

Forms and Specifications prepared under the direction of the Department of Drainage and Waters, State of Minnesota,

IN THE MATTER OF

(COUNTY) (~~SPECIAL~~) DITCH NO. 71,

COUNT....., MINNESOTA.

CONTRACT FORMS
and
SPECIFICATIONS

Bids to be opened at the office of the County Auditor of
County, at, Minnesota, at o'clock, M.,
on the day of 19.....

.....
County Auditor

.....
Engineer

**G-6
Compliance
with Laws**

The Contractor shall familiarize himself with and observe all state laws and local Ordinances and Regulations affecting those engaged or employed in the work, or the materials and appliances used in the work, or in any way affecting the conduct of the work, and of all Orders and Decrees of authorities having jurisdiction over the same. The Contractor shall at all times himself observe and comply with such existing and future Laws, Ordinances, Regulations, Orders, and Decrees; and the County or Counties shall not be held liable for any claim or liability arising from or based upon the violation of any such Law, Ordinance, Regulation, Order or Decree, whether by himself or his employees.

**G-7
Restrictions
on Disposition
of Plant, Etc.**

The Contractor shall not make any disposition of the plant, machinery, tools, appliances, supplies, materials or animals used on or in connection with the work, either by sale, conveyance or incumbrance, inconsistent with the rights and interests of the County or Counties.

**G-8
Preservation of
Bench marks
Government
Monuments**

Bench marks, survey stakes and monuments must be carefully preserved by the Contractor, and in case of their destruction by him, or any of his employees, such stakes will be replaced by the Engineer at the Contractor's expense.

**G-9
Protection of
Public and
Private Im-
provements**

Whenever it becomes necessary in the excavation of ditches or trenches to cross public or private highways or fences, the Contractor shall exercise care so as not to interfere unnecessarily with traffic or cause undue inconvenience to the landowners affected and to the general public. The Contractor shall confine his activities within the limits of the right-of-way and shall be held liable for any damages that may result because of the destruction of fences, trees, grain and any other property located outside of the limits of said right-of-way. Whenever a private or public highway is rendered impassible by the construction of an open ditch, steps to restore normal traffic conditions shall at once be begun by the Contractor by the erection of the permanent bridge designed for the location or of a temporary bridge to meet the requirements until such time as a permanent bridge can be erected. At the completion of any work affecting a highway crossing, railroad crossing or fence, the Contractor shall be required to remove all forms and temporary structures without delay and repair all fences, so as to restore said roads and fences to a condition which, in the opinion of the Engineer shall be suitable for use. The Contractor shall give proper notice to the owners of railroads, private roads, town roads, fence lines, telephone lines, telegraph lines, electric current transmission lines, or other structures, the interference with which becomes necessary in the performance of his work, before disturbing such structures; he shall provide watchmen, red lights and fences at his own expense, and take such precautions as may be necessary to protect life and property; and he shall be liable for all damages occasioned in any way by his act of neglect or that of his agents, employes or workmen.

**G-10
Data To Be
Furnished by
the Contractor**

The Contractor shall furnish the Engineer reasonable facilities for obtaining such information as he may desire respecting the character of material and progress of the work. In cases of dispute regarding the actual cost of any portion of the work the Engineer may demand all information necessary to determine said cost, such as the number of men employed, their pay, the time during which they work on the various classes of construction, copies of expense statements, bills for transportation charges on all machinery, material, and supplies shipped to the project, etc., in connection with the work under the Contract.

**G-11
Work in Ad-
vance of Engi-
neer's Stakes**

Work performed by the Contractor in advance of the setting of stakes by the Engineer will be done at the Contractor's own risk.

**G-12
Infringement
of Patents**

The Contractor shall be held responsible for any claims made against the County or Counties for any infringements of patents, by the use of patented articles, or methods used by him in the construction and completion of the work, or any patented process or processes connected with the work agreed to be performed under the contract, or any patented materials used upon the said work and shall save harmless the County or Counties from all costs, expenses and damages which the County or Counties shall be obliged to pay by reason of any infringement or alleged infringement of patents used in the construction and completion of the work.

**G-13
Clearing**

Unless otherwise specified in the Detail Specifications the Contractor shall remove all trees, stumps, brush, timber and other moveable objects from the right-of-way, except merchantable timber, which shall be cut into convenient lengths to facilitate handling and shall be disposed of along the sides of the right-of-way or on adjacent property as directed by the Engineer. When burning is directed by the Engineer, it must be done to the satisfaction of the State Department of Forestry and the Engineer. When the clearing of the right-of-way is specifically provided for in the Schedule of Prices submitted in the Proposal, the Contractor shall perform the work for the unit price submitted for such work; but when such specific proposal is not made for clearing, it is understood that any clearing found necessary shall be done by the Contractor in accordance with the requirements of these Specifications, and the cost of such clearing shall be understood to have been included in the price submitted in the Proposal for excavation.

**G-14
Board for Engineer and Assistants**

In cases where the Contractor maintains a camp for lodging and feeding employees, he shall, when requested, furnish board or lodging to the Engineer and his assistants, and shall make a charge therefore of \$..... per meal and \$..... for lodging. The Contractor shall submit monthly itemized statements to the Engineer of such meals and lodgings furnished, who will cause the same to be paid as a part of the cost of the work.

**G-15
Liability Insurance**

The Contractor shall carry liability insurance to protect his employees from injury sustained by reason of the carrying on of his work, and to meet the requirements of the Minnesota Workman's Compensation Act.

**G-16
Contingencies and Delays**

All risks and uncertainties that may develop in connection with the work are assumed by the Contractor as a part of this contract, and are compensated for in the Contract Price. He shall, except as otherwise definitely specified in this Contract, bear all loss from damages due to hindrances or delays arising out of the nature of the work to be done, to the action of the elements, or to any unforeseen and unexpected conditions or circumstances encountered, and no charge other than that included in the Contract Price shall be made by the Contractor against the County or Counties for such loss or damage.

When compensation is claimed by the Contractor for extra costs because of the failure of the County or Counties to provide the necessary information, right-of-way or site for installation, he shall present such claim to the County or Counties in writing, not later than 30 days after the close of the month during which such extra cost is claimed to have been incurred. Such claim for extra costs, if found justifiable by the Engineer, and approved by the County or Counties, shall be paid in the same manner as provided for making other payments. The County or Counties shall not be liable for damages or delays caused by other contractors performing related work.

If delays are caused by specific orders to stop work, given by the Engineer, by the performance of extra work, by unforeseen causes beyond the control of the Contractor, by the failure of the County or Counties to provide the necessary instructions for carrying on the work, or to provide the necessary right-of-way or site for installations, then such delay will entitle the Contractor to an equivalent extension of time. Application for extension of time must be approved by the Engineer, and shall be accompanied by the formal consent of the Sureties, but an extension of time whether with or without such consent shall not release the Sureties from their obligations which shall remain in full force until the discharge of the Contractor.

**G-17
Changes and Alterations**

If any variation in Plans or Specifications is made necessary by the exigencies of construction or local conditions, such change with costs shall be determined by the Engineer and agreed to in writing by the Contractor and County Auditor or Auditors; but without such written Agreement approved by the Engineer, no deviation from the Plans and Specifications will be allowed.

The Engineer may, without notice to the Sureties on the Contractor's bond, make such changes in the design, materials or machinery for installation or construction, or in the quantities or character of the work or material as he may deem advisable. Changes which may be ordered by the Engineer may include alterations, eliminations and additions in the line, grade, location and dimensions of ditches, tile, dams and other structures, and the shifting of locations to suit conditions disclosed as the work progresses. If such changes result in an increase or decrease in the cost to the Contractor, the Engineer will make such additions or deductions to be determined by methods outlined in Section G-18 hereof. The decision of the Engineer as to whether or not the Contractor is entitled to an addition or deduction because of changes which may have been ordered, shall be final, subject always to review by the Courts for any serious error on the part of the Engineer.

**G-18
Extra Work and Material Cost Plus Estimates**

If in the construction of a ditch or other structures, it becomes necessary to change the Design specified in the original Contract, such change may be made upon the written order by the Engineer filed with and approved by the County Auditor. If such change or changes are ordered at any time before the actual work of construction has commenced or the delivery of material for the same has been made, the cost of the work and material shall be based on the unit prices submitted in the Contractor's bid for the work and material of the same character and kind.

The Engineer may order work or material not covered by the Specifications and not included in the Schedule contained in the bid or listed in the Agreement. Such work or material, except as otherwise provided in Section T-7 and in Detail Specifications will be classified as extra work. Extra work and such work made necessary by changes in design and material, which in the opinion of the Engineer, are not susceptible of classification under the schedule of unit prices contained in the Agreement or which may not be determined by the application of the proportion provided in Section T-7, shall be performed by the Contractor, and he shall be paid therefore the actual cost, as determined by the Engineer, plus 15 percent thereof. For the purpose of determining the actual cost of said extra work, the Engineer shall have access to all the records on all items of cost incurred on the work as kept by the Contractor. The Engineer may, if he believes it advisable, keep separate and independent records of his own, covering said items of expense. He shall, during the time that such extra work is being done, have the right to examine the

books, pay-rolls, material and supply accounts and other records kept by the Contractor; and at any time when, in the opinion of the Engineer, the number of workmen and their compensation, the methods and appliances used in executing the work and the method of handling supplies and material are not in conformity with the most economical and commonly accepted practices, he shall have the right to order the Contractor to make such changes as will affect the greatest economy consistent with the best operation and workmanship of the Contractor's plant.

The items of expense which shall be considered legitimate and proper in computing the actual cost of extra work as herein before outlined shall include:

- (a) Additional machinery and equipment when needed. This item of expense shall include only the actual cost of erecting said machinery and equipment, including freight and drayage costs to the place of installation, but shall not include any freight or drayage charges for the removal of the same after the work for which it was erected and installed, has been completed.
- (b) Number of men employed and wages paid each.
- (c) The amount and kind of fuel used and unit cost, including freight, drayage and hauling cost.
- (d) The amount, kind and cost of cable and wire rope and of oils and lubricants, and all miscellaneous supplies required in the ordinary operation of the contractor's equipment and plant.
- (e) The cost of actual repairs to the plant, including extra parts, freight, drayage, and the time and expense of replacing.
- (f) The cost of railroad fares and miscellaneous traveling expenses actually and necessarily expended by the contractor or foreman in superintending and overseeing the work. Such items of expense must be shown to be necessary, just and reasonable, and the decision of the Engineer as to which of such items shall be paid, shall be final.
- (g) The cost of carrying Workman's Compensation Insurance as provided by the laws of the state.

Actual costs shall not include any allowances for office expenses, general superintendance or other general expenses. At the end of each month the Contractor shall present, in writing, his claims for items of costs incurred for extra work and material, accompanied by such verified itemized statements of said costs as may be required by the Engineer. The Engineer shall issue certificates and the Auditor make payment for extra work performed as outlined in Section G-23 hereof.

**G-19
Changes at
Contractor's
Request**

If the Contractor, on account of conditions developing during the progress of the work, finds it impracticable to comply strictly with these Specifications, and applies in writing for a modification of structural requirements or of methods of work, such changes may be authorized by the Engineer if not detrimental to the work and without additional cost to the County or Counties.

**G-20
Removing and
Rebuilding
Defective work**

The Contractor shall remove and rebuild at his own expense any part of the work that has been improperly executed, even though it has been included in the monthly estimates. If he refuses or neglects to replace such defective work, it may be replaced by the County or Counties at the Contractor's expense.

