PIPELINE RIGHT-OF-WAY CONSTRUCTION PROJECTS

AGRICULTURAL MITIGATION
THROUGH THE STAGES OF PROJECT PLANNING,
CONSTRUCTION/RESTORATION AND FOLLOW-UP MONITORING

By
New York State
Department of Agriculture and Markets
Albany, New York

Rev. 11-97
NYS DEPT. OF AGRICULTURE AND MARKETS

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1.0 INTRODUCTION

The following agricultural mitigation standards are designed to apply to transmission pipelines that affect agricultural land. These standards and practices apply to the early planning stage of the project through construction, restoration, and post-construction monitoring and rehabilitation. The specific details regarding “Agricultural and Soil Conservation Specialists/Inspectors”, in addition to the traditional environmental specialists, apply to projects of significant length or projects of relatively moderate length, but which affect proportionally significant or unique areas of agricultural resources.

These standards and practices for construction, cleanup and restoration of agricultural lands are for mineral soils only and, therefore, do not pertain to organic muckland soils. The New York State Department of Agriculture and Markets (Ag & Markets) recommends avoidance-routing around agricultural organic muckland soils. When this is not possible, project-specific development and implementation of agricultural mitigation techniques will be needed. The project sponsor's representatives should contact Ag & Markets during preliminary planning for such sites.
2.0 PLANNING

2.1 AGRICULTURAL AND SOIL CONSERVATION SPECIALIST/INSPECTOR

The Project Sponsor must retain a qualified Agricultural and Soil Conservation Specialist/Inspector (Agricultural Specialist) on each work spread for each phase: Environmental Management and Construction Plan (EM&CP) development, construction, initial restoration, post-construction monitoring and follow-up restoration. The Agricultural Specialist will submit site-specific agricultural information for EM&CP development to the Project Sponsor. This information will be obtained through field review as well as direct contact with affected farm operators, County Soil and Water Conservation Districts, Ag & Markets and others. The Agricultural Specialist will maintain regular contact with the Spread Environmental and Engineering Coordinators and appropriate on-site Project Inspectors throughout the construction phase. The Agricultural Specialist also maintains regular contact with the affected farmers and County Soil and Water Conservation Districts concerning farm resources and management matters pertinent to the agricultural operations and the site-specific implementation of the EM&CP. The Project Sponsor will consult with Ag & Markets at the same time they submit a request for an EM&CP modification concerning agriculture.

2.2 EM&CP MAPS

The Project Sponsor will provide on the general EM&CP plan maps the information described below concerning agricultural areas/uses.

2.2.1 Type of Agricultural Land and Facilities

A. Pasture/Grazing
   1. Unimproved grazing areas (brushy or wooded land used by livestock)
   2. Permanent open pasture (land devoted only to pasture use, not suited to tillage rotation)
   3. Improved pasture (including tillable rotation pasture/hayland)
   4. Livestock fencelines

B. Cropland
   1. Hayland
   2. Rotation cropland
   3. Long-term cropland (also includes agricultural lands enrolled in either the annual set-aside or the Conservation Reserve Program of the U.S.D.A. Consolidated Farm Service Agency). Such lands will be identified through consultation with the offices of the Consolidated Farm Service Agency and the County Soil and Water Conservation District.

C. Unique Agricultural Lands (Avoidance routing strongly recommended)
   1. Specialty cropland (vegetables, berries, etc.)
2. Orchard
3. Vineyard
4. Maple Sugarbush
5. Organic Muckland
6. Permanent Irrigation systems

2.2.2 Vulnerable Agricultural Soils

Vulnerable agricultural soils are defined as areas of cropland, hayland, or pasture which are somewhat more highly sensitive than other agricultural soils to construction disturbance due to slope, relative soil wetness, and/or shallowness to bedrock. Wetness conditions are the result of factors such as landscape position, soil texture, seasonal water table and/or slowly permeable subsoil horizons (e.g., areas of laterally draining subsoils). All vulnerable agricultural soils including, but not limited to, those identified in the county soil survey as fragipans, lacustrines, dense basal tills, soils with a seasonally high water table, or soils with less than 5 feet of depth to bedrock are to be located and identified on the project map using the following codes:

A. “VE” (designate the general area of vulnerability of erosion due to R-O-W factor(s) of slope and/or the texture of exposed soil).

B. “V/W” (designate the general area of vulnerability to soil horizon wetness as described above).

C. “V/B” (designate the general area of vulnerability due to shallow depth to bedrock).

D. “V/OR” (designate the location of unavoidable organic mucklands).

2.2.3 Other Features

In addition, the Project Sponsor will provide the following information on the general EM&CP maps:

A. Land and Water Management Features
   1. Subsurface drainage area (indicate each field)
   2. Open Ditch
   3. Diversion Terrace
   4. Buried water lines (farmstead consumptive use)
   5. Water source (developed springs, etc.)
   6. Unnamed water flow

B. Depth of cover if it varies from the agricultural standard (refer to 2.7).

C. Any off right-of-way access roads, work or storage areas. Map all such areas identified at the time of the EM&CP submission indicating their proposed locations and the location and size of all culverts to the extent
required. Any other areas that may be identified during construction will be considered and filed as a change in the EM&CP.

