BLUFFDALE

EST. 1848

STORM WATER DESIGN STANDARDS MANUAL

AUGUST 2018

ENGINEERING DEPARTMENT

2222 WEST 14400 SOUTH

BLUFFDALE, UTAH 84065

Assistant City Engineer
10-12-2018

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1 GENERAL

A. INTRODUCTION

This document clearly defines the City's the storm water design criteria and standards in accordance with the Storm Water Ordinance. Any deviation from these standards must be approved by the City Engineer in writing.

B. DEFINITIONS

Detention Storage: The storage of storm water runoff for controlled release during or immediately following the design storm event.
Discharge Point: A point or location where surface or pipe storm water runoff is concentrated before being released from the project area.
Easement: An interest in land created by grant or agreement, which confers a right upon owners (private or public) to some profit, benefit, dominion, or lawful use of another.
Engineer or City Engineer: City of Bluffdale Engineer or authorized representative.
Groundwater: Water beneath the earth's surface between the saturated soil and rock that supplies wells and springs.
Infiltration: That portion of the rainfall, which percolates into the ground surface.
Percolation: The process by which fluid passes through a porous substance.
Retention Storage: The storage of storm water runoff where the only outlet is infiltration and evaporation.
Spillway: A waterway in or about a hydraulic structure, for the release of excess water.
Subdivision: Any division of a property within a parcel (residential or commercial)
Storm Water Runoff: Water resulting from precipitation running off the surface of a drainage area during and immediately following a cloudburst event.
Tributary Watershed: The entire catchment area that receives storm water runoff for specific concentration point(s).
Waters of the State: All streams lakes, ponds, marshes, watercourses, wells, springs, irrigation systems, drainage systems, and all other bodies of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border upon this State or any portion thereof, except those bodies of water confined to and retained within the limits of private property, and which do not develop into or constitute a nuisance, or a public health hazard.

C. DRAINAGE AND IRRIGATION FACILITIES

1. The latest version of the City's standards and ordinances and Storm Water Design Standards Manual apply to the design of drainage facilities for any drainage system within the City, which is not under another jurisdiction's control.
2. The latest versions of the Salt Lake County ordinances and design standards apply to design and construction activities for all systems under Salt Lake County Control whether natural and manmade.
3. The latest version of canal regulations and design standards apply to design and construction affecting canals.

4. A copy of the construction/discharge permit from the Canal Company and Salt Lake County Flood Control (where applicable) is required to release storm water runoff into a canal.
5. Provide storm water drainage systems that are separate and independent from any sanitary sewer or irrigation systems.
6. Provide underground storm drainage systems that are constructed throughout the subdivision and drain to an approved outfall. The city engineer will direct inspection of these facilities. Complete the storm drain design prior to project acceptance and plat recordation.Complete storm drain design prior to and for plat approval. Complete construction of storm drain facilities prior to and for subdivision acceptance.
7. Provide a culvert or other structure, approved by the City Engineer, for any lots where the buildable area is separated from the street it accesses, by a water body or course.
8. Provide stabilization for the banks of any existing or proposed drainage channel including, but not limited to: irrigation ditches, canals, creeks, rivers, streams, or other water ways, according to the entity having jurisidiction.
9. Coordinate development with any entity having jurisdiction over a water body that may be impacted by the development.

D. WATER QUALITY

1. Design systems to comply with the requirements of State Department of Environmental Quality Division of Water Quality.
2. Comply with the requirements of U.S. Army Corps of Engineers and/or Department of Natural Resources, Division of Water Rights for construction activities that impact Waters of the State and Waters of the United States.
3. Comply with the “Storm Water General Permit For Construction Activities” required by State Department of Water Quality for public or private property within the limits of the City of Bluffdale. This requires filing for a permit through the Division of Water Quality for developments larger than 5 acres including smaller phases of the greater 5-acre development.
4. Provide a BMP to manage sediments, grease and floatables for all storm water systems, public or private. Provide calculations and test data showing effectiveness.