**G-21
Enforcement
of Contract**

Should the Contractor at any time fail or refuse to comply with these Specifications, or to furnish sufficient force or machinery to complete the Contract within the time specified, or fail or refuse to make such increase in his force as in the judgment of the Engineer shall be necessary, the County Auditor or Auditors, on ten days notice to the Contractor, may declare the Contract forfeited and award the same to other parties, or the work may be completed by force account, and the cost of finishing the work shall be deducted from the amount due the Contractor. If the cost of thus completing the work shall exceed the amount due the Contractor under the terms of his Contract at the time the Contract was declared forfeited by the County Auditor or Auditors, the Contractor or the Sureties on the Contractor's Bond, or both, shall be held liable to the County or Counties for the excess. If the cost of thus completing the work shall be less than the amount due the Contractor under the terms of the Contract at the time the Contract was ordered forfeited by the County Auditor or Auditors, the balance shall be paid the Contractor upon completion of the work.

**G-22
Failure to
Complete the
Work in Time
Agreed Upon**

Should the Contractor fail to complete the work or any part thereof within the time agreed upon in the Contract, or within such extra time as may be allowed for delays by formal extensions granted by the County Auditor or Auditors, the Engineer shall compute and appraise the cost to the County or Counties on account of the employment of Engineers, inspectors and other employees after the expiration of the time for completion, including all disbursements of the engineering account chargeable thereto. Should the completion of the Contract be unreasonably delayed, the amount so appraised and computed is hereby agreed upon as liquidate damages for the delay and will be deducted from any money due the Contractor under the Contract, and the Contractor and his Sureties shall be liable for any excess. The decision of the Engineer as to the appraisal of such damages shall be final.

**G-23
Estimates and
Payments**

The Engineer will inspect and make approximate measurements of the work performed by the Contractor including materials furnished, classified according to items named in the Agreement; and will compute the value of the same on the basis of the unit prices named in the Schedule of the Agreement. To this value will be added any amounts earned for extra work as outlined in Section G-18 of these Specifications.

At any time during the progress of the work, and at intervals not to exceed 30 days, the Engineer shall issue preliminary certificates for work done and approved, or for material or supplies furnished and delivered along the line of said proposed ditch, or otherwise delivered, according to the Contract, and the provisions of Section 5541 Gen. Statutes of 1913, and amendments.

**G-24
Acceptance
Shall Not
Constitute
Waiver**

No order, measurement, determination or certificate by the Engineer, or payment by the Auditor or Auditors of money, or payment for, or acceptance of the whole or any part of the work by the Engineer, or extension of time granted by the Auditor or Auditors shall operate as a waiver of any portion of this Contract or of any power herein provided, nor shall any waiver of any breach of this Contract be held to be a waiver of any other or subsequent breach.

GENERAL SPECIFICATIONS

Supplemental

(General specifications to cover requirements which may be peculiar to the job and not included herein. Information on this subject may be had by directing inquiry to engineer.)

SPECIFICATIONS FOR OPEN DITCH WORK

**D-1
Sizes, Slopes,
Etc.**

All open ditches shall be of the size and dimensions shown on the Report, Maps, Profiles, Plans and Specifications which are a part of this Contract, or such other dimensions as may be ordered by the Engineer as the work progresses. Changes, alterations and additions may be made as provided for in Sections G-17 and G-18 of General Conditions hereof.

**D-2
Excavation**

The Contractor shall, in all instances, be required to do the excavation specified in a first-class workmanlike manner. He shall be required to install the class of excavating plant and equipment best suited for the performance of the work, and the resulting ditch shall be the best that can be completed by the type of plant installed. When, because of the type of machinery used, size of ditch specified, or for any other reason it is found impracticable to construct a ditch in strict compliance with the required side slopes, the Contractor shall, in all instances, excavate the prism of the ditch to the specified width at top, width at bottom and to the required grade; and in all instances the outline of the prism of the constructed ditch at any given point must correspond with or be found outside of the outline of the prism of the specified ditch at that point and be coincident with it; and no claim shall be made by the Contractor for any material excavated in excess of that stipulated in the Engineer's design. The Contractor shall be required to remove sods, stumps and roots that may have been rolled back on the berme by the operation of the machine.

All material excavated is to be measured, estimated and paid for by the cubic yard, and the unit price stipulated therefore in the Proposal shall be the price per cubic yard to be paid for the excavation of all the material encountered and which must be removed in order to complete the job. Whenever a highway is to be constructed along the sides of the ditch from material removed therefrom, the cost of doing said work shall not be included in the unit price for excavation, but shall be done for the price submitted therefore in the Proposal.

**D-3
Disposition of
Excavated
Material**

The excavated material shall be placed on both sides of the ditch, in substantially equal quantities; but when ditch excavation is being done along highways, old channels, or for any other reason it becomes necessary, the Engineer may require the Contractor to deposit all the excavated earth on one side of the ditch. Whenever roads are to be constructed from the excavated material at points indicated on the Map, or where directed by the Engineer, the excavating Contractor will be expected to recognize that fact by the placing of the waste banks with special care so that the same will be uniform, continuous and on a straight line at a distance from the edge of the ditch sufficient to permit of such waste being levelled in both directions to a road grade having a surface width of feet and still leave a clean berme of at least feet. The disposal of the material excavated from the ditch shall in all cases be subject to the supervision and instructions of the Engineer.

**D-4
Obstructing
Culverts and
Ditches**

All culverts forming a part of said drainage system and installed by the Contractor, or any other party, for any purpose, either prior to or during construction, shall be maintained free from obstructions at the inlet and outlet by the excavating Contractor until said work has been finally completed.

**D-5
Old Channel
Bends Not To
Be Obstructed**

When the improvement required to be constructed under the Contract consists in the straightening and otherwise improving a creek, river or other water course, the Contractor must exercise care so as not to obstruct creeks, road ditches or other lateral drains, roadways at fords and watering places, or interfere with the natural drainage of the beds of old channel-bends cut off by the new channel. When necessary in order to dispose of the excavated material, the Contractor may obstruct the up-stream ends of such old channel bends, but in no case shall the down-stream ends be filled so as to interfere with the natural drainage of any waters which may accumulate in such old channel. When such obstructions are caused, the Contractor shall remove them as soon as ordered to do so by the Engineer.

**D-6
Clearing**

The Contractor shall remove all trees, brush, stumps and other organic matter within the limits of the stakes as set by the Engineer and shall dispose of the same in accordance with Section G-13 of the General Conditions unless otherwise set forth in Detail Specifications.

**D-7
Removal of
Bridges**

Unless provision is made therefore in the Contract the Contractor shall without extra compensation, remove all bridges and culverts along the line of the work in a careful and workmanlike manner and remove the material to one side of the line of the work to the satisfaction of the Engineer.

**D-8
Openings
Through Waste
Banks**

The Contractor will be required to leave openings through the waste banks at points where the ditch intersects highways, fords, watering places for stock and at intersections with creeks and other natural drains, and such other openings as may be required in the Plans or in Detail Specifications.

HIGHWAY SPECIFICATIONS

**D-9
General**

When so designated on Plans or by the Engineer, highways are to be constructed from the material excavated from the ditch, to conform to the following stipulations:

**D-10
Commencement
and Prosecution
of Work**

The Contractor will be required to commence the work of constructing the highways as soon as the material excavated from the ditches is in a condition to permit of its being spread and levelled. The judgment of the Engineer as to when the Contractor shall commence work shall prevail, and the Engineer's instructions as regards the commencement of road construction at any point or points, or along any portion or portions of the ditches shall be followed by the Contractor. The work shall be prosecuted with such force and at such a rate as will, in the judgment of the Engineer, insure the completion of the roads within a reasonable time after the completion of the ditches.

**D-11
Cross-Sections
of Roads**

Whenever the Contractor is directed to construct a highway along the ditch the embankment shall be levelled off so as to have a uniform and even surface. The width of the highway at the top shall not be less than feet, the surface to be convex in form with the center inches higher than the sides. The slope from the shoulder to the toe of the slope shall in no case be steeper than one (1) foot vertical to one and one-half (1½) foot horizontal. The height of the shoulders above the ground line or toe of the slope shall be that shown on the Plans and Contract Drawings. The construction of suitable approaches to bridges, culverts and lateral highways intersecting the ditch waste banks will be required of the Contractor. The cost of doing such work is to be included in the unit prices for highway construction stipulated in the Contract.

**D-12
Overhaul**

Overhaul shall consist of hauling suitable material for the filling in of low places or for surfacing. When this is deemed necessary by the Engineer, and there is not sufficient material in the embankment adjacent thereto to fill the shallow places, it shall be the duty of the Contractor, at the written instructions of the Engineer, to furnish such men, teams, and material as are necessary to do such work for which the Contractor is to receive the cost price, plus 15 per centum; said cost price to be determined by the Engineer in accordance with Sec. G-18 of General Conditions hereof.

**D-13
Surface of
Road**

The surface of the road shall be finished in a good workmanlike manner, with a blade grader or other similar machinery skillfully operated. It shall be left free from ruts, bumps, mounds, undulations, trash, sods and obstructions that are unsightly, dangerous or will materially interfere with the easy riding qualities of the road.

**D-14
Post at
Culverts**

In cases where one or both ends of existing bridges or culverts that are not provided with suitable rails, fall within the limits of the shoulders of the road, and when the Engineer directs, it shall be the duty of the Contractor to provide a four (4) inch cedar post, seven (7) feet long, paint the same white and place it vertically in the ground to a depth of at least three (3) feet at the end or ends of said bridges or culverts. The payment of the above shall be made as extra work at the rate of for each post in place.

**D-15
Estimates and
Payments**

Estimates of work done and progress and final payments for all items covered by these Specifications shall be made as provided in Section G-23 of the General Conditions hereof.

TILE SPECIFICATIONS

GENERAL

**T-1
American Society for Testing Materials Specifications To Govern**

Except as otherwise herein specified, the requirements set forth in the Standard Specifications for Drain Tile, Serial C4-16 of the American Society for Testing Materials shall apply to all tile furnished under this Contract. All tile delivered shall be of (clay) (cement) and shall answer the requirements of Standard Drain Tile as defined in said Specifications.

Absorption tests conducted in accordance with the procedure outlined in said Specifications shall result in a maximum average absorption by the Specimen of not more than per cent.

The Standard Specifications for Drain Tile, Serial C4-16 of the American Society for Testing Materials is appended to and made a part of these Specifications.

**T-2
Grade Line**

Unless otherwise specifically indicated on the Profile, the grade line shown thereon indicates the flow line or the elevation of the surface of the inside invert of the tile when placed in the required position in the trench.

**T-3
Excavation and Backfilling**

Unless otherwise designated in Detail Specifications all excavations shall be of the open trench type and in trenching where the cut does not exceed 6 feet in depth, the Engineer may require that the tile shall not be covered or blinded until after the work has been inspected by him. Immediately after such inspection all tile must be blinded with clay or loam to a depth of not less than 1 foot. Where the excavation exceeds 6 feet in depth, earth may be thrown back on the tile, but the Engineer may require such work to be uncovered at intervals for his inspection. The Contractor shall shape the bottom of the ditch approximately to fit the lower one-quarter of the outside circumference of the tile. After the tile is bedded true to line and grade, the Contractor shall carefully place the earth around the tile, working the earth down the sides and underneath the tile as far as practicable. In no case shall the trench be so excavated that the width of the same at a point even with the top of the tile will exceed the outer diameter of the tile by more than five tenths (.5) of a foot. The Contractor shall, upon the written order of the Engineer, backfill in a good and workmanlike manner, filling all excavated material back over the tile.

