Tooele’s comprehensive flood and storm water master plan includes five key goals:

• Prevent future flood damages.
• Solve existing flood/drainage problems.
• Preserve the natural and beneficial functions of the natural drainage system.
• Preserve and enhance stormwater quality.
• Enhance the community’s safety, environment, and quality of life.

**Ultimate watershed urbanization.**

Runoff generally becomes deeper and faster, and floods become more frequent, as watersheds develop. Water that once lingered in hollows, meandered around stream channels, and soaked into the ground now speeds downhill, shoots through pipes, and sheets off rooftops and paving. These channels are capable of conveying the runoff to adjoining property more rapidly than under pre-development conditions. The effects of urbanization on stormwater drainage are related to the change in the quality, runoff rate, and the volume of stormwater entering the natural drainage system. In an urban setting, no longer is the runoff delayed by minor topographic depressions, the vegetative cover, or the indirect routes natural surface runoff must follow.

But unless plans and regulations are based on future watershed urbanization, development permitted today may well flood tomorrow as uphill urbanization increases runoff. The impervious surfaces also reduce the area available for rainfall infiltration. The subsequent reduction of water infiltrating the soil may result in a lowering of the water table and a potential reduction in the amount of groundwater recharging streams during normally low flow periods. Erosion and sedimentation. Erosion and sedimentation rob hillsides of valuable topsoil, dam lowlands, clog streams, and pollute rivers. Builders must control site erosion from new development.

**Watershed-wide regulation.**

Floodplains are only part of flood-management considerations. Water gathers and drains throughout entire
watersheds, from uplands to lowlands. Each watershed is an interactive element of the whole. A change at one place can cause changes elsewhere, whether planned or inadvertent. In association with the altered drainage characteristics there are changes in water quality. The runoff from the urban area contributes pollution loading of nutrients, bacteria, sediment, heavy metals, oils, grease and, in the spring, road salt. The “first flush” is a phenomenon whereby the initial stormwater runoff picks up pollutants from catchment surfaces, such as roads and parking lots, and sewer deposits, where they have been collecting since the last storm. Once these pollutants are washed through the system, the pollution level of the stormwater decreases for the remainder of the storm.

Stormwater management has evolved in the past several years to a point where it is recognized that comprehensive planning with multi-agency involvement is necessary to ensure the protection of human life, property, and our natural receiving waters. The three key components which are developed in this planning process include the Watershed Management Plan, Subwatershed Plan, and Stormwater Management Plan. To ensure effective stormwater management, all three components should be completed and be directly related to the county planning process.

Watershed Management Plans are comprehensive strategies that establish broad water management goals and targets for an entire catchment. First, the plan documents and examines the physical, chemical and biological characteristics of the basin. This information is then used to define the existing and potential water uses. General goals, objectives, control methods and/or technologies are then evaluated and selected on a basin basis to protect or enhance the receiving waters.

Official Plans set out the objectives and policies which the county shall use to guide development. These plans should contain the stormwater management goals and targets established in the Watershed Management Plan. The county makes a commitment for comprehensive planning at all stages of land use planning.

Subwatershed Plans address the requirements for stormwater management on a sub-basin level. They use information prescribed in the Watershed Management Plan to develop necessary subwatershed stormwater
controls such as infiltration, trenches, extended swales (low-lying land) or stormwater ponds. This planning level is at the same scale as the neighborhood (secondary) plans, which provide more specific planning details such as land use and transportation corridors. Developing these two plans in an integrated manner will ensure the optimization of all resources within that sub-basin.

Similarly, Stormwater Management Plans and subdivision plans should be developed jointly. Stormwater management should be considered at an early stage in the subdivision planning process because it may significantly affect such items as the layout of subdivision lots, roadways and other services.

