrete around the shortened posts may be a solution.

Guardrail posts must have a firm foundation and backfill around the posts must be thoroughly compacted to minimize any future settlement. When post holes are over–excavated by auger or shovel, the bottom of the hole must be backfilled and thoroughly compacted to grade.

Steel posts should be driven in such a manner as to ensure no spreading, splitting, or brooming of the post. Beam rail laps should be made in the direction of vehicular traffic. Tight guardrail curves that have small radii require a decrease in the post spacing.

Figure 600 – 22: Installing Galvanized Steel Guardrail Beams

The final step is to install the guardrail delineators. This spacing should be closer than the standard roadway delineation, to accentuate the guardrail run, but the actual lay–out should be specified in the typical layout drawings.

Figure 600 – 23: Example Guardrail Delineators

Prior to acceptance, each section of guardrail should be inspected for its effectiveness and also for line and grade by observing the guardrail from several viewpoints. Guardrail inspection should also involve driving the roadway adjacent to the newly–installed guardrail in each direction, to make certain it serves the intended purpose and that the grade and alignment are pleasing to the eye, particularly at bridge approaches.

Existing guardrail to be reset should be carefully removed from the old location and reset at the designated locations. Resetting of guardrail should meet the same requirements as construction of new guardrail.

D. Measurement

The Plans and Specifications should be consulted for the proper limits of guardrail measurements. In the case of resetting the guardrail, a measurement should be taken prior to initial removal to account for possible lost or damaged material at a later date.

SECTION 607 – FENCES

607.1 – GENERAL

Fences delineate boundaries for properties acquired for public right–of–way. Fences also are used to discourage animals and people from entering the right–of–way area, and to discourage building encroachment upon State property. To accomplish these purposes, it is sometimes beneficial to erect the fence before construction begins.

NHDOT's fencing policy for Limited or Controlled Access Highways requires the use of chain link fencing to prevent children or pets, where that is possible, from entering the right–of–way and woven wire fencing for the remaining right–of–way where necessary. However, special fencing conditions, types, and installations may be specified in the Plans or by special Right–of–Way agreements.

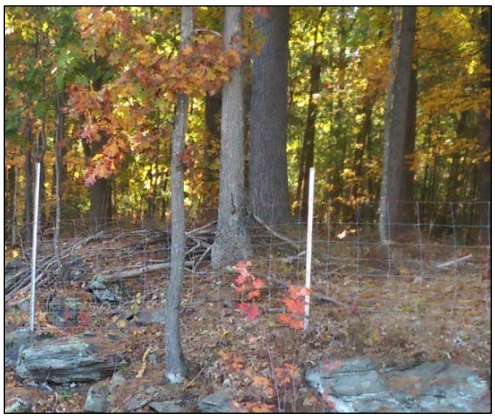

Figure 600 – 24: Highway Woven Wire Fencing Installation

607.2 – MATERIALS

The Standard and Special Detail drawings included in the contract specify the fencing material requirements. Prior to fence installation, the required material Certificates of Compliance should be submitted to the Contract Administrator. Wire and fabric gauges, post dimensions, material coatings, etc., should be checked and verified by the field personnel before incorporation into the work.

607.3 – CONSTRUCTION OPERATIONS

A. Fence Locations

The Contract Administrator should study the Plans and verify the location of right–of–way lines, control–of–access lines, location of gates, angle points, etc., before fencing construction operations are started, Fencing should not be positioned to obstruct the flow of streams or drainage areas, since this may act to collect water–borne materials, causing water back up and possibly resulting in property damage.

B. Fence Layout

The Survey Bureau is responsible for the fencing layout and this work should be done well in advance of the anticipated fencing installation to avoid Contractor delays. The Contractor then should layout the individual post locations, which should be checked as the fence is being erected for conformance with the Standards and Specifications.

C. Fence Construction

The Fence Inspector should be thoroughly familiar with the related Plans and Specifications. An inspection of the installation and erection of all fencing items should be conducted to ensure the following conditions have been met:

The post holes are excavated to the proper depth

The posts are firmly installed and erected true to line

The wire, fabric, and hardware are attached to the posts in the proper manner and at the proper elevation

The wire is installed on the specified side

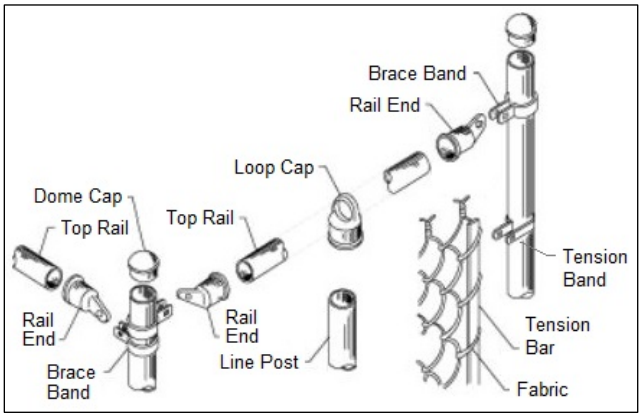

Figure 600 – 25: Chain Link Fence Components

Any obstructions, either above or below ground, that interfere with the proper alignment of the fence must be removed. If the fence line needs to be adjusted to avoid an unmovable obstruction, it should always be moved onto the State property side of the ROW line. Any dead trees that might fall onto the fence should be cut down and removed.

Good fence construction practice requires careful attention to line and grade. A string line should be used as a guide to maintain alignment and to eliminate minor variations in the grade of the post tops as the posts are being set in their final position. A carpenter's level may be used to verify that posts are vertical.

Concrete used for fence post bases should be poured slightly above the surrounding ground and rounded on top to drain water away from the post. Wire and fabric should be taunt and spaced as shown on the Plans with the specified clearance under the fabric to prevent children and small animals from crawling under the fence.

D. Fence Measurement

The Plans and Specifications should be consulted for the proper limits of measurement. In the case of resetting fencing, a measurement should be taken prior to initial removal to account for possible lost or damaged material at a later date.

SECTION 608 – SIDEWALKS

608.3 – CONSTRUCTION OPERATIONS

The location and grade of a sidewalk is usually dictated by the curb line. Sidewalk locations and grades, especially those not adjacent to curbs, should be laid out and verified well in advance of the work.

The Contract Administrator should review the typical roadway section sheets of the Plans and be familiar with the design and slope of the sidewalk, particularly in the vicinity of an approach or driveway. Once the sidewalk is constructed, the Contract Administrator should be concerned with the development of the area behind the sidewalk in regard to matching residential lawns, walks, and steps in a practical and aesthetic manner.

Figure 600 – 26: Concrete Sidewalk

Attention must be given to the location and timing of all utility structure alterations within or beneath the sidewalk so that this work is completed at the proper location and well in advance of the sidewalk construction.

SECTION 609 – CURBS

609.1 – GENERAL

The subsection is blank.

609.2 – MATERIALS

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609.3 – CONSTRUCTION OPERATIONS

Curb locations should be laid out and verified well in advance of the work. Proposed locations of driveways and drainage structures should be reviewed. The Contractor should set a line at the front top of the curb and have the Contract Administrator review it before any curb setting. Also, before any set curb is mortared, the line and grade should be sighted and approved by the project personnel.

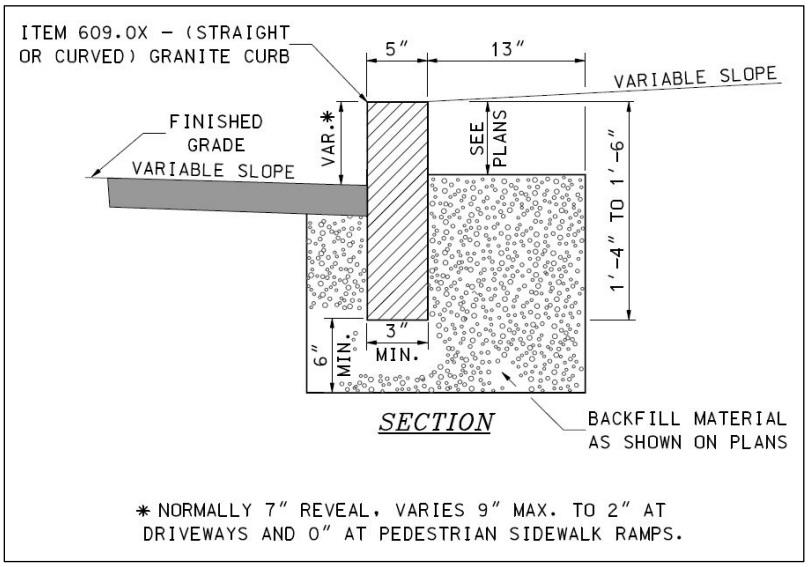

Figure 600 – 27: Concrete Curbing Section Detail

Where an abrupt change in pavement crown is encountered, such as where a roadway slope of 2% meets a bridge slope of 1%, care must be taken to construct a transition that will eliminate drainage problems without drastically changing the curb reveal and still give a pleasing grade to the curb and related guardrail. Setting a string line on stakes and sighting the line is a good method to lay out and check such transitions.

All curbs shall be set on a thoroughly compacted base. Excessive excavation without proper backfill and compaction before setting the curb shall be prohibited; this is especially important adjacent to structures.

When an island bounded by curbing is to be surfaced with concrete, the curb joints should coincide with the construction joints to allow for shrinkage cracking in the concrete. Bridge curbing is

normally adjusted to line and grade by a pair of wedges near each end of each curb. The line and grade must be checked and approved before any mortaring is done. After approval, the bottom of the curb at each end is mortared and allowed to set so the wedges may be removed, then the balance of the bottom of the curb is mortared.

Wooden wedges and any other items must be removed and the area under the curb completely filled with mortar. The most acceptable method of mortaring curb is to drive all mortar under the curb from the face side until it reaches the back, rather than place mortar from both sides. Any void or wooden wedge left beneath the curb will later become filled with water and is almost certain to freeze and loosen the curb.

Bituminous curb must be laid on a smooth firm surface, usually hot top or surface treatment, to provide a base for the curb and smooth area for the curb machine. Any rough or poorly graded area under the curb machine will be reflected and magnified in the line and grade of the curb.

SECTION 611 – WATER PIPES

611.1 – GENERAL

Water pipes provide new or replacement water service when required by adjacent construction activity. Construction and payment for the excavation and backfilling of this item are described in *Subsection 206 Structure Excavation for Pipes and Other Minor Structures* and *Subsection 603 Culverts and Storm Drains* of the Standard Specifications. Local water department personnel should be a part of the project preconstruction conference to be informed of the Contractor's proposed work schedule and to resolve any possible conflicts.

Before any water pipe installation work begins, the Contract Administrator should identify the persons or organizations to be notified in the event of a pipe break. Procedures must be implemented to minimize any inconvenience to the public if this occurs, and the Contractor and local water utility personnel must cooperate. The location of critical valves to shut down parts of the system affected by the break must be known to the proper authorities.

611.2 – MATERIALS

Because of the variety of materials available to construct water pipes, the Contract Administrator should carefully check the materials delivered before their incorporation into the work. Pipe lengths, couplings, and jointing materials should exhibit the proper markings that are required by the Standard Specifications. Any required material Certificates of Compliance should also be delivered to the Contract Administrator before any pipe installation work commences.

Figure 600 – 28: Installing Water Supply Pipe

611.3 – CONSTRUCTION OPERATIONS

The Contract Administrator and the Inspectors should be thoroughly familiar with the Standard Specifications and Special Provision requirements pertaining to this item. When a question of

proper practice arises, the Contract Administrator should consult the latest American Water Works Association Standards, which are available from the Hydraulics Engineer of the Highway Design Bureau.

Prior to the start of construction, all utility lines in the immediate construction area should be located and sufficiently referenced so that the chance of damage may be kept to a minimum. In the event that water service must be interrupted, the Contract Administrator should make certain that all those persons affected by the interruption are properly notified and cautioned to make alternative provisions during the anticipated interruption interval.

Because water pipe construction often involves narrow trench work, the Inspector should verify that the Contractor is in compliance with all OSHA regulations. Precautions should be taken to prevent drain water and other foreign matter from entering the water pipe line as it is installed to minimize extensive flushing and disinfecting and to reduce any potential health hazards to the consumer.

In those areas with an existing local water utility organization, the Contract Administrator should seek the organization's advice and cooperation to promote mutual satisfaction after State acceptance of the Contractor's work. The Contractor will reference and record all locations of pipes, valves, tees, etc., on As–Built Plans and provide a copy of the plans to the local utility.

SECTION 612 – SEWER PIPES

612.1 – GENERAL

Sewer pipes provide new or replacement sewer service when required by adjacent construction activity. Personnel of the New Hampshire Water Supply and Pollution Control Commission (NHDES) and local sewer departments should be part of the project pre–construction conference to be informed of the Contractor's proposed work schedule and to reach a complete understanding of the work to be done. Also, at this time correlation of sewer work with that of other utilities should be planned. Work on sewers often involves modifications or relocation of a portion of an existing system, which requires preplanned coordinated efforts to maintain the operation of the existing facility.

Exploratory excavation should be done by the respective utility at all locations where the sewer is to cross an existing utility, and the exact location of the top and bottom of the existing utility should be recorded to verify that there will be no interference with the sanitary sewer system.

A sanitary sewer system is carefully designed to carry a given flow in a specified size pipe installed on a specified grade. Where conflicts occur with other facilities being constructed on the project, the other facilities should be moved if possible to allow construction of the sewer as designed. If the sewer conflicts with existing facilities and must be altered, then a check with the designer is necessary to determine if a change in pipe size is required for the new flow line grade if a redesign is needed.

