Nephi Watershed Protection & Storm Drainage Master Plan

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June 2009

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SECTION 1
INTRODUCTION

BACKGROUND

Nephi City (City) is located on an alluvial fan. Rocky and clayey soils and steep slopes in the mountain watersheds east of the City make the Nephi area susceptible to flash flooding. Historically, the City has experienced significant localized flooding from cloudburst events that typically occur in the summer and fall. Because the radial contours of the alluvial fan in the City convey runoff water away from Salt Creek and Big Hollow, there are no major natural drainage corridors to collect and convey storm water runoff generated in most areas of the City. Historical newspaper articles contain multiple records of cloudburst events in the area that have produced flooding and debris flows across major highways and damage to businesses, livestock, and agriculture. Damaging flash floods that occurred in 1935, 1943, 1952, 1955, and 1956 prompted City officials and the Natural Resources Conservation Service (NRCS) to construct detention basins in Miller and Bigelow Canyons in 1961. In 1983 and 1984 some minor flooding occurred along the reach of Big Hollow located in the City in response to the melting of large snowpack in the Salt Creek watershed.

When I-15 was constructed by the Utah Department of Transportation (UDOT), culverts were installed where natural drainage paths existed to convey runoff across the right-of-way. Since then, development has occurred adjacent to the I-15 right-of-way, creating potential flooding problems where buildings are located near the outlets of the cross drainage culverts.

Prior to the recent development of a pressurized irrigation system in the area, runoff generated in the City was collected in a network of irrigation ditches that existed throughout the City. Those ditches conveyed both irrigation water and runoff to agricultural fields west of the railroad. Since the pressurized irrigation system was constructed, most of the irrigation ditches have been filled in or abandoned, leaving no means of conveying storm water runoff west of the railroad. This has resulted in increased flooding on agricultural fields, residential property, and business developments. The problems created by the abandonment of the historic irrigation/drainage system and the installation of pavement and other impervious surfaces associated with recent development have created drainage problems that did not previously exist.

The City has also allowed storm drain sumps that allow water to percolate into the ground to be installed in some of the recent developments in an effort to manage storm water runoff. Storm drain sumps have been successful utilized in other communities in Northern Utah to manage and dispose of storm water. However, City personnel have since found that collapsible soils exist in many of those areas. As storm water runoff has been discharged into some of the new sumps, the underlying soils have consolidated, creating sink holes that have caused damage to the sumps, roads, and curb and gutter.

Salt Creek conveys runoff from a 95 square mile mountain watershed to the mouth of Salt Creek Canyon located just east of the City. A structure has been constructed at the mouth of that canyon to divert water from Salt Creek into the Salt Creek Irrigation Channel. The main channel between that diversion and West Creek is referred to as Big Hollow. The reach of Big Hollow located in Nephi City is susceptible to flooding from both snowmelt and cloudburst events.

Recent development and growth in the City have exacerbated some drainage deficiencies and created significant concerns to City officials. Because of these drainage problems and the drainage problems that will occur as the City continues to develop, the City has seen the need to develop a plan to identify means to solve existing and projected future drainage problems. The City retained a team of consulting engineers consisting of Jones and DeMille Engineering and Bowen, Collins & Associates (BC&A) to develop a Watershed Protection and Storm Drainage Master Plan that identifies storm drain system improvements that are needed to protect life and property during periods of significant storm water runoff. This is the first Storm Drainage Master Plan to be developed for the City.

PURPOSE OF STUDY

The City's primary objectives of this study are to:

- Resolve flooding problems associated with I-15 culverts
- Identify improvements to resolve existing and future urban drainage problems
- Identify needed drainage corridors west of the City
- Develop a drainage system capital improvements plan that can be used to develop an appropriate funding source
- Develop a flood control plan for Salt Creek
- Involve stakeholders and other interested parties in identifying problems and recommended solutions.

The purpose of this report is to describe the methods used to accomplish these objectives, as well as to summarize the results and recommendations associated with the hydrologic and hydraulic analyses. This study seeks to address the following issues and challenges with regards to effective storm water management:

- **Growth.** Larger amounts of storm water runoff are generated from paved surfaces and curb and gutter as historically agricultural areas are developed and urbanized.
- **Lack of Major Drainage Corridors west of Main Street.** Existing cross drain culverts on Main Street drain onto farm land, residential lawns, or business parking. There are no functioning drainage corridors to West Creek. There are also multiple culverts on Main Street, I-15, and other locations in the City that

are damaged or have sediment or debris built up in them. Many of these culverts will not function properly during runoff events.

- **Lack of Drainage Facilities to convey storm water from the east of I-15.** There are no open channel conveyance facilities west of I-15 to convey runoff from many of the culverts that cross I-15.

- **Collapsible Soils.** Much of the urban area has collapsible soils making it difficult for sumps to operate and drain properly.

- **City Liability for Flood-Related Damage.** Increased storm water runoff from development combined with the inadequate capacity of existing storm water collection and conveyance facilities can potentially lead to flood-related damage claims.

- **Lack of Adequate Funding for Storm Drainage Improvements.** The arid climate and general infrequency of flood events in the western region of the United States means that many cities tend to assign a low priority to storm drainage improvements. This tendency generally results in significant under-funding of programs that address flood control problems.

SCOPE OF WORK COMPLETED

Tasks that were performed in completing this study are identified below.

- Collected and Reviewed Existing Information
- Field Survey Work Completed
- Developed Aerial Topographic Mapping
- Inventoried Existing Storm Drain Facilities
- Drainage System Evaluated and Planning Criteria Created
- Defined Boundaries of Drainage Basins and Subbasins
- Performed Hydrologic Analysis of Salt Creek and Big Hollow
- Developed Hydrologic Computer Model of Existing Land Use Conditions
- Developed Hydrologic Computer Model of Projected Full Build-Out Conditions
- Developed Hydraulic Models of Salt Creek and Big Hollow
- Evaluated Alternative Improvements to Storm Drainage System
- Developed Recommended Flood Control Plan for Salt Creek
- Developed Construction Cost Estimates for Recommended Improvements
- Prioritized Recommended Improvements
- Prepared Report
- Held Three Public Meetings
- Explored Funding Assistance Options.

SECTION 2
DESCRIPTION OF STUDY AREA

LOCATION

The Nephi Storm Drainage Master Plan study limits extend beyond the Nephi City boundaries on all sides of the City. The study area, shown in Figure 2-1, is generally bounded by the mountains on the east, 500 West on the west, just south of I-15 and gravel pit on the south, and just south of Exit 228 on I-15 and Highway 41 to the north.

In general, the storm drain facilities evaluated as part of this study are located within the Nephi City limits. In order to thoroughly evaluate the Nephi City storm water conveyance and detention facilities, it was necessary to take into account all contributing drainage areas, including mountain watersheds that drain through the City from east of the City.

ELEVATION

Elevations in the watershed area that drain to Nephi range from approximately 5,066 feet above M.S.L. at 500 West to approximately 10,400 feet above M.S.L. in the Salt Creek watershed east of I-15. The average elevation within the corporate limits of Nephi City is approximately 5,200 feet. The ground surface generally slopes from the mountains on the east toward West Creek, located about 3 miles west of the City limits.

