STORMWATER EVALUATION
&
RECOMMENDATIONS REPORT

of the

Watershed Improvement and Education Project

TOWN OF BASALT

In EAGLE and PITKIN COUNTIES, COLORADO

Prepared for:
ROARING FORK CONSERVANCY,
TOWN of BASALT,
and the
COLORADO DEPARTMENT OF PUBLIC HEALTH & Environment's
WATER QUALITY CONTROL COMMISSION

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PREFACE

This report presents the results of a **Watershed Improvement and Education Project** for the Roaring Fork Valley in Eagle and Pitkin Counties, and the Town of Basalt, Colorado. This Report was prepared by Matrix Design Group, Inc. of Denver, Colorado at the request of the Roaring Fork Conservancy in cooperation with the Colorado Department of Public Health & Environment's Water Quality Control Commission.

Copies of this report are available for public inspection or distribution, for a nominal fee, at the offices listed below.

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This Stormwater Evaluation Report was prepared under the direct supervision and direction of the undersigned whose seal as a Professional Engineer is affixed:

SECTION 1 - INTRODUCTION

1.1 Acknowledgement

The Roaring Fork Conservancy's (Conservancy) mission is to protect and enhance the streams and rivers within the Roaring Fork River watershed. The agency is involved in initiatives to measure the health of the Roaring Fork River, enhance riparian and aquatic habitat, and lead environmental programs. Stormwater runoff can have a major impact on the stream system, and therefore, the Conservancy is interested in better management of water quality from urban stormwater runoff.

The Conservancy applied to the Colorado Water Quality Control Commission for a grant to evaluate non-point source pollution and develop an education project on the stormwater impacts to water quality in the Basalt area. The State of Colorado awarded the Roaring Fork Conservancy a Grant under Section 319 of the Federal Clean Water Act on August 16, 1999. The Conservancy formed a partnership with the Town of Basalt on October 15, 1999 to develop a cooperative relationship for evaluation of stormwater runoff sources for quality and composition. The resulting ***Watershed Improvement and Education Project*** has two main components:

1. Evaluation of non-point source pollutants and developing recommendations for implementation of "Best Management Practices" (BMPs) in the Town of Basalt, and

2. Expansion of educational activities to include water quality monitoring programs, water quality analysis, and public outreach focused on preventative strategies to minimize soil erosion and stormwater runoff.

This grant will provide the means to develop a paradigm for educating the community on stormwater controls, and ultimately help to protect the vital water quality of the River. This project is designed to educate not only the Basalt community, but also other small mountain communities in the Roaring Fork Valley and other Western Slope watersheds.

This ***Watershed Improvement and Education Project*** is supported by the Roaring Fork RE-1 School District, Pitkin County, Roaring Fork Outdoor Volunteers, the Roaring Fork Chapter of the Audubon Society, the Roaring Fork Bioinventory Project, the Aspen Center for Environmental Studies, the Aspen Wilderness Workshop, the Roaring Fork Watershed Coalition, the Colorado Division of Wildlife, the Colorado Department of Transportation, the Aspen Ski Company Environmental Foundation, Trout Unlimited and the Basalt Beautification Committee.

1.2 Background

Basalt's concerns with stormwater have been typically related to local flooding. Residents complain when mud washes down the hillside, their basements flood, utilities are washed away, or roads become impassable. The community suffers when severe catastrophic floods cause widespread damage to property and loss of life. However, few people are keenly aware of the water quality impacts that stormwater has on the rivers, streams, and lakes. Stormwater runoff can have significant impacts on the receiving waters of the Roaring Fork and Fryingpan Rivers that run through the heart of town by affecting water quality and the aquatic ecosystem.

Many people are familiar with the environmental impacts from municipal and industrial wastewater discharges; however, few are aware of the environmental impacts attributable to ordinary stormwater runoff from urban areas. Studies have shown that runoff from development can contain significant quantities of the same general types of constituents that are found in wastewater and industrial discharges.

The impacts of stormwater on streams fit into four general categories:

1. Stream Hydrology: Urban development affects the environment through changes in the size and frequency of storm runoff events, changes in base flows of the stream, and changes in stream flow velocities during storms. Peak discharges into a stream can increase from urbanization due to a decrease in infiltration of rainfall into the ground, and loss of buffering vegetation and resultant reduced evapotranspiration. This results in more surface runoff and larger loads of various pollutants found in urban stormwater.