612.2 – MATERIALS

All material should be inspected prior to being incorporated into the work. The Inspector should also verify that all materials have been approved for use in the work and that all the required Certificates of Compliance have been received. Refer to the Standard Specifications and the Standard Sheets for more information regarding the material requirements for the planned sewer line.

612.3 – CONSTRUCTION OPERATIONS

The operations involved in the construction of sewer and soil pipes must conform to the applicable requirements of *Section 603 Culvert and Storm Drains* of this manual. The project personnel should be thoroughly familiar with these requirements as well as the requirements of the Standard Specifications and the Special Provisions, which usually contain detailed information from the system designer.

Sanitary sewers are laid straight between manholes both in line and grade. To achieve the required accuracy in laying out the system, laser beams are typically used. The use of a transit in setting line and grade on each length of pipe is also a method that can be used to produce an acceptable run of pipe.

Figure 600 – 29: Setting Line and Grade for Sewer Pipe Installation

Attention must be paid to the construction of the joints and bedding of the pipe in order to ensure that the sewer line passes the required tests conducted by the New Hampshire Department of Environmental Services (NHDES). Testing of sewer lines is to be conducted in accordance with the testing procedure outlined in the Standard Specifications or Special Provisions.

The Contractor shall reference and record the locations of all pipes, fittings, connections, etc., on the as–built plans and provide a copy of the plans to the local utility.

SECTION 614 – ELECTRICAL CONDUIT

614.1 – GENERAL

Prior to the start of conduit work, the Inspector should carefully study the Plans, Specifications, and Special Provisions. Layout should be checked in the field as soon as possible to determine if it may be advantageous to alter or change the runs somewhat to avoid obstacles unforeseen during design stages.

If a major change in circuitry is desired, the District Construction Engineer and the Traffic Bureau should be consulted. In general, conduit runs should be positioned well away from locations where signs, delineators, guardrail, etc., will later be placed. On new construction, all conduit located under paved surfaces shall be placed prior to placement of any pavement.

614.2 – MATERIALS

In general, the electrical conduit materials shall conform to the requirements outlined in *Section 614* Electrical *Conduit* of the Standard Specifications. Certificates of Compliance are required for any conduit used on the project.

A. Steel Conduit

Steel conduit shall be galvanized standard weight pipe. Each pipe segment shall be legibly marked by rolling, stamping, or stenciling indicating the name or brand of the manufacturer, the designation "ASTM A 53," and the length of the segment. Smaller diameter pipe segments are is usually bundled together with pertinent information marked on a tag that is securely attached to each bundle.

Conduit must meet the requirements of ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot–Dipped, Zinc–Coated, Welded and Seamless.

Figure 600 – 30: Installing Steel Electrical Conduit

Use the following table for field checking steel electrical conduit.

Steel Electrical Conduit		
Conduit Diameter (in)	Design Wall Thickness (in)	Minimum Wall Thickness (in)
3	0.21	0.19
4	0.24	0.21

B. Plastic Conduit

Electrical plastic tubing (EPT) and electrical plastic conduit (EPC), including fittings and joint requirements, shall be made from polyvinyl chloride (PVC), and shall conform to NEMA *TC 2–2013 Electrical Polyvinyl Chloride (PVC) Conduit*. Each conduit segment shall be labeled with the name of the manufacturer, the size of the conduit, and the designation "Rigid PVC Conduit." These markings shall appear on all conduit segments longer than 24 in, and on the packaging of all conduit segments shorter than 24 in.

The following table shows Schedule 40 PVC Pipe Dimensions.

Schedule 40 PVC Pipe Dimensions

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nominal Wt./Ft.	Maximum W.P. PSI*
1/8	0.405	0.249	0.068	0.051	810
1/4	0.540	0.344	0.088	0.086	780
3/8	0.675	0.473	0.091	0.115	620
1/2	0.840	0.602	0.109	0.170	600
3/4	1.050	0.804	0.113	0.226	480
1	1.315	1.029	0.133	0.333	450
1-1/4	1.660	1.360	0.140	0.450	370
1-1/2	1.900	1.590	0.145	0.537	330
2	2.375	2.047	0.154	0.720	280
2-1/2	2.875	2.445	0.203	1.136	300
3	3.500	3.042	0.216	1.488	260
3-1/2	4.000	3.521	0.226	1.789	240
4	4.500	3.998	0.237	2.118	220
5	5.563	5.016	0.258	2.874	190
6	6.625	6.031	0.280	3.733	180
8	8.625	7.942	0.322	5.619	160
10	10.750	9.976	0.365	7.966	140
12	12.750	11.889	0.406	10.534	130
14	14.000	13.073	0.437	12.462	130
16	16.000	14.940	0.500	16.286	130
18	18.000	16.809	0.562	20.587	130
20	20.000	18.743	0.593	24.183	120
24	24.000	22.544	0.687	33.652	120

The following table shows Schedule 80 PVC Pipe Dimensions.

Schedule 80 PVC Pipe Dimensions

Nominal Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nominal Wt./ft.	Maximum W.P. PSI*
1/8	0.405	0.195	0.095	0.068	1230
1/4	0.540	0.282	0.119	0.115	1130
3/8	0.675	0.403	0.126	0.158	920
1/2	0.840	0.526	0.147	0.232	850
3/4	1.050	0.722	0.154	0.314	690
1	1.315	0.936	0.179	0.461	630
1-1/4	1.660	1.255	0.191	0.638	520
1-1/2	1.900	1.476	0.200	0.773	470
2	2.375	1.913	0.218	1.070	400
2-1/2	2.875	2.29	0.276	1.632	420
3	3.500	2.864	0.300	2.186	370
4	4.500	3.786	0.337	3.196	320
6	6.625	5.709	0.432	6.102	280
8	8.625	7.565	0.500	9.269	250
10	10.750	9.493	0.593	13.744	230
12	12.750	11.294	0.687	18.909	230
14	14.000	12.41	0.750	22.681	220
16	16.000	14.213	0.843	29.162	220
18	18.000	16.014	0.937	36.487	220
20	20.000	17.814	1.031	44.648	220
24	24.000	21.418	1.218	63.341	210

Plastic Electrical Conduit Parameters						
	Schedule 80 PVC Conduit (EPC)		Schedule 40 PVC Conduit (EPC)		Concrete Encased PVC Tubing (EPT)	
Diameter (in)	Min. Wall Thickness (in)	Max. Wall Thickness (in)	Min. Wall Thickness (in)	Max. Wall Thickness (in)	Min. Wall Thickness (in)	Max. Wall Thickness (in)
2	0.218	0.248	0.153	0.174	N/A	N/A
3	0.300	0.336	0.216	0.242	0.149	0.144
4	0.337	0.377	0.237	0.264	0.150	0.170

Figure 600 – 31: PVC Electrical Conduit Installation

614.3 – CONSTRUCTION OPERATIONS

Conduit runs shall be properly laid out by the Contractor with sufficient detail so that their proper location, depth, and grade can be verified. Pull boxes, mast arm bases, and pedestal bases should be located slightly higher than their surrounding surfaces so that water will not pond over them, and pull boxes should not be located in areas that would allow water to collect.

Asphalt sealer should not be used to join precast conduit segments as it erodes the electrical wiring's neoprene covering. When working with steel conduit, field bends should be made with a hydraulic bender, taking care that the bend angle is not too sharp. For 90° bends, three to four settings of the hydraulic shoe are necessary to make a smooth bend without kinks or flat sections. Field cuts should be made with a pipe cutter and be square cut, threaded, and free of burrs. The pipe segments should be tightly screwed together.

Cut segments and damaged areas of the galvanized conduit shall be repaired by cold galvanizing. The location of the conduit run should be precisely referenced to aid in future identification and location of the run. Refer to *Division 800 Project Records* for instructions regarding documenting conduit run locations.

SECTION 615 – TRAFFIC SIGNS & DELINEATORS

615.1 – GENERAL

Traffic signs are erected in appropriate locations to control and route traffic and inform motorists of driving conditions.

615.3 – CONSTRUCTION OPERATIONS

Prior to installing any traffic signs or delineators, the Contract Administrator should field check the sign layout to determine if there are any omissions or necessary changes that might require Contract change orders. The Engineer should inform the Contractor in writing as to any changes in the number of signs or displayed signage information so that the correct signs can be ordered from the supplier.

Sign location and visibility are important factors. During construction layout, the sign location may be adjusted to so that the sign is behind a guardrail run or ahead of a tree or utility pole. Each sign location should be checked to determine that sight distance is ample, that the sign will not conflict with any roadway or bridge feature, and that the sign is so positioned to minimize splattering by snow and ice removal. Signs should not be located behind a lighting pole that may cause glare on a portion of the face and lessen its effectiveness. On major projects, it is advisable to review sign locations with the Traffic Bureau.

Figure 600 – 32: Overhead Interstate Highway Signs and Supports

The erection and height dimensions of specific signs are shown on the Standard Sheets in the Plans. In addition, overhead signs require approved shop drawings showing complete installation. Signs in urban areas are usually set high enough to allow pedestrian passage underneath, but consideration should be given to overhang and location near sidewalks and drives.

The Contractor shall stake all sign locations with the sign code number for review by the Contract Administrator prior to installation. The number of stakes required to provide the proper alignment, grade (height), and skew angle for the sign installation varies. Highway signs should be set at the correct skew angle to avoid being unreadable due to headlight glare at night.

During layout review, the Contract Administrator should verify that sign post excavation operations will only be made in areas known to be free of underground pipes, conduits, or other utilities. Where sign posts must be placed close to underground facilities, post holes should be hand–excavated. Close cooperation with the sign Contractor in regard to timing and method of layout will avoid situations in which layout stakes are knocked out by equipment before they can be used.

Refer to *Section 621 Delineators* of the Standard Specifications and the Standard Sheet for more information regarding the proper use of delineators.

A. Sign Inspection Checklist

The following highway sign inspection "memory jogger" checklist should be followed during the sign inspection process.

- All signs with a GA or GO designation shall have Type III sheeting for the copy, border, and background. No patching is allowed. Refer to Subsection 615.2.9.1 General and Subsection 615.3.2.8 Appearance of the Standard Specifications, and Sign Text Layout Sheet, Note 1 for more information.
- All GA and GO signs shall have their size and manufacturer's date labeled on the front face lower left corner. Refer to Sign Text layout Sheet, Note 4 for more information.
- GA and GO sign borders shall be rounded at the outside corners except where exit panels and signs meet. Refer to Approved shop drawings for more information.
- When panels are permanently removed from existing signs (including bridge mounted signs) the supports shall be trimmed to match the top of the sign. The supports shall not extend onto auxiliary panels. Refer to Standard No. PS–1A for more information.
- Supports for top auxiliary panels shall be aluminum Tee bar and shall extend to the top of the panel and shall overlap the main sign by at least 3 full planks. Refer to Standard No. PS–1A for more information.
- Supports for service symbol panels shall be galvanized "U" posts and shall overlap the main sign by a minimum of 2 full planks. Refer to Standard No. PS–1A for more information.
- Type A signs installed on I–beams and exit tabs on aluminum Tee bar shall have post clip assemblies on every plank, on each side of the beam or bar as well as at the top and bottom of the sign. Refer to Standard No. PS–1A for more information.

- All signs with bolts through the face shall have a nylon washer between the stainless steel fender washer and the sheeting. Refer to Standard No. PS–2 for more information.
- Signs installed on 4 in aluminum posts shall have backers extending the full width of the sign minus 6 in on each end. Refer to Standard No. PS–2 for more information.
- Spliced U–channels are not allowed. Refer to Standard No. PS–3 for more information.
- U–channels shall be galvanized. Refer to Subsection 615.2.5 Vertical Supports of the Standard Specifications for more information.
- Breakaway foundations shall have a maximum reveal of 4 in. Refer to Standard Nos. PS–3, PS–5A and PS–6B for more information.
- Non–Breakaway foundations shall be finished to match the adjacent slope. Refer to Standard Nos. PS–4A and PS–4B for more information.
- Sign mounting height shall be measured from the elevation at the edge of pavement to the bottom of the primary sign and shall be as specified in the MUTCD except as modified on the sign text layout sheets. A minimum mounting height on a conventional roadway in a rural district is 6 ft and everywhere else is at 7 ft, including all plank signs. Refer to Standard Nos. PS–4A, PS–4B, PS–5A, and PS–5B, Sign Text Layout Sheet Note 7, and MUTCD Section 2A–18 for more information.
- Hinge points on breakaway I–beams shall be located 3 in below the sign. Refer to Standard No. PS–6A “Assemble according to manufacturer’s instructions”.
- Invite Bureau of Traffic to a “pre–final” inspection when all NHDOT items are complete. Notify the Traffic Bureau if signs and pavement markings have not been completed when the final inspection is scheduled.

B. Type “C” Traffic Signs

All Type “C” signs shall have Type I sheeting unless otherwise specified in the Sign Text Summary. However, certain Type “C” traffic signs have specified types of sheeting as noted in the following table.