D. The proposed location of any compressor stations, valve stations, metering and regulating stations and any other proposed facilities. Agricultural areas should be avoided when siting any above ground facilities.

E. General locations for trench breakers, including a notation of the distance between breakers based on percent of slope, or an appended generic chart of trench breaker spacing by degree or percent of slope.

F. General locations for subsurface intercept drains to control soil saturation and/or aid trench breakers in minimizing water piping, based on the vulnerable agricultural soils data (see Section 2.2.2) and site monitoring. Such locations will generally coincide with “V/W” vulnerable agricultural soils and breaks in slopes.

2.3 DOCUMENTATION OF IMPLEMENTATION PROCEDURES

The Project Sponsor will explain in the EM&CP narrative how the respective features of agricultural-related mitigation will be included in the contractual specifications or otherwise be carried out. The narrative will describe the method by which the Project Sponsor's staff and the contractor's field supervisors will be trained on the agricultural mitigation plan, which includes management criteria and designed standards and practices.
2.4  CHERRY TREE VEGETATION

The Project Sponsor will identify Black Cherry trees located on the right-of-way near active livestock use areas during EM&CP development. Black Cherry tree vegetation is toxic to livestock when cut and wilted and shall not be stockpiled in areas accessible to livestock. During the clearing phase, such vegetation will be disposed of in a manner which eliminates contact with livestock.

2.5  TRENCH CROSSINGS

The open trench will be fenced and temporary livestock and farm equipment crossings (or trench plugs) will be provided where requested and/or needed, by the farm owner/operator.

2.6  UNDERLAYMENT FOR ROCK/GRAVEL FILL

Where access ramps are required from the highway to the pipeline construction area in agricultural fields, an underlayment of durable, geotextile matting will be placed over the exposed subsoil surface prior to the use of temporary gravel access fill material. All such material will be removed upon completion of the project. The use of durable, geotextile matting as an underlayment helps prevent rock and stone from becoming embedded in the subsoil material. Complete removal of the ramp upon completion of the project and restoration of the impacted site is required prior to topsoil replacement.

2.7  DEPTH OF COVER

2.7.1  Cropland, Hayland and Improved Pasture

In cropland, hayland and improved pasture a minimum depth of forty-eight inches of cover will be required; except where the new pipeline is located parallel and adjacent to an older existing pipeline that was buried with less than forty inches of cover. If such a situation occurs, a minimum depth of forty inches of cover will be required.

2.7.2  Unimproved Pasture

In unimproved grazing areas and land permanently devoted to pasture, a minimum depth of thirty-six inches of cover will be required.

2.7.3  Areas of Shallow Soil

In areas where the depth of soil over bedrock ranges from zero to forty-eight inches, the pipe shall be buried entirely below the top of the bedrock or at the depth specified for the particular land use (see 2.7.1 and 2.7.2), whichever is less. At no time will the depth of cover be less than twenty-four inches below the soil surface. All variances from this will be clearly stated in contract documents, construction drawings, or detailed drawings for special areas or crossings.
2.8 DRAIN LINE ALLOWANCE OF DEPTH

In existing agricultural fields where future surface and subsurface drainage plans have been identified by the owner/occupant or are on file with the Soil and Water Conservation District prior to EM&CP development, the Project Sponsor will provide adequate cover over the pipe to allow the future installation of major header drains and main drains across the right-of-way without obstruction due to the burial depth of the pipeline. It will be the responsibility of the Ag Specialist to determine the required elevations of the pipeline for clearance between the bottom of future drain systems and the top of the pipeline. Deviations to the standard depth of cover as detailed in section 2.7 will be specified in the EM&CP.

2.9 SUBSURFACE DRAIN REPAIR

During preparation of the EM&CP, a detailed drainage line repair procedure will be developed for the repair of crushed/severed clay tile and plastic drain lines. The procedure will be developed by the Ag Specialist in consultation with the local Soil and Water Conservation District. Specific drawings showing the generic technique to be implemented for drain line repairs will be provided by the Project Sponsor. The plan for the replacement of functional stone drainage systems severed during pipeline construction shall be prepared during the restoration phase by the Agricultural Specialist, in consultation with Ag & Markets and/or the Soil and Water Conservation District.

2.10 ALTERNATIVE GRAZING PLANS

The Ag Specialist(s) will work with the farm operators during the planning phase to develop a plan to delay the pasturing of the right-of-way, following construction, until pasture areas are adequately revegetated. The Project Sponsor will be responsible for maintaining the temporary fences on the right-of-way until the Ag Specialist determines that the vegetation on the right-of-way is established and able to accommodate grazing. At such time, the Project Sponsor will be responsible for the removal of the fences.
3.0 CONSTRUCTION/RESTORATION

3.1 CONTROL OF TRENCH WASHOUTS, WATER PIPING AND BLOWOUTS

Trench breakers are installed for the dual purpose of preventing trench washouts during construction and abating water piping and blowouts subsequent to trench backfill. The distance between permanent trench breakers may range from the relatively close-spaced formula of the toe of the upper trench breaker being level with the head of the lower trench breaker to the relatively greater spacing as detailed on the sample drawing “TRENCH BREAKER SPACING” or on the sample chart “PERMANENT SLOPE BREAKER SPACING”. The Project Sponsor will record each installed trench breaker location, by map referenced station-number.

