



Public Works Manual

Revised September 2015



Storm & Sewer

3.25 BLOCKS

Block lengths and widths shall be designed to allow convenient access and circulation for emergency vehicles and be practical and compatible with the overall design of the subdivision, topography, and natural features.

Where block lengths exceed 1,000 feet, pedestrian rights-of-way no less than 10 feet wide shall be provided through blocks, where needed for pedestrian circulation.

4.00 DRAINAGE ANALYSIS AND SYSTEMS DESIGN CRITERIA

4.01 GENERAL

Drainage systems for development shall be designed and constructed to insure that the public and private property and improvements within the development and down stream from the development are not adversely affected by storm water flow resulting from rainfall and snowmelt and associated hazards such as erosion, sedimentation and debris flow. Adequate positive drainage must be provided for all streets, gutters, ditches, culverts, storm sewers and other forms of drainage structures, which must drain to natural drainage ways, or other means of positive conveyance of runoff water. All drainage structures, road and street configurations and site grading shall be designed and constructed to carry the flow from a (Base Storm) 100 year frequency storm event with no damage to the drainage system or any public or private structures, improvements, infrastructure, or property.

The developer shall investigate and where appropriate, provide mitigation and adequate drainage capacity for storm flow as set forth in this section. Additionally, the developer shall investigate the potential for debris flow and provide detention storage with provisions for maintenance and cleanup following a debris flow event, as outlined in this section.

Drainage analysis and design of all systems related to drainage shall be prepared by a Colorado Registered Professional Engineer and submitted to the Town of Gypsum for review and approval. Analyses must be accomplished by methods acceptable to the Town of Gypsum.

4.02 OFF SITE DRAINAGE AND BASE STORM DISCHARGE

The major drainage system which serves as the primary drainage channel for the development and all drainage structures therein must safely convey the Base storm peak discharge and maintain it within the confines of public rights-of-way and easements.

The off-site Base storm event flow must be conveyed through the site in a manner which will not result in a peak flow at the discharge from the site which would be greater than the historic, pre-development peak flow. Street surfaces shall not be used to convey off-site Base storm event flow through the site, but these flows must be conveyed through the site in structures which do not result in an increase in flow rate from this off-site flow.

4.03 MINOR STORM EVENT AND MITIGATION BY DETENTION

The minor drainage system which collects on-site drainage and conveys it through the development to primary drainage channels shall consist of curb, gutter, inlets, storm drains, culverts, swales, ditches and detention facilities and shall be designed, at a minimum, to convey flows from the Minor storm (25 year frequency) event and shall be designed to maintain their integrity if overtopped by flows from a Base storm (100 year frequency) event. The post-development peak discharge for the Minor storm event shall not exceed the historic or pre-development peak discharge conditions for the Minor storm event.

If there is an increase in peak discharge from either the Minor or Base storm event, due to the change in site conditions as a result of the development, mitigation of the peak discharge must be accomplished by either detention or conveyance of peak discharge flow directly into Gypsum Creek or the Eagle river through drainage systems that do not have any adverse effect on any public or private property or improvements.

The mitigation of the peak discharge is required for each drainage channel that leaves the development and not simply the development as a whole. Trans-basin diversions of drainage shall be prohibited unless provisions are made for transportation of Base Storm peak flow and the potential accumulative effects thereof directly to the Eagle River without any adverse effect on any public or private property, infrastructure or improvements.

The design and implementation of mitigation of a storm event post-development flow must consider and mitigate any additive effect that the drainage from the site may have on other previously developed downstream sites.

When the drainage discharge from a development is modified from a pre-development "sheet flow" to one or more points of concentrated, post-development flow, facilities must be provided to convey the concentrated flow through the downstream properties to the next, existing, natural or created concentrated flow structure which is hydraulically capable of handling the Base Storm flow and the potential accumulative effects thereof, without any adverse effect on any public or private property, infrastructure or improvements.

4.04 DEBRIS FLOW MANAGEMENT SYSTEMS

Developments that may be subject to debris flows shall provide an analysis of the potential debris flow conditions and character, prepared by a geotechnical engineer with experience in debris flow management. The analysis shall establish a bulk-loading factor for the potential debris content to be expected in the flow from a 100-year storm event. The analysis shall also include an estimate of the gradational analysis of the potential debris.

Facilities shall be designed and constructed to detain the portion of the potential debris material which may be retained behind screening systems with a maximum opening size of 4 inches and to convey the water and the debris material passing the screening system, to surface drainage facilities where it may be cleaned up. In all cases, the minimum amount of debris, which may be assumed to be retained, shall be 50% of the debris produced during the base storm event. Under no circumstances shall debris flow be directed to underground storm drainage systems (storm sewers).

4.05 CALCULATION METHODS

Determination of storm runoff shall be made by the methods defined in the following Table.

AREA OF BASIN FOR DETERMINATION WHICH PEAK FLOW OR HYDROGRAPH IS BEING CALCULATED	SPECIFIC APPLICATIONS AND/OR BASIN CHARACTERISTICS	METHOD
LESS THAN 25 ACRES	TO DETERMINE STORAGE	MODIFIED
	VOLUME FOR PEAK DISCHARGE CONTROL WHERE BASIN CHARACTERISTICS ARE APPLICABLE TO THE RATIONAL METHOD	RATIONAL METHOD
ZERO TO 5 ACRES	AREA CHARACTERISTICS	SCS TR-55
	NOT APPLICABLE TO RATIONAL METHOD	
MORE THAN 5 ACRES AND LESS THAN 25 ACRES	IF ONLY ONE MAIN TRIBUTARY	TR-55
	IF THERE ARE MULTIPLE TRIBUTARIES	TR-20
MORE THAN 25 ACRES AND LESS THAN 640 ACRES	ALL CIRCUMSTANCES	TR-20
MORE THAN 640 ACRES		ARMY CORPS OF ENGINEERS HEC-1

Exemptions from the peak discharge control requirement are as follows:

- 1) Residential development occurring which does not require new subdivision of land.
- 2) Subdivisions which will result in a gross residential density of two (2) dwelling units per acre or less.
- 3) Waivers from peak discharge control requirements must be requested in writing and must include supporting engineering documentation. Waivers may only be granted when:
 - a. Increase in peak discharge for the Minor storm from the subdivision is less than ten percent (10%) over historic levels.