E. FLOODPLAIN

1. Comply with any FEMA requirements and guidelines in Special Flood Hazard Zones.
2. Do not build any structures in Zone A (1% chance or occurrence or 100 year event) of the FEMA regulated flood plain without approval from the City Floodplain Administrator and City Council.
3. Provide an Elevation Certificate prepared by a Profesional Engineer or Licensed Land Surveyor if you wish to show that a site or structure is above the Base Flood Elevation.
4. Provide a Letter of Map Revision (LOMR) prepared by a Professional Engineer if if you wish to show that a project is outside of the Special Flood Hazard Area (SFHA). This may lead to the flood insurance requirement being waived.
5. Provide a Letter of Map Revision Based on Fill (LOMR-F) prepared by a Professional Engineer if you wish to show that a project has been elevated by fill above the Base Flood Elevation (BFE) and is no longer in the SFHA. This may lead to the flood insurance requirement being waived.

6. Provide a Letter of Map Amdendment (LOMA) prepared by a Professional Engineer if you wish to show that a project, or parts of a project, are above the mapped elevation of the floodplain. This may lead to the flood insurance requirement being waived.
7. A Professional Engineer can request a Physical Map Revision (LOMR PMR) if a project results in major changes, such as bridges, culverts, channel changes, flood control measures, or large fills, that result in changes to the BFE or floodway. This may lead to the flood insurance requirement being waived.

F. DESIGN AND MODELING SOFTWARE

1. Use design and modeling software listed below or as approved by City Engineer. Provide all inputs and outputs clearly organized for review.
2. Approved design and modeling software:
    a. Bentley - Storm and Sanitary, Pond Pack
    b. Autodesk – Storm and Sanitary Analysis
    c. EPA-SWMM
    d. NRCS WinTR-55
    e. HEC-HMS
    f. HEC-RAS
    g. WMS

G. SUBMITTALS

1. Provide an 8 ½" x 11" bound drainage report, organized according to the outline in Appendix A, including all hydrologic and hydraulic design calculations, percolation and infiltration test results, additional design procedure information, and all supporting charts, tables, curves, figures, and certificates used in the overall drainage design. Also, include calculations for the storm water management during all phases of construction.
2. Provide 11”x17” plan sheets that include the infrastructure design as shown in Appendix B. Sheets must be prepared in CAD software and stamped by a professional Civil Engineer licensed in the state of Utah.
3. Provide the City a copy of all required permits related to stormwater design and construction including but not limited to State UPDES Storm Water Discharge Permit, Salt Lake County Flood Control, Stream Alteration Permit, United States Army Corp of Engineer permits, etc.

H. EASEMENTS

1. Provide a legal easement for all storm drain facilities on private property as approved by the City Engineer.
2. Provide 7.5’minimum each side of storm water pipe.
3. Provide a stormwater or drainage easement for all watercourses, drainage ways, channels, rivers or streams that are within the development. Center the easement on the center of the waterway. Provide access to storm drain easement through an additional easement connected to a public right-of-way. Extend the easement to the 1% chance (100 year event) of recurrence water

elevation. The 1% chance of recurrence (100 year event) water elevation must be determined by a engineer licensed in the State of Utah.

4. Extend easements 10 feet beyond the last manhole or inlet boxes on the line.
5. All easements shall be submitted and approved by the City Engineer and recorded before final subdivision approval will be granted.
6. Provide drainage easements for all drainage systems that carry water across private land outside the subdivision prior to and for subdivision acceptance.

2. DESIGN STANDARDS

A. STORM FREQUENCY DESIGN REQUIREMENTS

Table 1 contains the design return events to use for design of stormwater elements.

Table 1 – Storm Frequencies for Design

Type of Structure	Minimum Design Storm Frequency
Storm Drain System (pipes, gutters, channels, boxes, etc.)	10% Chance of occurance (10 year event); the intensity is based on time of concentration (*10-minute minimum*)
Streets (surface route)	1% Chance of occurance (100 year event) flows; duration for the intensity based on time of concentration (*10-minute minimum*)
Culvert (local)	50-year peak flow
Culvert (governed by Salt Lake County or separate Canal Company)	As Required by Salt Lake County or Canal Companies
Natural Stream/Bridge	1% Chance of occurance (100 year event) peak flow
Retention/Detention Facilities	1% Chance of occurance, 24 storm (100-year 24-hour)
Temporary Detention/Retention (*6-months max. period*)	10% Chance of occurance (10 year event) or as needed
Spillway Structures	1% Chance of occurance (100 yearevent)