Another stormwater management concept involves minor and major drainage systems. The minor system is considered as the “convenience” drainage system that carries storm flows during frequent rainfall events. The major system consists of the streets, swales and open channels that carry water during high but infrequent floods. Although the minor system is perceived by most to be the primary means of disposing of stormwater, as stated, it carries a small proportion of the total rainfall during an extreme storm. These systems are only designed to carry stormwater from a two- to ten-year storm. The purpose of a major drainage system is to transport the excess overland stormwater flow in a controlled manner. Uncontrolled overland flows erode properties, flood basements, damage foundations through the buildup of hydraulic pressures, and flood roads. Major drainage systems are now typically designed to handle the 100 year storm. They also provide the most cost effective method of expanding the drainage capacity of an area.

**Stormwater detention.**

One way to avoid increased flooding downstream from new development is to provide stormwater detention basins throughout watersheds. Detention of stormwater runoff serves as short-term storage of stormwater until it is slowly released under controlled conditions. Storage facilities include methods such as retention (wet), detention (dry) and infiltration ponds, flat roofs of commercial buildings, large parking lots, local and arterial streets, and subterranean tanks or silos.

Ponds are also an effective way to manage stormwater due to their large holding capacity. There are generally
two types of ponds, namely “dry” and “wet.” Dry ponds are typically dry; they hold water for a limited time only, releasing it to a receiving water slowly through a controlled outlet. Wet ponds are permanent water bodies designed to hold water until their capacity is exceeded, thus overflowing to a receiving water. They are long-term storage facilities and therefore provide long retention times. Wet ponds also serve as groundwater recharge sites.

New or substantially improved developments must detain the excess stormwater on site – unless they are exempted in master plans. Water from detention basins is released slowly downstream. In most instances, the county has found regional detention basins to function more satisfactorily than smaller, scattered on-site facilities.

The purpose of rooftop, parking lot, street and subterranean storage is to delay the runoff or reduce the discharge rate to the major and minor systems. The basic requirements for the use of this technique include a containment location and an outflow release device to control the rate of runoff. Where necessary, an emergency overflow device should be included. There are other methods of altering urban drainage. Groundwater recharge can be achieved through the use of porous pavement in roads and parking lots. In residential areas, well-designed landscaping techniques and construction materials can make the major drainage system effective yet unobtrusive.

**Valley storage.**

Flood water cannot be compressed. It requires space. Encroachments into a channel or floodplain can dam, divert, or displace flood waters. Tooele County requires compensatory excavation if a development – including a flood control project – would reduce valley storage. Preserving or recreating floodplain valley storage is a keystone of the county’s program.
EXECUTIVE SUMMARY
The Storm Drainage Master Plan for the Lake Point/Saddleback Region identifies stormwater drainage and flood control facilities for existing and future land use conditions within the study area. The total study area consists of approximately 13,000 acres. As development plans proceed, the need to plan and integrate an effective storm drain system for the entire area is obvious. The improvements investigated will convey and store stormwater runoff from the mountainside through the bench areas, under the existing railroad embankment, through the Lake Point area, under State Road 36 and Interstate 80, with eventual discharges to the Great Salt Lake. The following tasks were completed within the scope of work to complete the storm drainage master plan for the Lake Point/Saddleback study area.

Collect and review existing information (topography, soil, geology, planning, aerial photos) Inventory existing drainage facilities (field reconnaissance)
Define drainage basin boundaries
Develop hydrologic computer models for existing and proposed land use conditions Identify potential detention/retention basins for the following canyons: Rodgers, Green Ravine, Big, Coyote and Pole
Determine cost estimates for recommended improvements
Preparation of report

The proposed drainage system relies on retention facilities located at the base of the major canyons, approximate to the mouths of the canyons in the bench area, and along the eastern border of the railroad. In this manner stormwater runoff is captured, retained and infiltrated near to the point of generation and would not be conveyed through the entire basin. Stormwater runoff from the Lake Point and Salt Plant areas will be conveyed to ponds with the option for full retention or detention with a release rate.

The recommended storm drainage improvements are shown on Figure 6-1. Table E-1 summarizes the options and the associated costs. The recommended improvements include piped conveyance through the Lake Point area with regional ponds located at key design points.