Type "C" Traffic Sign Sheeting Types			
MUTCD Description	Sign Copy	Background Type	Designation Type
R5–1	"DO NOT ENTER"	III	III
R5–1a	"WRONG WAY"	III	III
M3–1i, M3–2i, M3–3i	Interstate Shields and auxiliary	III	III
M3–4i, M4–5i	Panels	—	—
W1–8	Chevrons, Speed Limit > 50 mph	I	III
W14–3	"NO PASSING ZONE"	I	III
OM1–3	Type I, Object Markers (yellow)	—	III
OM4–3	End of Road Markers (Red)	—	III
S1–1	School Warning	I	Fluorescent Yellow/Green
W16–7pL, W16–7pR	Supplemental arrow plaques for School Crossings	I	Fluorescent Yellow/Green
W16–9P	Supplemental "AHEAD" for School Zones	I	Fluorescent Yellow/Green
S4–3	"SCHOOL" plaque for Speed Limit Sign	I	Fluorescent Yellow/Green
S5–1	"SCHOOL SPEED LIMIT WHEN FLASHING," "SCHOOL" portion remainder of sign	I	Fluorescent Yellow/Green
GO and GA Series	All shields, legends, arrows, and borders	III	III

SECTION 616 – TRAFFIC CONTROL SIGNALS

616.1 – GENERAL

The placement of traffic signals consists of the erection, installation, and wiring of specialized equipment to control the flow of vehicular and pedestrian traffic. The traffic signal installation contract is usually let concurrently with road contract, as coordination of work is crucial to a successful project.

Figure 600 –33: Traffic Control Signal Lights

616.3 – CONSTRUCTION OPERATIONS

To coordinate the roadway and signal Contractor's activity relative to signal installation, the Contract Administrator should suggest the following order of work:

- Lay out the conduit network

  Usually conduit is installed by the road Contractor before the signal Contractor begins work. All conduit runs should be tied to prominent field features so as to minimize exploratory digging and should be recorded accurately in the proper field book.

- Excavate, form, and pour concrete pull box, pole, and controller bases

  This is usually the first work accomplished by the signal Contractor. The Contractor should stake the proper location and elevations for signal controller bases, hand holes, etc., for

review by the Contract Administrator. Important dimensions and detail of boxes and bases are shown on Standard Detail Sheets in the Plans.

When reviewing the Contractor's layout of a pole standard and pull box location, the Contract Administrator should ensure that no obstructions exist which will block the sight of the traffic signals or the pedestrian signals. Standards with crosswalk pushbuttons should be located close to the sidewalk. Poles should not be located over or too close to underground utilities.

Base and pull boxes should be constructed before the completion of adjacent road contract items so that topsoil, sidewalks, pavement, etc., can be finished without damage requiring unsightly patchwork.

The Contract Administrator should verify that conduits are properly capped and that reinforcing steel, ground rods, and anchor bolts in signal bases and/or boxes remain in position during the concrete placement. Pull boxes should drain water properly and should not be located in any depressed area or ditch. The top of the box should be flush or slightly higher than the surrounding surface.

- Install detector loops

  Detector loops should be placed in cuts made in the binder course of the pavement so that the wearing course completely covers the cuts used to install the loop wire.

- Erect light and signal posts

  In erecting light or signal posts, rope slings should be used to lift and move the posts into place to reduce the damage to galvanized or finished aluminum surfaces. Any scratches or peeled enamel on any post, signal head, or controller cabinet must be touched–up.

  If the touch–up enamel does not match the original enamel, the Contractor should repaint the entire post, head, or cabinet. After the pole has been properly aligned, the base bolts should be checked for tightness.

- Install power service

Coordination with the local power utility company will result in proper and timely installation of power service to the controller box.

- Install signal heads

  Adequate clearance for signal poles and equipment should be allowed to prevent damage from trucks turning at an intersection. When pedestrian signal heads are used, the supporting poles should be placed at least 30 inches behind curbs to protect the signal heads.

- Pull cable into the conduits

  The cables pulled from detectors and poles should have sufficient slack so that unauthorized splices are not necessary.

- Install wiring and tagging signals to the controller

  An electrical system is only as good as its conductors, terminals, and splices. Should any question arise pertaining to the technical nature of the electrical work, the Contract Administrator can consult with the Traffic Bureau. Color codes as set forth in the Specifications facilitate maintenance. Because of electrical shock hazards, all grounds and ground bonds referred to on the Plans should be given special attention to ensure a complete and safe installation. Wire splices indicated on the Plans should have the splice sleeves crimped tight and well–soldered, and application of electrical tape under slight tension will result in a neat watertight splice.

- Check out individual components and entire system

  Testing of completed electrical facilities includes operational timing tests and tests to determine the quality of the wiring workmanship. Failures of the electrical equipment due to manufacturing defects generally occur within a few days of being placed in operation. Only close inspection and quality workmanship in splicing and attaching connections and grounds will prolong the life and reduce the maintenance of the signal system. Final checkout should be done in the presence of an appropriate member of the Traffic Bureau.

SECTION 618 – UNIFORMED OFFICERS AND FLAGGERS

618.1 – GENERAL

Uniformed officers and flaggers are used on highway projects to provide dynamic traffic control operations in work zones. While flaggers are authorized to direct traffic, uniformed officers have specific authority for operations above and beyond that of a flagger, such as assistance in speed control and traffic law enforcement as necessary.

A. Legal Sources

Legal sources for content in this section include the following items:

- State of New Hampshire, Title VII, Sheriffs, Constables, and Police Officers, Chapter 104, Sheriffs and Constables
- State of New Hampshire, Title XV, Education, Chapter 188–F – Community College System of New Hampshire [Police Standards and Training Council, § 188–F:23, Definitions]
- State of New Hampshire, Title XX, Transportation, Chapter 228 – Administration of Transportation Laws
- State of New Hampshire, Title XX, Transportation, Chapter 236 – Highway Regulation, Protection, and Control Regulations
- State of New Hampshire, Title XXI, Motor Vehicles, Chapter 265 – Rules of the Road [Obedience to and Effect of Traffic Laws; § 265:3–b, Obedience to Flagpersons, and § 265:4, Disobeying an Officer]
- Federal Highway Administration, currently adopted *Manual on Uniform Traffic Control Devices* (MUTCD)
- U.S. Government, Title 23 – Highways, Chapter I, Subchapter G, Part 630, Subpart K

B. Authority

The New Hampshire State Legislature has delegated the Commissioner of the Department of Transpiration with full authority to control traffic in highway and bridge construction work zones on Class I, II, and III highways.

Reference NH Statute: *RSA § 228:21 Powers* covers the authority exercised by the Commissioner, Deputy, and Assistant Commissioners, which includes "…general supervision, control and direction, on behalf of the state, over all matters pertaining to the location, route, alteration, construction, reconstruction, maintenance, and discontinuance of highways constructed or maintained wholly or in part by money appropriated from the state treasury."

Reference NH Statute: *RSA § 228:37 Closing Highways; Detours; Penalty* covers the Commissioner's authority to "…close, regulate, or restrict traffic over any section of any Class I, II or III highway or bridge thereon when the public welfare or necessity so requires or in order to perform work on any such highway or bridge by posting notices at each end of such section of highway…and no town shall be liable to any person for damages or injuries caused in whole or in part by the use of such highway or bridge when such notices are posted…"

Reference NH Statute: *RSA § 236:1 Regulation* covers the Commissioner's regulatory obligations regarding the use of "Class I, II, and III highways or bridges in towns or cities without compact sections and in other towns and cities outside the compact portion thereof as determined by him, including the use of rights–of–way."

C. Definitions

- Flagger

A Flagger is a person trained in flagger operations who actively controls the flow of vehicular traffic into and/or through a temporary traffic control zone using hand–signaling devices or an Automated Flagger Assistance Device.

Figure 600 – 34: Flagger– Traffic Control

Reference MUTCD Guidelines: *Chapter 6E: Flagger Control* outlines the flagger's required qualifications and responsibilities, including proper clothing, use of signaling devices, procedures, and stations.

- Uniformed Officer

  A uniformed officer is a certified law enforcement officer who has legal authority to enforce traffic laws on the roadways within the work zone.

- Dynamic Traffic Control

  Dynamic Traffic Control can be continuously adjusted to meet changing work zone needs and traffic demands. Dynamic Traffic Control may be at a fixed location or it may be mobile, and requires either human intervention or automated/intelligent electronic devices. Dynamic Traffic Control is typically implemented using uniformed officers and/or flaggers.

D. Purpose

The purpose of the Department's Uniformed Officers and Flaggers policy is to provide a safe work zone through the prudent and consistent use of uniformed officers and/or flaggers in dynamic traffic control operations and traffic law enforcement. This policy provides guidance and consistency statewide with regards to the use of uniformed officers and/or flaggers, while ensuring efficient use of construction funding.

Reference US Law: *23 CFR § 630.1106 – Policy and Procedures for Work Zone Safety Management* covers all aspects of work zone safety, including the provision that "…policy and processes, procedures, and/or guidance for the systematic consideration and management of work zone impacts […] shall include the consideration and management of road user and worker safety on Federal–aid highway projects."

E. Policy

It is the policy of the Department of Transportation to take appropriate measures to reduce the likelihood of injuries and/or fatalities to workers and road users in NHDOT work zones. The use of appropriately trained uniformed officers and/or flaggers for the purposes of dynamic traffic control, presence, enforcement, and emergency assistance will be part of the safety measures taken.

Flaggers will be the primary means for providing dynamic temporary traffic control operations in work zones. Uniformed officers will be utilized for their specific authority for operations beyond that of a flagger, such as assistance in speed control and traffic law enforcement as necessary. The use of uniformed officers and/or flaggers in work zones should be consistent with the *Flagger and Uniformed Officer Use in Work Zone Policy*.

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION POLICY	NUMBER 402.06
TITLE Flagger and Uniformed Officer Use in Work Zones	DATE 05/29/2009
SUBJECT Flagger and Uniformed Officer Use for Temporary Traffic Control and Safety	RESPONSIBLE BUREAU

Authority: The State Legislature has delegated the Commissioner of the Department of Transportation with full authority to control traffic in highway/bridge construction work zones on Class I, II, III highways; RSA 228:21, 236:1, and 228:37.

Definitions:

Flagger: A person trained in flagger operations who actively controls the flow of vehicular traffic into and/or through a temporary traffic control zone using hand-signaling devices or an Automated Flagger Assistance Device. (MUTCD 6E.01)

Uniformed Officer: A certified law enforcement officer who has the legal authority to enforce traffic laws on the roadways within the work zone.

Dynamic Traffic Control is traffic control that can be continuously adjusted to meet changing work zone needs and traffic demands. Dynamic Traffic Control can be at a fixed location or mobile and requires either human intervention or automated/intelligent electronic devices. Dynamic Traffic Control is typically implemented using flaggers and/or uniformed officers.

Purpose: The purpose of this policy is to provide a safe work zone through the prudent and consistent use of flaggers and/or uniformed officers in dynamic traffic control operations and traffic law enforcement. This policy provides guidance and consistency statewide with regards to the use of flaggers and uniformed officers, while ensuring efficient use of construction funding. This policy was initiated to comply with the requirements of the Federal Highway Administration, 23 CFR Part 630, Subpart K, 630.1106(c) Uniformed Law Enforcement Policy.

Policy: It is the policy of the Department of Transportation to take appropriate measures to reduce the likelihood of injuries and fatalities to workers and road users in NHDOT work zones. The use of appropriately trained flaggers and uniformed officers for the purpose of dynamic traffic control, presence, enforcement, and emergency assistance will be part of the safety measures taken.

Flaggers will be the primary means for providing dynamic temporary traffic control operations in work zones. Uniformed officers will be utilized for their specific authority for operations beyond that of a flagger, such as assistance in speed control and traffic law enforcement as necessary. The use of flaggers and uniformed officers in work zones is to be consistent with the *NHDOT Flagger and Uniformed Officer Use in Work Zones Guidelines.*

A Municipal Work Zone Agreement (MWZA) outlining the Department of Transportation's authority and responsibility for controlling traffic within the work zone is to be signed by each municipality as detailed in the *NHDOT Flagger and Uniformed Officer Use in Work Zones Guidelines* prior to construction of applicable project.

Responsibility: The Chief Engineer is responsible for the development, oversight and updating of the *NHDOT Flagger and Uniformed Officer Use in Work Zones Guidelines.*

Approved: Date: 6/5/09

George N. Campbell, Jr.
Commissioner

References: 23 CFR Part 630 Subpart K, RSA 228:21, RSA 236:1, RSA 228:37, RSA 188-F:23, RSA 265:3-b, RSA 265:4, MUTCD

A *Municipal Work Zone Agreement* (MWZA) outlining the Department of Transportation's authority and responsibility for controlling traffic within the work zone is to be signed by each municipality as detailed in the *NHDOT Flagger and Uniformed Officer Use in Work Zones – Guidelines* prior to the commencement of construction operations.

F. Responsibilities

The project's Chief Engineer is responsible for the development, oversight, and updating of the *NHDOT Flagger and Uniformed Officer Use in Work Zones – Guidelines*.

Note: Content in this section was originally disseminated in NHDOT Policy Number 402.06 by NHDOT Commissioner George N. Campbell, Jr., June 5, 2009.

618.2 – FLAGGER AND UNIFORMED OFFICER USE IN WORK ZONES – GUIDELINES

Flagger and uniformed officers must adhere to the policies and procedures specified in the NHDOT document *Flagger and Uniformed Officer Use in Work Zones – Guidelines*. This document was developed by the NHDOT in cooperation with FHWA in 2009 and revised in 2013. The guidelines provide parameters to help estimators during the design phase and Contract Administrators during the construction phase identify the appropriate need and consistent use of flaggers and/or uniformed officers.