- b. It has been determined and can be demonstrated that natural or man made detention exists downstream and there is adequate capacity to handle the increased peak discharge. The subdivider has obtained legal right to utilize the required capacity of the existing facility.
- c. It has been determined that detention will cause a deleterious impact relative to Base storm drainage and peak discharge.
- d. Additions to existing structures do not result in a net increase of impervious area of a basin by more than fifty percent (50%).

The size and modeling of detention structures shall be calculated using the following methodologies:

A. Hydrology: TR-55, TR-20 and HEC-1 may be used to calculate the flow hydrology for both the Minor and Base storm events for off-site drainage and for calculating inflow hydrographs for the design of drainage detention facilities for on-site drainage. In the course of determining the Time of Concentration for the hydrologic analysis, "Overland Flow" or "Sheet Flow" shall be limited to a maximum length of 300 feet.

The Rational Method may be used in calculating on-site flows for the design of water conveyance structures. The Rainfall Intensity Curve included herein (Time-Intensity-Frequency Values) on page 54 shall be used for any Rational Method calculations within the Town of Gypsum.

When storm flows exceed 100 cfs an analysis of the water surface profile and a delineation of the flood plain must be provided using Standard Step or HEC-2 methodology.

B. Detention Pond Analysis: A routing analysis of runoff through the detention structure is required. This analysis shall include an inflow hydrograph, a stage storage curve of the detention basin and a stage discharge curve of the outlet structure. Acceptable computer programs for the preparation of the routing analysis are: Pond-2 by Haestad Methods and the Hydrologic module provided with the Soft Desk Civil Design software.

When drainage detention structures are used to mitigate post-development storm water flows, the drainage detention structures shall be designed for the maximum allowable impermeable area with the development at build-out conditions. Following is a table that provides the minimum acceptable percentage of impervious areas for various developments. For developments not included on this table, the maximum potential impervious areas will be determined by the Town of Gypsum zoning subdivision regulations, zoning regulations, land development code, and building codes.

Table 4.05
Minimum Acceptable Percentage of Impervious Areas for Developments

Development Type/ Density	Percent Impervious
Commercial/ Light Industrial/ Industrial	80%
Residential - Average Lot Size: 0.125 Acre or less	67%
Residential - Average Lot Size greater than 0.125 Acre and less than or equal to 0.25 Acre	40%
Residential - Average Lot Size greater than 0.25 Acre and less than or equal to 0.33 Acre	32%
Residential - Average Lot Size greater than 0.33 Acre and less than or equal to 0.5 Acre	27%
Residential - Average Lot Size greater than 0.5 Acre and less than or equal to 1.0 Acre	22%

4.06 DRAINAGE DESIGN CRITERIA

The following criteria shall be used in the design of drainage systems.

A. Pipe Size: The minimum storm sewer main size shall be 18-inch I.D. Under special conditions, such as low potential tributary flow, 12-inch I.D. storm sewer main will be considered. The minimum cover from top of pipe to finished grade shall be 2 feet. The minimum cover from backfill surface to top of pipe shall be 12-inches prior to crossing with heavy equipment.

When post-development storm water flows are to be mitigated by conveying the flows downstream as outlined in this manual, the required hydraulic capacity for the drainage conveyance structures shall be determined based on the maximum allowable impermeable area with the development at build-out conditions. Table 4.05 provides the minimum acceptable percentage of impervious areas for various developments. For developments not included on this table, the maximum potential impervious areas will be determined by the Town of Gypsum zoning subdivision regulations, zoning regulations, land development code, and building codes.

B. Curved Storm Sewer Alignment: For storm sewers, which are designed for construction in a curved alignment, the maximum deflections at pipe joints shall not exceed the maximum deflection called for in the manufacturer's recommendations. Storm sewers, which are constructed in a curved alignment, shall be provided with an insulated, 10 gauge copper trace wire, "UF" grade insulation or approved equal. The tracer wire shall be secured to the top of the pipe with tape, at intervals no greater than 10 feet and shall be continuous between manholes or daylighted ends of the pipe with no splices allowed. The tracer wire shall extend into the manhole by extending the wire up the outside of the manhole and

entering the manhole under the ring and cover. A steel nail shall be placed on each side of the wire under the cast iron cover ring to prevent crushing of the wire. The crossing of wire and nails under the cast iron cover ring shall be sealed with layers of manhole joint sealant both under and over the wire and nails. The tracer wire shall be tested for continuity after back fill of the pipeline and manholes is complete. Construction control of a curved storm sewer shall be accomplished by the confirmation of the designed elevation on each joint with an engineer's level.

C. Storm Sewer/Culvert Grades: All storm sewers and culverts shall be designed and constructed to provide a flow velocity of a minimum of 2 fps during the flow calculated as 50% of the peak flow generated by the 2-year storm event. In no case will a minimum grade for a culvert be required which exceeds two percent (2%).