<table>
<thead>
<tr>
<th>Table E-1 Summary of Cost Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option</strong></td>
</tr>
<tr>
<td>Option 1 - Retention/Infiltration ponds</td>
</tr>
<tr>
<td>Option 2 - Detention/Infiltration ponds with release rate in Lake Point</td>
</tr>
</tbody>
</table>

1.0 INTRODUCTION

1.1 Background
The Lake Point/Saddleback region, located in northeastern Tooele County, is currently being planned for future residential development. A significant portion of the study area is currently undeveloped. With the current planning for development, the need to investigate future stormwater facilities and integrate these facilities with ongoing planning was identified. Existing
storm water facilities that service the agricultural and residential development in the area consist of roadside ditches, open areas and low lying depressions.

1.2 Purpose of Study
The Storm Drainage Master Plan for the Lake Point/Saddleback Region identifies storm water drainage and flood control facilities for existing and future land use conditions within the study area. The total study area consists of approximately 13,000 acres. The study area designated for this plan is shown in Figure 1-1.

As development plans proceed, the need to plan and integrate an effective storm drain system for the entire area is obvious. The improvements investigated will convey and store storm water runoff from the mountainside through the bench areas, under the existing railroad embankment, through the Lake Point area, under State Road 36 and Interstate 80, with eventual discharges to the Great Salt Lake.

Coordination with the Bureau of Land Management (BLM) is included as part of the planning process and essential as storm water runoff from the western slopes of the northern Oquirrh mountainsides flow through the proposed Saddleback Development, which will be located at the base (bench area) of major canyons. Coordination and review with Tooele County and the Saddleback Development owners is also required, as the proposed storm drainage system will be owned and maintained by the County.

Through this storm drainage planning process, system wide improvements are recommended and a prioritization (phasing) of those improvements is performed. The prioritized list of improvements allows the County to budget and schedule for implementation of storm drainage improvements to service the community. Additional studies and further coordination efforts are outlined herein.

2.0 EXISTING CONDITIONS

2.1 Topography
The study area is located in the northeast corner of the Tooele Valley, along the west flank of the northern portion of the Oquirrh Mountain Range. The study area generally slopes to the west toward the Great Salt Lake. Topography throughout the area varies from 10 to 25% from the mountain slopes to the bench area. Through the bench area to the Lake Point area slopes are averaging 3 - 5%. Through Lake Point and the Salt Plant area, drainage slopes are very mild with average slopes of approximately one percent grade from east to west.

Due to the natural breaks in topography and the man-made roadway features, the study area was broken up into the following distinct regions: mountain, bench, Lake Point and Salt Plant

2.2 Soils
The National Resources Conservation Service (NRCS) 2000 Soil Survey of Tooele Area, Utah was used as a reference to determine soil types in the study area. Table 2-1 summarizes the soil types. Figure 2-1 depicts the project area with soil types.

The area was classified into twelve distinct soil associations. These soils fall into the Hydrologic Soil Groups (HSG) B, C and D for the purpose of storm drainage modeling. The HSG classification of B indicates permeability rates in the range of 0.60 to 60.00 inches per hour. HSG C soils have permeability rates in the range of 0.00 to 6.00 inches per hour and HSG D soils have permeability rates in the range of 0.00 to 2.00 inches per hour.

2.3 Land Use
Existing land use, within the boundaries of the study area, is predominately agricultural and mountainous, as depicted in Figure 2-2. The mountain and bench areas are currently undeveloped. The existing residential land use in
SITE LOCATION MAP
Storm Drainage Master Plan
Lake Point / Saddleback Region
Tooele County Utah

DATE
OCT 2003

FIGURE NUMBER
1-1

18-8  Tooele County General Plan
the area is classified as low density (approximately one acre per lot) and rural in nature. The majority of commercial development in the study area, to date, has occurred along State Route 36 (SR36). Undeveloped areas exist in the low lying lake Point area and heavy manufacturing activities associated with the production of salt exist in the Salt Plant region.

2.4 Natural Drainage
Natural drainage in the undeveloped mountain region of the study area collects in several canyon creeks, which generally flow from east to west. In other areas the natural drainage is primarily overland runoff that generally flows from east to west and ultimately discharges to the Great Salt lake.

2.5 Major Roadways
Interstate 80 (I-80) is the major east-west traffic route and SR36 is the major north-south traffic route.