B. HYDROLOGY

1. Methodology – Calculate peak runoff flows using the Rational Method or the SCS (NRCS) Peak Flow Method as outlined in the most current HEC-22 Urban Drainage Design Manual. Use the SCS (NRCS) Tablular Hydrograph Method to estimate total volume. Approved design and modeling software as outlined in Section 1-F may be used in modeling runoff. Any alternate methods used as input for software – that is not consistent with those previously stated - must be approved by the City Engineer.
2. Drainage areas – Consider the entire watershed that will contribute to the site. Refer to the Storm Water Master Plan for some of the watersheds. This may also require accounting for area outside the project site as well as areas that may become tributary as a result of re-grading and/or development.

3. Rainfall – Obtain the most up-to-date NOAA Atlas 14 precipitation data specific to the site.
4. Runoff Coefficient – For paved surfaces, use a C-value of 0.95. Determine all other values using good engineering judgment and obtain approval from the City Engineer.
5. Time of Concentration (A physical concept method, where a velocity is calculated for each reach of the flow path and time computed is preferred) – Use the Kinematic Wave Equation or other methods as approved by the Engineer to calculate the time of concentration. Route the storm flow using approved methods to get the correct time of concentration. For conveyance components of the system, calculate the time of concentration for the area that results in the highest peak flow. For example, if a smaller area with a higher runoff coefficient and a short time of concentration results in a higher peak flow than the full watershed with a lower composite runoff coefficient, use the higher flow from the smaller area. Any calculations for water storage must be for the full area to, and including, the pond.

C. HYDRAULICS

1. ROADWAY DRAINAGE

Design roadway drainage components in accordance with the FHWA HEC-22 manual. Design and install inlets and pipes to remove water from the roadway for at least a 10-year storm event. Show the HGL on the plans. The design HGL must be within the pipe (no pressure flow). Calculate the HGL with any ponds at a half-full starting condition and the peak flow in the conveyance system.

Runoff from a 1% chance of occurance(100 year event) storm event must be contained within the roadway and conveyed either below or above ground to the storage location. The city will not allow buildings in an above ground conveyance path. Legally record any above ground conveyance paths outside the roadway as a flood control easement. This easement must prevent building construction in the easement and allow city personal access for reasonable maintenance.

Where curb and gutter is used, the minimum longitudinal slope of the road and gutter shall be 0.5%. Spread is the lateral space or the ordinate from the face of the gutter to the edge of the water in the in the street. The maximum allowable spread on a collector street, during a 10-year storm event is the greater of 6 feet or the shoulder width. The maximum allowable spread on local roads, during a 10-year storm event, is the greater of 4 feet or the shoulder plus 1/4 the lane width.

2. LOT DRAINAGE

Consider general lot drainage during site plan development that supports proper drainage near buildings. Account for a descending grade around buildings, which ultimately terminates at public R/W or common area. Minimize flow paths through lots. (The city building official administers specific requirements of buildings and lot drainage systems.)

Runoff may not flow from one lot to another if rate and quantity are greater than pre-developed conditions or are in a manner that may unreasonably and unnecessarily cause more harm than the

pre-developed condition. Flows may not be impaired in either quantity or quality and may not cause an undue burden on downstream properties.

3. SPRING AND SURFACE WATER

Provide piped or open channel drainage for any spring or surface water that exists either previously to, or as a result of, the development. Locate these drainage facilities in the road right-of-way where feasible, or in a perpetual unobstructued easements of appropriate width. Provide facilities that adhere to the current adopted standards and specifications of the city.

Size culverts or other drainage facilities large enough to accommodate potential runoff from the entire upstream drainage area, whether inside or outside the subdivision. This should not exceed the historical flow. A Professional Civil Engineer must determine the necessary size of the facility, based on the requirements of this manual and using a 1% chance of occurrence (100 year) storm event. The design must be submitted for approval to the City Engineer.

The storm drainage design must also account for the affects on downstream drainage facilities. Provide storm drainage design that adequately addresses the limitiations of downstream drainage facilities and does not overload them.