D. Storm Sewer Manholes: Manholes shall be constructed in accordance with the detail drawings. The minimum grade difference in a manhole between the inlet and the outlet shall be 0.10 feet. The Town of Gypsum may, at its sole discretion, require individual manhole surveys to confirm adequate manhole grades, and any manholes found to have less than 0.10 feet of grade difference shall be reset.

Manholes shall be installed at all changes of grade, size, or alignment; at all storm sewer line intersections; and at distances no greater than 400 feet, unless approved in writing by the Town of Gypsum, and shall be located in an access easement for service. Landscaping will not be allowed to cover manholes.

Any manhole wherein the depth from the rim to the top of the pipe is less than 4.0 feet shall be constructed with a full 48-inch barrel section and a flat lid.

When it is necessary to locate a manhole within the pavement section of streets and roads, the manhole lid shall be provided with a concrete collar as illustrated in the details. Every effort should be made to locate the manhole outside of normal vehicle wheel paths. The finished grade of a manhole lid in a paved surface shall be 1/4 inch below the finished grade of the paved surface.

E. Storm Drain Materials: Unless specifically approved otherwise by the Town of Gypsum, all storm drain pipe and culverts shall be smooth interior corrugated polyethylene pipe in accordance with AASHTO M-252 and M-294, and shall be ADS- N12 or approved equal. Use of corrugated metal pipe (CMP) is strongly discouraged and may only be used for special conditions when specifically approved by the Town of Gypsum. At all culvert entrances/exits and at the entrance/exit of any day lighted storm sewer, the pipe entrance/exit shall be provided with a Flared End Section. Flared End Sections shall be polyethylene except for pipe sizes for which polyethylene end sections are not manufactured

F. Surface Drain Systems: Street sections shall be designed and constructed to prevent sheet flow or cross street drainage. If surface drainage from land adjacent to a street is to be directed to the street right-of-way, the curb and gutter or drainage swale on that side of the street shall be configured and sized to accommodate that drainage without cross street flow except at valley pans. No valley pans shall be constructed except at the position of the "STOP" condition at street intersections.

G. Pedestrian-Friendly Gutters: The surface drainage system shall be designed and constructed to result in flow in the curb and gutter section no wider than two and one half feet (2.5 ft) resulting from a two-year intensity storm. When the flow from a two-year intensity storm will result in a curb and gutter flow in excess of 2.5 feet wide, the flow shall be directed to an alternate drainage system such as a storm sewer or drainage channel.

4.07 STORM DRAINAGE

4.07.1 Scope

The work consists of the construction of storm sewer pipelines including manholes, catch basins, and other appurtenances normally used in storm sewer collection systems. The work includes the furnishing of all materials, excavation of trenches, installation of materials, backfilling, construction of manholes and catch basins, testing, cleaning and restoration of surface.

4.07.2 Materials

The type and class of pipe to be used in the work will be as shown on the plans and/or called for in the specifications. The following specifications will apply to pipeline and appurtenant materials.

<u>Material</u>	<u>Specification</u>
Polyvinyl Chloride pipe (PVC)	ASTM D-3034
PVC Over 15 inches I.D.	ASTM F-679
PVC Min. Standard Dimension Ratio	SDR 35
Acrylonitrile Butadiene Styrene (ABS)	ASTM D-2680
Precast Concrete Manhole Rings	ASTM C-478
Reinforced concrete Low- Head Pressure pipe	ASTM C-361-85a
Ductile Iron Pipe	AWWA C-151
Corrugated Polyethylene Pipe & fittings	ASTM F-405
Large Diameter Corrugated Polyethylene Pipe and fittings	ASTM F-667
Polyethylene Corrugated Drainage Pipe	AASHTO M-252
Polyethylene Corrugated Pipe 12" to 48"	AASHTO M-294
Corrugated Metal Pipe (CMP)	AASHTO M-218
	ASTM A-444
	ASTM A-760
	ASTM A-761
	ASTM A-762

4.07.3 Certification by Manufacturer

When required by the Town of Gypsum, the Contractor shall furnish certification by the manufacturer(s) of the pipe and materials to be furnished, certifying that they comply with the applicable specifications.

All pipe and materials shall be clearly marked with type, class and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.

4.07.4 Pipe Installation

The pipe shall be installed in accordance with the manufacturer's recommendations. The Contractor shall provide all tools and equipment including any special tools designed for installing each particular type of pipe used.

The Contractor shall be responsible for the safe and proper storage and handling of all material intended for the work furnished by him or to him and accepted by him until it has been incorporated in the completed and accepted work. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being handled, stored or installed.

PROTECTION OF WATER SUPPLIES

Storm sewer pipelines shall be located a minimum of ten feet horizontally from existing or proposed water mains. Whenever it is necessary that a storm sewer pipe cross above or within 18 inches below a water main, the storm sewer pipe within 10 feet of the water line shall be constructed of either ADS N12 pipe with concrete collar-encased joints or specification PVC sewer pipe with concrete collar-encased joints

4.07.5 Manholes

Manholes shall be constructed to the specifications set forth in section 1.07, on page 4. However, for storm drainage manholes ONLY, contractors do not need to re-grout the base to a smooth configuration.

4.07.6 Manholes and Catch Basins

Manholes and catch basins shall be constructed of precast concrete rings with frames and covers and steps in accordance with the details shown on the drawings.

Adjusting rings may be used for adjusting the manhole and catch basin top elevation to coincide with existing ground elevations, except the total height of adjusting rings used per manhole shall not exceed 12 inches. Adjusting rings shall be reinforced with the same percentage of steel as the riser and top.