3.2 TOPSOIL PROTECTION

In all agricultural portions of the right-of-way, topsoil will be removed from the subsoil stockpile area, trench, construction assembly and traffic zones. The depth of topsoil removal will include all of the “A” horizon down to the beginning of the subsoil "B" horizon, generally not to exceed a maximum of 12 inches. Topsoil removal up to a depth of 16 inches will be required in specially designated soils encountered along the pipeline route and identified in the EM&CP. All topsoil will be stockpiled and separated from other excavated materials. The Agricultural Specialist will determine depth of topsoil stripping per affected farm during EM&CP development by means of the County Soil Survey and on-site soil augering, if necessary. All topsoil material will be stripped, stockpiled, and uniformly returned to restore the original soil profile. During the clearing/construction phase, site specific depths of topsoil stripping will be monitored by the Agricultural Specialist. Where right-of-way construction requires cut-and-fill of the soil profile across grades, to the extent practicable, topsoil stockpiling will be located on the upslope edge of the right-of-way. Where topsoil cannot be seperately stored on the upslope side, suitable right-of-way space will be provided on the downslope side to ensure the complete segregation of the topsoil from all cut-and-fill material.

Right-of-way width for agricultural lands will generally be the maximum necessary to allow adequate space for traffic, the trench and construction area, and the separate stockpiles of both topsoil and spoil material. Except in special conditions, such as road and stream crossings that may require a greater working area, the temporary right-of-way construction width should range from a minimum of 80 feet for a 12 inch diameter pipeline\(^1\), to a maximum of 125 feet for a 36 inch diameter line. In projects using the relatively wide trenching method to meet construction worker safety requirements, a proportionally wider right-of-way will be temporarily acquired.

\(^1\) The term “minimum” refers to the absolute minimum width of the temporary construction right-of-way, under the very best of working conditions: that is, a level farmcape on deep, well drained soil. An 80 feet width, however, is not adequate as the initial, “available width” through farmlands with mild, rolling or moderately steep slopes, nor on soils that are less than well drained or shallow to bedrock. In those situations, the minimum available width of temporary construction right-of-way should be 90 feet. This allows for the inherent cut-and-fill grading; the drift of wet subsoil muds/spoil materials; and the special concerns of shallow bedrock soils, without jeopardizing the protection of the stockpiled topsoil materials. Certain site-specific conditions may accommodate the farmland protection in a slightly narrower space, leaving some of the temporary right-of-way unused. Nevertheless, the availability of the 90 feet for the construction of a 12 inch pipeline should be provided for the temporary periods of construction and restoration.
3.3 SUBSOIL PROTECTION (SHALLOW SOILS)

Construction through farm soils dominated by a shallow depth to bedrock can result in a significant loss of, or permanent damage to, the subsoil or “B” horizon and corresponding damage to the soil profile, regardless of the measures employed to protect the topsoil (“A” horizon) material. The structure and thickness of the thin layer of remaining subsoil over bedrock can be adversely impacted as a result of grading, construction traffic and trench excavation as well as backfilling that involves bedrock material. The actual need for subsoil protection, as well as the method to be employed, must be based on project-specific factors including the diameter of the pipeline to be constructed, the site-specific depth to bedrock and the thickness of the subsoil. Among the construction phase measures that may help to minimize damages are:

- Stripping and seperately stockpiling the “B” horizon of the right-of-way for a depth of 12 inches or to the top of the bedrock, whichever is shallower; or, stripping and seperately stockpiling the “B” horizon from the full top width of the trench and spoil pile zone.

- Removing excavated bedrock materials from the site at the time of excavation.

- Backfilling the work trench with imported subsoil material.

3.4 BLASTING REQUIREMENTS

In agricultural areas of till over bedrock which requires blasting, the Project Sponsor will use matting or controlled blasting to limit the dispersion of blast rock fragments. Farm owners/operators will be given timely notice prior to blasting on farm property.

3.5 SUPPLEMENTAL BACKFILL MATERIALS

In agricultural areas where the materials excavated during trenching are insufficient in quantity to meet backfill requirements, the soil of any agricultural land adjacent to the trench and construction zone will not be used as either backfill or surface cover material. Under no circumstances will any topsoil material be used for pipe padding material or trench backfill. In situations where imported soil materials are employed for backfill on agricultural lands, such material shall be of similar texture to the existing soils on site.

In order to satisfy agricultural restoration requirements, a portion of a farm's non-cropland may, in some specific instances, be considered as an alternative source of imported soils.