NATIVE SOILS

Figure 2-2 identifies the hydrologic soil group classifications that exist in the study area. These hydrologic soil classifications, based on infiltration potential, were established by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS). The information in Figure 2-2 is based on the NRCS Soil Survey for the Nephi Area (2000). Type A soils are well-drained sands, gravels, and sandy-loams, with high infiltration rates that generally result in low storm water runoff potential. At the other end of the scale, Type D soils have high clay content with low infiltration rates, generally resulting in relatively high storm water runoff during intense storm events.

Native soils in the study area are primarily composed of soil Types B, C, and D with moderate to high relative potential for storm water runoff. The predominance of Type C and D soils means that the mountains and undeveloped areas in the east portion of the study area are capable of generating significant runoff during high intensity cloudburst events. As shown on Figure 2-2, the area west of I-15 consists of primarily of Type B soils. Development with impervious surfaces in areas with Type B soils will significantly increase storm water runoff and often creates the need for new or larger storm water management facilities to manage runoff from the developed areas.

EXISTING DEVELOPMENT CONDITIONS

Nephi City is the largest city and the fastest growing community in Juab County. The population 2000 Census population was 4,733. The current population is estimated to be 5,370. Population growth, accompanied by the progression of urban development on the north and south sides of the City, has resulted in increased storm water runoff as historical agricultural lands with relatively low runoff potential have been converted to residential, industrial, and commercial developments with a lot of impervious paved areas and roof tops. As recent development has occurred, the City has enforced a requirement that curb and gutter be installed on streets that front new construction. The City currently has curb and gutter on about one-third of its streets. The typical paved widths of streets are 30 feet in the older and largest portion of the City, 66 feet in the older portion of the City where new homes are being constructed, and 48 feet in newer subdivisions. Installing curb and gutter and widening the width of the paved street section as part of new developments will increase the storm water runoff as the City continues to grow.

EXISTING MAJOR DRAINAGE CHARACTERISTICS

There are 16 drainage basins that produce runoff that impacts the City, 9 of which are mountain drainage basins that have potential to produce flash flooding due to the rocky and clayey soils in the area and the steep terrain. The major drainage basins are shown in Figure 2-3 along with their runoff discharge locations. During cloudburst events in the mountain watersheds, storm water is conveyed through canyons, washes, and ravines to culverts that cross I-15. Theses culverts concentrate storm water runoff in many areas that historically experienced shallow sheet flow. In most developed areas of the City, runoff flows off the asphalt streets onto gravel- and grass-lined shoulders where significant ponding and infiltration occurs.

All of the mountain watersheds east of the City, with the exception of Salt Creek, convey little or no runoff for long periods during the year due to the desert climate of the area. Salt Creek conveys streamflow year round. The majority of the streamflow in Salt Creek is diverted at the mouth of Salt Creek Canyon into the Salt Creek irrigation channel between mid-April and mid-October when irrigation water is utilized for agricultural purposes. Big Hollow is the major flood control channel through the City and conveys flood flows from Salt Creek to West Creek.

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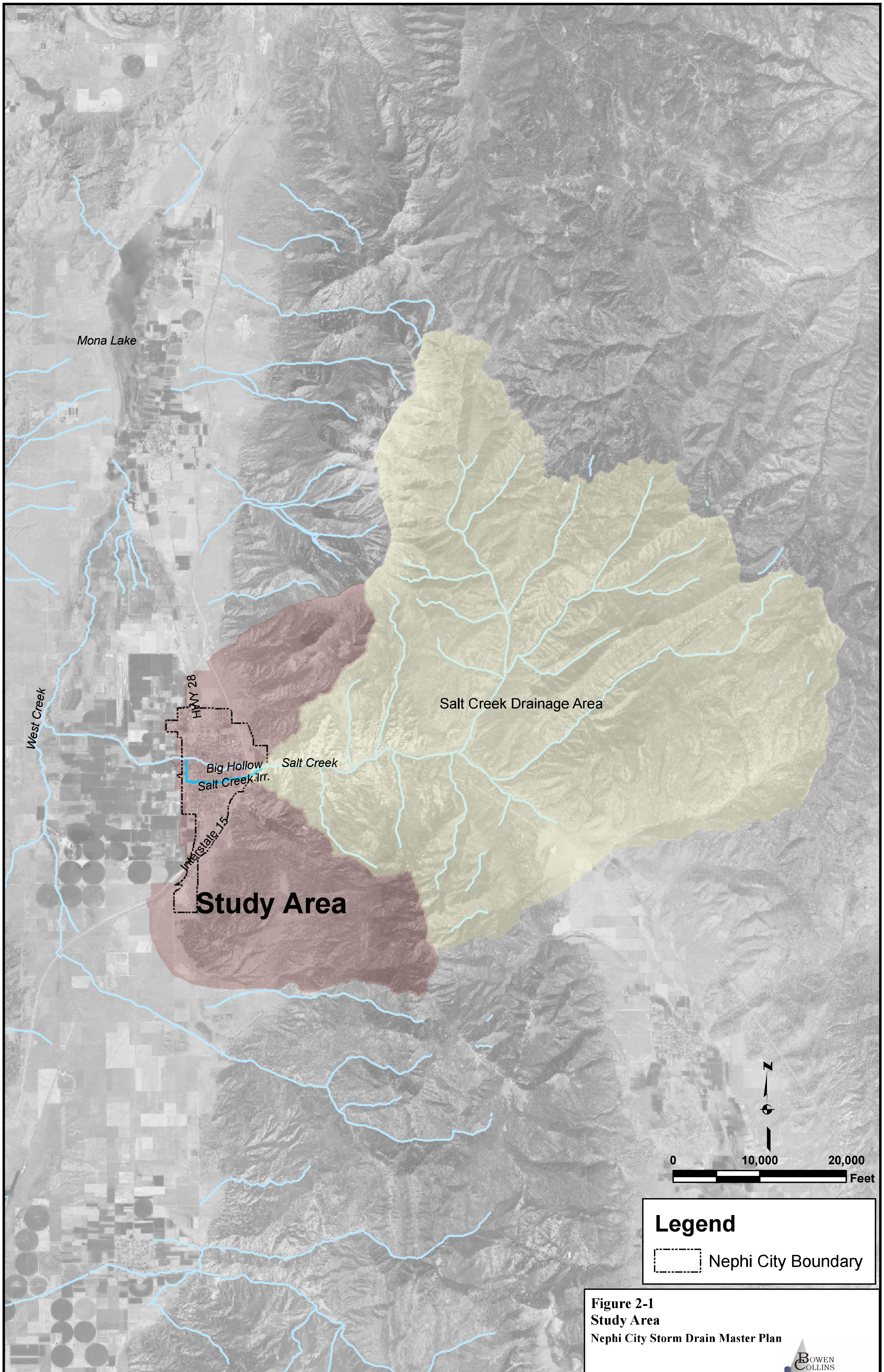