**T-4
Laying the Tile**

The laying of the tile shall begin at the outlet and proceed up-stream. If the load on the tile approaches the maximum strength the Engineer may require that not more than three feet of earth be first back-filled over the tile and allowed to thoroughly settle before the filling is completed. In no case shall the tile be covered with sand before having first been blinded with some other material. The tile shall be laid as directed in the foregoing section with close joints, true to line and grade. The manner of grading shall be such as will meet the approval of the Engineer in charge. The Contractor shall line the grade with not less than three targets at all times. So far as practicable no joints will be permitted which will exceed one-fourth inch in width. In case wider joints cannot be avoided because of curves in the drain such wider joints shall be covered with suitable patches so as to render the tile mud tight. If at any time the tile become filled with mud or sand to such extent that, in the judgment of the Engineer, the proper functioning of the tile drain will be interfered with, he may require the Contractor to clean such tile, for which no extra compensation will be allowed. The Contractor shall take every precaution to avoid covering or destroying the line of stakes placed by the Engineer for the Contractor's guidance. He shall be held strictly accountable for any such stakes covered or destroyed by him or his employees.

**T-5
Old Tile Lines To Be Connected**

The Contractor for labor shall be held responsible for the proper replacement of all old tile lines intersected and cut by the improvement, reconnecting same or cutting same into the improvement by a properly cemented junction as may be ordered by the Engineer. Such work shall be done by the Contractor without extra compensation, unless his Bid and Contract shall specifically provide for it.

**T-6
Inlets**

Where sewer pipe, catch basins or inlets are specified, they shall be constructed in accordance with the Plans. Where detailed Plans are not filed, the catch basin shall be built as follows: Three sewer pipe of the same size as the drain shall be substituted for drain tile, the center sewer pipe to have a Tee junction of the size specified for the catch basin. On this Tee shall be built up sewer pipe to the height ordered by the Engineer. The bell joints shall be cemented and rendered watertight and upon the top bell there shall be fitted a cast-iron grate. The backfilling around the catch basin shall be done immediately after the inspection of the catch basin, and must be thoroughly tamped in place.

**T-7
Change in Plans**

If in the Construction of the tile drain or drains it becomes necessary to change the Plans and Specifications, such change may be made as outlined in Sections G-17 and G-18 of the General Conditions hereof; except where such change will require the laying of the tile to depths for which prices have not been submitted in the bid for similar work, there shall be paid the rate established by the ratio existing between the prices bid and those given in TABLE 1 hereof.

**T-8
Responsibilities of Contractors doing Relative work**

When the work of constructing a tile drain is awarded to two or more Contractors each Contractor must perform his particular work with due regard to the convenience and needs of the others working on the same job. The Contractor furnishing the tile shall supply the sewer pipe for all inlets specified, and Y-junction tile for all junctions. He shall ship the tile at such times and in such quantities as will insure a constant supply of material to the labor Contractor and as may be determined to be necessary by the Engi-

neer. Such Contractor shall be held liable for any damages which may accrue to the County or Counties or to the labor Contractor for any failure to ship the tile within a reasonable time after delivery has been ordered by the Engineer except when such failure to deliver shall be due to causes beyond the Contractor's control.

The labor Contractor shall supply all labor and material required to excavate the trenches, lay and blind the tile and back fill the trenches. He shall furnish grates for inlets, labor and material for the construction of bulkheads and the cementing of joints whenever required.

The hauling Contractor shall furnish the labor and equipment required to unload the tile from the cars at the station delivered, for hauling the tile from the station to and distributing the same along the trenches. He shall be held to pay all the demurrage accruing because of his failure to unload the cars on time.

On all questions concerning the performance of related work and conflicting interests of Contractors, the decisions and instructions of the Engineer shall be final.

**T-9
Delivery of
Tile**

Delivery upon the site of the work shall not be permitted, nor partial estimates given for material delivered so far in advance of construction that it may not be used during the same season in which it is delivered, or for a shorter period in the discretion of the Engineer.

**T-10
Bulkheads**

Where bulkheads are specified, they shall be of such design as shall be specified for the particular drain. In all cases they shall be constructed of good quality concrete prepared and placed as specified under Concrete Specifications hereof.

**T-11
Railroad
Crossings**

If the railway company furnishes cast-iron pipe of the proper diameter on the line of drain prior to construction, the Contractor shall lay such pipe in place of tile without extra compensation.

If iron pipes are not so furnished, the Contractor shall incase the feet of tile which are situated under and immediately adjacent to the track, in a covering of four (4) inches of five (5) to one (1) mixture of concrete. Such work shall be done without extra compensation unless the Bid and Contract specifically provide for extra compensation therefore.

**T-12
Estimates and
Payments**

Estimates of work done and progress and final payment for all items covered by these Specifications shall be made as provided for in Section G-23 of the General Conditions hereof.

TABLE I.

Diam. of Tile; in Inches	DEPTH OF TRENCH IN FEET											
	4	5	6	7	8	9	10	11	12	13	14	15
5 & 6	5	7	9	12	16	21	26	32	40	48	56	64
7 & 8	6	8	11	14	18	24	30	37	45	53	62	71
9 & 10	7	10	13	17	21	28	34	41	49	58	68	78
12	8	12	16	20	26	32	38	46	55	64	74	85
14	10	14	18	23	29	36	43	51	60	70	80	91
15	11	15	20	25	31	38	45	53	62	73	83	95
16	12	16	21	26	33	40	47	55	64	75	86	98
18	13	18	23	29	36	43	51	60	70	81	92	104
20	15	20	26	32	39	47	55	64	75	87	99	112
22	16	22	28	35	43	51	60	70	81	93	106	120
24	18	24	31	38	46	55	65	76	87	100	113	127
26	19	26	33	41	49	58	69	80	92	105	120	136
28	21	28	36	44	53	62	73	85	98	112	127	144
30	23	30	38	47	56	65	77	89	102	118	134	152
32	25	32	40	50	60	70	81	94	108	124	141	159
34	27	34	43	53	63	74	85	98	115	130	148	168
36	29	37	46	56	66	77	89	103	119	136	155	175
38	32	40	49	59	70	81	93	107	123	141	162	184
40	36	44	53	62	73	85	97	112	129	148	170	194

Price, In Dollars Per 100 Feet For Digging, Laying Tile and Backfilling.

Example:—

On a certain contract, the maximum depth to which a 10 inch tile is to be laid on a given branch is 10 feet, for which the contractor has bid \$41.00 per 100 feet. After the execution of the contract if the engineer finds it expedient to change the location of said branch thereby making it necessary to lay the said 10 inch tile to a depth of 12 feet, for which depth there is no unit price bid. What shall the contractor receive for laying the 10 inch tile to this new depth?

From the table given above and from the bid submitted by the contractor, the following proportion is derived: X (the price sought for laying 10 inch tile 12 feet deep) : \$49.00 (the cost given in above schedule for doing this work) :: \$41.00 (the price bid by the contractor for laying 10 inch tile 10 feet deep) : \$34.00 (the cost given in above schedule for laying 10 inch tile 10 feet deep).

Solving, X : \$49.00 :: \$41.00 : \$34.00

X equals \$59.09, the price to be paid contractor.

Authorized Reprint from the Copyrighted
A. S. T. M. Standards (1916)
American Society for Testing Materials,
Philadelphia, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

Affiliated with the
International Association for Testing Materials.

STANDARD SPECIFICATIONS

FOR
DRAIN TILE

Serial Designation: C 4—16

The specifications for this material are issued under the fixed designation C 4; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

Adopted, 1914; Revised, 1916

Classes

1. (a) These specifications cover three classes of drain tile, namely, Farm Drain Tile, Standard Drain Tile, and Extra-Quality Drain Tile.

(b) The purposes for which these classes are intended to be suitable are as follows:

FARM DRAIN TILE, for ordinary private drainage work on farms, for moderate sizes and depths;

STANDARD DRAIN TILE, for ordinary district land drainage at moderate depths;

EXTRA-QUALITY DRAIN TILE, for district land drainage, for considerable depths and where an extra quality is desired.

Basis of Purchase

2. The purchaser shall specify the class or classes of tile to be supplied, whether Farm Drain Tile, Standard Drain Tile, or Extra-Quality Drain Tile. Standard Drain Tile shall be supplied where no other advance selection is stated.

Basis of Acceptance

3. (a) The acceptability of drain tile shall be determined (1) by the results of the chemical and physical tests hereinafter specified, and (2) by visual inspection, to determine whether the tiles comply with the specifications as to dimensions, shape, and freedom from visible external and internal defects.

(b) The acceptance of drain tile as satisfactorily meeting one of these two general requirements shall not be construed as in any way waiving the other.

I. Materials And Manufacture.

Materials

4. (a) These specifications shall apply to drain tile made of shale, fire clays or surface clays and to drain tile made of concrete.

(b) By shale is meant a stratified clay, usually red-burning, more or less indurated by heat or pressure, with well-marked cleavage, laid down prior to the present geological epoch.

(c) By fire clay is meant a stratified clay, usually buff-burning, usually less indurated than shales, with poorly marked cleavage, laid down prior to the present geological epoch.

(d) By surface clay is meant an unstratified, unconsolidated plastic glacial or alluvial clay, laid down by the glacial ice sheet, or on the flood plains of rivers, during the present geological epoch.

(e) By concrete is meant a suitable mixture of Portland cement, mineral aggregates and water, hardened by hydraulic chemical reaction.

(f) If the purchaser desires to exclude any of these materials he shall so specify in advance. All materials used shall be first-class of their kind and suitable for the purpose.

Manufacture

5. The method of manufacture shall be such as to insure excellence of product and uniformity in quality.

II. Chemical Tests And Requirements.

Chemical Tests and Requirements

6. The purchaser may prescribe in advance special chemical requirements in cases where drainage waters have marked acid or alkaline character, or are of abnormally high temperature, and may use chemical analysis of the tile to ascertain whether these special requirements are met. Without a special agreement in advance, no drain tile shall be rejected by reason of its composition as determined by ultimate chemical analysis.

The presence in drain tile of visible grains or masses of caustic lime, iron pyrites, or any other minerals which are known to cause slaking or disintegration of the tile, shall be construed as a valid ground for rejection, unless satisfactory proof be submitted that the tiles are permanent and durable, and that the objectionable minerals are not present in quantity or condition to work damage.

III. Physical Tests

Physical Tests 7. The physical tests of drain tile shall include (A) Strength Tests and (B) Absorption Tests; and may include (C) Freezing and Thawing Tests, when specified by the purchaser in advance, or when called for by the manufacturer or other seller as provided in Sections 34, 35, 47 and 52.

Selection of Specimens of Tile 8. The specimens of tile shall all be selected at the factory or at the shipping destination, or at the trench, at the option of the purchaser. The selection shall be made by a competent inspector employed by the purchaser. The inspector shall divide the tile into sub-classes if lack of uniformity in any particular warrants such division, and shall select enough representative specimens of tile from each sub-class for a complete set of standard physical tests.

Number and cost of Specimens of Tile 9. A standard physical test shall comprise tests of five individual tiles. Specimens of tile may be selected by the inspector in such number as he judges necessary to determine fairly the quality of all the tile. The manufacturer or other seller shall furnish specimens of tile without separate charge up to 0.5 per cent of the whole number of tile, and the purchaser shall pay for all in excess of that percentage at the same rate as for other tile.

(A) Strength Tests of Drain Tile.

Specimens of Tile 10. The specimens of tile shall be unbroken, full-size tile.

Moisture Condition of Specimens of Tile 11. The walls of the tile shall, at the time of testing, be as thoroughly wet as will result from completely covering with hay, cloth, or similar absorbent material, and keeping the covering wet for not less than 12 hours.

Temperature Condition of Specimens of Tile 12. No specimen of tile shall be exposed to water or air temperatures lower than 40° F. from the beginning of wetting until tested. Frozen tile shall be completely thawed before the wetting begins.

Weighing 13. Each specimen of tile shall be weighed on reliable scales just prior to testing, and the weights shall be reported.

Application of Load 14. Any machine or hand method which will apply the load continuously, or in increments not exceeding 5 per cent of the estimated total breaking load, may be used in making the test. The tile shall not be allowed to stand under load longer than is required for observing and recording the loads. All solid parts of the bearing frames and bearing blocks shall be so rigid that the distribution of the load will not be affected appreciably by the deformation of any part. All bearings and the specimens of tile shall be so accurately centered as to secure a symmetrical distribution of the loading on each side of the center of the tile in every direction.