D. WATER STORAGE FACILITIES

A professional engineer, licensed in the state of Utah, shall design water storage facilities with engineering judgment. The following requirements are intended to help the engineer in the design but do not represent all aspects that must be considered in the design.

1. DETENTION PONDS

a) Release Rate: Water must be released at or below pre-developed (before man disturbed it or prior to existing conditions whichever is lower) runoff rates for the 4% chance of occurrence (25 year event), 2% chance of occurance (50 year event) and 1% chance of occurrence (100 year event) events. The Storm Water Master Plan may designate maximum allowable discharge rates locations. If downstream system capacity is inadequate for pre-developed flows, the City Engineer may require further restrictions as necessary to prevent flooding and property damage.

b) Pond Sizing: Use the NCRS method, for the 1% chance of occurrence (100 year event) event with a duration that generates the largest needed pond, for pond sizing. Do not consider or use infiltration when sizing the pond. When calculating the storage needed, the release rate from the pond may not be constant at the maximum allowable release rate. The release rate should reflect the stage-storage-discharge relationship of the pond.

c) Maintenance: Design all structures to minimize any maintenance needed to function correctly. This may include the following measures:

i. Screening debris larger than the flow control device prior to the water reaching the device to prevent clogging. The screening device must have sufficient opening space to prevent increased headwater at all release rates while the screen is mostly clogged.
ii. Designing flow control devices to reduce clogging. This includes not using an opening smaller than 4 inches. (Design pond to meet release rate requirement even if the minimum opening applies.) Bevel the opening to minimize the thickness of the flow control device that debris may clog. (For example, do not use a small pipe though a box wall as the flow control device but a beveled thin plate over a larger opening.)
iii. No part of the outlet control can be adjusted to release more flow or require adjustment to function properly.
iv. Designate who is responsible to clean sediment and debris from the pond and when for proper functionality.
v. The structures associated with the pond should be non-obtrusive and fit the aesthetic feel of the area.
vi. Water must be stored in a manner that allows cleaning of the storage area. Water may not be stored in the voids of subsurface aggregate. Underground pipes/tanks with proper cleanout access are allowed. If underground storage is utilized, use a pretreatment manhole, which is easily accessible for maintenance, to reduce the amount of maintenance needed in the main storage area.

d) Public Safety: Ponds must meet safety requirements in accordance with the State guidelines as well as the following.

i. A fence shall be placed around all detention ponds with a depth greater than three feet.
ii. Structures or headwalls that create a fall risk shall be avoided.
iii. Ponds must have a primary overflow/spillway capable of releasing the outflow if the primary release structure were completely clogged.
iv. Ponds must have a secondary overflow/spillway capable of releasing the 1% chance of occurrence (100 year event) inflow rate to a safe location that will not damage adjacent property. Consider future development in the design.
v. Ponds must have 1 foot of freeboard from the 1% chance of occurrence (100 year event) water surface elevation to the secondary overflow/spillway.
vi. Pond side slopes must be 4:1 or flatter to allow egress of persons in the pond.
vii. Pond must be landscaped to enhance the aesthetics of the area and to prevent weed growth. The minimum landscaping is lawn irrigated by a sprinkling system adequate to keep the lawn green.

e) Water quality must be addressed in accordance with current state regulations. At a minimum measures shall be taken to reduce sediment and hydrocarbons from water. Inflow and outflow locations should be such that detention time is enhanced to allow time for settling to occur. A skimming device should be placed on the outflow device to reduce floating debris that enters the downstream system.

2. RETENTION PONDS

Retention is a feasible option when the soil where the retentioned is planed has "saturated infiltration rate" such that the volume of the 1%, 24-hour chance of occurance storm can be drained in 48-hours or less. For a retention basin the following condition application must be met.

A. Infiltration Rates: A professional geotechnical engineer, geologist, or soil scientist licenced in Utah must identify basin location and perform site-specific geotechnical investigation in accordance ASTM D5856 to determine the infiltration rate for the selected site. This applies to native material below the pond and any topsoil or landscaping material that will be placed to obtain a true post-construction infiltration rate.