Manhole and catch basin steps shall be non-corrosive type material such as rubber encased steel, aluminum, or nylon. Steps shall withstand vertical loads of 400 pounds and pull-out force of 1000 pounds.

Manhole and catch basin rings and covers, catch basin grates, and the supporting rings shall be designed to withstand H-20 AASHTO loading. Manhole rings and covers shall be non-ventilated type and shall conform to the standards of the Owner's system.

Manhole and catch basin bases shall be either Precast or cast in place on undisturbed or compacted earth. Manhole and catch basin base concrete shall have a minimum compressive strength of 3000 pounds per square inch in 28 days.

The cutting of pipe as necessary in the course of the work shall be accomplished in neat workmanlike manner without damage to the pipe. The cut shall result in a smooth cut at right angles to the axis of the pipe.

4.07.7 Tests

New storm sewer pipelines, which are constructed of pipe materials with watertight joints, will be tested to assure the Town of Gypsum that pipe laying and jointing are satisfactory. The contractor shall provide the labor and materials to conduct the following tests in the presence of the Town of Gypsum.

- a. Lamp Test Sewer mains shall be checked by the Town of Gypsum to confirm that the alignment of the pipe has not shifted during backfilling of the trench. The Town of Gypsum will inspect lengths of sewer main between manholes by using a bright light and observing for a "full moon" circle of the opposite end of the pipe. The Town of Gypsum may elect to "lamp" the sewer main from both ends of the pipe. Any visible alignment deflection, earth, rocks or other debris, or any other defect found by the Town of Gypsum shall be remedied prior to acceptance.
- b. Deflection Test. After the pipe has been installed and backfilled, all pipe shall be tested for deflection in the presence of the Town of Gypsum. This test shall consist of pulling a mandrel or rolling a ball (go-no go device) through the pipe. The maximum deflection allowable shall not exceed 5 percent of the pipe's internal diameter for final inspection.
- c. Storm Sewer pipeline shall be water tight with no ground water infiltration.

The contractor shall repair and/or replace any section of the system, which fails to meet testing standards, following which the section shall be retested.

4.07.8 Pipe Bedding and Trench Backfill

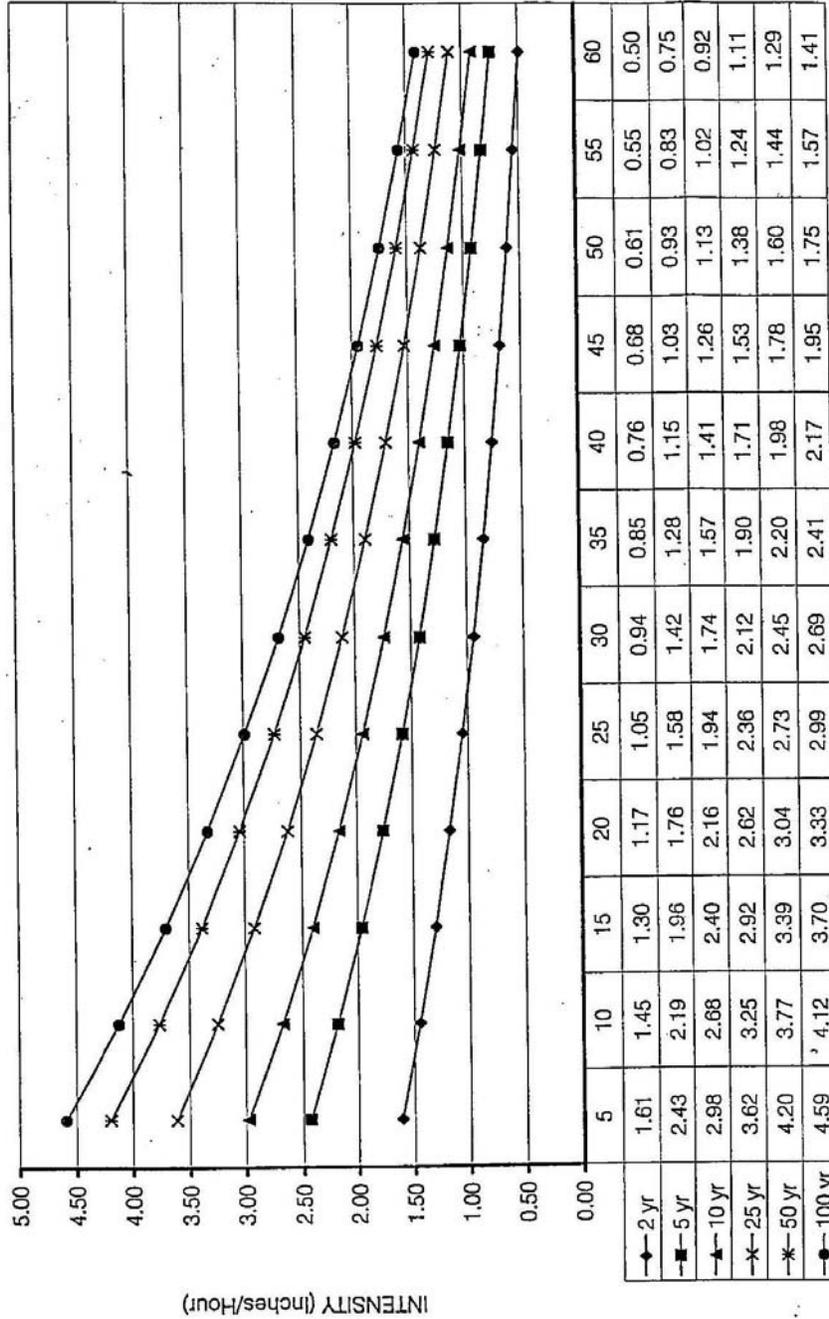
Pipe bedding material placed around and up to a point twelve inches (12") over the pipe shall consist of 3/4 inch washed rock. In the event that the subsurface drainage system is serving as an "under drain" under a water or sewer main, the 3/4 inch washed rock bedding material shall be continued up to a point six inches (6") above the top of the water or sewer main pipe.