The guidelines also provide an explanation for some of the processes that should be taking place prior the project being awarded, including the signing of a Municipal Work Zone Agreement by the municipality where the work is being performed. This Agreement either grants or acknowledges NHDOT's authority to control traffic in a work zone.

Through the contract language and Standard Specifications, the NHDOT then transfers this liability and responsibility to the Contractor, who shall set up the uniformed officer or flagging operation. If any traffic problems on the project occur, the Contract Administrator, or other NHDOT designated field representative, shall contact the Contractor's superintendent, who will make the necessary corrections or adjustments to the flagging operation.

Flaggers and law enforcement personnel, when used as a means to direct traffic within the construction zone, fall within the Commissioner's authority, particularly on Class I, II, and III roads. If the NHDOT is doing work on a Class IV, V, or VI highway, then a Municipal Work Zone Agreement should be established that formally delegates traffic control responsibility and liability to the NHDOT.

Reference NH Statute: *RSA 229.5 Classification of Highways* classifies New Hampshire highways as follows:

- Class I, Trunk Line Highways
- Class II, State Aid Highways
- Class III, Recreational Roads
- Class III–a, Boating Access Highway
- Class IV, Town and City Streets
- Class V, Rural Highways
- Class VI, Unmaintained Highways

The Commissioner shall follow the guidelines established in the currently adopted Federal Highway Administration's *Manual on Uniform Traffic Control Devices* (MUTCD) in exercising

their traffic control authority. The MUTCD provides a uniform and systematic treatment of highway conditions, including construction zones, on a nationwide basis. Such consistency has been found to be central to motorist safety.

Application of the MUTCD's principles requires familiarity with its widely accepted traffic engineering principles and doctrines. Proper utilization of its guidelines is crucial to meeting driver expectation on a statewide and national basis. Since motorists may find the loss of any consistency and uniformity to be dangerous, a unified traffic engineering approach under the Department of Transportation is one of the reasons why the legislature established these statutes.

Since any potential liability for state maintained roads rests with the Department pursuant to *RSA § 228:37 Closing Highways; Detours; Penalty*, interference with the established traffic control plan – that is, the flagger or uniformed officer – shall be regarded seriously. As the Commissioner's duly authorized representative in the field, the Contract Administrator shall address such interference immediately by working with the Contractor, the municipality, the municipality's police department, the District Construction Engineer, and/or the NHDOT Project Manager.

The Department's Project Managers are responsible for communicating traffic control intentions with the municipalities during the design phase. They must also ensure that any and all Municipal Work Zone Agreements are executed in advance of awarding the contract. Consequently, the Project Manager should be consulted to find out what type of discussions took place regarding traffic control, prior to meeting with the police department or municipality.

If it is determined and mutually agreed to by the Contract Administrator and Contractor that uniformed officer presence is required, the other area of jurisdictional contention or concern to be aware of is which police department should be hired.

The State Police have the requisite police power granted to them by the General Court per *RSA 106–B:12 Authority and Duties of Police Employees*.

Reference NH Statute: *106–B:12 Authority and Duties of Police Employees* states that "Police employees shall be ex–officiis constables throughout the state, shall patrol the highways, enforce the highway traffic laws and regulations, enforce the motor vehicle laws relative thereto and enforce regulations relative to the transportation of hazardous materials, pursuant to *RSA 106–B:15 [Jurisdiction of Police Employees]* and the director, division of state police, shall report to the director, division of motor vehicles, all violations of and prosecutions under the motor vehicle laws. Police employees shall have general power to enforce all criminal laws of the state and to serve criminal processes and make arrests, under proper warrants, in all counties. They shall not serve civil processes. No police employee shall act, be used or called upon for service within any town in any industrial dispute unless actual violence has occurred therein, and then only upon order of the governor. When any police employee shall apprehend any person who has committed or attempted to commit a felony the director shall immediately make a report to the attorney and the sheriff of the county in which the offense was, or was suspected of being, committed and such

cases shall be investigated and prosecuted by said county officials with the cooperation of said police employees."

Reference NH Statute: *RSA 106–B:15 Jurisdiction of Police Employees* states that "Police employees have jurisdiction on all turnpikes, toll roads and interstate highways and nothing in this section shall be construed to limit the authority of local police officers. A police employee shall not act within the limits of a town having a population of more than 3,000 or of any city, except when he witnesses a crime, or is in pursuit of a law violator or suspected violator, or when in search of a person wanted for a crime committed outside its limits, or when in search of a witness of such crime, or when traveling through such town or city, or when acting as an agent of the director of motor vehicles enforcing rules pertaining to driver licenses, registrations and the inspection of motor vehicles, or when requested to act by an official of another law enforcement agency, or when ordered by the governor. No criminal case shall be abated, quashed, or dismissed and no evidence in a criminal case shall be suppressed or excluded because a police employee has failed to comply with the jurisdictional limits of this section, provided, that the police employee had a good faith belief that he had authority to act when he acted."

State police employees have state–wide jurisdiction to patrol the highways and enforce highway traffic and motor vehicle laws, in addition to the general power to enforce all criminal laws of the state. County sheriff's deputies have statewide jurisdiction per *RSA 104:6, Powers*.

Reference NH Statute: *RSA 104:6, Powers*, which states that "I. Sheriffs and their deputies shall have throughout the state the same power and authority to serve criminal or civil processes, investigate crimes and to pursue and apprehend criminals that they have in their respective counties. II. Notwithstanding any law to the contrary, sheriffs and their deputies shall have authority to enforce civil orders issued by any court."

In order to minimize competition and friction between state and local police forces, *RSA 106–B:15 Jurisdiction of Police Employees* was written to limit state police jurisdiction. If possible, and in the best interest of the traveling public, the boundaries set forth by *RSA 106–B:15* should be honored. However, if the Department of Transportation so elects, it may legally establish a contractual preference requiring the use of state police employees on all state highway projects, including those located in cities or towns with populations exceeding 3,000 people.

The need to provide guidance to contractors, administrative convenience, or comity between state agencies are all sufficient to justify a requirement that state police employees be recognized as the primary source for uniformed traffic control officers on the job. Refer to the *Flagger and Uniformed Officer Use in Work Zones – Guidelines* for additional information.

Note: Information in this section is based on two legal opinion documents from New Hampshire's Department of Justice, Office of the Attorney General; the first, issued on

December 11, 1995 by Senior Assistant Attorney General Michael Walls is *Use of Uniformed Officers on Construction Projects;* the second, issued on December 30, 1996 by Senior Assistant Attorney General Mark Hodgdon is *Nottingham Project 11144, Jurisdiction over Traffic Control.*

- Uniformed Officer Training

  All uniformed officers working on all NHDOT funded projects, including those that are municipally managed, shall have successfully completed a NHDOT–approved course on *The Safe and Effective Use of Law Enforcement Personnel in Work Zones*. An NHDOT–approved course shall be taken once every four years.

  Approved training information may be found on the NHDOT's website at the following URL:

  http://www.nh.gov/dot/business/municipalities.htm.

  This training requirement should be discussed at the preconstruction meeting and as often as necessary throughout the duration of the project to help ensure that the officers who are on site are properly trained. A "Train–the–Trainer" course is offered by the New Hampshire Police Standards and Training Council (PSTC), as well as an online training course offered by the Response Network (TRN) at PoliceCommunity.net.

  Trainers who complete the required training by the Police Standards and Training Council are then qualified to train other officers. The online course offered by the Response Network is for officers who want to work the detail directly, but it is not for training additional officers.

  The NHDOT maintains a database for both the classroom and online training to facilitate tracking of officers who have received the training, and this database may be found on the intranet at the Construction Bureau's site . This database should be kept up to date, but in lieu of credentials from NHDOT, the officer or municipality must provide proof that they have been properly trained.

- Flagger Training

  All flaggers working on contract work for the NHDOT shall meet the flagger training conditions found in *Section 618 Uniformed Officers and Flaggers* of the Standard Specifications. Refer to *Subsection 618.3.1 Construction Requirements* for more information.

- Uniformed Officer Training and Reimbursement

  All uniformed officers working on contract work for the NHDOT shall meet the uniformed officers training conditions found in *Section 618 Uniformed Officers and Flaggers* of the Standard Specifications. Refer to *Subsection 618.3.5 Personal Requirements and*

Authority for more information. In addition, uniformed officers shall be reimbursed as specified in *Subsection 618.4.1 Method of Measurement.*

- Officers as Flaggers

Uniformed officers are not generally used for flagging purposes, but it is possible that an officer may perform flagging duties from time to time. If an officer is flagging, then they are required by the Department of Labor (NHDOL) and MUTCD to use a stop/slow paddle when stopping and releasing traffic. In no instance should hand signals or flags be used in lieu of paddles on a standard two–way road where traffic for the work zone activity is being "stopped and released" in only two directions.

An exception to the stop/slow paddle requirement may be at an intersection where traffic is coming from more than two directions. In these instances, a plan for safely directing traffic should be discussed in advance of the work commencing. Stop/slow paddles may be used at intersections with multiple approaches if it is determined that the safest or best plan is to assign flaggers at the various legs of an intersection.

SECTION 619 – MAINTENANCE OF TRAFFIC

619.1 – GENERAL

Traffic maintenance is the Contractor's responsibility, day and night, and it is the Contract Administrator's duty to see that this responsibility is properly discharged. The term "traffic maintenance" can be broad in meaning. Some examples may include grading and watering the roadway, constructing and maintaining small detours around work areas, setting up and taking down of temporary work signs to notify the public of upcoming traffic patterns, and the paving of cross–pipe patches.

The superintendent must be constantly aware of traffic maintenance and should anticipate potential trouble areas, taking necessary action to minimize inconvenience to the traveling public. The Contractor shall assign reliable personnel to this important and continuous part of the work.

At or shortly after the Pre–Construction Conference when the Contractor has a proposed schedule of operations, the type and number of signs required should be reviewed to anticipate what additional signs are needed. This need may change as the project progresses, but advance planning should result in the Contractor having them available when they are required.

Should the Contractor propose a revision to the traffic control plan, it should be formally presented in writing for approval. Depending on the scope of change, the District Construction Engineer can help make a determination of what level of review will be required. The Highway Design Bureau and/or Traffic Bureau may also need to review the traffic control plan prior to approval. All revisions to the traffic control plan must be approved prior to the work taking place.

Whether or not the original traffic control plan or a revised version is implemented, the Contract Administrator should continue to evaluate both the plan and operation as to its effectiveness to safely guide the traveling public through the project. If part of the traffic control plan is clearly not working as it was intended, then it should be revised. There are situations in which the planned traffic control plan may be improved upon based on field conditions that may not have been apparent at the time of its inception. Any and all changes made to the traffic control plan shall be documented.

The Contract Administrator must have the contact information (phone numbers, email addresses, etc.) of the Superintendent and their next–in–command. This contact information should be obtained at the pre–construction conference and maintained in the project field office for easy reference. A copy of the emergency contact information shall be forwarded to the Construction Bureau and the Traffic Management Center (TMC). Typically the Construction office sends this information to the TMC as part of the pre–construction meeting minute distribution, but this should be verified.

The superintendent should set up a system of recording pertinent data regarding damage to vehicles of the traveling public and all complaints.

All project personnel should be alert to criticisms and suggestions from the traveling public. Although some of these may be unwarranted, some will point out oversights or inadequacies in traffic maintenance. A review of the project during the night time hours is also suggested to assure 24–hour safety. Some Contract Administrators will have personnel from another project or even a member of their family drive through the project from time to time and offer their suggestions as to ways to improve drivability.

619.2 – MATERIALS

Permanent construction signage is a pay item, and is listed on the project plans by code number with the standard sheets displaying the respective signs. When signage and other traffic control items are delivered to the project, they should be inspected to verify that they are in good condition and they conform to the standards. Strict inventory must be kept to ensure that there are no shortages. Before paying for this item, the Contractor shall provide a Certificate of Compliance stating that traffic control devices being provided meet the testing and evaluation criteria of the National Cooperative Highway Research Program's *NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features*.

An important part of traffic maintenance is dust control. Calcium chloride provides a practical method of dust control on potentially dusty sections of construction areas open to traffic. Its use usually eliminates the nuisance and impediment to heavy traffic caused by water trucks interfering with traffic and eliminates the messy condition of a freshly watered surface that covers the cars and windshields with mud.

In order for calcium chloride to be effective immediately, it requires moisture from the air or ground. When the air is hot and dry, the ground surface should be moistened before the calcium chloride is applied. All necessary grading should be done before application, as the dust–controlling benefits are almost eliminated by re–grading.

If used, calcium chloride will be paid for as provided in *Subsection 109.04 Payment for Revisions to the Contract* of the Standard Specifications. Labor and equipment will be subsidiary.

619.3 – CONSTRUCTION OPERATIONS

Prior to the start of any construction, signs shall be erected at the beginning and end of the project work zone and at all important connecting roads. Consideration shall be paid to high traffic volumes, limited sight distances, highly populated areas, etc.

The location of signs and warning devices shall be as specified in the plans and Specifications or as designated by the Contract Administrator. The signs shall be erected prior to the beginning of all other work and not removed until all other items of the Contract are complete. Close attention must be paid to the sign layout to ensure no visibility conflicts occur with driveways, existing signing, or signals.

Before starting an operation that will change the flow of traffic or require a different highway maintenance operation, the superintendent should discuss the proposed construction signing with the Contract Administrator. The Specifications and the currently adopted *Manual on Uniform Traffic Control Devices* (MUTCD), cover the requirements and should be frequently consulted.