3.6 BACKFILL PROFILE AND TRENCH CROWNING

In areas of cropland, including rotation hayland, permanent hayland and improved pastureland, ripped or blasted bedrock or concentrated volumes of excavated stone or rock material may be used for backfill, but no closer than twenty four (24) inches in mesic soils nor thirty (30) inches in frigid soils from the exposed working construction surface of the right-of-way. (To determine
the temperature regime of the soil, consult the U.S.D.A. Natural Resources Conservation Service, formerly S.C.S.). All excess rock not utilized as trench backfill will be hauled away. The remaining backfill materials will consist of suitable subsoil over the rock fill material. Trench crowning will occur during the backfill operation of the construction phase, using subsoil materials over the trench to allow for trench settling. The stockpiled topsoil will be spread over the entire affected right-of-way, after the initial ripping of the exposed subsoil and the rock cleanup has been completed. In areas where trench settling occurs after topsoil spreading, imported topsoil will be used to fill each depression. Topsoil from the right-of-way or from adjacent agricultural land will not be used to backfill depressions.

3.7 SUBSOIL RIPPING, STONE REMOVAL, TOPSOIL COVER AND SUBSOIL SHATTERING

In all agricultural sections of the right-of-way where topsoil is stripped, the Project Sponsor shall break up the exposed construction surface subsoil with deep tillage by such devices as a deep-ripper or heavy duty chisel plow. Following the deep ripping and chiseling, all stone and rock material four inches and larger in size which has been lifted to the surface shall be collected and taken off site for disposal. Upon approval of the subsoil decompaction and the stone removal by the Agricultural Specialist, the topsoil that has been temporarily removed for the period of construction shall then be replaced. Finally, deep subsoil shattering shall be performed with a subsoiler tool having angled legs. Stone removal shall be completed, as necessary, to eliminate any additional rocks and stones brought to the surface as a result of the final subsoil shattering process. Due to the generally unsuitable weather for continuing agricultural land restoration in late autumn, subsoil decompaction and topsoil replacement activities shall not be performed after October 1, unless approved on a site-specific basis by the certifying agency and Ag and Markets in consultation with the Agricultural Specialist.
4.0 TWO YEAR MONITORING AND REMEDIATION

The Project Sponsor will provide a monitoring and remediation period of no less than two years immediately following the full-length activation of the pipeline or the completion of initial right-of-way restoration, whichever occurs last. The two year period allows for the effects of climatic cycles such as frost action, precipitation and growing seasons to occur, from which various monitoring determinations can be made. The Project Sponsor will maintain a project work spread Agricultural Specialist on at least a part-time basis through this period. The monitoring and remediation phase will be used to identify any remaining agricultural impacts associated with right-of-way construction that are in need of mitigation and to implement the follow-up restoration.

4.1 GENERAL MONITORING AND REMEDIATION

General right-of-way conditions to be monitored include topsoil thickness, relative content of rock and large stones, trench settling, crop production, drainage and repair of severed fences, etc. Impacts will be identified through on site monitoring of all agricultural areas along the right-of-way and through contact with respective farmland operators and County Soil and Water Conservation Districts.

Topsoil deficiency and trench settling shall be mitigated with imported topsoil that is consistent with the quality of topsoil on the affected site. Excessive amounts of rock and oversized stone material will be determined by a visual inspection of the right-of-way and periodic probes of the trench area. Results will be compared to portions of the same field located outside of the right-of-way. Included in the determination of relative rock and large stone content is the right-of-way’s condition subsequent to farm plowing/tillage and the relative concentration of such materials within the right-of-way as compared to off the right-of-way. All excess rocks and large stones will be removed and disposed of by the Project Sponsor.

On site monitoring shall be conducted at least three times during the growing season and shall include a comparison of growth and yield for crops on and off the right-of-way. When the subsequent crop productivity within the affected right-of-way is less than that of the adjacent unaffected agricultural land, the Agricultural Specialist, in conjunction with the Project Sponsor as well as other appropriate organizations, will help to determine the appropriate rehabilitation measures for the Project Sponsor to implement. During the various stages of the project, all affected farm operators will be periodically apprised of the duration of remediation by their respective work spread Agricultural Specialist. Because conditions which require remediation may not be noticeable at or shortly after the completion of construction, the signing of a release form prior to the end of the remediation period will not obviate the Project Sponsor’s responsibility to fully redress all project impacts. After completion of the specific remediation period, the Project Sponsor will continue to respond to the reasonable requests of the farmland owner/operators to correct project related affects on the impacted agricultural resources.

4.2 SPECIFIC MONITORING AND REMEDIATION
4.2.1 Compaction Testing and Remedial Action

After the moisture of the soil profile on the affected right-of-way has returned to equilibrium with the adjacent off right-of-way land, subsoil compaction will be tested using an appropriate soil penetrometer or other soil compaction measuring device. Compaction tests will be made for each soil type identified on the affected agricultural fields. The subsoil compaction test results within the right-of-way will be compared with those of the adjacent off right-of-way portion of the affected farm field/soil unit. Where representative subsoil density on the right-of-way exceeds the representative subsoil density outside the right-of-way, additional shattering of the soil profile will be performed using a deep, angled-leg subsoiler tool. Deep shattering will be applied during periods of relatively low soil moisture to ensure the desired mitigation and to prevent additional subsoil compaction. Oversized stone/rock material which is uplifted to the surface as a result of the deep shattering will be removed. In the event that subsequent construction or clean-up activities result in new compaction, additional deep tillage will be performed to alleviate such compaction.