Choice of Bearings 15. The purchaser shall choose (1) sand bearings, (2) hydraulic bearings, or (3) three-point bearings, for use in making strength tests of drain tile. (See Sections 18, 19 and 20.)

Calculation and Reporting of Test Results 16. The test results shall be calculated and reported, in pounds per linear foot of tile, in terms of the "Ordinary Supporting Strength."¹

The ordinary supporting strength shall be calculated by multiplying the test breaking loads by the following factors: For sand bearings, 1.00; for hydraulic bearings, 1.25; for three-point bearings, 1.50.

The results of the strength tests shall be reported separately for each of the five individual specimens of tile constituting a standard test, together with the average.

Modulus of Rupture 17. The modulus of rupture may or may not be calculated and reported, at the option of the purchaser. When reported it shall be calculated by the equations²

$$M=0.20 r \frac{W}{12} \dots\dots\dots (1)$$

$$f = \frac{6M}{t^2} \dots\dots\dots (2)$$

where M=maximum bending moment in wall in pound-inches per inch of length, r=radius of middle line of tile wall in inches, W=ordinary supporting strength, calculated as prescribed in Section 16, in pounds per linear foot of tile, f=modulus of rupture in pounds per square inch, and t=thickness of tile wall in inches.

¹The "ordinary supporting strength," when calculated as specified in Section 16, is approximately equal to the actual supporting strength of a tile when laid in a ditch by the "ordinary" method. See note under Table II.
²The coefficient of 0.20 in equation (1) approximates the value found by theoretical analysis and also that determined by extended tests.

Five-eighths of the weight of the tile per linear foot for sand bearings, or three-fourths for hydraulic or three-point bearings shall be added to W in computing the maximum bending moment M , when such addition exceeds 5 per cent of W . The value of t used shall be the average thickness of the wall at the top of the tile or that at the bottom, selecting the lesser of the two.

Sand Bearings

18. (See Fig. 1.)—When sand bearings are used, the ends of each specimen of tile shall be accurately marked in quarters of the circumference prior to the test. Specimens shall be carefully bedded, above and below, in sand, for one-fourth the circumference of the tile measured on the middle line of the wall. The depth of bedding above and below the tile at the thinnest points shall be one-half the radius of the middle line of the wall.

The sand used shall be clean, and shall be such as will pass a No. 4 screen.

The top bearing frame shall not be allowed to come in contact with the tile nor with the top bearing plate. The upper surface of the sand in the top bearing shall be struck level with a straight edge, and shall be covered with a rigid top bearing plate, with lower surface a true plane, made of heavy timbers or other rigid material, capable of distributing the test load uniformly without appreciable bending. The test load shall be applied at the exact center of this top bearing plate, in such a manner as to permit free motion of the plate in all directions. For this purpose a spherical bearing is preferred, but two rollers at right angles may be used. The test may be made without the use of a testing machine, by piling weights directly on a platform resting on the top bearing plate, provided, however, that the weight shall be piled symmetricaly about a vertical line through the center of the tile, and that the platform shall not be allowed to touch the top bearing frame.

The frames of the top and bottom bearings shall be made of timbers so heavy as to avoid appreciable bending by the side pressure of the sand. The interior surfaces of the frames shall be dressed. No frame shall come in contact with the tile during the test. A strip of cloth may, if desired, be attached to the inside of the upper frame on each side, along the lower edge, to prevent the escape of sand between the frame and the tile.

Hydraulic Bearings

19. (See Fig. 2.)—When hydraulic bearings are used, the ends of each specimen of tile shall be accurately marked in halves of the circumference prior to the test.

An hydraulic bearing shall be composed of a wooden platen, to which is attached, as hereinafter described, a section of rubber hose. The hose shall lie against the tile, and the pressure shall be applied to the hose through the platen.

The platen shall be built of strong wood, and shall be not less than 6 by 6 in. in section, and its least length shall be the length of the tile plus 8 in. One-inch quarter rounds, with their convex surfaces facing and 2 in. apart in the clear, shall be firmly attached to the bearing side. The straight portion of this face shall extend at least the length of the tile, and the platen beyond this length may be cut to the arc of a circle.

Between the quarter rounds shall be laid a piece of $2\frac{1}{2}$ in. hose which shall be closed in a water-tight manner at each end by clamps. The hose shall contain a volume of water not less than one-half nor more than two-thirds its capacity, when completely distended. This hose may be attached to the platen at either end in any satisfactory manner which will not induce wrinkling when under test pressure.

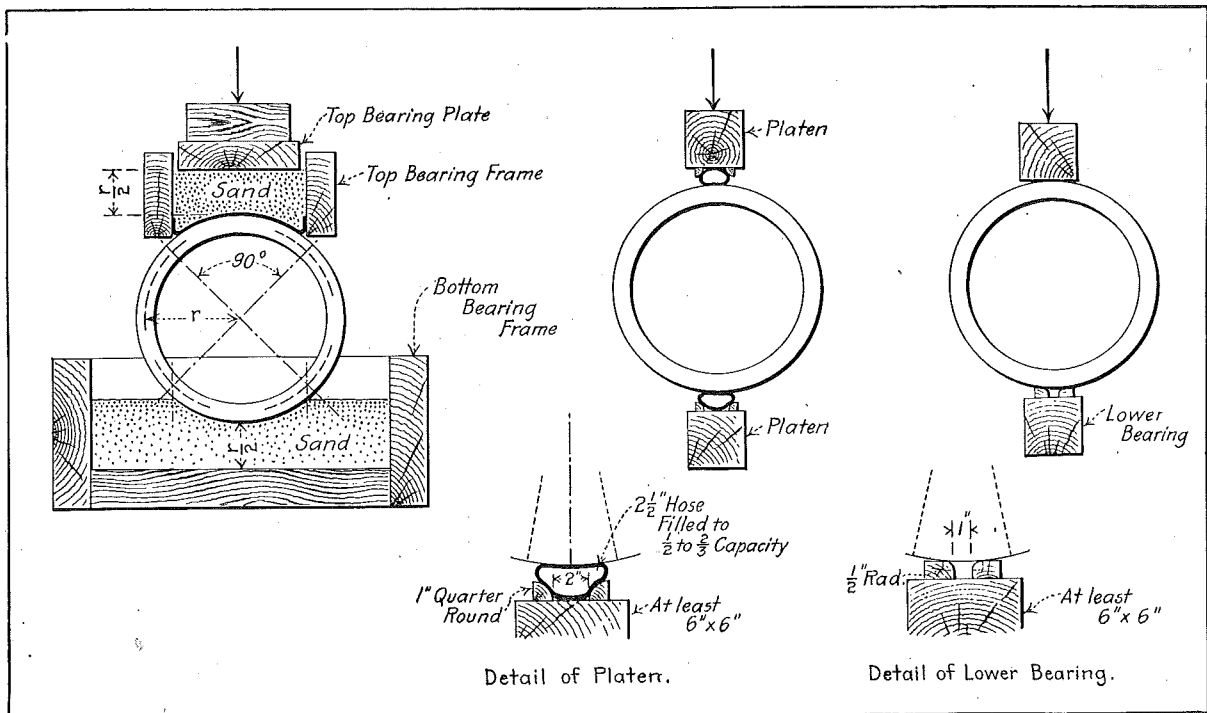


Fig. 1.—Sand Bearings

Fig. 2.—Hydraulic Bearings

Fig. 3.—Three-Point Bearings

The test load shall be applied at the middle of the top bearing, in such a way as to leave the bearing free to move in the vertical plane of the axis of the tile.

It is recommended that stops be screwed to the platen, symmetrical with the point of application of the load, and at a distance apart not greater than the length of the tile plus $\frac{1}{2}$ in. This will help center the load coming upon the tile.

Three-point Bearings

20. (See Fig. 3).—When three-point bearings are used, the ends of each specimen of tile shall be accurately marked in halves of the circumference prior to the test.

The lower bearings shall consist of two wooden strips with vertical slides, each strip having its interior top corner rounded to a radius of approximately $\frac{1}{2}$ in. They shall be straight, and shall be securely fastened to a rigid block with their interior vertical sides 1 in. apart.

The upper bearing shall be a wooden block, straight and true from end to end.

The test load shall be applied through the upper bearing block in such a way as to leave the bearing free to move in a vertical plane passing midway between the lower bearings.

In testing a tile which is "out of straight," the lines of the bearings chosen shall be from those which appear to give most favorable conditions for fair bearings.

Test Specimens

(B) Absorption Tests of Drain Tile

21. Not less than three separate test specimens from each of five separate tiles shall be taken as a "standard sample" for the absorption test. Of the three specimens from each tile, one shall be taken from one end, another from the opposite end, and the third shall be taken from the middle portion of the tile. Each specimen shall be of from 12 to 20 sq. in. in area, measured upon the exterior or convex side, and shall be as nearly square as the nature of the material will readily permit. The specimens shall be obtained by breaking the tile and shall be apparently sound, solid pieces of the wall of the tile, and shall not show cracks or fissures or shattered edges due to the shock of breaking or cutting. The specimens may be obtained from the broken pieces of the tiles used in the strength test, if the restrictions as to the size and location of the specimens can be duly observed. The specimens shall be so marked as to permit the identity of each one to be ascertained at any stage of the test.

Drying Test Specimens

22. Preparatory to the absorption test, all specimens shall be first weighed and then dried in a drier or oven, at a temperature of not less than 110°C (230°F .) for not less than three hours. After removal from the drier, the specimens shall be allowed to cool to a temperature of 20 to 25°C . (68 to 77°F .) and reweighed. If the specimens were apparently dry when taken, and the second weight closely checks the first, the specimens shall be considered dry. If the specimens were known to be wet when taken, they shall be placed in the drier for further drying treatment of two hours, and reweighed. If the third weight checks the second, the specimens shall be considered dry. In case of any doubt, the specimens must be redried for two-hour periods until check weights are obtained.

Weighing and Re-weighing

23. The balance used shall be sensitive to 0.5 g. when loaded with 1 kg., and weighings shall read at least to the nearest gram. Where other than metric weights are used, the same order of accuracy must be obtained.

In reweighing after immersion, the specimens shall be removed from the water, not allowed to drain for more than one minute, the superficial water removed by towel or blotting paper, and the specimens at once put upon the balance.

Immersion of Test Specimens

24. Specimens after weighing shall be placed in a suitable woven-wire receptacle, packed tightly enough to prevent jostling, covered with distilled water or rainwater, raised to the boiling point and boiled for five hours, and then cooled in water to a final temperature of 10 to 15°C . (50 to 59°F .)

Calculation Reporting of Results

25. The test results shall be calculated as percentage of the initial dry weight, carried to the nearest first decimal place. The results shall be reported separately for each individual specimen, together with the mean of the fifteen or more specimens comprising the standard sample, the maximum and the minimum single observations entering into the mean, and the variation between the maximum and the minimum of the three specimens of each tile represented in the standard sample.

(C) Freezing and Thawing Tests of Drain Tile.

Test Specimens

26. The test specimens employed in making the absorption test shall preferably be used for the freezing and thawing test. In the event that the same specimens are not available, another set selected as specified in Section 21 shall be taken.

Drying Test Specimens

27. In the event that new specimens for the freezing and thawing test must be prepared, they shall be dried as specified in Section 22.