B. Design Criteria:
   a. Determine the volume to be retained using the NRCS method.
   b. The volume to be retained is the difference of runoff from the drainage basin draining into the pond, when is fully developed less the historical runoff flow from the same area.
   c. The runoff volume are for the 1% rate of occurance event for a duration of 24 hours.
   d. Pond average surface area, A (square feet) = Vd/D_b
      i. Vd = volume of stormwater to be retained (cubic feet)
      ii. D_b = maximum depth (feet)
   e. D_b = FS u k t
      i. FS = factor of safety = 0.4
      ii. K = saturated hydraulic conductivity (feet/hour) determined from the geotechnical investigation
      iii. t = maximum allowed ponding time, 48 hours
      iv. u = soil moderation factor
         1. sand = 0.5
         2. sandy clay = 1
         3. Medium and heavy clay = 2

C. Freeboard: Provide 1 foot of freeboard from the calculated 1% chance of occurrence (100 year event) water surface and the overflow/spillway.

D. Maximum Drain Time: size the pond to drain within 48 hours of the completion of the design storm.

E. COLLECTION FACILITIES

1. Place all storm water infrastructure according to City standard details and requirements. Consult with the City Engineer for any variations.
2. Provide vehicular access to any City storm water facilities within an easement that is not accessible from the public right-of-way.

1. PIPE DESIGN, MATERIAL, SIZE, AND CONSTRUCTIONS

a) The Following are the requirements for all storm water pipe or hyrdraulic conduits used for storm water within the city ROW.Design all buried pipes in accordance with the current AASHTO LRFD Bridge Design Specifications.
b) Design all buried pipes for a 100 year service life.
c) Design and provide buried pipes to have sufficient capacity to carry AASHTO HL-93 live loading at design minimum and maximum cover heights. Make provisions for project specific live loads, including construction loading and fire truck loading if applicable.
d) Do not place any pipes where the cover height is less than 1.0 foot, or less than AASHTO LRFD Bridge Design Specifications minimum cover, or the pipe manufacturer's recommended minimum cover. Use the manufacturer's recommended fill height tables for the maximum pipe cover height or do not exceed applicable city standards and specifications unless submitted with a site specific design and approved by the City Engineer.
e) Provide minimum 15" pipe sizes.
f) Do not exceed 5% deflection on pipe joints.
g) Provide a minimum flow velocity of 3 ft/s and a maximum flow velocity of 15 ft/s.
h) Do not decrease pipe diameter in the downstream direction.
i) Align the pipe crowns at when two or more pipes of different diameters meet at a box.
j) Provide precast concrete pipe compliant with AASHTO M170. Provide reinforced concrete pipe compliant with AASHTO M207. Provide non-reinforced concrete pipe compliant with AASHTO M86. Provide pipe cover according to city details and specifications. Provide pipe with joints compliant with AASHTO M198, ASTM C443 or ASTM C1628.
k) Provide corrugated wall high-density polyethylene (HDPE) thermoplastic pipe compliant with AASHTO M294. Provide corrugated wall high-density polypropylene (HDPP) thermoplastic pipe compliant with AASHTO M330. Provide polyvinyl chloride (PVC) thermoplastic pipe compliant with AASHTO M304. Provide pipe cover according to city details and specifications. Provide pipe with joints compliant with ASTM D3212, ASTM F2764, or ASTM F2648.
l) Provide corrugated steel pipe compliant with AASHTO M36 or M245. Provide corrugated aluminum pipe compliant with AASHTO M196. Do not allow differing metal types to contact one another without site specific design approved by the City Engineer. Provide manufacturer certification that the metal pipe has a 100 year service life through a combination of coatings and site-specific conditions, where necessary. Provide pipe cover according to city details and specifications. Provide pipe with joints compliant with ASTM A760.
m) Excavate and backfill trenches in accordance with city standards and specifications, UDOT Specifications Sections 02056 (Embankment Borrow, and Backfill) and 02317 (Structural Excavation and Backfill).
n) Provide backfill material compliant with AASHTO M145 A1 or A3 well-graded material (SW) with a maximum aggregate size of 1.5 inches. Before using other materials, provide project specific design calculations detailing structural adequacy, signed and sealed by a Professional Engineer licensed in the State of Utah, for the review and acceptance of the City Engineer.
o) Compact backfill in 6 inch lifts to the required density before proceeding to the next lift. Fully compact in haunch areas (lower side regions of pipe). Backfill uniformly on all sides of buried pipes.
p) The city inspects pipe installation according to UDOT Specifications Section 02610 (Drainage Pipe).