4.2.2 Control of Soil Saturations and Seeps

For lands disturbed within or adjoined to agricultural areas where the construction alters the natural stratification of soil horizons and natural soil drainage patterns, the Project Sponsor will rectify the effects with measures such as subsurface intercept drain lines. Selection of the type of intercept drain lines to install to prevent surface seeps and the seasonally prolonged saturation of the backfilled trench zone and adjacent areas will be performed by a qualified Agricultural Specialist. Drawings of such drain locations will be provided by the Project Sponsor during monitoring and follow-up remediation. All drain lines will be installed according to Natural Resource Conservation Service (formerly SCS) standards and specifications.

4.3 COMMUNICATION ACCESS

The Project Sponsor will provide all farm owners/operators with a telephone number to facilitate direct contact with the Project Sponsor and the project's Agricultural Specialist(s) through all of the stages of the project, including operation and maintenance.
REPAIR OF SEVERED TILE LINE

Void between plastic drainage tubing and rigid support pipe to be sealed with plastic reducer or approved equal.

Perforated, corrugated steel asphalt-coated support pipe.

Natural Ground.

Existing Tile Drain.

Install insert coupling into each end of existing tile and attach length of plastic drain tubing through support pipe.

Backfill to be tamped in 6 in. layers beneath and around corrugated pipe.

End of pipe to bear on undisturbed soil for a min. of 3 feet, measured perpendicular from the wall of the trench.

<table>
<thead>
<tr>
<th>Tubing size</th>
<th>Corrugated pipe size</th>
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<tbody>
<tr>
<td>4”</td>
<td>6”</td>
</tr>
<tr>
<td>6”</td>
<td>8”</td>
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<tr>
<td>8”</td>
<td>10”</td>
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</tr>
<tr>
<td>12”</td>
<td>18”</td>
</tr>
<tr>
<td>18”</td>
<td>20”</td>
</tr>
</tbody>
</table>

NOTES:
1. All corrugated pipe to be 16 gauge steel.
2. Plastic drain tubing and corrugated pipe to be installed so the holes are centered on each side of the bottom of the pipe.
3. All material to be contractor supplied.
4. The perforated rigid support pipe is shouldered back into the firm, undisturbed soil profile to ensure consistent gravity flow gradient of the tile line across the trench as the backfill material gradually settles for up to two years.

SAMPLE
A-5
NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SUBSURFACE DRAIN
(Ft.)

CODE 606

DEFINITION
A conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water.

PURPOSE
• Improve the soil environment for vegetative growth, reduce erosion, and improve water quality by:
  ◦ Regulating water table and ground water flows,
  ◦ Intercepting and preventing water movement into a wet area,
  ◦ Relieving artesian pressures,
  ◦ Removing/reducing surface runoff,
  ◦ Leaching of saline and sodic soils,
  ◦ Serving as an outlet for other subsurface drains, and
  ◦ Regulating sub-irrigated areas or waste disposal areas.
• Collect ground water for beneficial uses.
• Remove water from heavy use areas, such as around buildings, roads, and play areas; and accomplish other physical improvements related to water removal.
• Regulate water to control health hazards caused by pests such as flukes, flies, or mosquitoes.

CONDITIONS WHERE PRACTICE APPLIES
This standard applies to areas having a high water table where the benefits of lowering the water table or controlling ground water or surface runoff justify installing such a system.

This standard applies to areas suitable for the intended use after installation of required drainage and other conservation practices. The soil shall have enough depth and permeability to permit installation of an effective and economically feasible system.

In areas where an outlet is available, either by gravity flow or by pumping, the outlet shall be adequate for the quantity and quality of effluent to be discharged.

CRITERIA
Subsurface Drain design and construction shall comply with all applicable federal, state and local laws and regulations.

Conservation practice standards are reviewed periodically, and updated as needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

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The design and installation shall be based on adequate surveys and investigations.

**Capacity.** One or more of the following shall determine the required capacity:

- Application of a locally tried and proven drainage coefficient to the acreage drained, including added capacity required to dispose of surface water entering through inlets.
- Yield of ground water based on the expected deep percolation of irrigation water from the overlying fields, including the leaching requirement.
- Comparison of the site with other similar sites where subsurface drain yields have been measured.
- Measurement of the rate of subsurface flow at the site during a period of adverse weather and ground water conditions.
- Application of Darcy’s law to lateral or artesian subsurface flow.
- Estimates of lateral or artesian subsurface flow.

**Size.** The size of subsurface drains shall be computed by applying Manning’s formula. The size shall be based on the required capacity and computed by using one of the following assumptions:

1. The hydraulic gradeline is parallel to the bottom grade of the subsurface drain with the conduit flowing full at design flow.
2. The conduit flowing partly full where a steep grade or other conditions require excess capacity.
3. Conduit flowing under pressure with hydraulic gradeline set by site conditions on a grade that differs from that of the subsurface drain. This procedure shall be used only if surface water inlets or nearness of the conduit to outlets with fixed water elevations permit satisfactory estimations of hydraulic pressure and flows under design conditions.