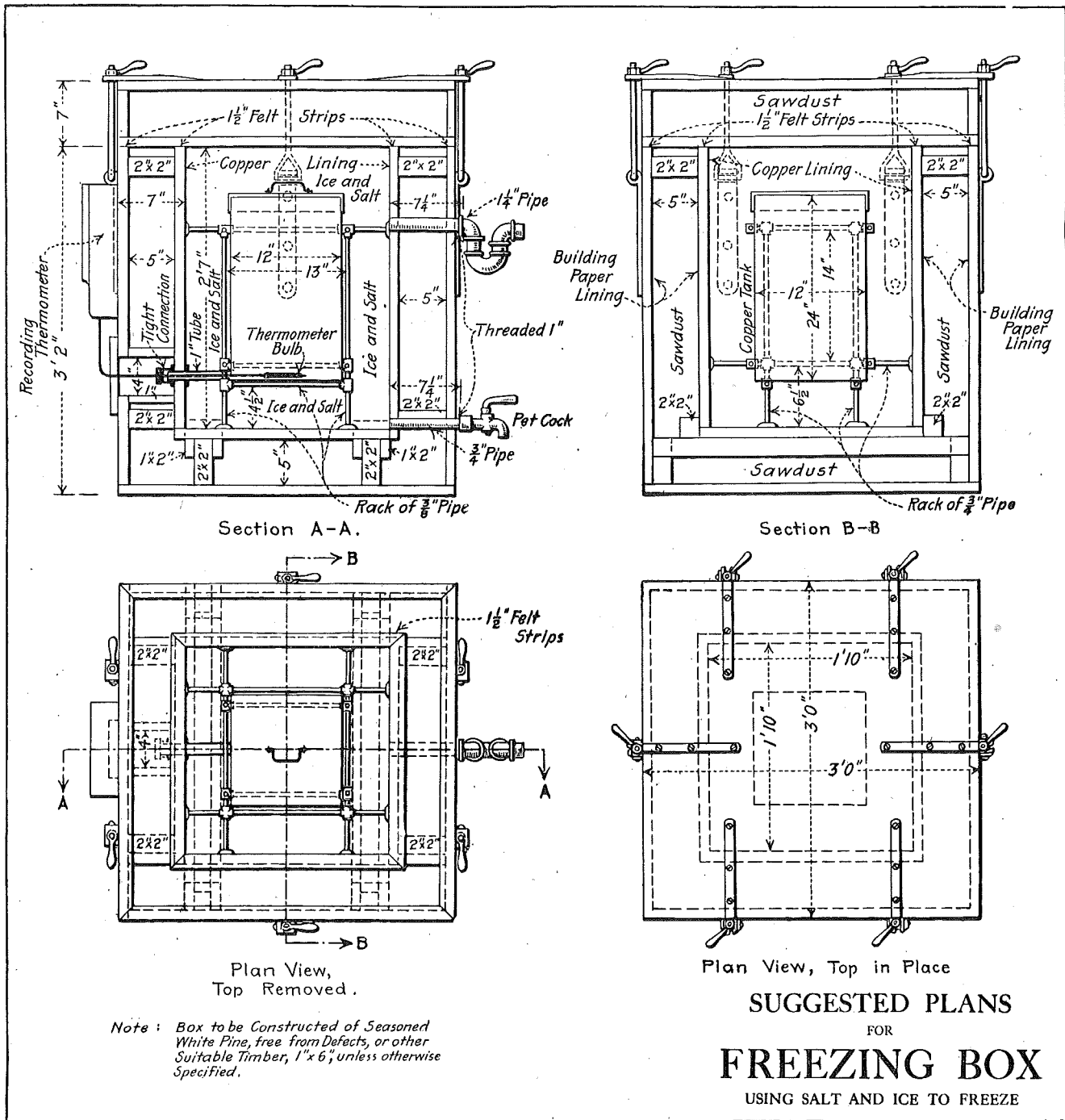
Weighing and Reweighing

28. The same scales and weights as are specified in Section 23 for the absorption test or others of equivalent sensitiveness and accuracy shall be employed for the weighings required in the freezing and thawing test. The same procedure in weighing and reweighing as specified in Section 23 shall be used.

Immersion of Test Specimens

29. In the event that new specimens for the freezing and thawing test must be prepared, they shall be immersed and boiled and cooled in water as specified in Section 24.

PLATE I.
1916 A. S. T. M. Standards
Standard Specifications for Drain Tile



Freezing and Thawing

30. When the specimens (either from the absorption test or from a specially prepared series) have been weighed after saturation with water, they shall be returned to the water, and kept immersed till the freezing test is begun. For freezing, they shall be placed with their concave faces upward in water-tight metal trays, suitably mounted in a rigid metal crate,¹ and immersed in ice water until the specimens have attained substantially the temperature of the water, after which the water shall be drawn down to a depth of 1/2 in. in each tray. The crate shall then be lifted as a whole, without disturbing the specimens, and placed in the freezing apparatus.

Freezing shall be performed in a quiet atmosphere, free from perceptible natural or artificial currents. If artificial freezing apparatus is employed,² the apparatus shall have sufficient heat-absorbent capacity to enable the temperature of the freezing chamber to be brought to -10° C. ($+14^{\circ}$ F.) or below, within thirty minutes after the introduction of the specimens. The temperature in the freezing apparatus shall not fall lower than -20° C. (-4° F.). The freezing shall be continued until the water in the trays is frozen solid. Exposure to freezing conditions in excess of this requirement shall be considered as without significance.

At the conclusion of freezing under the specified conditions, the crate of specimens shall be withdrawn and at once immersed in water at a temperature of 85 to 100° C. (185 to 212° F.) in a special receptacle of proper size. Heating shall be continued so that the water will regain the required temperature as soon as practicable after the specimens are immersed. A temperature of 85 to 100° C. (185 to 212° F.) shall then be maintained for not less than 15 minutes. At the conclusion of the thawing treatment, the crate of specimens shall be cooled down rapidly in water to 10 to 15° C. (50 to 59° F.) and then inspected. The condition of each sample after each thawing shall be noted in the records.

31. Failure under the freezing and thawing treatment shall be considered to be reached when:

- (a) The specimens show superficial disintegration or spalling with loss of weight of more than 5 per cent of the initial dry weight; or
- (b) The specimens are badly cracked in other than lamination planes; or,
- (c) The specimens show evident loss of structural strength.

IV. Physical Test Requirements.

32. The physical test requirements for the different classes of drain tile shall be as given in Table I.

Method of Determining Failure in Freezing and Thawing Tests

Physical Test Requirements

Notes:
 Rack Constructed of $\frac{5}{8}$ " x $\frac{5}{8}$ " x $\frac{1}{8}$ " Galvanized Angles, except as Noted. All Connections Riveted or Soldered.
 Trays, $11 \times 11 \times \frac{1}{2}$ " outside, Made of No. 17 Galvanized Steel.

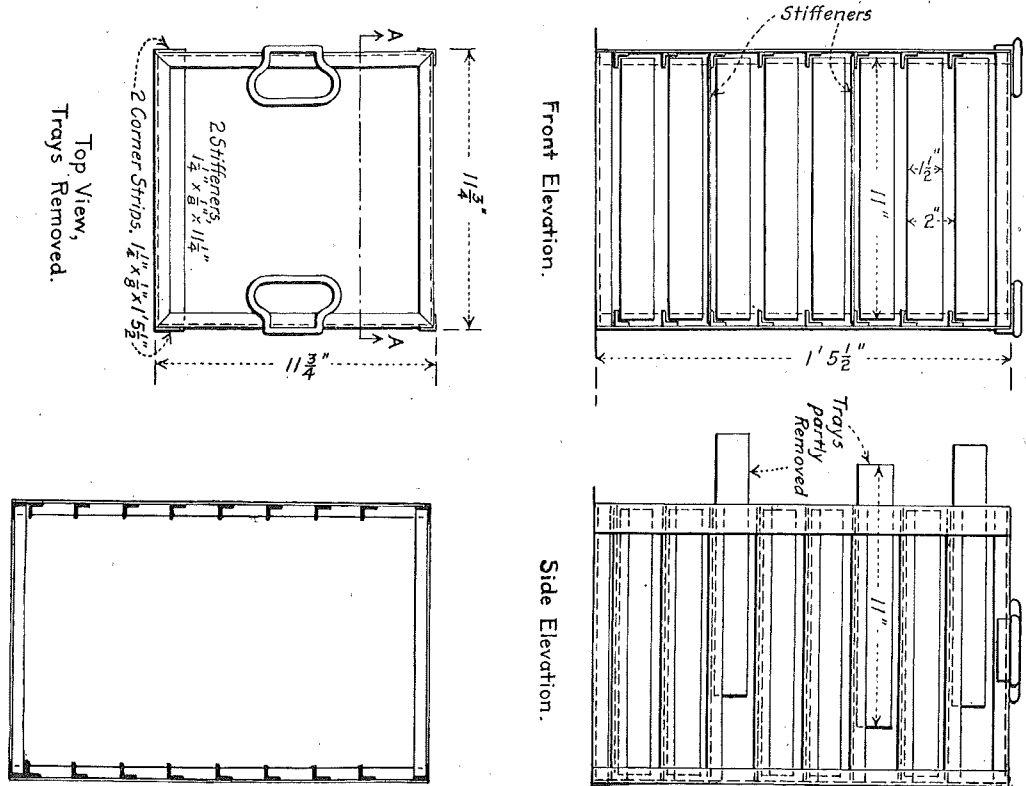


Fig. 4.—Suggested Plans for Freezing Crate and Trays

Absorption Requirements for Drain Tile made of Mixed Clays

33. Drain tile made of mixtures of surface clays with other clays shall conform to the absorption requirements for surface-clay tile in Table I when the proportion of surface clay is 75 per cent or more, and to the requirements for shale and fire-clay tile for all other proportions.

¹Fig. 4 shows the crate and trays suitable for use in the box for artificial freezing illustrated in Plate I.
²Artificial freezing will generally be necessary. It may be conducted in a commercial zero (F.) refrigerating room, or in an artificial freezing box similar to the one shown in Plate 1, in which zero (F.) temperatures can readily be produced by the use of salt and ice.

Appeal from Absorption Test to Freezing and Thawing Test

34. In the event that a standard sample (Section 21) of tile fails to meet the requirements of the absorption test, the manufacturer or other seller may demand recourse to the freezing and thawing test, to be made at his expense. In such recourse, the number of tiles tested shall be four times the number represented by the standard sample (Section 21). If the material passes the freezing and thawing test satisfactorily, it shall not be rejected on account of its failure to meet the absorption requirements specified in Table I, but the average percentage of absorption of the specimens used in the freezing and thawing test shall be adopted as the maximum allowable mean absorption for the contract in question.

Limits of Fluctuation of Individual Test Specimens in Physical Tests; Culling and Retesting when Limits Exceeded

35. In the strength tests, individual tiles of a standard test whose mean strength is satisfactory may fall 25 per cent below the requirement for the average without causing rejection. In the absorption test, the absorption of individual tiles of a standard sample, (Section 21) which gives a satisfactory mean absorption percentage, may exceed the average by 25 per cent without causing rejection. In the freezing and thawing test, at least 95 per cent of all the tiles tested shall meet the requirement.

In the event of the failure of a standard sample (Sections 9, 21 and 26) to meet the above requirements, the manufacturer or other seller may thoroughly cull the material and submit a portion of retest at his own expense, and for such retest the number of tiles per sample shall be 10 for the strength and absorption tests and 20 for the freezing and thawing test. In the event of the failure of the material after culling to pass the requirements it shall be rejected without further test.