2.6 History of Flooding
The most well known historical flooding events occurred during the wet years of 1983 and 1984. During that time there was a significant amount of snowpack in the Oquirrh Mountains. Temperatures rose quickly during the month of May and caused the snow to melt quickly producing runoff. The flooding from the runoff lasted for approximately three to four days in the lake Point area. Debris flows also occurred during these years and are described further in the accompanying report titled “Evaluation of Debris Flow Potential and Proposed Mitigation Measures” by Stantec Consulting.

2.7 Field Observations
The existing storm drain system was observed during a site visit in the month of May. Little drainage conveyance was observed other than that needed to cross the railroad and to convey flows across. SR36 and I-80. Photographic documentation (Attachment 1) and Geographic Information System (GIS) maps summarizing the existing system were created.

3.0 FUTURE CONDITIONS

3.1 Land Use
Future land use information and land planning information was obtained from Saddleback Development and discussions with Tooele County Engineering and Tooele County Planning. Figure 3-1 depicts the future land use for the study area.

Future residential areas will remain, on the average, at a low density, approximately one acre per lot. Recreational land uses will be included in the overall residential development on the bench area, by Saddleback Development. In the lower regions of the study area, SR 36 to the Great Salt Lake, future land use is anticipated to be commercial, office and industrial.

3.2 Drainage
As urbanization of rural areas occurs, increased storm water runoff will occur due to increased impervious areas. Many of the existing roads in the Lake Point/Saddleback region currently have little to no formal drainage system. With more development and population, a system will be required to convey the increased flows away from roadways to natural drainages. Conveyance systems will generally follow main collector roadways where possible.

The proposed drainage system relies on retention facilities located at the base of the major canyons, approximate to the mouths of the canyons in the bench area, and along the eastern border of the railroad. In this manner storm water runoff is captured, retained and infiltrated near to the point of generation and would not be conveyed through the entire basin. It is observed that soils and topography allow for infiltration at the higher elevations of the study area, where it may not be as feasible in the lower regions of the study area.

Stormwater runoff from the Lake Point and Salt Plant areas will be conveyed to ponds with the
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Very sandy clay loam and sandy clay loam</td>
</tr>
<tr>
<td>B</td>
<td>Sandy clay loam and sandy clay loam</td>
</tr>
<tr>
<td>C</td>
<td>Clay loam and sandy clay loam</td>
</tr>
<tr>
<td>D</td>
<td>Clay loam and sandy clay loam</td>
</tr>
<tr>
<td>E</td>
<td>Clay loam and sandy clay loam</td>
</tr>
<tr>
<td>F</td>
<td>Clay loam and sandy clay loam</td>
</tr>
<tr>
<td>G</td>
<td>Clay loam and sandy clay loam</td>
</tr>
</tbody>
</table>

**Soil Description**

**Table 2-1**

**Farmlands:**

- A: Extremely deep, clay loam
- B: Very deep, sandy clay loam
- C: Deep, clay loam
- D: Deep, clay loam
- E: Deep, clay loam
- F: Deep, clay loam
- G: Deep, clay loam

**Series:**

- A: Tule Lake
- B: Mono Lake
- C: Lake Mead
- D: Colorado River
- E: Rio Grande
- F: Cibola
- G: San Juan
option for full retention or detention with a release rate. Due to the potential impervious areas of these lower sections and poor infiltration capacity of the soils, the system components consisting of detention with a release rate are justified.

3.3 Irrigation Canals
The ET irrigation canal through the project area is no longer in use and abandoned. The canal facilities are in place with the potential for use as storm water conveyance facilities.

3.4 Water Quality
Currently, both State and Federal agencies are regulating quality of storm water runoff from municipal discharges from urban areas. At this time, Tooele County is not listed by the State and Federal agencies as having to comply with the Phase 1 or Phase 2 National Pollutant Discharge Elimination System Permits for Municipal Storm Sewer Systems. However, this report will address water quality best management practices that may be integrated with storm drain systems to reduce the discharge of pollutants to the maximum extent practicable.