After the select pipe bedding material has been placed and compacted as called for above, a single layer of geotextile fabric shall be placed over the top of the washed rock. The geotextile fabric shall be Mirafi 500X or approved equal. After placement of the fabric, the remainder of the trench shall be backfilled. All backfill material shall be free from cinders,

ashes, refuse, organic and frozen material, boulders or other unsuitable material. From one foot above the pipe to a point 24 inches below the surface or road sub grade, stones which do not exceed 15 inches in maximum dimension may be included in the backfill.

TOWN OF GYPSUM RAINFALL INTENSITY CURVE

Town of Gypsum - TIME-INTENSITY-FREQUENCY VALUES



2 yr
 5 yr
 10 yr
 25 yr
 50 yr
 100 yr

5.00 UNDERDRAINS AND SUBSURFACE DRAINAGE SYSTEMS

5.01 GENERAL

Underdrains and subsurface drainage systems shall be constructed as a part of land development infrastructure when it is necessary to lower the level of near surface ground water in order to facilitate the construction and/or long-term maintenance of underground utilities and improve the stability of street subgrades.

5.02 PIPE SIZE AND GRADES

The selection of a pipe size and the design of the vertical alignment for an underdrain or subsurface drainage system shall be made only after consultation with representatives of the Town of Gypsum who can provide historical, empirical data from previous installations within the Town. At a minimum, the underdrain pipe shall consist of 8-inch smooth interior factory perforated SDR35 PVC or ADS-N12 pipe. Underdrain alignments will typically follow sanitary sewer mains and shall be designed and constructed so that the spacing between the underdrain and the sewer main pipe will be as follows: Minimum Horizontal Spacing between outside edges of pipe shall be 3-feet. Underdrain pipe shall be constructed below the Sewer Main Pipe and there shall be a minimum vertical spacing of 12-inches between the bottom of the Sewer Main Pipe and the crown of the Underdrain Pipe.

5.03 CLEANOUTS AND MANHOLES

A cleanout shall be installed at the upstream end of each subsurface drain or underdrain pipeline, at each vertical or horizontal bend and at intervals not greater than 400 feet. Cleanouts shall be constructed in accordance with the standard detail for sanitary sewer cleanouts. A manhole shall be installed at the confluence of two or more pipelines. Manholes shall be constructed in accordance with the standard detail for Storm Sewer Manholes.

5.04 SUBSURFACE DRAINAGE

5.04.1 Scope

The work consists of the construction of subsurface drainage pipelines including cleanouts, manholes, catch basins and other appurtenances normally used in subsurface drainage collection systems. The work includes the furnishing of all materials, excavation of trenches, installation of materials, backfilling, construction of manholes and catch basins, testing, cleaning and restoration of surface.

5.04.2 Materials

The type and class of pipe to be used in the work will be shown on the plans and/or called for in the specifications. The following specifications will apply to pipeline and appurtenant materials.

<u>Material</u>	<u>Specification</u>
Polyvinyl Chloride pipe (PVC)	ASTM D 3034
PVC Over 15 inches I.D.	ASTM F 679
PVC Min Standard Dimension Ratio	SDR 35
Acrylonitrile Butadiene Styrene (ABS)	ASTM D 2680
Precast Concrete Manhole Rings	ASTM C478
Reinforced concrete Low Head Pressure Pipe	ASTM C 361 85a
Ductile Iron Pipe	AWWA C151
Corrugated Polyethelene Pipe and Fittings	ASTM 405
Large Diameter Corrugated Polyethelene pipe and fittings	ASTM F 667
Polyethlene Corrugated Drainage Pipe	AASHTO M 252
Polyethylene Corrugated Pipe 12' to 14'	AASHTO M 294

Unless specifically approved otherwise by the Town of Gypsum, all subsurface drainage pipes shall be factory perforated, smooth interior corrugated polyethylene pipe in accordance with AASHTO M 252 and M 294 and shall be ADS N12 or approved equal; or factory perforated, PVC sewer pipe SDR 35. Field perforation of ADS N12 of SDR35 PVC will not be accepted.

6.00 EROSION AND SILTATION CONTROL AND REVEGETATION

6.01 TEMPORARY AND PERMANENT EROSION CONTROL DURING CONSTRUCTION

An erosion and sediment control plan shall be submitted, for review, to the Town of Gypsum as a part of the subdivision or development improvement and infrastructure plan submittal. The approved plan shall be implemented, prior to and throughout the course of construction and surface restoration of the site. Additionally, drainage surfaces shall be constructed to prevent erosion during flood flow resulting from a 100-year storm event. An erosion control plan must be submitted and a permit obtained from the State for all land disturbed over one acre.

The erosion and sediment control plan shall contain provisions for:

A. The diversion of clear and off-site water from excavation areas and onsite drainage and detention structures;

B. Velocity and sediment control of onsite drainage through the use of silt fences and straw/hay bale check dams;

C. Protection of culverts and storm drainage systems from sedimentation with straw/hay bale check dams;

D. Protection of surfaces until permanent erosion protection and vegetation are accomplished.

Structures and methods illustrated on Standard Plan No. M-107-1, Colorado Department of Transportation, Standard Details, may be considered in the preparation of the erosion and sediment control plan.