q) Provide video inspection of all installed piping at least 30 days after installation. Include the grouting around the beginning and ending of pipe runs at each box in the video. Mandrel testing is required for all thermoplastic and metal piping. Verify that horizontal and vertical alignment deviations are within tolerance. Verify that pipe deflections are no more than 5%. Verify that pipes have not joint gaps or damage. Repair or replace, at no cost to the city, any pipes that do not meet the specifications or that is damaged, as directed by the Engineer.

2. MANHOLES (CLEAN-OUT BOXES)

a) Design per APWA Plan No. 330, 341 or approved equivalent.
b) Design at the end of each line, at all changes in pipe size, direction and slope. Refer to HEC-22 for cleanout spacing.
c) No City manholes allowed on private property. Exceptions require written and recorded easement.
d) Design with 1-foot sumps in bottom to collect sediment.

3. INLET BOXES

a) As approved by the Engineer, per Bluffdale, APWA or UDOT standard. Provide metal-frame casting with water quality markings that either by word or symbol prohibits pollutants to be discharged into drain. Combination inlet cleanout boxes are not allowed. Make inlet opening large enough for maintenance access or place separate manhole as needed, in any case no less than 2'x4' grate and frame for junction box/inlet and 3'x1.5' for a simple inlet.
b) Minimum inside dimensions for:
Junction boxes (connecting to two or more pipes) – 4 feet x 4 feet,
Simple inlet boxes (connected by one pipe only) – 3 feet x 4 feet.
c) Design spacing to limit spread as described above. If manhole cleanouts are used, do not exceeding 500 feet maximum spacing.
d) Design double inlet box at low points in vertical curves and at the low points of downgrade cul-de-sacs or dead ends.
e) Locate inlet boxes at intersections with secondary streets. Place inlets so as to minimize pedestrian inconvenience. Locate inlet boxes to not conflict with driveway connections.
f) Design with 0.5-foot sumps to collect sediment.
g) Design to eliminate water channels in roadways.
h) No curb inlets are allowed. Use only grate inlets.

F. STORM WATER RUN-OFF AND EROSION CONTROL DURING CONSTRUCTION

1. Prepare a plan addressing the control of the quantity and quality of storm water runoff during construction.

2. Key elements of this plan:
   a) Control runoff at all boundaries.
   b) Design a surface route for run-off that terminates at the proposed water storage facility or a temporary facility.
   c) Design a stabilized construction entrance.

3. Best Management Practices (BMPs) include, but are not limited to, intervening terraces, diverter terraces, V-channels, runoff computations, drainage dispersals walls, subdrains and detention/retention systems etc. These systems may be coupled with the permanent water quality systems.
4. Provide erosion control and revegetation BMPs on the project plans. Erosion and sedimentation control measures will be inspected upon installation and throughout construction of the subdivision.

G. IRRIGATION DITCHES – GUIDELINES FOR NEW DEVELOPMENTS ONLY

1. If needed, pipe open irrigation ditch within or adjacent to the boundary of the development. Verify with both property owners prior to piping.
2. Relocate irrigation pipes to front yards where possible.
3. Investigate all existing irrigation systems (pipe or ditch) within or adjacent to the project limits and determine if they are to be perpetuated. Notify the respective irrigation users of all public hearing dates and provide the City with all the names and addresses of affected shareholders. Coordinate with the respective shareholders or representative and provide a written document, which identifies the agreements between the two parties. Include pipe sizes, known flows and any other relevant information.
4. Irrigator permission is required to pipe ditches.
5. Irrigator permission is required for elimination of ditches or runoff discharges to them.
6. Design piping of sufficient size to handle the anticipated flow in existing ditch minimum.
7. Design appropriate boxes, diversions, gratings, and covers to minimize irrigation hazards. Design 4” maximum grate opening.
8. Design clean-out boxes per the agreements with irrigators. Design irrigation structures in public R/W in accordance with city standards. Irrigation lids are to be bolted.
9. Diversion boxes and cleanout boxes requiring multiple people to access them are not allowed in back yards and any allowed will require city approval. Irrigation system not in the public R/W requires an easement.
10. Provide easements on plat not less than 7.5’ each side of pipe. Identify as “Irrigation Easement”
11. “Replacement in kind” is the minimum.