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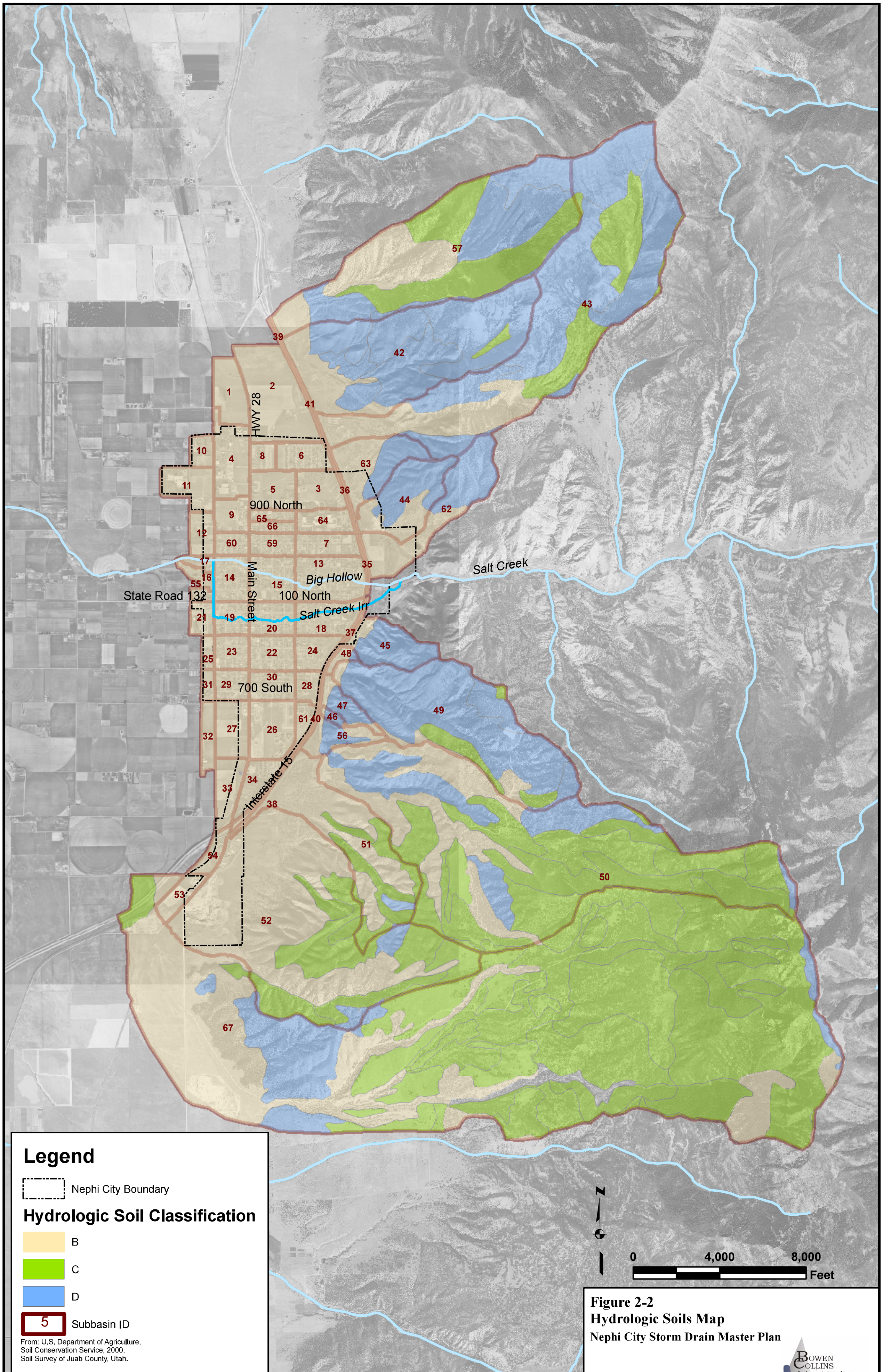

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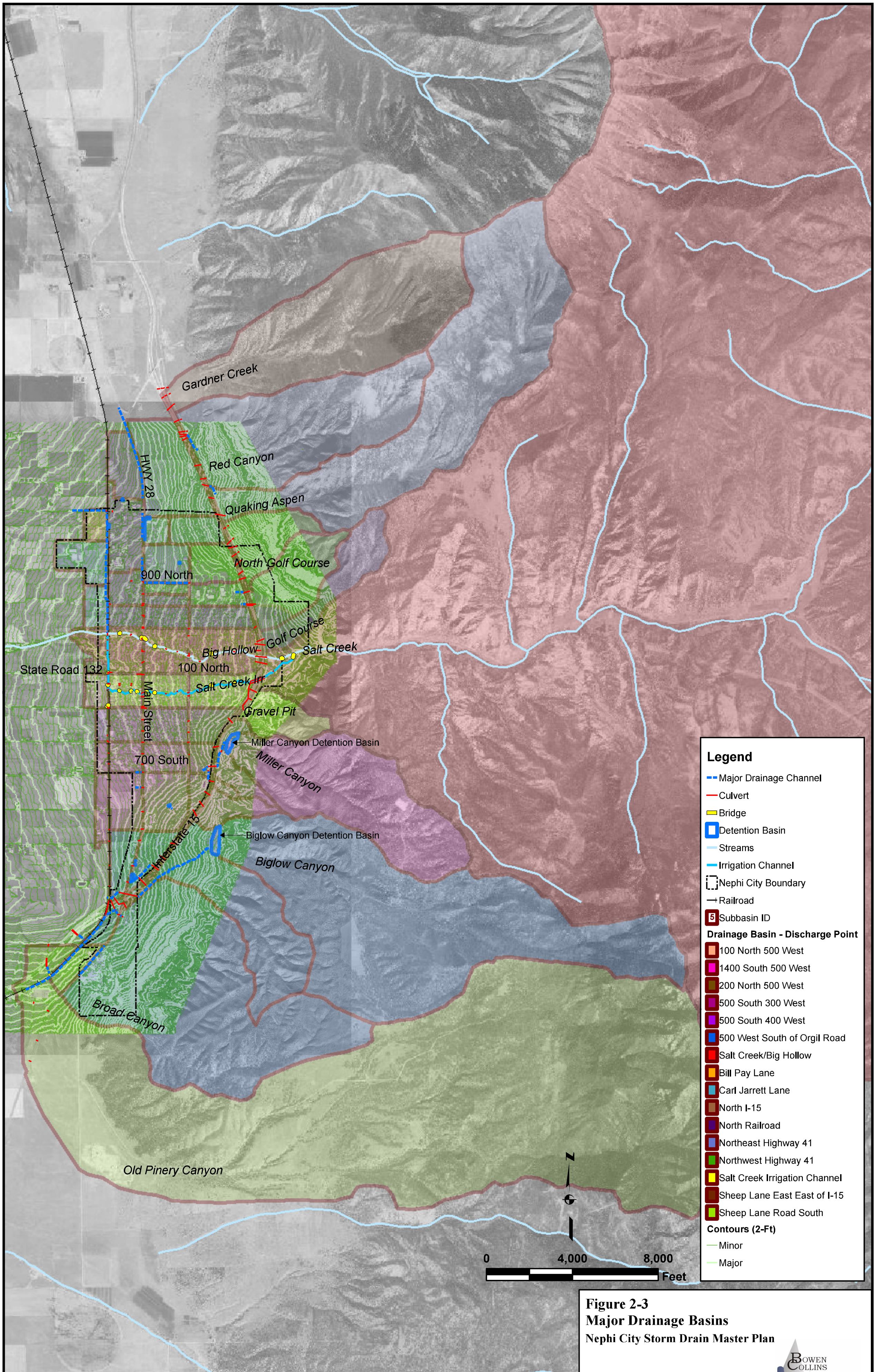