2. Stream Morphology: When the hydrology of the stream changes, it results in changes to the physical characteristics of the stream. Such changes include streambed degradation, stream widening, and streambank erosion. As the stream profile degrades and the stream tries to widen to accommodate higher flows, bank erosion increases along with increases in sediment loads.

3. Stream Water Quality: Water quality is impacted through urbanization as a result of erosion during construction, changes in stream morphology, and transport of accumulated deposits from the urban landscape into the river. Water quality problems include turbid water, nutrient enrichment, bacterial contamination, organic matter loads, metals, salts, temperature increases, and increased trash and debris.

4. Aquatic Ecology: Pollutant loading from stormwater runoff can significantly alter aquatic ecology, and if left untreated, could diminish aquatic conditions to a level that would threaten the Roaring Fork River's "Gold Medal" fishery classification.

Urbanization affects stormwater runoff by increasing the following:

- The volumes and rates of surface runoff,
- The concentrations and the types of pollutants,
- The amount of pollutants carried to receiving waters.

Urbanization causes a reduction in open land areas, an increase in impervious areas, and accelerated surface runoff (which reduces flooding around development, but increases downstream riverine flooding and reduces water quality). The influx of commercial, residential, and industrial products into an urban area such as Basalt often brings new pollutants that result in increased concentrations of these pollutants in stormwater. Additional impervious areas can make pollutants easier to wash off the surface and quicken their conveyance through the watershed. The cumulative effect results in much larger loads, and in the delivery of certain pollutants, such as petroleum-based products, not normally found in non-urban and non-industrial runoff.

1.3 Purpose and Scope

This Stormwater Evaluation Report specifically addresses stormwater runoff in the Town of Basalt. It also provides a useful case study for other towns and counties to use as a basis for developing local stormwater runoff water quality controls. Although Basalt is not currently required to develop a stormwater quality control plan, the Phase II National Pollutant Discharge Elimination System (NPDES) stormwater regulations will eventually require stormwater programs from every community. This plan is a proactive approach for the Town of Basalt to begin protecting their receiving waterways before they are irreversibly degraded.

Need for Stormwater Controls

Basalt is a small mountain community without detailed stormwater runoff controls or federally mandated stormwater regulations. The Town is nonetheless experiencing the effects from urban stormwater runoff, particularly given increasing trends in population growth and land development. Within or near the three-mile stretch of the Roaring Fork River between the Upper Bypass Bridge and the Lower Bypass Bridge on Highway 82, activities include the following:

- Construction and use of transportation corridors and bridges,
- Filling of the river channel and floodplain,
- Degradation and removal of natural vegetation,
- Recreational use (rafting and angling) and facility development (golf course),
- Increased residential and commercial improvements along the river, and
- A growing number of contributors to non-point source pollution runoff.

The effect of non-point source pollution on the Roaring Fork River watershed's water quality could be significant, given the dramatic changes occurring across the landscape. The Town of Basalt requires stormwater management practices for certain activities. However, it does not have a comprehensive stormwater plan, resulting in an unspecified pollutant load entering both the groundwater table and river. Potential pollutants in the stormwater runoff include suspended sediments, bacteria, nitrogen, phosphorus, and dissolved metals. The ***Colorado Non-point Source Pollution Assessment Report and Management Plan*** has identified stretches of the Roaring Fork River that have elevated metals concentrations. Understanding the impact of stormwater runoff on water quality and developing a recommended plan for managing such runoff is crucial to protecting the health of the Roaring Fork River watershed.

Water Quality in the Project Area

The Colorado Department of Health Water Quality Control Commission has given the following classifications for the Roaring Fork River: aquatic life is Class 1 – cold, recreation is Class 1, dissolved oxygen minimum standard is 6.0mg/1, pH range is between 6.5 and 9.0, and the fecal coliform maximum level is 200 count/100ml.

While portions of the Roaring Fork River have been classified as "Gold Medal" waters by the Colorado Division of Wildlife, signifying the excellent quality of its fishery, it is facing strong development pressures that typically introduce disturbance of riparian and aquatic habitat and a decline in water quality. In early 1998, there was an abnormally high fecal coliform reading along the Roaring Fork River upstream from Basalt. Insufficient information was available to determine its source. In the project area, the unstable stream channel contributes to high sediment loads, thereby increasing turbidity and diminishing water quality.