The Utah Division of Water Quality through the Utah Pollutant Discharge Elimination System permit program currently regulates storm water discharges from industrial sources.

4.0 BASIN DELINEATION
Major basins were delineated based on land use and ultimate discharge points. The study area was divided into four regions as listed in Table 4-1. The major basin delineation is shown in Figure 4-1.

<table>
<thead>
<tr>
<th>Region</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain</td>
<td>Oquirrh Mountains east of the proposed Saddleback development</td>
</tr>
<tr>
<td>Bench</td>
<td>Area between the Oquirrh Mountains and the railroad</td>
</tr>
<tr>
<td>Lake Point</td>
<td>Area between the railroad and 1-80</td>
</tr>
<tr>
<td>Salt Plant</td>
<td>Area between 1-80 and the Great Salt Lake</td>
</tr>
</tbody>
</table>

The major basins were further divided into drainage sub-basins. The delineation of these sub-basins was performed using topographic information as well as major roadways and expected development scenarios provided by the governmental agencies and the developers involved. The drainage basin and sub-basin delineation was reviewed and modified as necessary. The sub-basin delineation is shown in Figure 4-2.

5.0 COMPUTER MODEL DEVELOPMENT

Pondpack© software, developed by Haestad Methods, was used to estimate peak flows from the 1 O-year storm and detention/infiltration volumes from the 1 DO-year storm for each sub-basin at key design points along the main collection system. The Soil Conservation Service (SCS) Curve Number Method was selected for the hydrologic modeling. The input parameters used in Pondpack© are discussed below.

5.1 Routing Method
Pondpack© allows the user to define the method for routing flows to downstream reaches. Generally, the Muskingham-Cunge Method is the preferred technique for master planning purposes. This technique allows the user to define either a channel or conduit cross-section along with a Manning ‘n’ value. The routing is utilized to account for hydrograph attenuation due to travel time and the inflow hydrograph. This method does not account for backwater, flows exceeding the conduit capacity or pressure flow. To check conduit capacity and hydraulic grade line, a separate pipe calculation is required.

5.2 Design Storm
A 10-year, 24-hour storm was utilized to calculate peak runoff flows for system conveyance design purposes. A 1 DO-year, 24-hour storm was utilized to calculate volumes for detention/infiltration facilities.

5.3 Precipitation
The standard SCS Type II design storm distribution
### TABLE 6-4

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soult Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 6-3

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 6-2

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 6-1

|----------------|-------------|----------|------------|------------|------------|------------|
represents the drainage area. This distribution shows 50 percent of total rainfall to occur in a brief period (approximately 1.5 hours), which is typical of the intense short duration storm experienced within the Tooele Valley. The 24-hour storm, while longer than that needed to determine peak runoff values for conveyance systems, is appropriate for determination of runoff volumes for detention and infiltration. This is a widely accepted and documented methodology.

Precipitation for the Lake Point/Saddleback region was obtained from the “Estimated Return Periods for Short-Duration Precipitation in Utah”, 1971, by Utah State University. Precipitation for the canyons area was obtained from the “NOAA Atlas 2, Volume VI”, by US Department of Commerce, National Oceanic and Atmospheric Administration and National Weather Service, Office of Hydrology. Table 5-1 lists the precipitation data for both the Tooele Valley and the mountain region.

5.4 Soils and land Cover
The SCS Curve Number Method is used to model rainfall losses due to infiltration and estimate net runoff volumes. The NRCS General Soils Map (Tooele Valley) is utilized to determine the Hydrologic Soil Group (HSG) for each sub-basin area.

The land use and the HSG are used to select a runoff curve number (RCN). The assigned RCN dictates the amount of precipitation that will be lost to infiltration and abstraction.

5.5 Time of Concentration
Pondpack© offers several methods to estimate time of concentration for each sub-basin. A flow path is mapped from the most hydraulically remote part of the sub-basin to the design point and a travel time is estimated for each segment of the flow path based on slope and land cover. The sum of the travel time components is adjusted based on basin size to give a lag time.

For the purpose of this study, a hand calculation will be utilized and checked using the SCS Curve Number Method. A minimum travel time of 15 minutes is used in the study.