Figure 2-3
Major Drainage Basins
Nephi City Storm Drain Master Plan

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SECTION 3
STORM DRAINAGE FACILITY INVENTORY

One of the major tasks of this study was to develop an inventory of existing storm drainage facilities within the City limits. Field work to complete the inventory was performed by Jones and DeMille, BC&A, and City personnel. Inventory information collected in the field was compiled into a GIS database of storm drainage facilities and is presented in Figure 3-1. Information from this inventory was used to estimate hydraulic capacities of major storm drainage facilities within the City.

Storm drain facilities inventoried as part of this study can be placed into two categories:

1. Storm water catch basins, manholes, sumps, culverts, open channels, and storm drain pipes.

2. Storm water detention and retention facilities.

NEPHI CITY STORM DRAIN FACILITY INVENTORY

Figure 3-1 shows the locations of storm drain facilities that were inventoried as part of this project. Table 3-1 also summarizes the size of storm drains and major drainage ditches, and provides estimates of the capacity of the inventoried storm drains. The storm drain inventory includes major open channels, storm drains, catch basins and manholes, sumps, and detention and retention facilities.

Table 3-1
Estimated Peak Storm Water Discharges and Capacities for Major Open Channels and Pipelines
Nephi City Storm Drainage Master Plan

	Existing Development		Future Development			
Major Channels	**10-Year Peak Storm Water Flow (cfs)**	**100-Year Peak Storm Water Flow (cfs)**	**10-Year Peak Storm Water Flow (cfs)**	**100-Year Peak Storm Water Flow (cfs)**	**Bottom Width or Pipe Diameter (feet)**	**Estimated Channel or Pipe Capacity (cfs)[(1)]**
Within City Boundaries						
900 North	20	-	50	-	.5	10.5
west side of Highway 91	44	-	82	-	1	10.5
300 West, Big Hollow to 1500 N	22-28	-	50-115	-	1	18
Outside City Boundaries						
below Miller Canyon Detention Basin	-	30	-	30	4	80
Below Bigelow Detention Basin	-	50	-	50	5	120
Storm Drain Pipelines						
Within City Boundaries						
150 North to 100 West to Big Hollow	11	-	11	-	1 to 3	2.7
700 North	3	101	17	-	1.5	14.5
700 North to 900 North	20-30	101	17-35	-	2.5	43

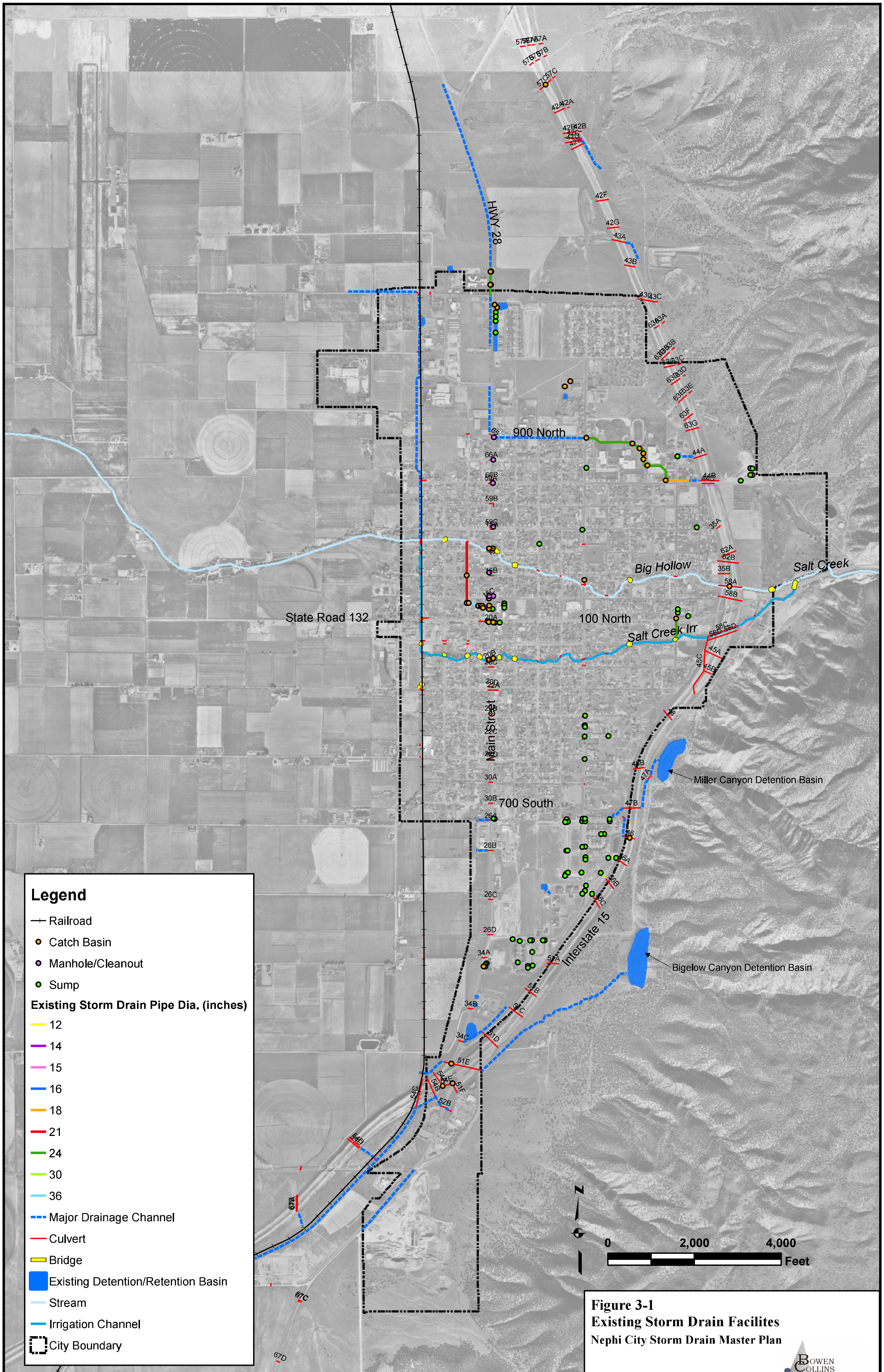

Figure 3-1
Existing Storm Drain Facilites
Nephi City Storm Drain Master Plan

Bowen Collins & Associates, Inc. Consulting Engineers

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SECTION 4
HYDROLOGIC ANALYSIS

INTRODUCTION

A hydrologic model of the study area shown in Figure 2-1 was developed for the purpose of estimating storm water runoff volumes and peak discharges generated by a design cloudburst event. The model development process is outlined in the following general steps, with detailed information on each step provided later in this section:

1. Delineate drainage basin and subbasin boundaries based on topography, parcel maps, aerial photography, and existing storm drainage facility information

2. Estimate hydrologic modeling parameters for each subbasin based on soil type, land use, slope, and other storm water conveyance characteristics.