All subsurface drains shall have a nominal diameter that equals or exceeds 3 inches.

**Depth, Spacing, and Location.** The depth, spacing, and location of the subsurface drain shall be based on site conditions, including soils, topography, ground water conditions, crops, land use, outlets, and saline or sodic conditions.

The minimum depth of cover over subsurface drains in mineral soils shall be 2 feet. This minimum depth shall apply to normal field levels and may exclude sections of line near the outlet sections laid through minor depressions where the conduit is not subject to damage by frost action or equipment travel.

The minimum depth of cover in organic soils shall be 2.5 feet for normal field levels, as defined above, after initial subsidence. Structural measures shall be installed if it is feasible to control the water table level in organic soils within the optimum range of depths.

Heavy duty corrugated plastic drainage tubing shall be required for all installations in New York State with the following exception: When a sand and gravel filter envelope is used, standard tubing sizes 3", 4", 5", 6", and 8" may be used.

The maximum depth of cover for standard duty corrugated plastic tubing shall be 10 feet for trench widths of 2 feet or less (measured at tubing and to 1 foot above top of tubing). Heavy-duty tubing shall be specified for depths greater than 10 feet, trench widths more than 2 feet, or in rocky soils.

For computation of maximum allowable loads on subsurface drains, use the trench and bedding conditions specified and the crushing strength of the kind and class of drain. The design load on the conduit shall be based on a combination of equipment loads and trench loads. Equipment loads are

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based on the maximum expected wheel loads for the equipment to be used, the minimum height of
cover over the conduit, and the trench width. Equipment loads on the conduit may be neglected when
the depth of cover exceeds 6 feet. Trench loads are based on the type of backfill over the conduit, the
width of the trench, and the unit weight of the backfill material. A safety factor of not less than 1.5
shall be used in computing the maximum allowable depth of cover for a particular type of conduit.

Minimum Velocity and Grade. In areas where sedimentation is not a hazard, the minimum grades
shall be based on site conditions and a velocity of not less than 0.5 feet per second (ft/s). If a hazard
exists, a velocity of not less than 1.4 ft/s shall be used to establish the minimum grades if site
conditions permit. Otherwise, provisions shall be made for preventing sedimentation by use of filters
or by collecting and periodically removing sediment from installed traps, or by periodically cleaning the
lines with high-pressure jetting systems or cleaning solutions.

Maximum Velocity without Protection. Design velocities shall not exceed those given in Table 1
unless special protective measures are installed.

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Velocity, ft/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand and sandy loam</td>
<td>3.5</td>
</tr>
<tr>
<td>Silt and silty loam</td>
<td>5.0</td>
</tr>
<tr>
<td>Silty clay loam</td>
<td>6.0</td>
</tr>
<tr>
<td>Clay and clay loam</td>
<td>7.0</td>
</tr>
<tr>
<td>Coarse sand or gravel</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Maximum Grade and Protection. On sites where topographic conditions require that drain lines be
placed on steep grades and design velocities will be greater than indicated in Table 1, special
measures shall be used to protect the conduit or surrounding soil. These measures shall be specified
for each job according to the particular conditions of the job site.

The protective measure shall include one or more of the following:
1. Enclose continuous perforated pipe or tubing with fabric-type filter material. A fabric filter shall not
   be used when the silt fraction (0.05 mm to 0.002 mm) in the soil around the conduit is 40 percent or
greater.
2. Use non-perforated continuous tubing, a watertight pipe, or seal joints.
3. Place the conduit in a properly graded sand and gravel envelope or blinding with the least erodible
   soil available.
4. Select rigid butt end pipe or tile with straight, smooth sections and square ends to obtain tight fitting
   joints.
5. Wrap open joints of the pipe or tile with tar impregnated paper, burlap, or special fabric-type filter
   material.
6. Install open-air risers for air release or entry.

Iron Ochre Control. If drains are to be installed in sites where iron ochre and manganese dioxide
problems are likely to occur, provisions should be made to allow access for cleaning the lines. Each
drain line should outlet directly into an open ditch and/or should have entry ports as needed to provide
access for cleaning equipment. Drain cleaning provisions should be installed in such a way that the
drains can be cleaned in an upstream or rising grade direction. If possible, drains in ochre-prone

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areas should be installed during the dry season when the water table is low and the iron and manganese dioxide is in its insoluble form.

Where possible, in areas where the potential for such problems is high, protection against their development can be provided by designing an outlet facility to ensure permanent submergence of the drain line.

Protection against Root Clogging. Problems may occur where it is necessary to place drains in close proximity to perennial vegetation. Roots of water-loving trees, such as willow, cottonwood, elm, and soft maple, or some shrubs and grasses growing near subsurface drains may enter and obstruct the flow.

Where possible, use non-perforated tubing or closed joints through the root zone area. Where this is not possible, water-loving trees should be removed from a distance of at least 100 feet on each side of the drain. A distance of 50 feet should be maintained from other species of trees except for fruit trees. Orchards can often be drained by drain lines located close to the fruit trees.

Where crops and grasses may cause trouble on drain lines, facilities may be installed to provide a means for submerging the line to terminate the root growth as desired or to maintain a water table above the drain lines to prevent growth into the system.