5.6 Percent Impervious
Specific land uses will be assigned a percent impervious for estimation of peak runoff. The percent impervious reflects “directly connected” impervious areas. Impervious areas that are not directly connected, that is, must surface flow over pervious areas to reach the storm water conveyance, are considered pervious for the purposes of generating runoff estimates. A weighted runoff curve number (RCN) will be developed to reflect percent impervious. Table 5-2 lists land use and the corresponding percent impervious.

<table>
<thead>
<tr>
<th>land Use/Percent Impervious</th>
</tr>
</thead>
<tbody>
<tr>
<td>land Use</td>
</tr>
<tr>
<td>Open Space/Mountainous Area</td>
</tr>
<tr>
<td>Residential (1 ac/lot)</td>
</tr>
<tr>
<td>Commercial/Light Industrial</td>
</tr>
</tbody>
</table>

Percent impervious considers open space incorporated in neighborhoods. These numbers will be verified by review of available aerial photos. A “weighted” percent impervious will be used for basins with mixed land use.

5.7 Modeling Assumptions
At this time, most of the study area is not yet urbanized and assumptions were made for planning purposes with respect to the type and density of future development:

- The sub-basins are modeled assuming the hydrologic process can be represented by parameters which reflect average conditions within each sub-basin
- For existing conditions, runoff, in excess of existing capacities, is assumed to be surface flow to the next down-gradient sub-basin, with no street detention. Due to the rural nature of some of the sub-basins,
street detention facilities are not feasible. Actual peak flows for existing conditions may be smaller due to street flooding currently acting as detention.

- As detailed survey data were not available, modeling of small flooding areas within sub-basins was not conducted. The models should be updated periodically to reflect future improvements.

6.0 RESULTS

6.1 Individual Sub-basins
The sub-basin data developed for the storm water modeling of future conditions is shown on Tables 6-1 through 6-4. The resultant peak flows generated for the 10-year and 100-year 24-hour design events is shown in cubic feet per second (cfs) for each sub-basin on the tables. Calculations are located in the Technical Appendix to this report.

6.2 Pipe Routing and Sizing
Storm drain pipe alignments were designed based on topography, available corridors (major roadways) and outfall locations. The hydrographs calculated for each sub-basin were then routed through the conveyance system in the storm water model and combined at key design locations to give a peak design flow for the pipe (1 O-year design event). The pipe sizes were estimated using the Manning equation for open channel flow assuming gravity flow conditions with the pipe slope similar to the slope of the roadway. These pipe sizes may be reduced if necessary and the peak flow still carried by the pipe under a pressure head situation. The gravity design size gives the County an added factor of safety over minimizing pipe sizes by designing with a pressure head. The required pipe sizes to convey the peak flow for the 10-year event are shown on Figure 6-1. These pipe sizes are based on reduction of peak flows by on-line detention/infiltration as shown in the figure.

6.3 Detention/Infiltration Pond Sizing
Detention/infiltration ponds are utilized to reduce peak flows from the design storm event by detaining the excess water and releasing at a restricted rate or infiltrating over a longer period of time. The use of detention/infiltration ponds reduces the required pipe sizes and resultant corridor needed for pipe construction. The detention/infiltration areas may be utilized for open space and recreational needs and may also offer an opportunity to trap sediment and debris from storm water runoff. The detention/infiltration shown in Figure 6-1 is based on a release rate of 0.2 cfs per acre of contributing area, which is similar to pre-developed conditions. Detention/infiltration is shown for the 1 DO-year design storm events. The 1 DO-year event is assumed to reach the detention/infiltration area both through the piped conveyance under surcharged conditions and by overland flow. The detention/infiltration area sizing estimated in the storm water modeling should be reviewed during the design phase when actual physical design parameters are available.

6.4 Open Channel Conveyance
The master planning prepared in this report assumes the use of piped storm water conveyance to natural drainage in keeping with locally accepted practices. An alternative conveyance is the use of open channels.