3. Combine subbasin, channel routing, and storage elements in an integrated hydrologic model

4. Develop a design precipitation event (or events) using local rainfall data.

DRAINAGE BASIN DELINEATION

Aerial photography and topographic mapping was obtained for all of the detailed study area and the area between the Nephi City limits and West Creek as part of this study. Because Juab County personnel were interested in the area west of the City limits, Juab County provided funds to help purchase the aerial mapping. The aerial photography and topographic mapping were used in conjunction with the existing storm drainage facility inventory to delineate drainage basins and subbasins. The drainage basins and subbasin boundaries are shown in Figure 4-1 along with their drainage areas.

The major drainage basins were divided into subbasins with areas generally between 12 and 129 acres for hydrologic modeling purposes, with some larger subbasin delineations used in the undeveloped mountain region of the study area. The Salt Creek Drainage Area was not hydrologically modeled because statistical analyses performed by the USGS were available for use in estimating the 100-year discharge at the canyon mouth.

DESIGN STORM

After multiple discussions with Nephi City personnel, a 3-hour design storm with a 10-year return period was selected for the basis of the hydrologic analyses in urban areas and a 24-hour design storm with a 100-year return period was selected as the basis for the hydrologic analyses in mountain drainage basins was for this study. The 3-hour design storm utilizes a modified Farmer-Fletcher precipitation distribution. The 24-hour design storm utilizes the SCS Type 2 precipitation distribution. Other cities and counties in Utah along the Wasatch Front utilize similar design storms in planning and designing storm drain facilities. The precipitation distributions for the 10-year, 3-hour and the 100-year, 24-hour design storms are shown graphically in Figures 4-2a and 4-2b. More detailed information on the 10- and 100-year design storms is included in the Technical Appendix.

Precipitation depth-duration-frequency data from NOAA Atlas 14 (2007) were used in developing the design storm depths. The design storm precipitation depths used in the study are presented in Table 4-1.

Table 4-1
Design Storm Depth, Duration, Frequency Data
Nephi City Storm Drainage Master Plan
(from NOAA Atlas 14)

Precipitation Frequency Estimates (inches)		
ARI* (Years)	**3 Hour**	**24 Hour**
10	1.02**	1.81
25	1.27**	2.1
100	1.75	2.54**

* **ARI** is the Average Recurrence Interval.
** Values used in hydrologic analysis

MODELING METHODS AND ASSUMPTIONS

The hydrologic analysis of the study area was performed using the HEC-HMS software package developed by the U.S. Army Corps of Engineers (USACE). HEC-HMS uses the HEC-1 Flood Hydrograph Package algorithms in a Windows environment, with additional pre- and post-processing capabilities. A complete description of HEC-HMS modeling methods and capabilities is presented in the USACE HEC-HMS User's Manual. The model input parameters were assembled using multiple data sources, including drainage basin delineations, soil surveys, land use maps, recent aerial photography, and model input data used in similar hydrologic studies within or in the vicinity of the study area.

The following standard assumptions were made in completing the hydrologic analyses of the study area:

1. Rainfall return frequency is equal to associated runoff return frequency.

2. Design storm rainfall has a uniform spatial distribution over the watershed with a modified Farmer-Fletcher temporal distribution.

3. Normal (SCS Type 2) antecedent soil moisture conditions exist at the beginning of the design storm.

4. The hydrologic computer model adequately simulates watershed response to precipitation.

5. All storm water runoff generated by the model is conveyed through downstream model elements (the hydrologic model does not account for storm drain inlet or conveyance deficiencies).

Modeling Parameters for Mountain Drainage Basins

The subbasins for undeveloped drainages in the study area were hydrologically modeled using the SCS Curve Number Method. The assigned curve number defines the amount of precipitation that will be lost to infiltration and abstraction. Table 4-2 shows the curve numbers applied to sub-basins within the undeveloped drainages. Groundcover in the mountains and foothills of the study area generally consists of cedars, sagebrush, junipers, and scrub oak; the predominant ground cover for each sub-basin was chosen based on aerial photographs. Typical soils in the study area consist primarily of hydrologic soil Types B and C, as shown in Figure 2-2. These soils generally consist of sandy to clayey loams, and exhibit fair to poor infiltration characteristics. An average (fair to poor) watershed vegetation condition was assumed for this study rather than a poorly vegetated or burned watershed.

Table 4-2
SCS Curve Numbers for Undeveloped Drainage Areas[(1)]
Nephi City Storm Drainage Master Plan

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Pinyon-juniper—pinyon, juniper, or both; grass understory	Poor	NA	75	85	89
	Fair	NA	58	73	80
	Good	NA	41	61	71
Sagebrush with grass understory	Poor	NA	67	80	85
	Fair	NA	51	63	70
	Good	NA	35	47	55
Vegetated Urban Areas					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80

(1) From SCS TR-55 (1986), Table 2-2a and Table 2-2d, Runoff Curve Numbers for Arid and Semiarid Rangelands.

Drainage basin lag times were estimated based on approximate collection channel lengths and slopes using the USACE version of Snyder's equation for lag time (USBR, 1989).

$$\text{Lag Time} = 1.8\left(\frac{LL_{ca}}{S^{0.5}}\right)^{0.33}$$

where:

L = the longest water course in a given basin from the drainage boundary to the point of concentration (in miles)
L_{ca} = the length along L from a point perpendicular to the basin centroid to the point of concentration (in miles)
S = the overall slope of L (in feet per mile).

Typical subbasin lag times for undeveloped drainages ranged from about 25 to 90 minutes, depending on basin slope and geometry.

Modeling Parameters for Urban Drainages

The subbasins for urban drainages in the study area were hydrologically modeled using the SCS Curve Number Method. Table 4-2 shows the curve numbers applied to subbasins within the urban drainages. In areas of urban development, the top layer of native soil is typically paved over or replaced with topsoil which supports the growth of lawns and other urban vegetation. The percentages of impervious area for each subbasin were assigned based on the City's land use map shown in Figure 4-3, recent aerial photographs, and the information shown in Table 4-3.