TABLE I.—PHYSICAL-TEST REQUIREMENTS FOR DIFFERENT CLASSES OF DRAIN TILE

Internal Diameter of Tile, In	Farm Drain Tile			Standard Drain Tile			Extra-Quality Drain Tile					
	Minimum Average Ordinary Supporting Strength, lb. per linear ft.	Maximum Average Absorption by Standard Boiling Test, per cent			Minimum Average Ordinary Supporting length 15 per linear ft.	Maximum Average Absorption by Standard Boiling Test, per cent			Minimum Average Ordinary Supporting Strength, lb. per linear ft.	Maximum Average Absorption by Standard Boiling Test, per cent		
		Shale and Fire-Clay Tile	Surface-Clay	Concrete Tile		Shale and Fire-Clay Tile	Surface-Clay Tile	Concrete Tile		Shale and Fire-Clay Tile	Surface-Clay Tile	Concrete Tile
4	800	11	14	12	1200	9	13	11	1600	7	11	10
6	800	11	14	12	1200	9	13	11	1600	7	11	10
8	800	11	14	12	1200	9	13	11	1600	7	11	10
10	800	11	14	12	1200	9	13	11	1600	7	11	10
12	800	11	14	12	1200	9	13	11	1600	7	11	10
14	900	11	14	12	1200	9	13	11	1600	7	11	10
16	1000	11	14	12	1300	9	13	11	1600	7	11	10
18					1400	9	13	11	1800	7	11	10
20					1500	9	13	11	2000	7	11	10
22					1600	9	13	11	2200	7	11	10
24					1700	9	13	11	2400	7	11	10
26					1800	9	13	11	2600	7	11	10
28					1900	9	13	11	2800	7	11	10
30					2000	9	13	11	3000	7	11	10
32					2100	9	13	11	3200	7	11	10
34					2200	9	13	11	3400	7	11	10
36					2300	9	13	11	3600	7	11	10
38					2400	9	13	11	3800	7	11	10
40					2500	9	13	11	4000	7	11	10
42					2600	9	13	11	4200	7	11	10

NOTE:—When the freezing and thawing test is specified or demanded, as provided in Section 7, the number of freezings and thawings to be endured shall be as follows: For farm drain tile, 8; for standard drain tile, 12; for extra-quality drain tile, 16.

Strength Test Requirements When Manufacturer is held Responsible for Cracking in Ditches

36. The manufacturer or other seller shall not be held responsible for cracking of drain tile in ditches unless by special agreement in advance, and in any event his obligation shall be held to be discharged by the delivery of the drain tile having the minimum ordinary supporting strengths specified in Table II; and, if it is not otherwise specified in advance by the purchaser, tile shall be supplied of the strengths specified for clay ditch filling, for "ordinary" pipe laying and for widths of ditch at the level of the top of the tile equal to 0.5 ft. greater than the outside diameters of the tile. The purchaser shall furnish to the manufacturer or other seller complete information in advance of receiving bids, as to the number of linear feet of drain tile of each diameter required for each different depth of ditch, measured to the nearest foot from the surface of the ground to the top of the tile.

V. Visual Inspection

Visual Inspection and its Purposes	37. All drain tile shall be given a thorough visual inspection at the trench by a competent inspector employed by the purchaser. The purposes of the visual inspection shall be: (1) to cull and reject imperfect individual tiles; and (2) to determine whether the tiles, independently of meeting the chemical and the physical test requirements, comply with the specifications of general properties, especially as stated hereinafter.
Shape	38. All drain tile shall be of approximately circular cross-section, except when otherwise specified in advance. They shall be approximately straight, except in the case of special connections. The ends shall be so regular and smooth as readily to admit of making close joints by turning and pressing together adjoining tile.
Nominal Sizes	39. The sizes of drain tile shall be designated by their interior diameters.
Minimum Lengths	40. Drain tile smaller than 12 in. in diameter shall have a minimum length of 12 in. Tile of from 12 to 30 in. in diameter, inclusive, shall have lengths not less than the diameters. Tile larger than 30 in. in diameter shall have a minimum length of 30 in.
Structure	41. Drain tile shall be substantially uniform in structure throughout, and the inspector shall investigate this property by examining fractured surfaces.
Ring	42. Drain tile shall give a clear ring when stood on end and while dry tapped with a light hammer.
Color	43. The inspector may use the color of drain tile as a general guide in sorting and inspecting, but he shall first so familiarize himself with the raw materials and the processes used in the manufacture of the particular tile in question as to be competent to interpret the true meaning of variations in their color.
Inside Smoothness	44. Drain tile shall be reasonably smooth on the inside.
Cracks, Checks, Chips and Broken Pieces	45. Drain tile shall be free from cracks and checks extending into the body of the tile in such a manner as to decrease the strength appreciably. Tile shall not be chipped or broken in such a manner as to decrease their strength materially or to admit earth into the drain.
Use of the Terms Vitrified and Hard-Burned	46. All drain tile shall be sufficiently "vitrified" or "hard-burned" to afford the degree of supporting strength, percentage of absorption, and resistance to freezing and thawing specified in the physical test requirements prescribed in Table I.
Appeal from results of Visual Inspection	47. The manufacturer or other seller may appeal from decisions of the inspector on questions of strength or structure when such decisions are based on visual inspection alone, in which case the point at issue shall be determined by standard physical tests, the cost of which shall be paid by the appellant, if the inspector was right, or by the purchaser if his inspector was in error.
Additional Distinctive Physical Characteristics	48. Drain tile of the different classes shall, in addition to all requirements heretofore specified, have the distinctive physical characteristic prescribed in Table III.
VI. Testing, Inspection and Rejection.	
Making and Reporting Tests	49. All tests shall be made by experts employed by the purchaser. Full reports of all tests shall be furnished the manufacturer or other seller on his request. Tests shall be made and reported promptly.
Expense of Making Tests	50. The purchaser shall pay the expense of making all tests except as otherwise specified in Sections 9, 34, 35, 47 and 52.
Number of Tests	51. The number of standard tests to be made shall be determined by the purchaser.
General Tests and Inspection at Factory	52. In all contracts for ten or more carloads of tile, preliminary general tests and inspection shall be made at the factory by the purchaser upon demand of the manufacturer or other seller. The expense of such tests and inspection shall be paid by the manufacturer or other seller.
Inspector	53. The inspector shall be employed by the purchaser.
Inspection	54. The manufacturer or other seller of the drain tile shall afford the inspector all reasonable facilities for his work, both as to the selection of specimens for tests, and as to visual inspection. Inspection shall be completed promptly.
Rejection	55. The inspector shall plainly mark all drain tile which he rejects, and such rejected tile shall be removed promptly by the manufacturer or other seller. Upon request of the purchaser, the manufacturer or other seller shall give full account of the removal of rejected tile.

BRIDGE SPECIFICATIONS

General

B-1 Location, Delivery of Material, Etc.

The Engineer will set stakes where piling are to be driven, and will furnish stakes and other information for the guidance of the Contractor. The Contractor's Bid for the completion of a bridge shall include all items of expense to be incurred and shall include the grading of suitable approaches to connect with the highway on which the bridge is located. All material required for any given bridge shall be delivered on the ground so that the work of construction may be commenced immediately after the excavation of the ditch has been completed. The Contractor will be required to prosecute the work of construction in a manner that will insure the completion of the bridge within a reasonable time so as to prevent undue delay in the resumption of public traffic. The question as to what shall be a reasonable time shall be construed by the Engineer.

All parts forming a structure shall be built in accordance with the Contract Drawings. The workmanship and finish shall be equal to the best practice in modern bridge building.

B-2 Abutments

FORMS, EXCAVATION AND BACKFILLING—The amount bid per cubic yard for abutments and piers shall include the furnishing of material and the making of all necessary forms, excavations and backfilling of trenches around the footings. Material for backfilling shall be tamped, and shall be free from sod, wood or organic matter and the roadbed shall be restored to its original condition as a part of the Contract.

WIDTH—Any abutment for a span with a roadway not exceeding 20 feet, shall not be less than 22 feet in length on the back of the wall. For wider roadways the main wall shall not be less than 24 feet in length.

STABILITY—Abutments, except those for short spans where said spans are anchored to the abutment, shall be so designed and have wings of such length that they will be independent of support from the span.

PILING—Piling are to be driven to a firm and solid foundation according to Engineering News For-

mula
$$P = \frac{2Wh}{S+1}$$
 where

P=safe load on piles in tons

W=weight of hammer in tons

h=fall of hammer in feet

S=average penetration in inches per blow for the last three blows.

Rings or followers are to be used on piling to prevent splitting and undue brooming from the blows of the hammer. After the piling have been driven to a firm and solid foundation they shall be cut off squarely and to the proper elevations so as to furnish true bearings with the cap or sill.

B-3 Clearing up

After the completion of the construction work the Contractor shall, as a part of his Contract, clear up the premises, remove all false work, form work, etc. He shall remove all obstruction from the stream, leaving the waterway in as good condition as before the work was commenced.

B-4 Temporary Bridges

If so ordered, the Contractor shall build and maintain a safe and satisfactory temporary crossing while the work is in progress, and until such time as the new structure can be used.

BRIDGE SPECIFICATIONS

Timber Bridges

B-5 Workmanship

Abutting joints shall be cut or dressed true and straight, and fitted close together. In joints where strength and rigidity are dependent upon contact bearings, the surfaces shall be truly faced so as to provide full contacts, after the parts of the structure have been properly lined and assembled. All spikes and nails are to be driven so as to draw the pieces firmly together. All parts of the structure which are to receive paint are to be of dressed material.

B-6 Timber Re- quirements

All timber shall be cut from sound trees and sawed to standard sizes, close grained and solid, free from defects such as injurious ring-shakes and crooked grain, unsound knots, knots in groups, decay, large pitch pockets, or other defects that will materially impair its strength.

Rough timbers when sawed to standard size, shall mean that they shall not be over $\frac{1}{4}$ inch scant from actual size specified. For instance, a 12 inch x 12 inch timber shall mean not less than $11\frac{3}{4}$ x $11\frac{3}{4}$ inches actual measurement.

Standard dressing means that not more than $\frac{1}{4}$ inch shall be allowed for dressing each surface, for instance, a 12 inch x 12 inch timber shall, after dressing the four sides, measure not less than $11\frac{1}{2}$ x $11\frac{1}{2}$ inches.

B-7 Quality of Timber

STRINGERS—White, Norway and Yellow Pine, Douglas Fir, Tamarack and White Oak—Shall not show less than 80 % of heart on each of the four sides, measured across the side anywhere in the length of the piece. Loose knots, or knots greater than $1\frac{1}{2}$ inches in diameter will not be permitted at points within 4 inches of the edge of the piece.

CAPS—White Pine, Norway and Yellow Pine, Douglas Fir, Tamarack, White Oak and Western Hemlock—Shall be square edged, except they may have 1 inch wane on one corner, or ½ inch wane on two corners. Knots must not exceed in their largest diameter ¼ the width of the face of the stick in which they occur. Ring-shakes extending not over ⅓ the length of the piece are admissible.

POSTS, RAILINGS, AND WHEEL-GUARDS—White Norway and Yellow Pine, Tamarack and Douglas Fir—Shall show not less than 75% heart measured across the face anywhere on the length of the piece, and be free from knots over 2 ½ inches in diameter, which must not be in groups.

FLOORS—Norway and Yellow Pine, Douglas Fir, Hemlock, Western Hemlock and Tamarack—Shall be square edged, except they may have 1 inch wane on 1 corner. Knots must not exceed in their largest diameter ¼ the width of the face of the stick in which they occur. Ring-shakes extending not over ⅓ of the length of the piece are permissible.

PILING—Cedar, Oak and Tamarack—All piling shall be cut from sound live trees of slow growth, firm grained, free from ring-shakes, decay, large unsound knots or other defects that will impair their strength and durability. They shall be butt cut above the ground swell and be uniformly tapering from the butt to the tip. They shall be so straight that a line stretched from the center of the pile at the butt to the center of the pile at the tip will not leave the center of the pile at any point more than 3 inches for 20 feet, 4 inches for 30 feet, 6 inches for 40 feet and 8 inches for 50 feet in length. No short bends shall be allowed. All knots shall be trimmed close to the body of the pile and the bark peeled.

B-8
Bolts, Drift-
Bolts, Washers,
Spikes, etc.