Silt fence shall be constructed around all earthwork areas to control erosion and siltation of adjacent public or private lands. Silt fence shall be comprised of geotextile fabric expressly manufactured for use in silt filtration, attached to and supported by 14 gage livestock wire fence with maximum 6 inch openings. The silt fence shall be a minimum of 30 inches high, above the adjacent grade, with a minimum of 12 inches of the geotextile fabric buried in a 6 inch deep ditch on the upslope side of the fence. The geotextile fabric shall be attached to the upslope side of the livestock fence. The silt fence shall be supported by 5 foot long steel posts, driven 2 feet in the ground on the down slope side of the fence at maximum 10 foot intervals along the fence.

Temporary erosion control measures shall remain in place and functional until the permanent erosion control revegetation efforts are approved by the Town of Gypsum to be sufficiently mature to perform their intended function.

A permanent erosion control plan shall be submitted, for review, to the Town of Gypsum as a part of the subdivision or development improvement and infrastructure plan submittal. The approved plan shall be implemented, as a part of construction of the development or subdivision infrastructure.

The erosion control plan shall contain provisions for:

A. The stabilization of all surfaces potentially subject to erosion from surface water flows or wind. For purposes of surface stabilization design, the following factors shall be used for Maximum Permissible Mean Channel Velocities:

Unprotected soil	1.50 fps
Unreinforced vegetation with density equivalent to sod	5.00 fps
Loose rip-rap (size designed for velocity).....	10.00 fps

Permanent synthetic reinforced matting for vegetation reinforcement will be considered. Flexible channel lining systems are preferred over concrete pavement.

B. Velocity control of onsite surface drainage systems to maintain the velocity of flood flow from a 100 year storm event at rates less than the maximum permissible erosional velocity of the drainage structure surface;

C. Protection of inlets and outlets of culverts and storm drainage systems from erosion by high velocity flow;

D. Inclusion of minimal maintenance erosion protection surfaces: i.e. synthetic matting reinforced vegetation with dry land species;

6.02 REVEGETATION

A permanent revegetation plan shall be submitted, for review, to the Town of Gypsum as a part of the subdivision or development improvement and infrastructure plan submittal. The approved plan shall be implemented, as a part of construction of the development or subdivision infrastructure.

The revegetation plan shall contain provisions for:

A. Complete revegetation of all disturbed surfaces in accordance with the Seeding and Mulching specifications included herein;

B. The planting of live native or ornamental trees and shrubs of species acceptable to the Town of Gypsum where applicable.

In residential developments, live ornamental trees shall be planted at a minimum spacing of 100-feet along each side of residential streets or one tree per lot, whichever is greater.

In areas where roads are constructed through native trees and shrubs, the cut and fill slopes of the road shall be replanted with native tree and shrub species, which match those adjacent to the road in both species and approximate density. These revegetation specifications shall consider vehicular line of site at intersections and curves in the roads. Minimum line of sight shall be maintained in accordance with AASHTO standards. In these areas, the cut and fill slopes should be revegetated only with native grass and low-lying shrub species.

In commercial developments, live ornamental trees, shrubs, and ground cover shall be planted in the landscape areas around the perimeter of the development as well as within non-paved islands within the roads and parking lots and adjacent to buildings. The live plantings shall have an average spacing of one (1) tree and five (5) shrubs per 100-feet of perimeter or per 200 square feet of island. The Town of Gypsum shall approve all tree, shrub, and groundcover species. Drought resistant and "xeriscape" plantings are encouraged to reduce irrigation water usage and consumption.

When revegetation is called for to be accomplished by the placement of sod, the sod shall be drought resistant, blue grass as provided by Rivendell Sod Farm, Inc., of Garfield County, Colorado or approved equal. Areas to be revegetated with sod shall be prepared by rototilling the soil to a depth of 6-inches. Prior to placement of the sod, the area shall be fertilized in accordance with the recommendations of the provider of the sod.

Mutton grass	<i>Poa fendleriana</i>	3 lbs/Acre
Blue joint Reed grass	<i>Calamagrostis canadensis</i>	2 lbs/Acre
Western Wheat grass	<i>Agropyron smithii</i>	2 lbs/Acre
Bunchgrass	<i>Sporobolus airoides</i>	2 lbs/Acre
Rushes	<i>Juncus balticus</i>	1 lb/Acre

WETLANDS

Rushes	Juncus balticus	3 lbs/Acre
	Scirpus americanus	3 lbs/Acre
Sedge	Carex, spp	3 lbs/Acre
Spikesedge	Eleocharis macrostachya	2 lbs/Acre
Cottongrass	Eriophorum angustifolium	2 lbs/Acre
Marsh Marigold	Caltha leptosepala	.5 lbs/Acre
Lousewort	Pedicularis groenlandica	.5 lb/Acre

Rate refers to Pure Live Seed (PLS) and corresponds to USDA-SCS recommendations, Colorado Agronomy Note No. 61, March 16, 1981.

6.02.1 Certification by Manufacturer

When requested by the Town of Gypsum, the Contractor shall furnish certification by the manufacturer(s) of the erosion control materials to be furnished on this project, certifying that they comply with the goals of the project and applicable specifications.

All seed tags and containers shall be delivered to the Town of Gypsum upon request and planting material identification labels shall remain legible and attached to the individual plant until Town of Gypsum authorizes removal.