Table 4-3
Average Percent Impervious Area
by Land Use Category(1)
Nephi City Storm Drainage Master Plan

Land Use Category	Average Impervious Area **(%)**
Highway Commercial	60
Commercial/Industrial Mix	50
Commercial/Residential Mix	40
Central Business District	40
Light Industrial Residential Mix	35
High Density Residential	30
Low Density Residential	20

Drainage basin lag times were calculated based on approximate collection channel lengths and slopes using the following equation for lag time (Humphrey, 1993).

$$\text{Lag Time} = T_o + T_g + T_p + T_c$$

where:

T_o = Overland flow time
T_g = Gutter flow travel time
T_p = Pipe flow travel time
T_c = Channel flow travel time

$$T_o = (0.66 * L^{0.50} * n^{0.52}) / (S^{0.31} * i^{0.38})$$

where:

T_o = overland flow time of concentration, in min
L = overland flow length, in feet
n = roughness coefficient of overland flow
S = average of precipitation, in inches per hour
i = intensity of precipitation, in inches per hour

$V_g = (1.12/n) * S_x^{0.67} * S^{0.50} * T^{0.67}$

where:

V_g = velocity of flow in the gutter
S_x = street cross slope
S = street longitudinal slope, in feet per foot
T = spread of flow in gutter
d = depth of flow in gutter
n = Manning's n for pavement

$$V_p = (1.49/n) * R^{0.67} * S^{0.50}$$

where:

V_p = velocity in pipe, in feet per second
R = hydraulic radius, D/4 for full pipe flow, in feet
D = diameter of pipe, in feet
S = slope, in ft/ft
N = Manning's n

$$V_c = 37.0 * w^{0.667} * S^{0.5}$$

where:

V_c = velocity, in feet per second
b = bottom width, in feet
n = $0.16 * (V*R)^{-0.58}$

Typical subbasin lag times for the urban drainages ranged from 10 minutes to 45 minutes, depending on subbasin size, slope and geometry.

Channel and Storage Routing

The Muskingum-Cunge channel routing method was used for routing runoff from subbasins to and through the primary storm drain conveyances. Detailed information on channel geometry, slope, and roughness collected during surveys of the canals and creeks was used where appropriate. Storm drain inventory information was combined with topographic information, where necessary, to estimate routing parameters for storm drain pipelines. In areas where this information was not collected, typical routing parameters were assigned based on field observations. Manning's channel roughness values of 0.035 to 0.045 were used for natural and irrigation channels, while a value of 0.015 was used for concrete-lined channel sections and storm drain culverts.

Storage routing elements were included in the model to simulate major detention basins. In general, only detention basins with volumes greater than one acre-feet were included in the model (local onsite detention was not included in the model, except as noted in the projected future land use conditions modeling explanation provided later in this section). Where available, volume-discharge relationships for these detention facilities were obtained from the City. For many of the cases where this information was not available, capacity was estimated based on maps of existing topography and outfall capacities were estimated based on existing storm drain inventory information. It is estimated that the capacities of the Miller Canyon, Bigelow Canyon, and 1450 North detention basins are approximately 75, 106, and 1.5 acre-feet respectively.

MODEL CALIBRATION

In general, calibration of a hydrologic model of an urban area refers to the process of adjusting parameters to achieve results consistent with available reference information in nearby areas, rather than adjusting for actual stream flow observations from the study area. Based on information from drainage studies from nearby areas, the natural (undeveloped) subbasins in the study area were calibrated to generate peak runoff ranging from 100 to 700 cfs per square mile for a 100-year 24-hour design storm, with an average of 280 cfs per square mile. Urban subbasins were calibrated to generate peak runoff ranging from 0.1 to 0.35 cfs per acre for a 10-year 3-hour design storm for existing development conditions, with an average of 0.15 cfs per acre based on data from nearby small urban drainages.

PROJECTED FUTURE LAND USE CONDITIONS

For the purposes of this study, it was assumed that the current trends of growth and development in the City would continue. The hydrologic model for existing land use conditions was modified to represent projected future land use conditions based on zoning and projected land use maps provided by the City. The Projected Land Use Map is shown in Figure 4-3. The hydrologic model for future land use also reflects the City's direction to place curb and gutter on all of its streets.

Mountain drainages east of the City limits and south of SR-132 were assumed to remain undeveloped in the future. Planned development east of the City limits and north of SR-132 shown in Figure 4-3 was incorporated into the hydrologic model. If development occurs east of the areas planned for development shown in Figure 4-3 and the associated storm water runoff is conveyed into the City, storm water runoff will need to be detained or retained to reduce the post-development peak discharges to a level no greater than the estimated peak discharges from pre-developed conditions. Effects of development in these areas on City storm drain facilities should be carefully modeled, since existing downstream detention facilities may not be capable of accommodating significant increases in runoff volume, even if peak flows are detained to pre-development rates.

HYDROLOGIC MODELING RESULTS

Rainfall-runoff simulations were completed using the 10-year 3-hour, 25-year 3-hour, and 100-year 24-hour design storms for both existing and projected full build-out conditions. Average estimated peak discharges generated in the older part of town for existing development conditions generate approximately 0.15 cfs/acre for a 10-year design storm. Future development conditions (with curb and gutter and wider streets in the same area) would generate between 0.30 and 0.45 cfs/acre from the same storm. Detailed results, as well as HEC-HMS model schematics, are included in the Technical Appendix.