With the pressures of population growth and urban development in the Roaring Fork Valley, which cause increased point source discharge loads and nonpoint source runoff, it is important to use the best practices and technology available to maintain water quality and limit degradation of beneficial uses. Although the Roaring Fork mainstem and most of its tributaries are classified by the State as Class 1 Cold Water Aquatic Life, and Class 1 Recreation, Water Supply and Agriculture, the State can lower the water quality classification for allowable pollutant loading from wastewater dischargers. An example of this was the change in water quality standards in 1999 for ammonia discharge to Landis Creek in Spring Valley. Significant development was proposed and subsequently approved, but the flow in Landis Creek is small and applicable ammonia standards for the wastewater discharge were very difficult to meet under the previous standard. The State classification was changed from Cold Water Aquatic Life Class 1 to Class 2, with an associated change in un-ionized ammonia standard from 0.02 mg/l to 0.1 mg/l. While this standard change would not be appropriate for the Roaring Fork and key tributaries where there is an established cold water fishery, this issue demonstrates that development will have conflicts with high quality stream standards. Conversely, in the water quality classification review of 1999, it was determined that fisheries and portions of the habitat in Brush Creek through Snowmass Village had improved over time, and the state classification of Brush Creek was upgraded from Cold Water Aquatic Life Class 2 to Class 1. The key is for communities to work together to implement consistent programs for watershed protection, and exercise the political will to ensure that all citizens are doing their part to maintain water quality. Improving stormwater management practices is an important step in protecting and enhancing water quality conditions.

1.4 Evolution of Stormwater Regulations

In 1972, Congress passed what is currently referred to as the **Clean Water Act** (CWA). The Act established the **National Pollutant Discharge Elimination System** (NPDES) program. Until recently, efforts under the NPDES program have focused on non-stormwater discharges from industries and municipal wastewater treatment plants. In the last several years, the EPA has expanded the NPDES program to cover municipal stormwater discharges.

Phase I Stormwater Regulations

The CWA placed controls on non-stormwater point discharges, but it has become evident that diffuse sources such as stormwater runoff can significantly impact water quality. In 1987, the CWA was revised to include stormwater discharges. The CWA defined municipal and industrial stormwater runoff discharges as "point source" and called for a two-phase permitting strategy.

Phase I affected municipalities with populations over 100,000. These municipal discharges included Colorado cities of Denver, Lakewood, Aurora, Colorado Springs and the Colorado Department of Transportation. Regulation of municipal stormwater discharges (MS4 permits) requires that certain programs be in place. These programs are:

1. Commercial/Residential Management Program. This program includes application and maintenance of structural stormwater controls, and evaluation of permanent water quality facilities.

2. "Illicit Discharge" Management Program to separate stormwater and sanitary sewer discharges. This program generally includes the prevention of illicit discharges and illegal disposal, and educational activities to promote public reporting of illicit discharges and improper disposal of toxic materials.

3. Industrial Facilities Program. The purpose of this program is to have municipalities control industrial stormwater discharges into their local stream system.

4. Construction Sites Program. This program involves ensuring that adequate measures are taken to control runoff from construction sites 5 acres and larger that pose water quality concerns.

5. Municipal Facility Runoff Control Program. This program requires that measures comparable to those required for industrial activities be implemented at municipal facilities.

6. Wet Weather Monitoring Program. The purpose of this program is to monitor trends in water quality which may be the result of stormwater runoff.

Phase II Stormwater Regulations

When the amendment to CWA was passed in 1987, the intent under the stormwater program was to require MS4's that were under 100,000 in population to apply for an NPDES permit no later than October 1992. This date was later changed to October 1, 1994, and now to March 2003.

On January 9, 1998, EPA published draft rules for the Phase II program. These draft regulations include many more municipalities and construction sites by:

1. Reducing construction site size from 5 acres to 1 acre for development required to obtain an NPDES stormwater permit.

2. Expansion of the MS4 permits to communities with populations under 100,000, and possibly stated for communities with over 10,000 beds.

For Colorado, this means that approximately 50 additional communities could potentially fall under this program, most of which are on the Front Range. However, a few West Slope communities will also be included. Based upon their population, Grand Junction and Mesa County will automatically be included in the program. Durango must be evaluated for inclusion in the program. **Glenwood Springs**, Palisade, Fruita, Montrose, Cortez, Craig and Steamboat Springs may be designated for inclusion in the Phase II program. Based upon the bed count, the towns of Aspen and Snowmass Village may eventually be included in the program. The regulation proposes covering these Phase II communities under a general permit rather than individual permits. The proposed programs that will be required in the general permit include:

1. Public Education and Outreach on Stormwater Impacts. This would require the distribution of educational materials to the public or other equivalent outreach efforts.