Materials. Subsurface drains include conduits of plastic, clay, concrete, bituminized fiber, metal, or other materials of acceptable quality.

The conduit shall meet strength and durability requirements for the site. All conduits shall meet or exceed the minimum requirements of the appropriate specifications published by the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), or the American Water Works Association (AWWA).

Foundation. If soft or yielding foundations are encountered, the lines shall be stabilized and protected from settlement by adding gravel or other suitable materials to the trench, by placing the conduit on a treated plank that will not readily decompose or on other rigid supports, or by using long sections of perforated or watertight pipe having adequate strength to ensure satisfactory subsurface drain performance. The use of a flat treated plank is not recommended for corrugated plastic tubing.

Filters and Filter Material. Filters will be used around conduits, as needed, to prevent movement of the surrounding soil material into the conduit. The need for a filter will be determined by the characteristics of the surrounding soil material, site conditions, and the velocity of flow in the conduit. A suitable filter should be specified if:

1. Local experience indicated a need.
2. Soil materials surrounding the conduit are dispersed clays, silts with a plasticity index less than 7, or fine sands with a plasticity index less than 7.
3. Deep soil cracking is expected, or
4. The method of installation may result in voids between the conduit and backfill material.

If a sand-gravel filter is specified, the filter gradation shall be designed in accordance with National Engineering Handbook (NEHR) Part 833, Chapter 26, Grading Design of Sand and Gravel Filters.

Specified filter material must completely encase the conduit so that all openings are covered with at least 3 inches of filter material except that the top of the conduit and side filter material may be covered by a sheet of plastic or similar impervious material to reduce the quantity of filter material required. In all cases the resulting flow pattern through filter material shall be a minimum of 3 inches.

Artificial fabric or mat-type filter materials may be used, provided that the effective opening size, strength, durability, and permeability are adequate to prevent soil movement into the drain throughout the expected life of the system.

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**Envelopes and Envelope Material.** Envelopes shall be used around subsurface drains if they are needed for proper bedding of the conduit or to improve the characteristics of flow of ground water into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but they must not contain materials that will cause an accumulation of sediment in the conduit or that will render the envelope unsuitable for bedding of the conduit.

Envelope materials shall consist of sand-gravel, organic, or similar material. Sand-gravel envelope materials shall all pass a 1.5-inch sieve; not more than 30 percent shall pass a No. 60 sieve; and not more than 5 percent shall pass the No. 200 sieve. ASTM-C-33 fine aggregate for concrete has been satisfactorily used and is readily available.

Where organic or other compressible materials are used, they shall be used only around a rigid wall conduit and above the centerline of flexible tubing. All organic or other compressible material shall be of a type that will not readily decompose.

**Placement and Bedding.** The conduit should not be placed on exposed rock or stones more than 1.5 inches in diameter for 5 inch or larger tile and stones no more than 1/8 inch diameter for tile less than 6 inches. Where such conditions are present the trench must be over-excavated, a minimum of 6 inches and refilled to grade with a suitable bedding material.

The conduit must be placed on a firm foundation to ensure proper alignment. Prevent runoff and surface water from entering the trench.

If installation will be below a water table or where unstable soils are present, special equipment, installation procedures, or bedding materials may be needed. These special requirements may also be necessary to prevent soil movement into the drain or plugging of the envelope if installation will be made in such materials as quicksand or a silt slurry.

For trench installations of corrugated plastic tubing 8 inches or less in diameter, one of the following bedding methods will be specified:

1. A shaped groove or 90° V-notch in the bottom of the trench for tubing support and alignment.
2. A sand-gravel envelope, at least 3 inches thick, to provide support.
3. Compacted soil bedding material beside and to 3 inches above the tubing.

For trench installations of corrugated plastic tubing larger than 8 inches, the same bedding requirements will be met except that a semi-circular or trapezoidal groove shaped to fit the conduit will be used rather than a V-shaped groove.

For rigid conduits installed in a trench, the same requirements will be met except that a groove or notch is not required.

All trench installations should be made when the soil profile is in its driest possible condition in order to minimize problems of trench stability, conduit alignment, and soil movement into the drain.

For trench installations where a sand-gravel or compacted bedding is not specified, the conduit should be blinded with selected material containing no hard objects larger than 1.5 inches in diameter. Blinding should be carried to a minimum of 3 inches above the conduit.

All installations shall meet the minimum requirements of the appropriate ASTM specification.

**Auxiliary Structures and Protection.** Structures installed in drain lines must not unduly impede the flow of water in the system. Their capacity must be no less than that of the line or lines feeding into or through them. The use of internal couplers for corrugated plastic tubing will be allowed.

If the drain system is to carry surface water flow, the capacity of the surface water inlet shall not be greater than the maximum design flow in the drain line or lines. Covers or trash racks should be used to ensure that no foreign materials are allowed in the drain lines.

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The capacity of a relief well system will be based on the flow from the aquifer, the well spacing, and other site conditions and will be adequate to lower the artesian water head to the desired level.

The size of relief wells is generally based on the available materials rather than on hydraulic considerations. Such wells will not be less than 4 inches in diameter.