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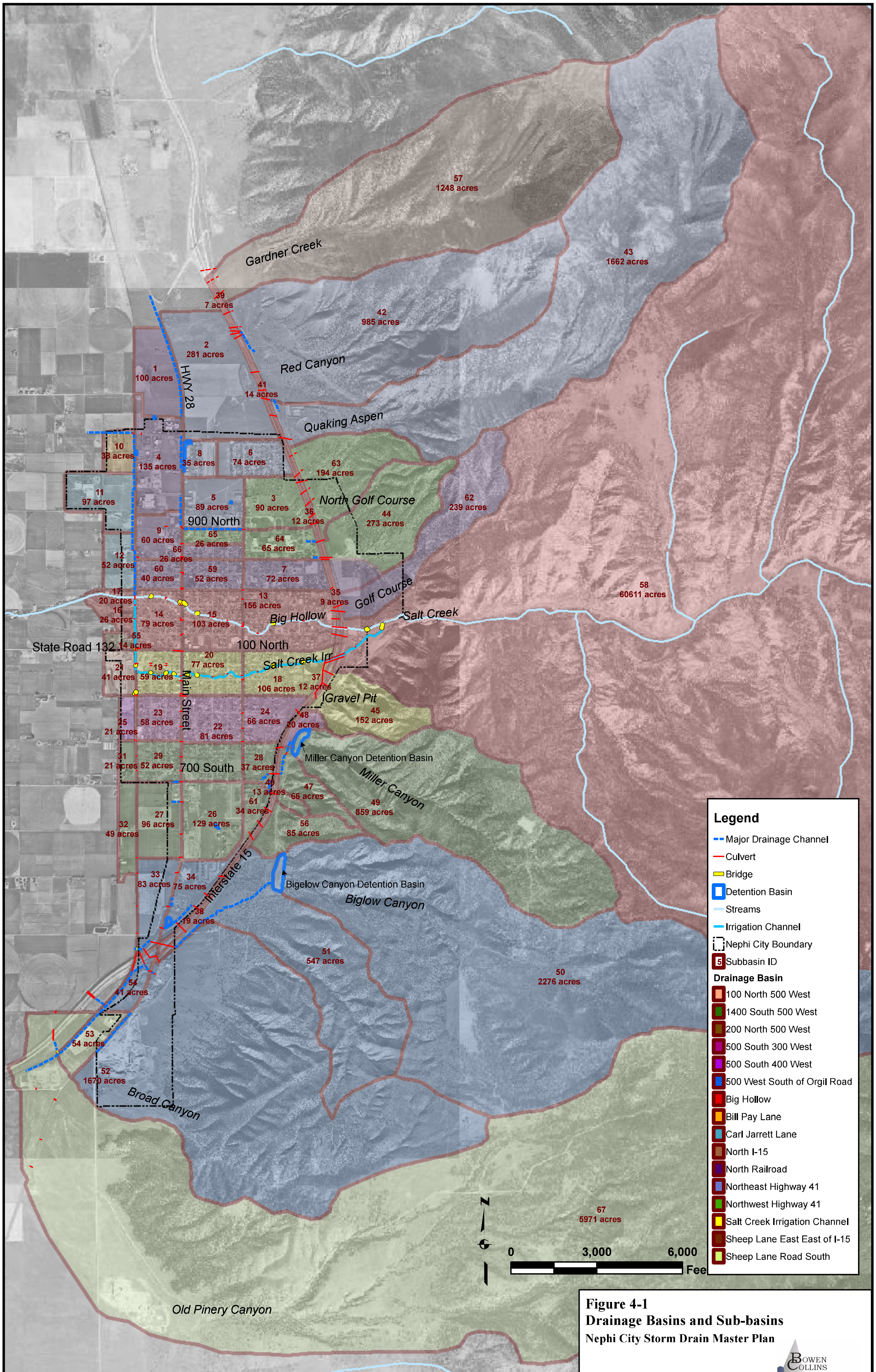

Figure 4-1
Drainage Basins and Sub-basins
Nephi City Storm Drain Master Plan

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Figure 4-2a
10-Year 3-Hour Design Storm Precipitation Distribution
Nephi City 2008 Master Drainage Plan Update