The Contract Administrator should ensure that the Contractor maintains and properly protects all construction signs necessary to properly warn and safeguard the traveling public. The Specifications require the Contractor to be responsible for proper signing on the project. A daily check should be made of the signs on the project and the Contractor is required to immediately set up or replace any which may have been knocked down or damaged.

When the sign packages are taken down at the end of the operation they should be removed completely from the roadway. Leaning signs against any barriers or guardrails in prohibited. If sign packages are set up every day in the same location then at the end of the operation they shall be laid down several feet outside the limits of the shoulders. Signs shall not be left on the shoulder, as this could be hazardous for a vehicle that leaves the travelled way, whether in error or deliberately.

Greatly reduced visibility due to darkness and fog may create problems that must be given special attention. Monitoring the project under these conditions will typically highlight any trouble spots with signage. Under severe or unusual weather conditions, signs may blow over, become covered with snow, or splashed with mud. Project personnel responsible for maintenance of traffic must verify that the signage is still properly deployed and displayed.

Accident locations and the occurrence of skid marks should be carefully reviewed for any indications of a problem that may not have been apparent otherwise.

The Contractor shall ensure the safety and convenience of any residents along the roadway who may be impacted by construction activities. Residents should receive timely notifications of any interruptions to their roadway access. Informed residents are more cooperative residents. In some cases, residents may require roadway access because of illness, a funeral, or a scheduled delivery, and the Department must make every effort to accommodate them with the least amount of interference.

The Traffic Bureau should be consulted for information regarding all aspects of signing from the project's beginning through to completion. The Traffic Bureau will provide essential services and materials, including pavement marking for detours and on temporary surfaces as well as approach signs and devices off the project.

"Real–Time" traffic information has become the norm for today's electronic–savvy motorists. With better dissemination of real–time information to the traveling public, the more informed they will be at making decisions prior to even entering NHDOT work zones. They may even choose an alternate route if they have all the information regarding current traffic conditions.

The Department has formalized this process on all Interstate Highway projects by implementing the Real–Time System Management Information Program (RTSMIP), otherwise known as the "**1201 Rule**." The details of this rule may be found in **Engineering Bulletin 14-001**. It basically establishes time frames in which lane closures and other traffic-impacting operations must be reported to the TMC for dissemination. It is extremely important that the requirements of this rule be fully complied with as this is a mandate from FHWA.

SECTION 622 – WITNESS MARKERS AND BOUNDS

622.1 – GENERAL

Witness markers are for directing highway maintenance crews to the location of drainage structures and small culverts that might otherwise be hidden in tall grass, under snow, or under water. Witness markers should be placed adjacent to the ends of culverts that have a diameter of less than 24 in, underdrain outlets, and basins that are outside of pavement and lawn areas.

Bounds are set to provide permanent reference points so that the roadway centerline and right–of–way lines can be located. The Contract Administrator should receive a set of right–of–way plans showing bound locations. The Contract Administrator should then make arrangements for a NHDOT survey crew to verify that the bound locations match what is shown on the general plans. The exact location for each bound will be established from reference stakes set by the survey crew, and the reference stakes shall not be removed until the position of the bound has been checked by the survey crew.

622.3 – CONSTRUCTION OPERATIONS

Boundary markers are usually precast concrete and are either buried flush in urban areas or left projecting 4 to 6 in above ground level. When a bound cannot be set because of its proposed location is not feasible, as in a watercourse, for example, this must be noted in the project record book and on the record plan. When a bound cannot be set, but a pin is set instead, the pin's location should also be noted in the project record book and on the record plans. The Contract Administrator shall check with Highway Design prior to making any field changes.

Figure 600 – 35: Precast Concrete Boundary Markers

SECTION 624 – RAILROAD PROTECTION

624.1 – GENERAL

This item is intended to pay for the installation of Railroad Protective Devices. The Contract will spell out the full requirements. The Contract Administrator should refer to *Subsection 104.07 Railway–Highway Provisions* of the Standard Specifications and the Special Provisions for additional railroad protection requirements.

624.3 – CONSTRUCTION OPERATIONS

When highway construction operations are carried out near or across railroad lines, NHDOT personnel will consult with the railroad company's Construction Engineers and/or Inspectors to coordinate all aspects of the work. Appropriate railroad personnel should have access to the work site and be afforded full cooperation in all matters pertaining to the construction. The Contract Administrator shall verify that all work performed on the railroad company's right–of–way by the Contractor is done in such manner as not to interfere with the movement and safety of railway traffic.

Figure 600 – 36: Railway Crossing

Shortly after the preconstruction conference, a separate meeting with the railroad company's Engineer should take place. The agenda should include the Contractor's work schedule, any falsework or cofferdam plans, and equipment proposed for use on the project. The railroad company's Construction Engineer shall verify that the railway line's standard clearances are maintained, that existing drainage conditions are not altered, and that any necessary changes to overhead or buried lines and signals are given due consideration.

SECTION 632 – RETROREFLECTIVE PAVEMENT MARKINGS

632.1 – GENERAL

Pavement markings are normally specified in the plans, and are reviewed by the Traffic Bureau. Pavement marking materials include traffic paint, glass beads, temporary and permanent tape, and preformed thermoplastic. The specifications for these items are reviewed and revised often, so the Contract Administrator should refer to the latest edition of the Standard Plans, the Supplemental Specifications, and the Special Provisions in the contract for current information.

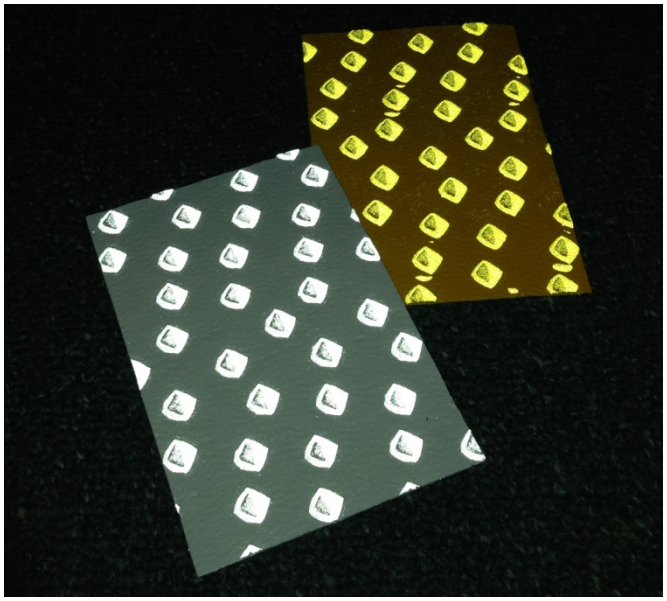

Figure 600 – 37: Wet Reflective Pavement Marking Examples

632.3 – CONSTRUCTION OPERATIONS

Pavement markings are "finishing touches" on the project and are highly visible. The quality of the overall job may be measured by the travelling public by the appearance of the pavement markers. All pavement marking locations should be carefully laid out; once installed, their position may not be adjusted. The majority of work that may affect the markings should be completed prior to final marking. The pavement should be clean and dry prior to installing markings.

Note: Improperly positioned pavement markings cannot be reset.

The pavement marking foreman should be fully apprised of the pavement marking plans before commencing work. The Bureau of Traffic should review the pavement marking layout prior to any striping application. The Traffic Control Plan should be discussed with all project personnel in specific regard to the pavement marking operations and minimizing traffic disruptions. Any

changes in the pavement marking layout should be approved by the Traffic Bureau and the District Construction Engineer, and be MUTCD compliant.

The Specifications indicate the method of measurement and tolerances for pavement markings along with their reflectivity values.

632.4 – PAVEMENT MARKER CHECKLIST

Using the following "memory jogger" checklist for installing pavement markings will result in proper placement.

- Standard Plan *PM–1*

  Passing zones shall always have the single broken line (dual passing) located on the right side of the construction center line when traveling South to North or West to East.

- Standard Plan *PM–2*

  The broken line layout shall be a 10 ft (± 2 in) stripe and a 30 ft (± 2 in) gap. Refer to *Subsection 632.3.1 General* for more information.

- Standard Plans *PM–3* & *PM-4*

  The edge line should match into the gore line. The travelway side of the markings shall match into each other.

  The edge (white) and median (yellow) line markings shall be offset a minimum of 2.5 ft from either the curb line or edge of pavement.

- Standard *PM–7*

  Tapering edge lines at 10:1 is only required on the departure and after an intersection when the shoulder is greater than 5 ft, unless shown on the plans.

  Stop bars shall end at the edge line or the edge of pavement in the absence of an edge line.

  Side road edge lines shall not be continued around a corner.

  Centerlines shall be continuous past residential driveways, but shall break at commercial drives with traffic controls (signals and stop signs), at minor side roads, and at intersections with turn lanes.

- Other Pavement Marking Considerations:
  - Pavement marking paint samples shall be submitted according to NHDOT Test Procedure C1. Refer to *Subsection 632.2.1 Traffic Paint* of the Standard Specifications for more information.

- Resurfacing projects Contractor shall provide detail drawings and videotape of the existing pavement markings to ensure the markings are reestablished. Refer to *Subsection 632.3.1.1.2* of the Standard Specifications for more information.
- Longitudinal and transverse lines shall be straight and true. Refer to Standard Plan PM–2 for specified tolerances and *Subsection 632.3.1.2* of the Standard Specifications for more information.
- Pavement markings shall be applied in one pass at the specified width. Refer to *Subsection 632.3.1.4* of the Standard Specifications for more information.
- Trucks used in pavement marking applications on the project are subject to annual inspection by the Bureau of Traffic. Refer to *Subsection 632.3.2.1.1* of the Standard Specifications for more information.
- The applied paint thickness for pavement markings shall be 20 mils. Reflective glass beads shall be applied at a rate of 8 lbs/gal of paint. Refer to *Subsection 632.3.2.4* and *Subsection 632.3.2.5* of the Standard Specifications for more information.
- 4 in wide traffic paint stripes with a thickness of 20 mils shall be applied at a rate of 240 ft /gal.
- 6 in wide traffic paint stripes with a thickness of 20 mils shall be applied at a rate of 160 ft /gal.

SECTION 641 – LOAM

641.1 – GENERAL

Loam application areas are normally specified in the plans, usually around bridges, interchanges, islands, and next to existing residential lawn areas.

641.3 – CONSTRUCTION OPERATIONS

Loam areas around homes should receive the necessary attention to render them attractive and have them blend well with existing lawns. Loam areas should be carefully graded and have a smooth transition from a roadway slope to a flat area that will not be scalped during mowing operations. The District Construction Engineer should approve any changes to planned loam areas.

Figure 600 – 38: Spreading Loam

SECTION 642 – LIMESTONE

642.1 – GENERAL

Soils in New Hampshire are normally somewhat acidic and top soil from forested land, swampy areas, and moss covered areas is likely to be the most acidic. Limestone is used to achieve a minimum pH of 5.5. The various seed mixtures that are normally used on NHDOT projects will all benefit from the application of limestone.

642.3 – CONSTRUCTION OPERATIONS

Application by mechanical spreader, except in small areas, will provide the most uniform coverage. Soil samples should be tested for their actual pH value which will assist in determining the limestone application rate. Refer to *Table 1 –Limestone Required to Raise Soil pH to a Minimum pH of 5.5* in *Section 642 Limestone* of the Standard Specifications for the appropriate application rate. Limestone applied at a rate of 2 tons/acre will give typically give the desired

result given NH's soil conditions. Pulverized limestone is generally absorbed quickly with short–lived effects, whereas a pelletized limestone takes longer to absorb, but will be of benefit for a greater length of time.

SECTION 643 – FERTILIZER

643.1 – GENERAL

Fertilizer will usually be used with the topsoil items and with plant materials.

643.3 – CONSTRUCTION OPERATIONS

Fertilizer may be applied by mechanical spreader, hydroseeder, or by hand. Large areas usually require application by mechanical spreader or hydroseeder. The proper amount of fertilizer in use should be verified with spot checks during application.

SECTION 644 – GRASS SEED

644.1 – GENERAL

Several factors influence the proper establishment of turf and grass. The most important factor is seed bed preparation, particularly on the heavier glacial tills where finishing operations tend to compact and plane the slope. The soil should be loose and friable, with a depth of 3 to 4 in. This will allow the grass seed's fine hair roots to penetrate the soil deep enough to establish themselves. The quantity and quality of topsoil used is another significant factor. Good topsoil supplies organic material, dormant seed, and soil micro–organisms as well as some of the nutrients required for plant growth.

644.2 – MATERIALS

Seeding materials stored on the job should be protected from moisture and rodents. Heat, fuels, and herbicides are detrimental to germination and any such contaminated or improperly stored seed should be rejected. The seed bag tag should be checked to verify that the proper seed mix for the project application is being used. At least one tag from the bag of each seed type should be retained for the project records.

644.3 – CONSTRUCTION OPERATIONS

The seed bed should be properly prepared. Refer to *Subsection 641.3.1 Construction Requirements* of the Standard Specifications for information regarding this operation. Seeding is normally performed with a hydroseeder, in which case the fertilizer is applied in the water along with the seed. The rate of seeding should be checked at the beginning of operations and spot checked thereafter by measuring the area seeded and the actual quantity of seed used, from which the rate of application can be calculated.

Seeds require moisture and warmth to promote germination. Consequently, in order to promote rapid growth, seeds should be sown during the time of year when these conditions are present. Sowing of the seeds in the spring of the year permits the development of turf during the immediate growing season. Seeds may be sown during the summer when a suitable mulch cover is provided to conserve moisture and to protect the seed from detrimental effects of the heat.