6.02.2 Temporary Erosion Control

During construction activities, efforts shall be made to minimize disturbed soil movement by both wind and water. Should wind erosion become an evident problem, a water truck shall be required to maintain a moist condition in the construction area.

Existing natural vegetation shall be protected where possible.

Straw bales or fabric silt fences shall be installed at critical points where potential water erosion with resultant soil movement off the site exists.

The Town of Gypsum shall direct placement of temporary erosion control measures on a site-specific basis as needed and as phase development of the project occurs.

6.02.3 Permanent Erosion Control

Slopes shall be constructed per project drawings and specifications. Erosion control and revegetation procedures shall be implemented according to the angle of repose of the finish grade slope.

Existing natural vegetation shall be protected where possible.

6.03 DUST CONTROL

6.03.1 Scope

The contractor's equipment and construction operations shall not contribute excessively to air pollution by discharging smoke, exhaust fumes, dust or other contaminants into the air in such quantities as to exceed the limits legally imposed by any local, State, or Federal standards.

Control of dust generation on the site and measures taken to prevent dust from leaving the site shall be a continuous process from project start up to final acceptance. The Contractor shall furnish and apply dust palliative on earthwork areas and haul roads to prevent the generation of dust on the site or other work areas.

Dust palliative may consist of water or a dilution of water and an approved substance. Application of water or water mixture shall be accomplished with acceptable sprinkling equipment. Whenever earthwork or other activity is taking place on the site, which could result in the generation of dust, the Contractor shall have a water truck available on site to immediately wet down dust generating areas.

If dust is generated to the degree that it may be observed exiting the site, the dust generating activity shall be recessed until measures are taken to prevent further dust generation.

6.03.2 Topsoil

Pre-Construction;

Prior to any excavation within the project, Contractor shall provide a composite soil sample for each major plant community to an appropriate testing facility for evaluation. The soil evaluation shall consist of the following parameters:

1. Soil Texture
2. Sodium Absorption Ratio (SAR)
3. Electro conductivity
4. PH
5. Organic Content
6. Nutrient content
 - Nitrogen
 - Phosphorous
 - Potassium
7. Micronutrient needs

During Construction;

All available topsoil within the areas proposed for grading shall be stripped to a depth suitable for reuse (as determined from the pre-construction soil tests) and stockpiled for revegetation. Large, woody plant material shall be removed (grubbed) prior to topsoil stripping to minimize the amount of unsuitable materials in the topsoil, however a lesser amount of these materials is desirable since these materials contain native seed or plant parts (rhizomes, roots and sprigs) that will grow and aid in establishing plant cover. The woody plant material shall be either chipped and spread over the final surface as mulch, or removed from the site and properly disposed.

Post-Construction, Revegetation;

Prior to the use of the stockpiled topsoil, the Contractor shall collect and provide a composite topsoil sample to an appropriate testing facility for evaluation. The results of the evaluation shall indicate the required soil amendments to bring the topsoil to the acceptable chemical and organic quality desired for the successful establishment and optimum growing media standards for the specific revegetation treatments. The results of the soil evaluation shall be distributed to the Owner and Town of Gypsum upon completion of the evaluation.

Additional topsoil required to complete the proposed erosion control and revegetation treatments shall be imported, stockpiled, tested and amended as needed to conform to the desired amounts and quality.

6.03.3 Revegetation Procedure

All proposed plantings (trees, shrubs and ornamental plants) shall be installed after topsoil placement and seedbed preparation and prior to seeding of the completed cut/fill slopes. Shrubs shall be spaced 3 to 4 feet apart in a random arrangement or grouping rather than in rows. Planting holes shall be dug perpendicular to the face of the slope and shall be large enough to accept the plant without bending or curling the roots. Remove containers before planting and pack firmly to eliminate air pockets. If soil moisture is deficient, water the plants immediately after transplanting.

Protection of the plantings from wildlife foraging shall be accomplished by installing individual or group forage protection/exclusion devices or by the use of boundary electric (two-wire) fencing. Said protection appurtenances and methods shall be reviewed and approved by the Town of Gypsum prior to installation.

For Repose Angle steeper than 2:1:

Scarification shall be required on all slopes designated for topsoil application. Scarify hard surfaces to provide at least 6- inches of loosened material. Scarification operations shall be performed across the slope, not up and down. Where rock outcrops prevent scarification, additional rocks shall be worked into the slope and combined with cluster plantings of shrubs. Topsoil shall be applied at an average depth of six (6) inches (18.6 cubic yards per 1000 square feet). Surfaces shall be smoothed following topsoil application and all rocks (> 6-inch diameter), debris and unsuitable materials shall be removed.

Fertilizer (slow release nitrogen) and soil amendments should be applied in the final stages of seedbed preparation and worked into the soil surface prior to seeding. Application rates shall be determined by the site-specific soil tests and/or as specified by the Town of Gypsum. Minimum application rates shall be approximately 40 to 80 lbs available Nitrogen and 50 to 100 lbs available P₂O₅ per acre.

Seed mixtures shall be broadcast seeded by the use of hand held canister seeder or other approved mechanical means using the specified seed mixture and rate.

Immediately following seeding, the area shall be raked to assure that the seed is buried to a depth of 3 inch.

Seeded areas (Dryland Mix) shall be mulched with an application of Soil Guard, Bonded Fiber Matrix (Weyerhaeuser) by a certified applicator according to manufacturers instructions, utilizing standard hydraulic mulching equipment at a rate of 3,000 pounds p acre. The applicator shall not apply the product in advance of rainfall, such that the bonded fiber matrix has an opportunity to cure for a minimum of 24 hours after installation.