APPENDIX A – REPORT OUTLINE

Cover Page

- Project's name
- Project's location
- Date of completion of the report
- Name of the entity that prepare the report
- Address of the entity preparing the report

Table of contents

- List all the sections/chapters (in roman numerals) included in the report and corresponding page numbers
- List all the pictures with their titles and corresponding page numbers
- List all the tables with their titles and corresponding page numbers
- Number pictures and tables sequentially and according to section/chapter number

Section I - GENERAL

Introduction

- Describe of the project/feature for which the report is being written
- List reasons for the report
- List the objectives of the report
- List agencies that are involved
- Give any other pertinent general information
- Give an overview of the report explaining how it is organized

Location

- Describe the location of the project and project vicinity
- Provide a location map derived from USGS quad map or better
- Include the legal location description of the project

Project/Problem Definition

- Historical definition
- Present day conditions
- Prospects

Section II - ENGINEERING

Hydrology

- Define drainage basins
- Provide a drainage map clearly showing drainage features and boundaries
- Provide drainage basin characteristics
- Area
- Average Slope
- Length of longest drainage path

Type of soil cover
Type of soil
Other characteristics
Run-off calculations
Explain choice for method of computation
Provide input and output data
Organize input and results in a table

Hydraulics

Define physical features being analyzed
Show contour map of location
Provide survey of the stream. The survey should be included in the appendix and provided in an XYZ digital format
Describe tools that will be used to complete the analysis and the reason for choosing those tools
Present and describe any input files to compute analysis
Present output (tabulate)
Compute scour according to FHWA's HEC 18 and 23

Section III – CONCLUSIONS AND RECOMMENDATIONS

REFERENCES

APPENDICES

APPENDIX B – PLAN SHEETS

Drawings: Concept Stage

Provide adequate information to determine the site drainage patterns for the entire project area. Drawings should include but not be limited to:

1. Existing topography showing all existing drainage features within 100 feet (City Engineer may increase this amount) of the project site (existing watercourses, storm drains, canals, irrigation ditches, springs, culverts, etc.).
2. Any surrounding areas outside the project site that influence the project or that the project may influence downstream or adjacent to the project.
3. Water storage locations, volume and area required.
4. Any surface water route that is part of the storm water system.
5. Delineate the FEMA 100 year flood plain, where applicable.
6. Existing structures of any kind.

Drawings: Preliminary and Final Stages

Provide adequate information to determine the site drainage patterns for the entire project area. Drawings should include but not limited to the following:

1. Topography at 1-foot minimum contour intervals (proposed and existing).
   a. Existing topography showing all existing drainage features with-in 100 feet (City Engineer may increase this amount) of the project boundary (location of existing watercourses, storm drains, canals, irrigation ditches, springs and culverts etc.).
   b. Proposed watercourses.
2. Tributary drainage areas, flow directions, inlets, conveyance system outlets, catch basins, waterways, culverts, detention basins, elevations, grades, capacities, orifice plates etc.
3. Any above ground 100-year flow routes and termination points.
4. Delineate the 100-year flood plain as designated by FEMA.
5. Water storage volume and area, high flood mark, and freeboard noted, including max depth, side slopes, and spillways.
6. Any surrounding areas outside the project site that influence the project or that the project may influence downstream or adjacent to the project.
7. Storm water management and erosion control plan during the construction period.
8. Plan and profile drawings
9. Existing structures
10. Soil, Geotechnical, or exploratory report
11. Previously redlined plan sets

Drawings: As-Builts

Provide correct information so that the city can update their records with the following information.

1. Submit electronic as-built drawing files in Civil 3D format.

2. Modify the construction plans to represent the as-built condition.
3. Remove all unnecessary text and duplicates.
4. Remove call outs for relocations and demolitions
5. As-builts shall be stamped and signed by the engineer.