Generally, seeds require approximately 7 to 21 days for germination, depending on the species and weather conditions. Some species under favorable conditions may germinate sooner, but unfavorable conditions such as lack of moisture, or insufficient warmth tend to delay germination of all species.

Seeds should not be broadcast if winds prohibit the even distribution of the seed. Mechanical seeders should produce a satisfactory cover operated in one direction only. When seeding is by hand–operated devices, it should be done in two directions at right angles to each other. Light raking or other approved methods are required to cover the seed to the specified depth. Care should be taken to preserve proper seed distribution. Seeded loam should be subjected to light rolling only to set the seed without compacting the soil.

Some types of grass seed may be inoculated with beneficial bacteria before application. The bacteria assist in establishing a successful legume–bacterial symbiosis in the soil. Inoculated seed should stay in solution more than 30 minutes. Refer to *Subsection 344.3.1.4* of the Standard Specifications for information regarding the proper handling of seed inoculums and the procedure for application. The use of inoculated seed must be approved prior to application.

When loading a hydroseeder, the last material to add to the mixture should be the seed. Hydroseeding mixtures must be used within four hours. The hydroseeder should be thoroughly flushed with clean water at the end of each day's work.

Figure 600 – 39: Hydroseeding a Slope

SECTION 645 – EROSION CONTROL

645.1 – GENERAL

Severe erosion is caused by the action of wind, rainfall, and runoff on bare soil. Clearing, grading, and other construction activities remove the vegetation and compact the soil, increasing both runoff and erosion. Excessive runoff then causes gully erosion, increased stream bank erosion, and results in increased off–site erosion, sedimentation, and flooding problems. Effective erosion and sediment control can be achieved by careful attention to the following principles:

- Protect the land surface from erosion
- Manage runoff and keep velocities low
- Capture sediment on–site
- Integrate erosion and sediment control with the construction schedule
- Inspect and maintain the erosion and sediment control practices

The following are principles for controlling erosion and off–site sedimentation from construction sites:

- Schedule construction operations in order to minimize soil exposure during the rainy season.
- Minimize disturbance and soil exposure by retaining natural vegetation, adopting phased construction techniques, and using temporary cover.

- Vegetate and mulch all denuded areas to protect the soil from winter rains. The primary method for controlling sediment pollution from construction sites should be to minimize raindrop impact on bare soil.
- Utilize proper grading, barriers, or ditches to minimize concentrated flows and divert runoff away from denuded slopes or other critical areas.
- Keep the sediment on–site by utilizing sediment basins, traps, or sediment barriers.
- Monitor and inspect sites frequently to ensure that the measures are functioning properly and correct problems promptly.

645.2 – NPDES PERMIT REQUIREMENTS

Projects that disturb one or more acres of land will be subject to the conditions specified in the U.S. Environmental Protection Agency's (EPA) Construction General Permit issued on February 16, 2012. This Permit requires the Contractor to implement a range of erosion and sediment controls and pollution prevention measures to control the discharge of pollutants from construction sites. If applicable, refer to the Special Attention in your Contract concerning the Contractor's obligation relative to the National Pollutant Discharge Elimination System (NPDES) Storm Water Construction General Permit.

The Contractor and NHDOT are both required to use EPA's Notice of Intent (NOI) to prepare and submit an NOI for the project. Upon receipt of the completed Stormwater Pollution Prevention Plan (SWPPP), contact the Bureau of Environment at (603) 271–3226 to request an electronic submittal of the eNOI for the project.

Upon completion of a project covered under the EPA–issued Construction General Permit, the Contractor and the NHDOT are similarly responsible for submitting an electronic Notice of Termination (eNOT) form to the EPA.

645.3 – EROSION CONTROL STRATEGIES

There are many factors to consider in developing erosion control strategies for the project, including sequencing the erosion control measures, accounting for sensitive site conditions, slope stabilization, and controlling stormwater flow through the site.

A. Standard Erosion Control Sequencing Applicable to all Construction Projects

- Perimeter controls shall be installed prior to any earth moving operations. Perimeter controls and a stabilized construction exit shall be installed as shown in the BMP Manual and as directed by the SWPPP plan preparer.
- Erosion, sedimentation control measures, and infiltration basins shall be cleaned, replaced, and augmented as necessary to prevent sedimentation beyond project limits throughout the project duration.

- Erosion and sediment control measures shall be inspected in accordance with the Construction General Permit and *Section 645 Erosion Control* of the Standard Specifications.
- An area shall be considered stable if one of the following has occurred:
    - Base course gravels have been installed in areas to be paved.
    - A minimum of 85% vegetated growth has been established.
    - A minimum of 3 in of non–erosive material such as stone or rip–rap has been installed.
    - Temporary slope stabilization conforming to has been properly installed.
- All stockpiles shall be contained with a perimeter control. If the stockpile is to remain undisturbed for more than 14 days, mulching will be required.
- A water truck shall be available to control excessive dust at the direction of the Contract Administrator.
- Temporary erosion and sedimentation control measures shall remain until permanent vegetation has been established and approved by the ECS.
- Construction performed any time between November 30th and May 1st of any year shall be considered winter construction and shall conform to the following requirements:
    - All proposed vegetated areas which do not exhibit a minimum of 85% vegetative growth by both October 15th, or which are disturbed after October 15th, shall be stabilized in accordance with data found in tables in *Part K* of this subsection.
    - All ditches or swales which do not exhibit a minimum of 85% vegetative growth by October 15th, or which are disturbed after October 15th, shall be stabilized temporarily with stone or in accordance with data found in tables in *Part K* of this subsection.
    - After November 30th, incomplete road surfaces, where work has stopped for the season, shall be protected in accordance with data found in tables in *Part K* of this subsection.
    - Winter excavation and earthwork shall be done such that no more than one acre of the project is without stabilization at one time, unless a Winter Stabilization Plan has been approved by NHDOT.

B. Planning Activities to Account for Sensitive Site Conditions

- Clearly flag areas to be protected in the field and provide construction barriers to prevent trafficking outside of work areas.

- Construction shall be sequenced to limit the duration and area of exposed soils.
- Protect and maximize existing native vegetation and natural forest buffers between construction activity and sensitive areas.
- When work is to be performed in and near water courses, stream flow diversion methods shall be implemented prior to any excavation or filling.

C. Minimizing the Amount of Exposed Soil

- Construction operations shall be sequenced to limit the duration and area of exposed soils. Minimize the area of exposed soil at any one time. Phasing shall be used to reduce the amount and duration of soil exposed to the elements and vehicle tracking.
- Utilize temporary mulching or provide alternate temporary stabilization on exposed soils in accordance with data found in tables in *Part K* of this subsection.
- The maximum amount of disturbed earth shall not exceed a total of five acres from May 1st through November 30th, or exceed one acre during winter months, unless the Contractor demonstrates to the Department that the additional area of disturbance is necessary to meet the Contractor's Critical Path Method schedule (CPM), and the Contactor has adequate resources available to ensure that environmental commitments will be met.

D. Controlling Stormwater Flowing onto and through the Project

- Divert off site runoff or clean water away from the construction activity to reduce the volume that needs to be treated on site.
- Divert storm runoff from upslope drainage areas away from disturbed areas, slopes, and around active work areas and to a stabilized outlet location.
- Construct impermeable barriers as necessary to collect or divert concentrated flows from work or disturbed areas.
- Stabilize, to appropriate anticipated velocities, conveyance channels, or pumping systems needed to convey construction stormwater to basins and discharge locations.

E. Protecting Slopes

- Intercept and divert storm runoff from upslope drainage areas away from unprotected and newly established areas and slopes to a stabilized outlet or conveyance.
- Consider how groundwater seepage on cut slopes may impact slope stability and incorporate appropriate measures to minimize erosion.

- Convey stormwater down the slope in a stabilized channel or slope drain.
- The outer face of the fill slope should be in a loose ruffled condition prior to turf establishment. Topsoil or humus layers shall be tracked up and down the slope, disked, harrowed, dragged with a chain or mat, machine–raked, or hand–worked to produce a ruffled surface.

F. Establishing Stabilized Construction Exits

- Install and maintain construction exits, anywhere traffic leaves a construction site onto a public right–of–way.
- Sweep all construction related debris and soil from the adjacent paved roadways as necessary.

G. Protecting Storm Drain Inlets

- Divert sediment–laden water away from inlet structures to the extent possible.
- Install sediment barriers and sediment traps at inlets to prevent sediment from entering the drainage system.
- Clean catch basins, drainage pipes, and culverts if significant sediment is deposited.
- Drop Inlet Sediment Barriers should never be used as the primary means of sediment control and should only be used to provide an additional level of protection to structures and down–gradient sensitive receptors.

H. Soil Stabilization

- In areas adjacent to a wetland resource, all exposed soil areas shall be stabilized within three days.
- In all other areas, temporary soil stabilization measures should be applied within 14 days of achieving final grades or temporary suspension of work. Refer to data found in tables in *Part K* of this subsection for guidance on selecting temporary soil stabilization measures.
- A quick growing grass mix, such as annual or perennial ryegrass, shall be sown in all inactive construction areas that will not be permanently seeded prior to September 15th, of any given year, in order to achieve vegetative stabilization prior to the end of the growing season.
- Soil tackifiers may be applied in accordance with the manufacturer's specifications and reapplied as necessary to minimize soil and mulch loss until permanent vegetation is established.

I. Retaining Sediment On–site and Controlling Dewatering Practices

- Temporary Sediment Basins shall be sized to retain the volume of a 2–year 24–hour storm event on–site for areas under five acres of disturbance.
- Temporary sediment basins shall be sized to retain the volume of a 2–year 24–hour storm event and control a 10–year 24 hour storm event on–site for areas with more than five acres of disturbance.
- Construct and stabilize dewatering infiltration basins prior to any excavation that may require dewatering.

J. Additional Erosion and Sediment Control General Practices

- Use temporary mulching, permanent mulching, temporary vegetative cover, and permanent vegetative cover to reduce the need for dust control. Use mechanical sweepers on paved surfaces where necessary to prevent dust buildup. Apply water, or other dust inhibiting agents or tackifiers, as approved by the NHDES.
- All stockpiles shall be contained with temporary perimeter controls. Inactive soil stockpiles should be protected with soil stabilization measures (temporary erosion control seed mix and mulch, soil binder) or covered with properly anchored tarps.
- Erosion and sediment control measures shall be inspected in accordance with *Section 645 Erosion Control* of Standard Specifications, weekly and within 24 hours after any storm event greater than ½ in of rain per 24–hour period. Erosion and sediment control measures will also be inspected in accordance with the guidance memo from the NHDES contained within the contract proposal and the EPA Construction General Permit.
- Permanent stabilization measures shall be constructed and maintained in locations as shown on the construction plans. Vegetative stabilization shall not be considered permanently stabilized until plant growth covers at least 85% of the disturbed area. The contractor shall be responsible for temporary erosion and sediment control measures until all areas are permanently stabilized.
- Care shall be taken to ensure that sediments do not enter any existing catch basins during construction. The Contractor shall place temporary stone inlet protection over inlets in areas of soil disturbance that are subject to sediment contamination.
- Temporary and permanent ditches shall be constructed, stabilized and maintained in a manner that will minimize scour. Temporary and permanent ditches shall be directed to drain to sediment basins or storm water collection areas.

- Winter excavation and earthwork activities need to be limited in extent and duration, to minimize potential erosion and sedimentation impacts. The area of exposed soil shall be limited to one acre, or that which can be stabilized at the end of each day unless a winter construction plan, developed by a qualified engineer or a CPESC specialist, is reviewed and approved by the Department.
- Slopes steeper than 3:1 will receive turf establishment with matting or other temporary soil stabilization measures detailed in tables in *Part K* of this subsection. The contractor may also consider a soil binder in accordance with the NHDES approvals or regulations

K. Selecting Temporary Soil Stabilization Measures

The following tables specify the soil stabilization measures to be used for dry mulch, hydraulically applied mulch, and rolled erosion control blanket applications.

Selecting Temporary Soil Stabilization Measures (1)				
Dry Mulches				
Application Areas	HMT	WC	SG	CB
Slopes				
Steeper than 2:1	No	No	Yes	No
2:1 Slope	Yes	Yes	Yes	Yes
3:1 Slope	Yes	Yes	Yes	Yes
4:1 Slope	Yes	Yes	Yes	Yes
Winter Stabilization	4 tons/acre	Yes	Yes	Yes
Channels				
Low Flow Channels	No	No	No	No
High Flow Channels	No	No	No	No

Abbreviation	Stabilization Measure
HMT	Hay Mulch and Tack
WC	Wood Chips
SG	Stump Grindings
CB	Compost Blanket

Note: All slope stabilization options assume a slope length ≤10 times the horizontal distance component of the slope, in feet.

Selecting Temporary Soil Stabilization Measures (2)				
Hydraulically Applied Mulches				
Application Areas	HM	SMM	BFM	FRM
Slopes				
Steeper than 2:1	No	No	No	Yes
2:1 Slope	No	No	Yes	Yes
3:1 Slope	No	Yes	Yes	Yes
4:1 Slope	Yes	Yes	Yes	Yes
Winter Stabilization	No	No	Yes	Yes
Channels				
Low Flow Channels	No	No	No	No
High Flow Channels	No	No	No	No

Abbreviation	Stabilization Measure
HM	Hydraulic Mulch
SMM	Stabilized Mulch Matrix
BFM	Bonded Fiber Matrix
FRM	Fiber Reinforced Matrix

Note: All slope stabilization options assume a slope length ≤10 times the horizontal distance component of the slope, in ft.