For Repose Angle 2:1 or flatter:

Scarification shall be required on all slopes designated for topsoil application. Scarify hard surfaces to provide at least 6- inches of loosened material. Scarification operations shall be performed across the slope, not up and down. Where rock outcrops prevent scarification, additional rocks shall be worked into the slope and combined with cluster plantings of shrubs.

6.04 RESTORATION OF GROUNDS

6.04.1 Scope

Restoration of grounds (also called clean-up) shall be a continuous process from project start-up to Final Acceptance of the work by the Town of Gypsum. The Contractor shall, at all times, keep property on which Work is in progress free from an accumulation of waste material or rubbish caused by employees or caused by the Work, and he shall carry on a constant program to maintain plant areas, structure sites, rights-of-way, and the surface of streets and roads in a condition satisfactory to the appropriate authority, grantor of the rights-of-way, and the Town of Gypsum.

Upon completion of the Work, the Contractor shall remove all remaining rubbish, tools, equipment, scaffolds and surplus materials from the job and leave the Work areas clean and free of debris.

Unless otherwise provided for in the construction specifications, clean-up shall include the re-grading, re-surfacing, rebuilding and replacing of all, asphalt pavement gravel and concrete on roads on which construction took place or affected. It shall also include the regrading or rebuilding of all borrow pits, borrow ditches, irrigation ditches and driveways and the regrading and revegetation of landscaped areas disturbed by the construction. Revegetation of lawn areas shall be accomplished using sod. Clean-up shall commence as soon as the construction site is occupied and shall be a continuous process, if necessary, in order that the site of the work shall always have an appearance and/or utility equal to that which existed at start of the work.

Surfaces shall be smoothed and topsoil shall be applied at an average depth of six (6) inches (18.6 cubic yards per 1000 square feet). Finished surface shall be smoothed following topsoil application and all rocks (> 6-inch diameter), debris and unsuitable materials shall be removed.

Fertilizer (slow release nitrogen) and soil amendments should be applied in the final stages of seedbed preparation and worked into the soil surface prior to seeding. Application rates shall be determined by the site-specific soil tests and/or as specified by the Town of Gypsum. Minimum application rates shall be approximately 40 to 80 lbs available Nitrogen and 50 to 100 lbs available P₂O₅ per acre.

Seed mixtures shall be broadcast seeded by the use of hand held canister seeder or other approved mechanical means using the specified seed mixture and rate.

Immediately following seeding, the area shall be raked to assure that the seed is buried to a depth of 3 inch.

Seeded areas (Dryland Mix) shall be Hydromulched with an application of Silva-Fiber Plus, wood fiber mulch and tackifier or Town of Gypsum approved equal, using only designated materials per manufacturers recommendations over the seeded area at a rate of 2000 lbs/acre.

Some cut or fill areas may require an alternative treatment once the initial construction practices (Grading) are completed to assure success in erosion control and revegetation.

6.04.2 Alternative Protection

Site excavation may produce slopes that shall not be conducive to the above erosion control and revegetation practices due to rock outcrops or other impervious subsurface materials. In this case, rock aggregate, which is aesthetically pleasing to view, Crib Retaining Walls, or stacked boulder walls may be substituted for topsoil and planting in limited areas. Revegetation of the rock slopes shall be performed by creating pockets of soil that provide adequate rooting depth. Treatment of bare root plantings with polyacrylamide slurry to hold the moisture around the roots shall be performed at the direction of the Town of Gypsum.

6.04.3 Maintenance

Successful plant establishment is obtained by the following principles:

- a. Provide for adequate water control of the area;
- b. Prepare a seedbed or site that will provide soil stability during plant establishment;
- c. Use proper planting techniques at the proper season;
- d. Mulch to protect the soil and provide a better environment for plant growth;
- e. Fertilize and apply soil amendments as needed; and
- f. Protection from wildlife (Deer and Elk, etc.) foraging.

Artificial irrigation shall be provided and encouraged during the first and subsequent growing seasons, indefinitely, to assure establishment and continued success of the revegetated and planted areas.

Apply irrigation water in a fine spray and at a rate that does not cause runoff and erosion.

Irrigation system design and details shall be provided within the applicable project drawings and specifications.

6.04.4 Success and Approval of Revegetation Work

The results of the work of seeding and mulching and other revegetation and landscape work can only be evaluated after a sufficient period of time has elapsed for germination to occur or for live plants to root and become established in the new environment. This period of time is normally a minimum of one growing season and may be as long as two years. The Town of Gypsum will evaluate the work after, what is in their best judgment, a reasonable period of vegetation establishment and will approve the work if, in their best judgment, functional success has been achieved. Deficiencies in functional success shall be corrected.

7.00 EXCAVATION

7.01 SCOPE

The work shall consist of the excavation required by the drawings and specification and disposal of the excavated materials.

7.02 CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definition or will be designated as unclassified. Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrappers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of three cubic yards and equipped with attachments such as shovel, backhoe, bucket, dragline or clam shell appropriate to the character of the materials and the site conditions. Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation. Excavation will be classified according to the above definitions by the Town of Gypsum, based on its judgment of the character of the materials and the site conditions. The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material. For the purpose of this classification, the following definitions shall apply: Heavy ripping equipment shall be defined as rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a tractor having a power rating of at least 300 horsepower (at the flywheel). Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12 to 20 cubic yards. Pusher tractor shall be defined as a track type tractor having a power rating of at least 300 net horsepower (at the flywheel) equipped with appropriate attachments.

7.03 UNCLASSIFIED EXCAVATION

Items designated, as "Unclassified Excavation" shall include all materials encountered regardless of their nature or of the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.