Open channels do have some benefits over piped conveyance when they can be designed in conjunction with landscaping and overall site planning. There are some water quality benefits attained by using vegetated open channels (sediment trapping, biological uptake of pollutants/nutrients) and a reduced peak flow due to detention/infiltration in the channel and slower travel times. The open channels allow for easier access for inspection and maintenance and more flexibility if a new connection or increased capacity is required. The channels are often cheaper to construct than piped systems.

As proposed improvements are implemented, we recommend the County consider the option of using open channels on a project specific basis.
In rural subdivisions, the open channel concepts can be incorporated into the landscaped frontage of the lot and be maintained by the individual lot owner. In industrial and commercial areas, use of open channel conveyance can be combined with green space in the site planning stage to provide for storm water runoff and to provide water quality enhancement.

6.5 Water Quality
This storm drain plan does not specifically address water quality concerns relating to storm water discharge. As Tooele County implements the improvements described in this report, structural improvements should be designed to include appropriate water quality controls. Such controls may include:

- Extended catch basins to trap sediment
- Hooded outlets on catch basins to trap oil and floatables
- Oil/water separators for large paved areas to trap oils, sediments and floatables
- Detention/infiltration design to consider holding of the “first flush” to allow for settlement of suspended solids
- Use of vegetation to trap sediments and absorb nutrients
- Protection of storm water inlets and conveyances during construction activities

New and innovative storm water quality controls are being used throughout the nation as the National Pollutant Discharge Elimination System (NPDES) Program matures. Through contact with other municipalities, Tooele County may keep current regarding new controls that may better suit the specific application.

6.6 Analysis
The results of the hydrologic and hydraulic analyses have been printed under separate cover as a Technical Appendix to the Master Plan. The computer files have been submitted to Tooele County to allow for updating of the sub-basin data as land use changes and improvements are realized.

6.7 Additional Studies
An additional analysis was completed for the drainage of the five named canyons. This analysis consisted of determining how much pond storage would be needed to capture the 500-year flow from each of the named canyons. The 500-year storm was calculated using the Utah Department of Transportation (UDOT) method shown below:

500-year, 24-hour precipitation = 1.7 * 1 DO-year, 24-hour precipitation

500-year, 24-hour precipitation = 1.7 * 3.4” = 5.78”

The results for this study are summarized in Table 6-5. Calculations are located in the Technical Appendix to this report.

<table>
<thead>
<tr>
<th>Canyon</th>
<th>500-year Storage (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rodgers Canyon</td>
<td>120.7</td>
</tr>
<tr>
<td>Green Ravine</td>
<td>11.9</td>
</tr>
<tr>
<td>Big Canyon</td>
<td>132.9</td>
</tr>
<tr>
<td>Coyote Canyon</td>
<td>124.8</td>
</tr>
<tr>
<td>Pole Canyon</td>
<td>102.7</td>
</tr>
</tbody>
</table>

7.0 RECOMMENDATIONS AND PRIORITIZATION

7.1 Recommendations
The recommended storm drainage improvements are shown on Figure 6-1. Cost estimates are given in Attachment 2 of this report for two options; each option includes construction costs for the improvements. Table 7-1 summarizes the options and the associated costs. The recommended improvements include piped conveyance through the lake Point area with regional ponds located at key design points.

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Cost</th>
</tr>
</thead>
</table>

Table 7-1 Summary of Cost Estimates
7.1.1 Further Studies
It is recommended that the following items be studied further to allow for a better understanding of the storm water system:
1. Conveyance of storm water through the Salt Plant area
2. Conveyance of storm water across 1-80
3. Review the twelve canyons to optimize storage requirements
4. Verify that Green Ravine requires storage versus another larger canyon area

7.2 Prioritization
The proposed improvements, developed by hydrologic and hydraulic analysis, were ranked to produce a prioritized list of improvements that is listed below.

1. Big Canyon infiltration pond
2. Storm water conveyance system through Lake Point Conveyance across SR36 and I-80
3. Coyote Canyon infiltration pond
4. Pole Canyon infiltration pond
5. Swale along east side of railroad
6. Rodgers Canyon infiltration pond
7. Green Ravine infiltration pond
8. Swale along east side of SR36