Note: Products containing Polyacrylamide (PAM) shall not be applied directly to or within 100 ft of any surface water without prior written approval from the NH Department of Environmental Services.

Selecting Temporary Soil Stabilization Measures (3)				
Rolled Erosion Control Blankets				
Application Areas	SNSB	DNSB	DNSCB	DNCB
Slopes				
Steeper than 2:1	No	No	No	Yes
2:1 Slope	No	Yes	Yes	Yes
3:1 Slope	Yes	Yes	Yes	No
4:1 Slope	Yes	Yes	No	No
Winter Stabilization	Yes	Yes	Yes	Yes
Channels				
Low Flow Channels	No	No	Yes	Yes
High Flow Channels	No	No	No	Yes

Abbreviation	Stabilization Measure
SNSB	Single Net Straw Blanket
DNSB	Double Net Straw Blanket
DNSCB	Double Net Straw–Coconut Blanket
DNCB	Double Net Coconut Blanket

Note: All slope stabilization options assume a slope length ≤10 times the horizontal distance component of the slope, in feet.

Note: All erosion control blankets shall be made with wildlife–friendly biodegradable netting.

645.4 – BEST MANAGEMENT PRACTICES FOR STRUCTURES

A. Construction Specifications for Surface Roughening

- Roughen slopes to form shallow grooves by normal tilling, disking, harrowing, or use of a cultipacker–seeder. Make the final pass of any such tillage on the contour.
- Make grooves formed by such implements no more than 10 in apart and not less than 1 in deep.
- Refrain from excessive surface roughening where mowing is planned.
- Limit surface roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.

- Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back–blade during the final grading operation.
- Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.

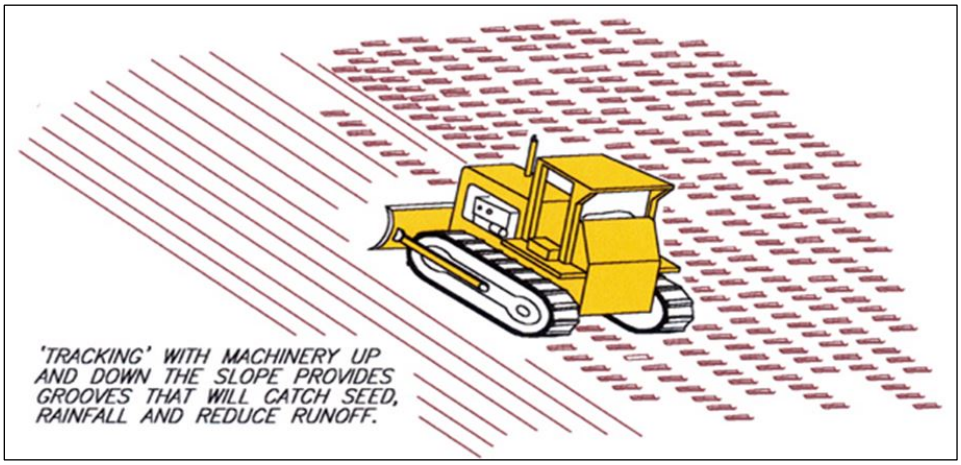

Figure 600 – 40: Surface Roughening on Slope by Tracking

B. Construction Specifications for Temporary Gravel Construction Exits

- The aggregate size for construction of the pad shall be 2 to 3 in stone. The gravel shall be placed to the specific grade and dimensions shown on the plans, and then spread smooth.
- The thickness of the pad shall not be less than 6 in. Geotextile fabrics shall be used, if necessary, to improve the stability of the foundation in locations subject to seepage or a high water table.
- The width of the pad shall not be less than the full width of all points of egress and shall not be less than 12 ft wide. The length of the pad shall be as required, but not less than 50 ft
- Locate construction exits to limit sediment leaving the site and to provide for maximum utility by all construction vehicles. Entrances that have steep grades and that occur at curves in public roads shall be avoided.
- All sediment spilled, dropped, washed, or tracked onto the public right–of–way shall be immediately removed.
- Drainage shall be provided to carry water to a sediment trap or other suitable outlet.
- When necessary, wheels shall be cleaned to remove sediment prior to entrance onto the public right–of–way. When washing is required, it shall be done on an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin.

- All sediment shall be prevented from entering any storm drain, ditch, or watercourse through use of sand bags, gravel, straw bales, or other approved methods.

C. Inspection and Maintenance of Temporary Gravel Construction Exits

- The gravel pad shall be maintained in a condition to prevent mud or sediment from leaving the construction site.
- Gravel material shall be replaced when surface voids are filled.
- Any structure used to trap sediment shall be inspected after each rainfall and cleaned out as necessary.
- Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.
- Any sediment deposited on paved roadways shall be removed within 24 hours.

D. Construction Specifications for Slope Drains

- A common cause of slope drain failure is water saturating the adjacent soil and seeping along the pipe. Proper backfilling around and under the pipe haunches with stable soil material and hand compacting the backfill in 6 in lifts to achieve firm contact between the pipe and the soil at all points will reduce this type of failure.
- Place slope drains on undisturbed soil or well–compacted fill at locations and elevations shown on the SWPPP plans.
- Slightly slope the section of pipe under the dike toward its outlet.
- Ensure that all slope drain connections are watertight.
- Ensure that all fill material is well–compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 ft apart.
- Extend the drain beyond the toe of the slope and adequately protect the outlet from erosion.

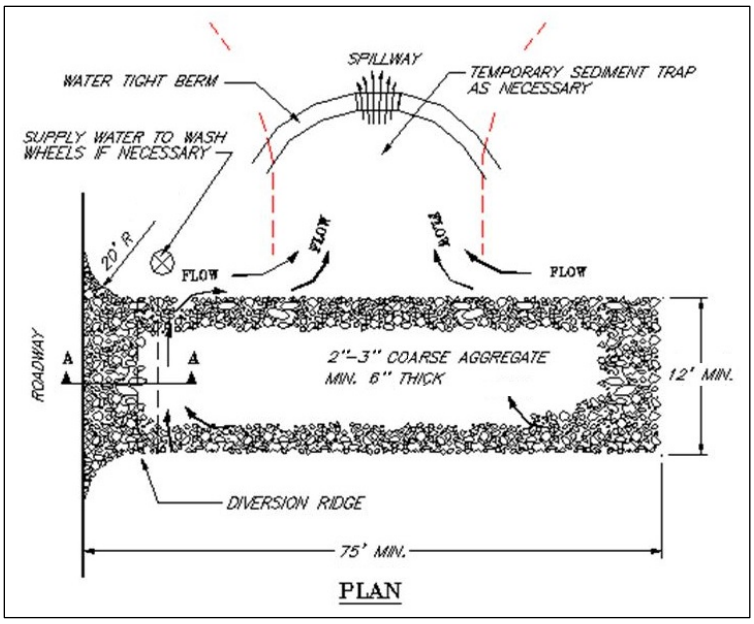

Figure 600 – 41: Slope Drain (Plan View)

E. Maintenance of Slope Drains

Inspect the slope drain and supporting diversions after every significant rainfall and promptly make necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas properly stabilized.

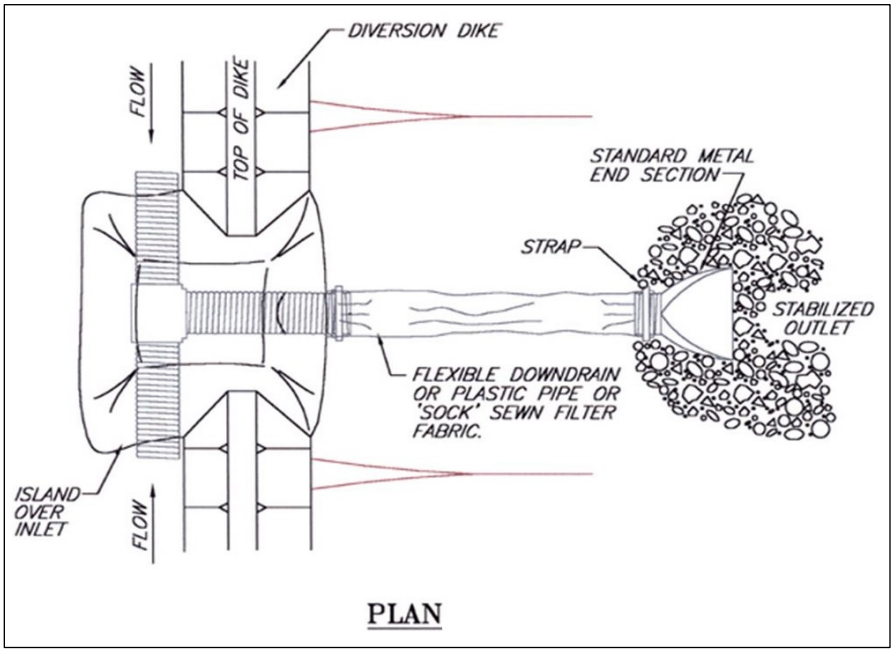

Figure 600 – 42: Slope Drain with Diversion Dike and Flexible Downdrain (Plan View)

F. Construction Specifications for Waterbars

- Waterbars should be installed as soon as the right–of–way has been cleared and graded.
- Waterbars should be built at an angle of 45° to 60° from the centerline.
- The diversion should have a minimum positive grade of 2%.

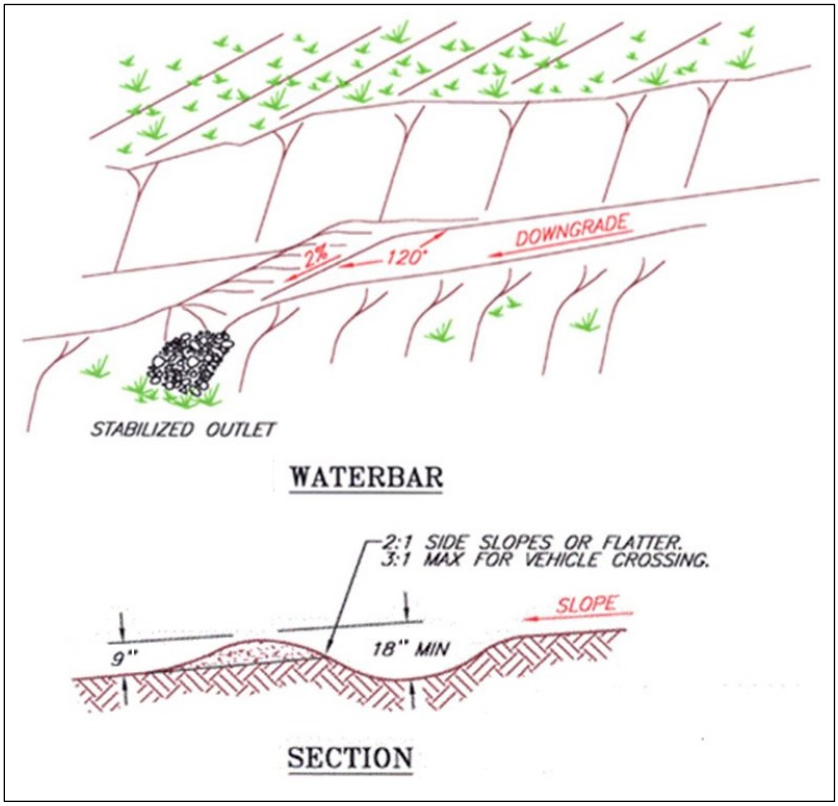

Figure 600 – 43: Waterbar Configuration

G. Inspection and Maintenance of Waterbars

- Periodically inspect waterbars and after every heavy rainfall for erosion damage. Immediately remove sediment from the flow area.
- Check outlet areas and make timely repairs as needed.

H. Construction Specifications for Sediment Basins with Skimmer Outlets

- A skimmer will control filling and draining of the basin and help to utilize the surface area and volume to create conditions that will maximize sedimentation.
- Basin size should be determined for the entire catchment to the basin, not just the disturbed area. The skimmer drains the entire basin, so that sediment will dry out for removal.
- Maximize surface area; shallow depth maximizes trapping efficiency and keeps sediment away from the skimmer.

- Excavate a shallow pit under the skimmer to catch sediment, so up–and–down movement is not restricted.
- The skimmer must settle down level so that trash does not flow under the bottom edge of the float.
- Outflow from the skimmer will still be turbid, so dispersing the outflow into a wooded or vegetated buffer is recommended for additional treatment.
- Provide positive drainage through the skimmer and the pipe through the dam so that ice does not form and clog the pipe.
- Skimmer outlets should be either a 4 in Schedule 40 pipe through the dam (where there is no riser) or a 4 in Schedule 40 connection on the riser.
- Instead of a riser and barrel, a spillway lined with fabric can be used in appropriate locations.
- Baffles are necessary for proper sediment trapping efficiency, and to keep sediment away from the skimmer – they are not optional.
- Use common sense in baffle placement to allow sediment removal without damaging the baffles.
- A minimum orifice diameter of ½ in is recommended to avoid clogging.