BOLTS—Bolts shall be of wrought iron or steel, made with square heads, standard size, the length of the thread to be 2 ½ times the diameter of the bolt. The nuts shall be made square, standard size, with thread fitting closely the thread of the bolt. All threads shall be cut according the U. S. Standards.

DRIFT-BOLTS—Drift-bolts shall be of wrought iron or steel, with or without square heads, pointed or without points, as may be called for on Plans, or may be ordered by the Engineer.

SPIKES—Spikes shall be of wrought iron or steel, square or round, as called for on the Plans, steel wire spikes when used for spiking planking shall not be used in lengths of more than 6 inches; if greater lengths are required wrought iron or steel spikes shall be used.

WASHERS—Shall be of cast iron. The diameter shall be not less than 3 ½ times the diameter of the bolt for which it is used, and its thickness equal to the diameter of the bolt; the diameter of the hole shall be ½ inch larger than the diameter of the bolt.

SPECIAL CASTINGS—Shall be made true to pattern, without warp, free from flaws and excessive shrinkage, size and shape to be as called for by the Plans.

B-9
Painting

After structure has been erected complete, all exposed parts (except floor and piling) shall be covered with two coats of paint. The first coat shall consist of a mixture of 8 pounds of Iron Oxide to each 1 gallon pure Linseed Oil. The second coat shall consist of a mixture of 22 pounds of Red Lead to each 1 gallon pure Linseed Oil. The pigments of the two coats must differ in color so that they may readily be discernable. Before the second coat is applied, all checks, cracks, holes or crevices which are apt to hold water must be filled with thick paint, or some other water-proof compound.

B-10
Estimates and
Payments

Estimates of work done and progress and final payments shall be made as provided in Section G-23 of General Conditions hereof.

BRIDGE SPECIFICATIONS

Steel Bridges

All steel shall be made by the open hearth process.

The steel shall be uniform in character for each specified kind. All finished bars, plates and shapes shall be free from cracks on the face or corners and have a clean, smooth finish.

Shearing shall be neatly and accurately done and all portions of the work neatly finished.

Material shall be thoroughly straightened in the shop by methods that will not injure it, before being fabricated.

B-11
Process of
Manufacture
B-12
Finish

SIZE OF RIVETS—The size of rivets called for on the Plans shall be understood to mean the actual size of the cold rivet before heating.

RIVET HOLES—When general reaming is not required the diameter of the punch shall not be more than 1/16 inch greater than the diameter of the rivet; nor the diameter of the die more than ⅛ inch greater than the diameter of the punch. Material more than ¾ inch thick shall be sub-punched and reamed or drilled from the solid.

B-13
Rivets, Rivet
Holes, Punch-
ing, etc.

PUNCHING—All punching shall be accurately done. Drifting to enlarge on fair holes will not be allowed. If the holes must be enlarged to admit the rivet, they shall be reamed. Poor matching of the holes will be cause for rejection.

SUB-PUNCHING AND REAMING—Where reaming is required, the punch shall have a diameter not less than 3/16 inch smaller than the normal diameter of the rivet. Holes shall be reamed to a diameter not more than 1/16 inch larger than the normal diameter of the rivet. All reaming shall be done with twist drills.

EDGES—Sheared edges or ends shall, when required, be milled at least ¼ inch.

BURRS—The outside burr on reamed holes shall be removed.

B-14
Erection

(a) FALSE WORK—The Contractor shall furnish all material, build and erect all false work and assume all liability for any accidents or damage to property, that may occur to said property during the erection of the structure.

(b) ASSEMBLING—Riveted members shall have all parts firmly drawn together with bolts before riveting is commenced.

(c) REAMING—If holes do not line up they shall be reamed out to proper alignment. Drifting or distortion of the metal will not be allowed.

(d) RIVETING—Rivets shall be driven by pressure tools wherever possible. Pneumatic hammers shall be used in preference to hand driving. Rivets shall look neat and finished with heads of approved shape, full and of equal size. They shall be central on shank and grip the assembled pieces firmly. Recupping and calking will not be allowed. Loose, burned or otherwise defective rivets shall be cut out and replaced. In cutting out rivets, great care shall be taken not to injure the adjacent metal. If necessary, they shall be drilled out.

(e) TURNED-BOLTS—Wherever bolts are used in place of rivets which transmit shear, the holes shall be reamed parallel and the bolts turned to a driving fit. After nuts have been turned tight, threaded ends of bolts shall be cold-riveted to prevent the nuts from loosening or being removed.

(f) FINISH OF JOINTS—Abutting joints shall be cut or dressed true and straight and fitted closely together. In compression joints, depending on contact bearing, the surfaces shall be truly faced, so as to have even bearings after they are riveted up complete and when perfectly aligned.

(g) SCREW THREADS—Screw threads shall make tight fits in the nuts and shall be U. S. Standard, except above the diameter of 1 3/8 inch, when they shall be made with six threads per inch.

(h) FIELD RIVETS—Field rivets shall be furnished to the amount of 15 per cent plus ten rivets in excess of the normal number required for each size.

(i) NAILING PIECES—The nailing pieces shown on the plans shall be rigidly bolted to the channels or I-beams by means of 5/8 inch bolts not more than 3 feet apart. Nailing pieces to the sides of the beams or channels shall have the top of the nailing pieces flush with the top of the beam or channel.

**B-15
Painting**

Steel work before leaving the shop, shall be thoroughly cleaned and given one coat of pure Boiled Linseed Oil and Red Lead mixed in the proportions of 25 pounds of Red Lead to one gallon of Linseed Oil. This coat shall cover all joints and open spaces. All parts which come in contact and those which are not accessible for painting after erection shall be given two coats of paint before leaving the shop. Painting shall be done when the surface of the metal is perfectly dry. It shall not be done in wet or freezing weather unless protected under cover.

PAINTING AFTER ERECTION—After the Bridge is erected the metal work shall be thoroughly cleaned of mud, grease or other material, then thoroughly and evenly painted with two coats of paint. The first coat shall consist of a mixture of 8 pounds of Iron Oxide to each one gallon of pure Boiled Linseed Oil. The second coat shall consist of a mixture of twenty-two pounds of Red Lead to each one gallon of pure Linseed Oil. All recesses which will retain or through which water can enter, must be filled with thick paint or some water-proof cement before the final painting. The different coats of paint must be of distinctly different shades or colors, and one coat must be allowed to dry thoroughly before the second coat is applied. No painting shall be done in wet or freezing weather.

**B-16
Estimates and
Payments**

Estimates of work done and progress and final payments shall be made as provided in Section G-23 of General Conditions hereof.

CONCRETE SPECIFICATIONS

**X-1
Forms**

Contractors shall provide all necessary material and means for building the forms for all concrete structures.

All forms shall be so constructed as to be held rigidly in place, line and elevation. If at any period of the work, after the concrete has been placed, the forms show signs of bulging or sagging, that portion of the concrete shall be immediately removed on notice by the engineer and the forms shall be re-set and securely braced against further movement.

All forms are to remain in place until, in the opinion of the Engineer, it is safe to remove them.

**X-2
Materials**

(a) CEMENT—The cement shall be Portland cement which meets the requirements of the latest Standard Specifications of the Am. So. for Testing Materials.

(b) WATER—The water used in concrete shall be fresh, clean, and free from dirt and sewage. The use of alkali water will not be allowed.

(c) FINE AGGREGATES—These shall consist of sand, crushed stone, or gravel screening graded from fine to coarse, which material when dry, will pass through a screen having holes one-fourth (1/4) inch in diameter. The aggregates should be composed of hard material, free from soft particles, vegetable loam or other deleterious matter. It shall not contain clay in excess of four (4 %) per cent and not more than six (6 %) per cent shall pass a sieve having 100 meshes per lineal inch. The fine aggregate shall be of such quality that mortar composed of one part Portland cement and three parts of fine aggregate by weight when made into briquetts shall show a tensile strength of at least seventy (70 %) per cent of the strength of one to three mortar of the same consistency made with the same cement and standard Ottawa sand.

(d) COARSE AGGREGATES—These shall consist of crushed stone or gravel graded in size, which is retained on a screen having holes one-fourth ($\frac{1}{4}$) inch in diameter; it shall be clean, hard, durable and free from all deleterious matter. Aggregates containing soft, flat or elongated particles shall not be used. For reinforced concrete (unless otherwise specified in the Drawing) the maximum size of the coarse aggregates shall be such as to pass a one and one-half ($1\frac{1}{2}$) inch ring. Where concrete is used in mass, sizes shall not exceed two and one-half ($2\frac{1}{2}$) inches in their greatest diameter.

(e) PIT-RUN—Pit run gravel when used must be of such quality that when screened through a 4 mesh screen, the sand and the gravel obtained will conform to the requirements of fine and coarse aggregates respectively. The proportion of pebbles to sand shall not exceed two to one and the volume of the cement shall be one part of cement and two parts of sand.

(f) METAL REINFORCEMENT—The metal reinforcing steel shall be made by the basic open-hearth process and shall meet the requirements of the Specifications Adopted for Reinforcing Bars by the Association of American Steel Manufacturers.

**X-3
Unit of
Measure**

The unit of measure shall be the cubic foot. A bag containing not less than ninety-four (94) pounds of cement shall be assumed as one cubic foot of cement. Fine and coarse aggregates shall be measured separately and loosely thrown into the measuring receptacle. No wheel-barrow measurements shall be allowed.

**X-4
Proportions**

The concrete unless otherwise specified on Drawings shall be mixed in the proportion of one (1) cubic foot Portland cement, two (2) cubic feet of fine aggregates, and four (4) cubic feet of coarse aggregates. If pit-run is used, proportioning shall be made one cubic foot of Portland cement to four (4) cubic feet of sandy gravel to be taken from the pit.

**X-5
Measuring
Proportions**

Methods of measurement shall be used which will secure separate uniform measurements at all times of the proportions of the various ingredients, including water.

**X-6
Mixing**

The ingredients of concrete shall be thoroughly mixed to the desired consistency and the mixing shall continue until the cement is uniformly distributed and the mass is uniform in color and of a homogeneous consistency.

(a) MACHINE MIXING—Where conditions will admit, a batch mixer of a type approved by the Engineer, which insures uniform mixing of the material throughout the mass shall be used. Each batch shall remain in the mixer for a period of not less than one minute after all the materials are in the drum. During this period the drum shall operate at the speed for which it is designed, but not less than fourteen (14) nor more than twenty (20) revolutions per minute. The entire contents shall be removed from the drum before the materials are placed therein for the succeeding batch.

(b) HAND MIXING—When it is necessary to mix by hand the mixing shall be done on a water-tight platform and special precautions shall be taken to turn the materials until the mixture is homogeneous in appearance and color.

(c) CONSISTENCY—The material shall be mixed wet enough to produce a concrete of such consistency as will flow into the forms and around the metal reinforcement, and which on the other hand, can be conveyed from the place of mixing to the forms without separation of the coarse aggregates from the mortar.

(d) RE-TEMPERING—Re-mixing concrete with water after it has practically set will not be permitted.

(e) PLACING OF CONCRETE—(1) After the addition of water the mixture shall be handled rapidly from the place of mixing to the place of the final deposit, and under no circumstances shall concrete be used that has partially set before final placing.

(2) The Concrete shall be deposited in such a manner as will permit the most thorough compacting, such as can be obtained by working with a straight shovel, or slicing tool kept moving up and down until the ingredients have been steered to their proper place by gravity and the surplus water has been forced to the top.

(3) In depositing concrete under water special care shall be exercised to prevent the cement from floating away, and to prevent the formation of laitance. Unless otherwise specified, concrete for placing under water shall consist of a $1\frac{1}{2} : 2 : 4$ mixture.

(4) Before placing concrete the form shall be thoroughly wetted and the space to be occupied by the concrete freed from debris.