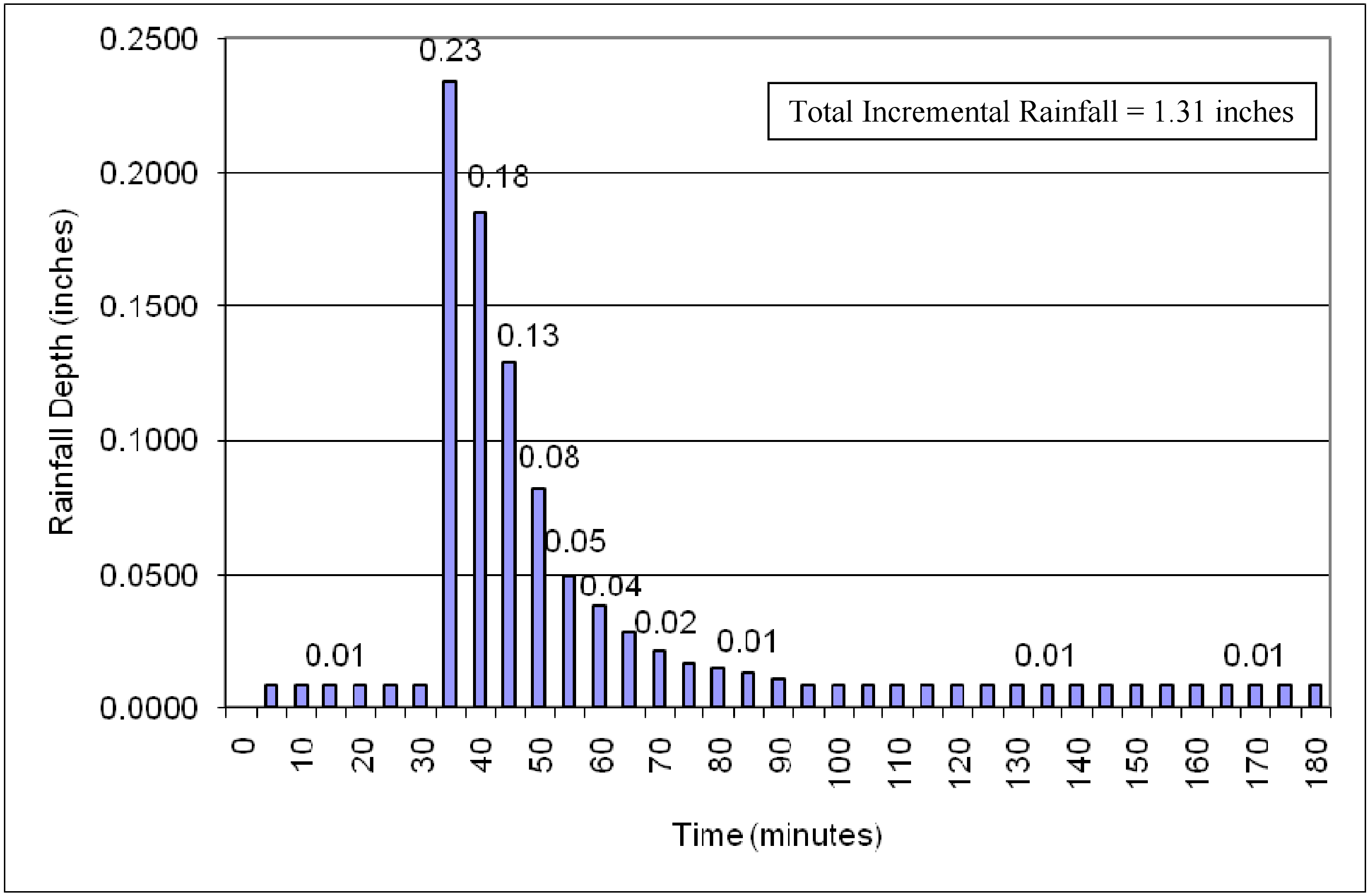
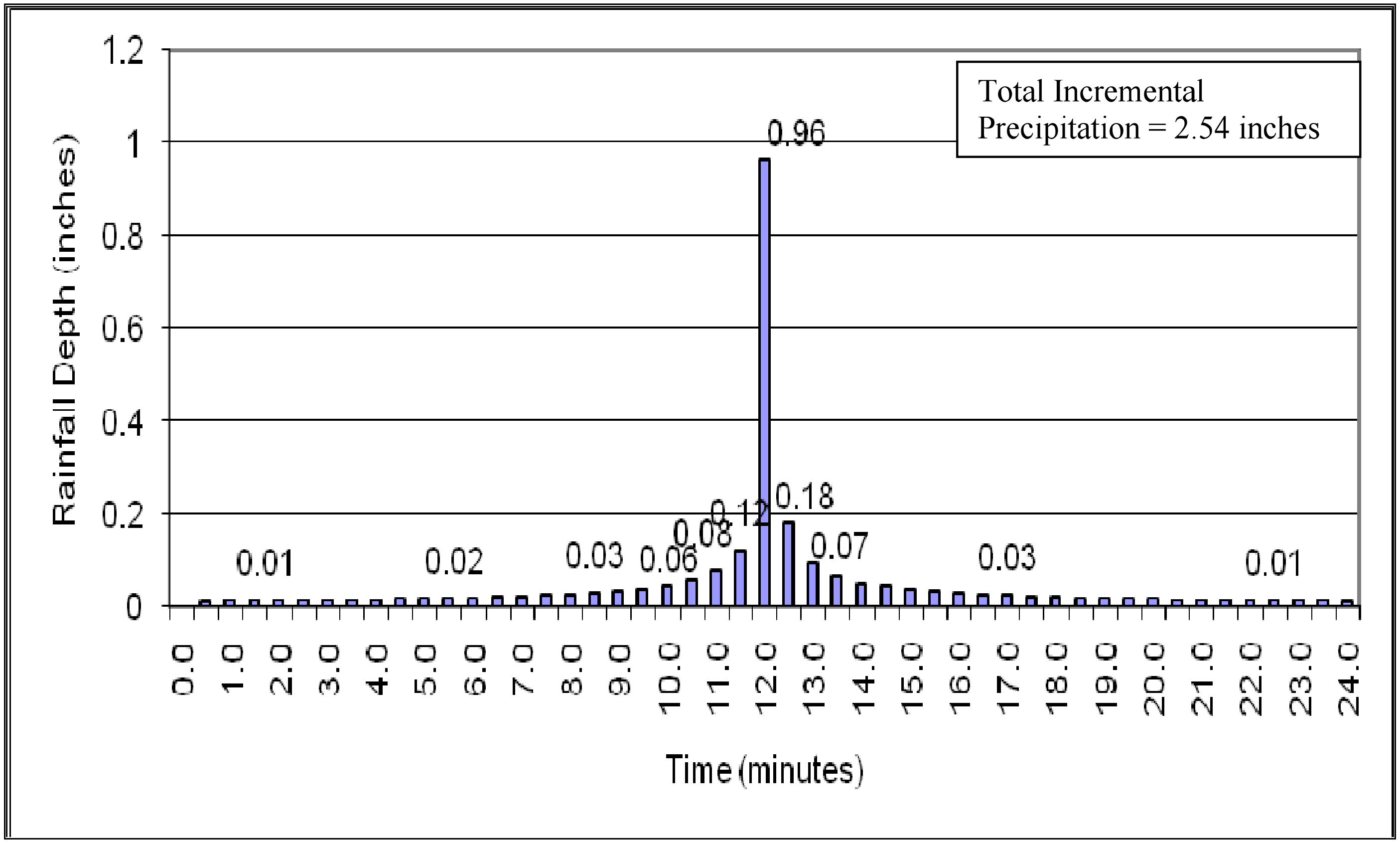
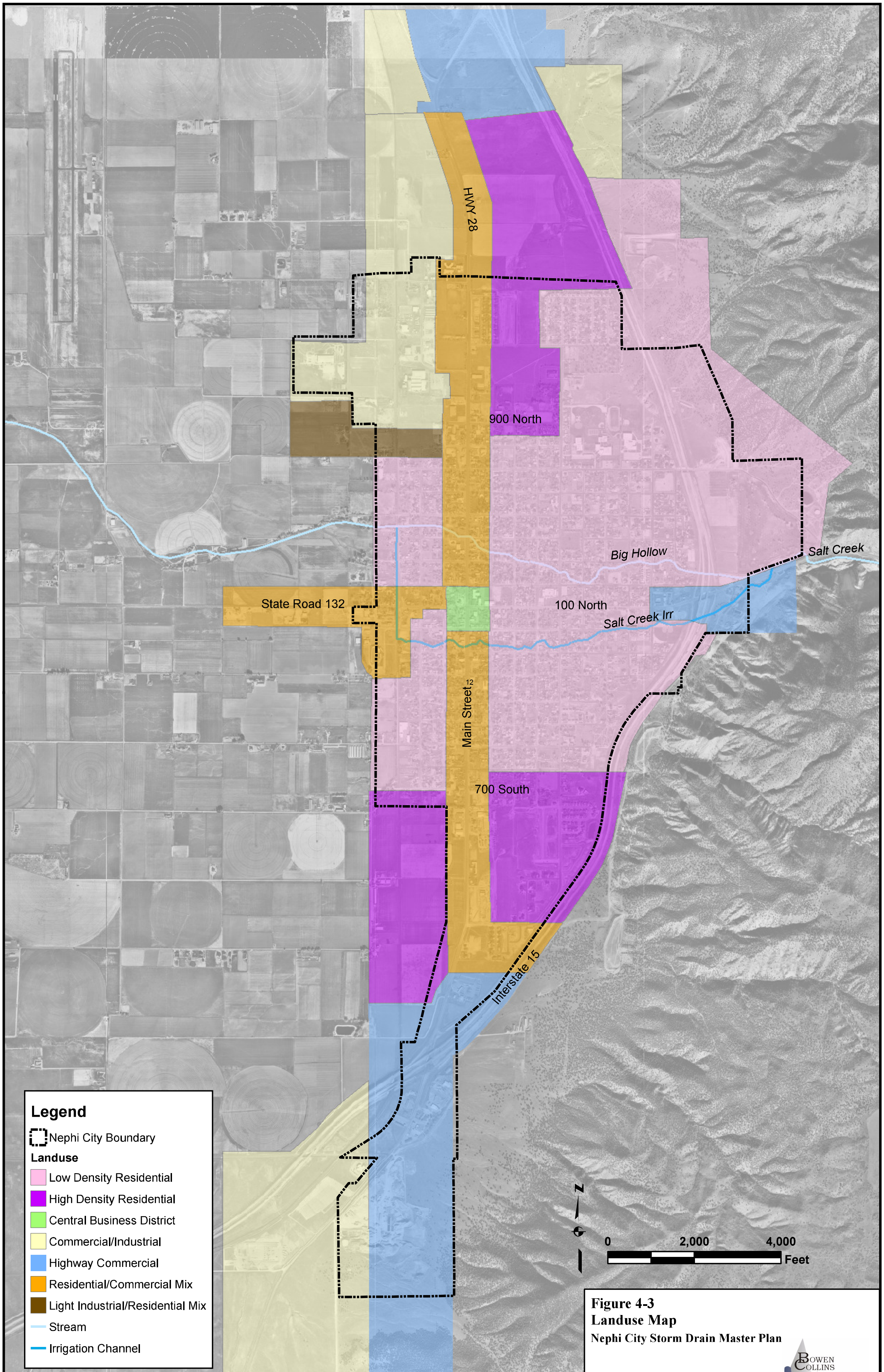


Figure 4-2b
100-Year 24-Hour Precipitation Design Storm Distribution
Nephi City 2008 Master Drainage Plan Update





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