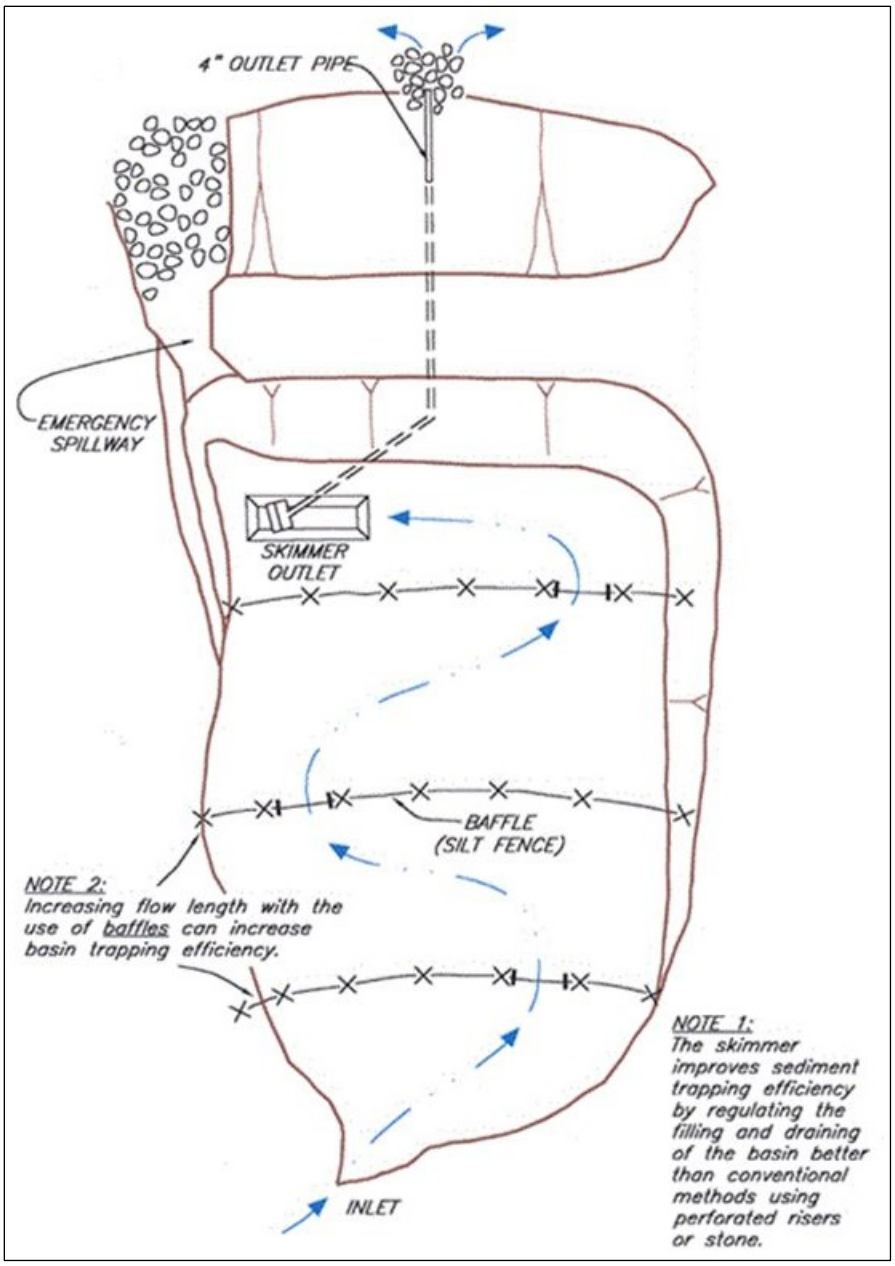

Figure 600 – 44: Sediment Basin with Skimmer Outlet

Source: Erosion Draw 5.0 Software, by Salix Applied Earthcare [www.erosiondraw.com]

645.5 – SOIL EROSION AND WATER POLLUTION CONTROL CHECKLIST

Verify that the following items being considered and are adequate protective measures being taken during construction.

Soil Erosion and Water Pollution Control Checklist (1)	
Item	Protective Measure
1. Control Clearing And Grubbing	Keep the exposed erodible area to a minimum; Only the clearing and grubbing area is needed for immediate grading
2. Construct Sedimentation Basin	Construct prior to grading; Control grading so runoff will first enter basin
3. Job Access And Haul Roads	Control drainage at top of roadway; Locate so runoff does not discharge into stream or drainage
4. Interceptor and Toe–Of–Slope	Construct early and protect adjacent private property
5. Provide Positive Drainage in Cuts	Crown surface of cut and install side ditches
6. Crown–Berm–Drain Embankments	Visibly crowned – earth berms with periodic slope drains; Provide drainage through “windows”
7. Cut to Fill Slope Drainage	Require temporary drain as embankment is built; Use stone, pipe, or hose
8. Early Slope Treatment	Grade and treat cut slopes as cut is made; Embankment slopes no later than subgrade
9. Ditch Treatment/Ditch Lines	Pave or line immediately after ditch excavation; Treat slopes as soon as ditch is excavated; Install check dams in ditch lines to slow water velocity
10. Use Drainage Structures	Make sure ditch grade meets inlet grate; Install lining at inlet
11. Uncompleted Drainage	**Prohibited**! Complete the installation and provide adequate inlet and outlet protection
12. Drainage Outfall Treatment	Ensure that temporary treatment is provided before water is discharged; Dumped stone, hay bales
13. Ditch Transitions and Junctions	Build up far side of ditch and carry far enough downstream

Soil Erosion and Water Pollution Control Checklist (2)	
Item	Protective Measure
14. Temporary Stream Crossings	Maintain full channel width; Use granular backfill (stone, if available); Provide adequate cross drainage
15. Temporary Stream Diversions	Locate to keep velocity at a minimum; Consider erosion of new channel and treat if necessary
16. Median Stream Drainage	Slope median back from stream or construct sedimentation dam or basin; Treat slopes early
17. Stockpiling	Keep stockpiles away from the stream
18. Borrow Pits – Disposal Sites	Require proper grading and drainage; Treat slopes to restore growth; Check haul roads
19. Work and Storage Area	Prohibit discharge of pollutants into the stream; Sedimentation basins or special treatment may be required
20. Stage Construction	Provide means for temporary drainage; Ensure all erodible areas are treated

SECTION 646 – TURF ESTABLISHMENT

646.1 – GENERAL

This item is normally used to establish turf on construction projects. The work consists of preparing the soil and furnishing and applying the specified seed types, fertilizers, limestone, mulch, and tackifiers. The project personnel should refer to the Specifications and requirements for more information regarding turf establishment operations.

646.3 – CONSTRUCTION OPERATIONS

Turf Establishment is usually specified by designers rather than separate items such as seed, fertilizer, limestone, etc. This item is paid for by the square yard or acre and the Contractor is obligated by the contract to return to the site if for some reason the seeded areas do not establish acceptable growth. This does not relieve the Contract Administrator from verifying that that the proper dosages of seed, fertilizer, limestone, etc. are administered per the Specifications. This should include spot checks to count fertilizer and limestone bags and verifying that the proper seed mixture is being used.

SECTION 647 – HUMUS

647.1 – GENERAL

Humus is dark, organic material that forms in soil when plant and animal matter decays. Humus is normally used on all earth slopes that are not loamed. Areas to receive humus should be dressed and the humus spread as soon as possible after completion of earthwork in those areas. All areas to be seeded shall be prepared to provide a reasonably firm but friable seed bed. Sloped areas shall not be left excessively smooth; the surface shall be left in a ruffled condition such as may be produced by the use of tracked vehicles running up and down the slope. This will allow the erosion control measures of seeding and mulching to proceed and a root growth to be established in the least amount of time.

Note: Humus should be collected on–site from roadway excavation and embankments before going outside the project to obtain it.

SECTION 648 – SOD

648.1 – GENERAL

Sod is an item that is well covered by the Specifications.

The following checklist may be useful in the field.

Before sodding, verify the following:

- All sodding materials are approved
- Sod is in good condition and has not been stored for too long
- Areas to be sodded are properly shaped and tilled
- Fertilizer and lime are applied as required

During sodding, verify the following:

- Sod is kept moist and is not damaged by handling
- Sod strips are laid in the proper direction
- Sod is placed with close joints
- Sod is properly tamped into place
- Sod placed in drainage channels and on steep slopes is properly secured with pegs, staples, or matting

After sodding, verify the following:

- Sod is kept moist until rooted

- Pegs and staples are driven flush with the surface

Figure 600 – 45: Sodding a Slope

SECTION 650 – PLANTING

650.1 – GENERAL

Many projects contain some form of landscape treatment including the planting of trees, shrubs, vines, or other forms of ground cover. Occasionally there may be stand–alone landscape project. In either case, the design of these treatments originates from the Bureau of Highway Design's Roadside Development Section.

The Construction Bureau supplements these efforts with two Landscape Specialists whose main function is to assist the Contract Administrators with any plantings on their projects. The Contract Administrator should contact one of these specialists as soon as the project begins so they have an opportunity to review the plans and also so they have it on their schedule. The Landscape Specialist also acts as a liaison between the Contract Administrator and the Roadside Development Section.

Although landscaping may offer an aesthetically pleasing aspect to the project, more often than not it is included in the project for a specific purpose. The Contract Administrator should by no means eliminate, move or relocate any plantings without the consent of Roadside Development and the Landscape Specialist. The plantings could be part of an environmental commitment or possibly a barrier to block glare from on–coming traffic. Whatever the reason, it may not be readily apparent and for that reason should be left to professionals in the field of horticultural practices.

650.2 – MATERIALS

The Contract Administrator shall have the Landscape Specialist inspect all the plant material that is to be incorporated into the finished project and verify the following conditions:

- The plant materials should have no damaged tips, no damaged bark on the main stem, and no damaged root systems.
- Deciduous trees with damaged tips may be salvaged by pruning if the amount pruned is not extensive and the natural shape is not harmed; pruning about 20% of live wood is desirable at the time of planting.
- Balled and burlapped plant material should be properly handled to ensure that the root ball is not penetrated and the roots are not exposed to air.
- If medium and large size plant varieties are delivered to the project with bare roots, bundled in moss or a similar moisture–retentive material, they should be heeled into a temporary trench with earth covering the roots if they are not scheduled to be planted for more than 48 hours after delivery.
- Root systems must be kept moist at all times, with particular attention paid to the fine feeder roots which will quickly die with exposure to wind and sun.

650.3 – CONSTRUCTION OPERATIONS

Some varieties of plant materials can be successfully transplanted from the wild, especially when small, but in general, nursery stock is preferred. Landscape Specialists should be consulted when any questions arise about planting operations. The Roadside Development Section may also be contacted for further advice and assistance.

Figure 600 – 46: Tree Plantings

Planting operations should be conducted at the proper time, as timing is critical for the success and the survival of the plants. The Contractor shall schedule the planting operations in such a way that the plantings will be done at optimal time of year for the particular plants, but this may not always be possible due to any number of unforeseen circumstances.

SECTION 658 – TRANSPLANTING PLANT MATERIAL

658.3 – CONSTRUCTION OPERATIONS

Transplanting of plant materials often requires more careful treatment than planting from nursery stock. Medium and large trees and shrubs that have been growing undisturbed for many years may have a large extensive root system requiring a much larger ball of earth and roots than normal. Also, these transplanted materials require careful watering for some time in their new location. Consideration should be given to the new locations for the plant materials as changes from dry to damp and light to shade etc., may prove unsatisfactory for some plants. Where questions arise about transplanting, the Landscape Specialists should be consulted.

SECTION 693 – TRAINING PROGRAMS

693.1 – ON–THE–JOB TRAINING PROGRAM (OJT)

The primary objective of the On–the–Job Training (OJT) program is to provide training and skills upgrading to project personnel, including minorities and women, towards the attainment of journey–level status. Contract Administrators shall actively support this objective when performing the tasks described in this subsection.

Contractors must complete the *OJT Program Enrollment Form* prior to the OJT trainee beginning work and submit it to the NHDOT Office of Federal Compliance. If the Contract Administrator receives this form directly from the contractor, it should be forwarded to the External EEO Coordinator in the Office of Federal Compliance. The Contract Administrator should retain a copy of the enrollment form, with the assigned work classification, for the project record.

Each Friday, Contractors must submit a "Weekly Trainee Report" for each OJT trainee directly to the Contract Administrator. The Contract Administrator must review, sign and forward all Weekly Trainee Reports no later than Monday following the report week. A copy of the report should be retained by the Contract Administrator to calculate progress payments for training.

Periodically, the Contract Administrator shall observe the OJT trainee to ensure the trainee is performing functions that are related to the selected work classification. The Contract Administrator should contact the External EEO Coordinator with any concerns regarding the OJT trainee; e.g., work attendance, job performance, or other compliance issues. The Contract Administrator will assist the Federal Compliance Officer and/or the External EEO Coordinator in facilitating on–site interviews with OJT trainees.

Refer to *Division 800 Record Book* and *Section 693 Training Programs* of the Standard Specifications for more information.

SECTION 698 – FIELD FACILITIES

698.1 – GENERAL

The Specifications and Special Provisions sufficiently cover the requirements for the Field Office and the Physical Testing Laboratory. These specifications will vary greatly depending on the size and location of the project.

The fireproof file cabinet should be used for all project records and left locked every night.

Required equipment and toilet facilities should be in operating condition prior to payment on estimates. The field office computer shall also be complete and fully functional. The Contractor shall make arrangements for the installer to connect with the Construction Bureau Office through the CMS Administrator and verify that all hardware and software are operating optimally.

Inventories should be taken of laboratory equipment when the facility arrives on the project and again upon departure. This inventory should be filed with the Contract records. No payment should be made on field facilities and the Contractor should not be allowed to start earthwork until all equipment specified in *Section 698 Field Facilities* of the Standard Specifications or Special Provision Addenda is complete.