Junction boxes, manholes, catch basins, and sand traps must be accessible for maintenance. A clear opening of not less than 2 feet will be provided in either circular or rectangular structures.

The drain system must be protected against velocities exceeding those given in Table 1 and against turbulence created near outlets, surface inlets or similar structures. Continuous or closed-joint pipe must be used in drain lines adjoining the structure where excessive velocities will occur.

Junction boxes shall be installed where three or more lines join or if two lines join at different elevations. In some locations it may be desirable to bury junction boxes. A solid cover should be used, and the junction box should have a minimum of 1.5 feet of soil cover.

If not connected to a structure, the upper end of each subsurface drain line will be capped with a tight-fitting external cap of the same material as the conduit or other durable materials.

The outlet must be protected against erosion and undermining of the conduit, entry of tree roots, damaging periods of submergence, and entry of rodents or other animals into the subsurface drain. A continuous section of rigid pipe without open joints or perforations will be used at the outlet end of the line and must discharge above the normal elevation of low flow in the outlet ditch. Standard corrugated plastic tubing is not suitable for the outlet section. Minimize the visual impact of projecting outlets.

The invert of the outlet pipe shall be above the low water level and at least one (1.0) foot vertical distance above the excavated ground line. This distance can be reduced to 0.5 foot when the ground line grade away from the outlet exceeds 5 percent, or under other conditions when approved by the Area Engineer.

Metal outlet pipes are recommended; however, other rigid pipe may be used if adequate protection from vehicular and livestock traffic is provided. PVC outlet pipe shall have a minimum wall thickness of 0.24" for 4", 0.28" for 6", and 0.32 for 8".

Continuously submerged outlets will be permitted for water table control systems if planned and designed according to the standard for Drainage Water Management (code 554).

The outlet pipe and its installation will conform to the following requirements:

1. If burning vegetation on the outlet ditch bank is likely to create a fire hazard; the material from which the outlet pipe is fabricated must be fire resistant. If the likelihood is great, the outlet pipe must be fireproof.

2. Two-thirds of the pipe will be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch side slope or the side slope protected from erosion. The minimum length of the pipe will normally be 8 feet. Under certain conditions shorter sections are appropriate; e.g., steep-sided mains and laterals (1 (horizontal) : 1 (vertical) or less) with a narrow bottom width of 3 feet, commonly referred to as "minimum ditches," for outletting individual subsurface drain laterals. For conduits 10 inches in diameter and greater, longer outlet sections shall be considered, such as:
   - 10 inches and 12 inches in diameter, use 12 feet.
   - 15 inches and 18 inches in diameter, use 16 feet.
   - Use 20 feet outlet pipe for all diameters larger than 18 inches.

3. If ice or floating debris may damage the outlet pipe, the outlet shall be recessed to the extent that the cantilevered part of the pipe will be protected from the current in the ditch.

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4. Headwalls used for subsurface drain outlets must be adequate in strength and design to avoid washouts and other failures.

Watertight conduits strong enough to withstand the expected loads will be used if subsurface drains cross under irrigation canals, ditches, or other structures. Conduits under roadways must be designed to withstand the expected loads. Shallow subsurface drains through depressed or low areas and near outlets must be protected from damage caused by farm machinery and other equipment and from freezing and thawing.

Criteria for removal of water from heavy use areas, such as around buildings, roads, and structures.

Where the subsurface drainage is an integral part of a structural design the whole design including the subsurface drain will be part of the appropriate standard.

CONSIDERATIONS

When designing subsurface drainage systems, consider the effects the system will have on water quantity and quality.

Effects on quantity to consider include: water budget, base flow and runoff to water uses and users, groundwater recharge, and volume of soil water needed to improve plant growth.

Water quality effects that should be considered include: delivery of sediment, changes in the delivery of dissolved salts, such as nitrates, on downstream water uses and users, changes in delivery of dissolved substances to the aquifer, downstream water temperatures, and the effects on the visual quality of downstream water.

If a concern exists of tile lines picking up polluted water from manure spreading, consider installing tile blocks, stopable catch basins, or other temporary flow blocking devices, or outlet into a vegetated area.

Consider adding collector mains to minimize the visual impact, potential fear from ice or debris damage, and to facilitate maintenance of the grassed ditch bank.

Consideration shall be given to possible damages above or below the point of discharge that might involve legal actions under federal, state, or local laws. Consideration shall be given to maintaining or enhancing environmental values.

Considerations must be given to preventing adverse impacts to delineated wetlands regulated by State and Federal regulations.

PLANS AND SPECIFICATIONS

Plans and specifications for installing subsurface drains shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) Plan must be prepared and reviewed with the landowner or operator responsible for the application of this practice. The O&M Plan shall provide specific instructions for proper operation and maintenance of each component of this practice and shall detail the level of inspections, maintenance, and repairs needed to maintain the effectiveness and useful life of the practice.

Annually inspect the tile outlet to ensure that a free drainage condition exists, that the minimum overfall height is assured, that the headwall is functioning appropriately, and that the rodent guard is in place.

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REFERENCES


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