(5) Before placing fresh concrete on or against concrete which has set, the surface of the latter shall be roughened, thoroughly cleaned of foreign material and laitance, and drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts of fine aggregate.

(6) The faces of the concrete exposed to premature drying shall be kept wet for a period of at least three days.

**X-7
Placing of
Reinforcement**

The metal reinforcement shall be carefully placed in accordance with the Plans and adequate means shall be provided to hold it in its proper position until the concrete has been deposited and compacted.

Whenever it is necessary to splice the reinforcement by lapping, the length of the lap shall not be less than forty diameters. Splices shall not be made at the points of maximum stress.

**X-8
Joints in walls**

If at any time the work is interrupted so that the concrete already deposited attains its initial set, the surface of such concrete shall be chipped off for a sufficient depth to expose the coarse aggregates, the loose material swept or washed away, the surface thoroughly wetted and flushed with a thin 1 to 2 mortar before concreting is resumed. Concrete shall be placed in continuous horizontal layers in all abutments and piers. No plane of set will be allowed at a distance of less than 18 inches below the top of the wall.

**X-9
Protecting
Concrete
While
Curing**

Concrete structures shall be kept protected from the direct rays of the sun by means of canvas, straw or other means approved by the Engineer, and shall be kept continually wet for a period of one week after placing the same.

**X-10
Freezing
Weather**

The concrete shall not be mixed or deposited at freezing temperatures, unless special precautions, approved by the Engineer, are taken to avoid the use of materials containing frost or covered with ice crystals, and to provide means to prevent the concrete from freezing after being placed in position and until it is thoroughly hardened.

**X-11
Surface finish**

Upon the removal of the form work, all projecting ends of wires, bolts and rods shall be cut off smooth and flush with the face of the concrete. In case the concrete, as exposed upon the removal of the forms, is not sufficiently smooth, then the surface must be treated in whatever manner the Engineer requires.

**X-12
Estimates and
Payments**

Estimates of work done and progress and final payments shall be made as provided in Section G-23 of General Conditions hereof.

CULVERT SPECIFICATIONS

General

**Y-1
Location, etc.**

The Contractor will be required to place culverts in the ditches or through the waste banks at the points indicated on the Map or at such other points as the Engineer may direct. Such culverts are to be of the dimensions shown on Plans, unless otherwise directed by the Engineer.

Culverts shall be placed to center lines and grades ordered by the Engineer and designated by stakes set at points of installation.

**Y-2
Construction**

All culverts are to be placed in a careful workmanlike manner, on an even compact footing, and unless otherwise directed by the Engineer, shall have a fall of at least 3 inches in 24 feet in the direction of drainage.

The culverts must be covered to a depth of at least 1 foot over the highest point of the culvert, and when more filling is needed to provide a suitable approach for a road crossing over the culvert, such filling must be made by the Contractor. Backfilling around the culvert must be free from sod, wood, or vegetable matter, and must be thoroughly tamped. Unless otherwise designated on the Plans, the ends of the fills over and around the culverts are to be built up from sods. The price per lineal foot for which the Contractor has agreed to furnish and install culverts, is to include all expenses of furnishing, hauling, placing and constructing sod end retaining walls.

**Y-3
Clearing up**

After the completion of a Contract the Contractor shall as a part of his Contract, clear up the premises and remove all false work, form work, etc. He shall remove all obstructions from the stream, leaving the waterway in as good condition as before the work was commenced.

CONCRETE CULVERTS

**Y-4
Construction**

Concrete culverts shall be of the Design and placed in accordance with the Specifications of the Engineer. The amount bid per cubic yard for concrete in place shall include the construction and erection of all necessary forms, the excavation of all material and backfilling the trenches around the footings up to the natural surface of the ground. Backfilling shall be tamped and the material shall be free from sod, wood or vegetable matter and the roadbed shall be restored to its original condition as a part of the Contract. All concrete furnished shall comply with the requirements set forth under Concrete Specifications hereof.

CORRUGATED METAL CULVERT

**Y-5
Classes of
Metal**

Two classes of base metal for use in corrugated metal pipe are recognized in these Specifications, Class "A" and Class "B". Class "A" includes the metals commonly designated as pure irons, which are the products of the open hearth furnace in which the refining operation is carried forward until the impurities are reduced to a relatively low percentage, and may include not to exceed 0.2% of copper.

Class "B" includes those metals commonly designated as copper bearing steels which are the normal product of the open hearth furnace with which is alloyed a small percentage of copper.

**Y-6
Quality of
Metals**

Class "A" base metal shall contain not more than twenty-five hundredths (.25) per cent in the aggregate of the following metaloids—carbon, sulphur, phosphorous, silicon and manganese, and shall contain not more than four hundredths (.04) per cent of carbon, thirty-five thousandths (.035) per cent of sulphur and six thousandths (.006) per cent of phosphorus.

An allowance may be made in the aggregate amount of the five metaloids specified above of four hundredths (.04) per cent. The addition of not more than 0.2% of copper will be permitted.

Class "B" base metals shall contain not more than seven tenths (.7) per cent in the aggregate of the following metaloids:—carbon, sulphur, phosphorus, silicon, and manganese, and shall contain not more than fifteen hundredths (.15) per cent of carbon, two hundredths (.02) per cent phosphorus, and five hundredths (.05) per cent sulphur.

The metal shall have a tensile strength of not less than 40,000 lbs., and an elastic limit of not less than 25,000 lbs.

After the sheets are rolled they may be promptly annealed and they shall be free from blisters, seams, slag or foreign materials.

**Y-7
Galvanizing**

All materials entering into the construction of the pipe shall be galvanized in such a manner that the galvanizing forms a continuous impervious, pure zinc coating, uniform in thickness. It shall be so applied that it will adhere firmly to the metal. Plates having blisters or other imperfections in the galvanizing, after corrugating, shall be rejected. The galvanizing coating shall contain not less than three-quarters of one pound of zinc, per square foot of surface and for the two sides of 1 square foot of metal not less than 2 ounces nor more than 2 1/4 ounces. The amount of spelter shall be determined by test conducted in an approved manner by an Inspection Bureau.

**Y-8
Workmanship**

All material and workmanship shall be first-class in every particular. Culverts shall have a truly circular cross-section. They shall be truly straight throughout their entire length. They shall be free from all imperfections such as bends, dents or crimps in the metal.

**Y-9
Rivets and
Riveting**

All rivets shall be of the same material as specified for the culvert. They shall be well galvanized. Rivets shall be of the following dimensions:—

- No. 16 gauge material, 5/16 in. diameter x 5/8 in. long.
- No. 14 gauge material, (two thicknesses of sheets), 5/16 x 5/8 in.
- No. 14 gauge material, (three thicknesses of sheets), 5/16 x 3/4 in.
- No. 12 gauge material, (two thicknesses of sheets), 3/8 x 3/4 in.
- No. 12 gauge material, (three thicknesses of sheets), 3/8 x 7/8 in.
- No. 10 gauge material, (two thicknesses of sheets), 3/8 x 7/8 in.
- No. 10 gauge material, (three thicknesses of sheets), 3/8 x 1 in.

All rivets shall be driven cold in such a manner that the plates shall be drawn together throughout the width of the seam. No rivet shall be closer than twice its diameter from the edge of the metal. All rivets shall have neat, workmanlike and full size heads. They must be driven without bending and must fully fill the hole.

**Y-10
Corrugation**

All corrugations shall not be less than 2 1/2 inches, center to center, nor more than 3 inches. The corrugations shall have a depth of not less than 1/2 inch for 2 1/2 inches and not less than 5/8 in. for 3 in. corrugations.

**Y-11
End Reinforce-
ment**

The end of all corrugated metal culverts shall be reinforced with a galvanized iron band, riveted to the culvert at intervals of ten (10) inches or less. This band shall be equivalent in cross-section to 3/8 x 1 in. for No. 16 metal, 3/8 x 1 1/2 for No. 14 and No. 12 metal and 1/2 x 2 in. for No. 10 metal. Any other styles or reinforcement may be used which will furnish equal strength with the above, and that may be approved by the engineer.

**Y-12
Shape**

All corrugated metal culverts shall be a true full circle and shall be of such length as is indicated on the plans, they shall not, however, be shorter than the width of the finished roadway plus three times the height at edge of roadway above floor of culvert.

**Y-12
Thickness of
Metal**

Culverts shall be made of sheets of the following thickness before galvanizing:		
Clear inside diameter		U. S. Gauge
18 in. and smaller		No. 16
Over 18 in. up to and including 30 in.		No. 14
Over 30 in. up to and including 48 in.		No. 12
Over 48 in. up to 72 in.		No. 10

Metal culverts over 48 inches in diameter will not be used without special strengthening, the design for which must be approved by the Engineer in charge.

**Y-13
Seams**

All joints shall be lap joints. Longitudinal seams shall lap not less than two inches. They shall be riveted with one rivet at each corrugation. Circumferential shop riveted seams shall lap at least one full corrugation. Rivets in circumferential seams shall not be more than ten (10) inches apart.

To cover irregularities in construction an allowance may be made of $\frac{1}{4}$ inch in net diameter of 12 and 18 inch pipes, and not more than $\frac{1}{2}$ inch in larger sizes. If the deficiencies exceed these figures the pipe may be rejected, or a suitable deduction may be made from Contract Price.

Y-14
Field Joints

Field joints shall be made with bands of the same material as the culvert and shall not be less than 8 inches wide for culverts up to 30 inches in diameter, and 11 inches for larger sizes—such bands shall be connected at the ends by angles or straps having a cross-section equal to 1 inch by $\frac{1}{4}$ and fastened by bolts not less than $\frac{1}{2}$ in. in diameter. All such connections shall be made of galvanized or otherwise suitably protected iron.

Y-15
Mill Inspection

If the purchaser so elects, all culverts shall be manufactured from materials which shall have been inspected at the rolling mill by a well known Inspection Bureau, this Bureau to be designated by the Engineer in charge. The expense of this inspection shall be borne by the Contractor. The Inspector shall take samples from each heat rolled. He shall make a chemical analysis and a physical test of each heat. All plates used shall have the heat number plainly marked thereon and shall be accompanied by a certificate signed by the Inspection Bureau that they comply with these Specifications. Besides the test pieces described above, there shall be attached to the finished culvert another piece which can be cut off when the culvert arrives at destination and this test piece will then be used for such as the Engineer in charge may require. The purchaser may instead of having the material inspected by an Inspection Bureau, demand a certificate from the laboratory of the mill in which the material was rolled. This certificate to show the tensile strength, elastic limit and chemical properties of the material, but in this case also a test piece should be attached to the finished culvert.

Y-16
Indentification

The manufacturer of each brand of metal for which Proposals may be received, shall file with the Engineer a statement setting forth the name or brand of the metal proposed to be furnished, with a complete typical analysis of the metal contained therein, which statement shall be sworn to for the manufacturer by the proper executive.

No metal will be accepted under these Specifications and no bids will be considered for either Class "A" or Class "B" requirements until after the sheet metal manufacturer's statement has been filed as above. Misbranding or other misrepresentations or non-uniformity of product will be considered as sufficient reason to discontinue the acceptance of any pipe under these Specifications.

No pipe will be accepted unless the metal is indentified by a stamp on each section showing:—

First: Name of Manufacturer.

Second: Name of brand, and

Third: The gauge.

These identification brands shall be placed on the sheets by the manufacturer of the sheets only in such a way that when rolled into culverts such identification shall appear on the outside of each section of the pipe. Pipe having sections not stamped shall be promptly rejected.

Y-17
Estimates and Payments

Estimates of work done and progress and final payments shall be made as provided in Section G-23 of General Conditions hereof.

SUPPLEMENTAL AND DETAIL SPECIFICATIONS

(Open Ditch, Tile, Bridges, Etc.)

(Specifications to cover details of structures or requirements which may be peculiar to each job, are to be inserted under this heading.)