2. Public Involvement/Participation. This element involves public notification and inclusion of the public in the development and implementation of the municipalities' stormwater management program.

3. Illicit Discharge Detection and Elimination. This involves some identification of pollutant sources, and the control and detection of illicit discharges.

4. Construction Site Program. This requires the development, implementation, and enforcement of a program for controlling runoff from construction sites that are equal to or greater than one acre.

5. Post-Construction Stormwater Management in New Development and Redevelopment. This would require the development and implementation of a program to address stormwater runoff from development and redevelopment sites equal to or greater than one acre.

6. Pollution Prevention/Good Housekeeping for Municipal Operations. As proposed, this involves the development and implementation of an operation and maintenance program to reduce the pollutant runoff from municipal sites such as parks and open spaces, fleet maintenance facilities, building oversight, and stormwater system maintenance facilities.

1.5 Guiding Principals

This report was developed as a first step to implementing programs which help protect the water quality of the Roaring Fork River. Guiding principals of this document are:

- Protect receiving water bodies from degradation.
- Maintain and implement water quality standards which preserve the Roaring Fork River as an irreplaceable resource of the Valley.
- Protect the public health and safety by preserving safe drinking water supplies, and minimizing pollutant loading to aquatic ecosystems and recreation areas.
- Develop technically feasible, maintainable drainage solutions which are acceptable to the community.

1.6 Goals and Objectives

This project's major goals are to:

1. Identify, describe and evaluate stormwater runoff sources, runoff quantity, and water quality composition,
2. Assess the programs and ordinances in place to manage stormwater runoff,
3. Develop appropriate best management practices and recommendations,

4. Develop a proposed plan for monitoring stormwater runoff, and
5. Expand environmental education activities to achieve greater awareness of the importance of water quality to healthy river ecosystems and establish improved stormwater management.

This report evaluates and describes the existing stormwater runoff conditions in Town of Basalt, focusing on discharges into the three-mile stretch of river between the Upper and Lower Bypass Bridges. No master drainage plan has previously existed for this reach in the Town of Basalt.

SECTION 2 – PROJECT APPROACH

This project evaluated stormwater runoff within the Town of Basalt and identified Best Management Practices (BMP's) and recommendations for implementation. The following approach was used to complete the Basalt Stormwater Evaluation Plan. The first phase included a physical examination of the Basalt hydrology. The second phase included recommendations for improved stormwater management and water quality sampling of stormwater runoff.

Phase I: Define the Physical Characteristics of Stormwater Runoff in Basalt

1. The watershed boundaries and sub-basins are delineated for stormwater runoff in Basalt for on-site, as well as off-site, drainage basins. This was accomplished using available topographic mapping and conducting several site visits to confirm boundaries through complicated areas such as downtown. Site visits were also necessary to identify the type and size of culverts and other stormwater controls.
2. The major point-source stormwater outfalls are identified and correlated with the watershed boundaries.
3. The potential non-point and point stormwater pollution sources are identified by understanding land use within the watershed boundaries. This information was used to characterize potential pollutants from the stormwater runoff and help identify water quality testing parameters at each outfall.
4. Cursory hydrology is calculated for each watershed, sub-basin and outfall. At elevation 6,600 feet, Basalt's stormwater runoff is dominated partially by snowmelt. The hydrology evaluated discharge rates for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storms using the Soil Conservation Service's Technical Release 55 methodology.

Phase 2: Develop Strategies for Evaluating and Improving Runoff Water Quality

1. Existing Best Management Practices, such as retention ponds and grass swales are identified on the base mapping.
2. Recommendations for improving runoff water quality are identified on the mapping. Recommendations generally include the use of retention ponds, detention ponds, disconnecting impervious surfaces, and isolating potential contaminants from mixing with stormwater.
3. Town ordinances and policies that currently address stormwater management are evaluated.
4. A water quality sampling protocol program is included for evaluation of stormwater runoff. A list of parameters for water quality testing is included based upon basin land use and recommendations from programs across the nation testing similar urban stormwater runoff.

SECTION 3 - STUDY AREA DESCRIPTION

3.1 Drainage Basin Characteristics

The Roaring Fork River is a major tributary to the Colorado River. The headwaters of the Roaring Fork River start above 14,000 feet elevation at Independence Pass near the Town of Aspen and continue approximately 60 miles downstream to the confluence at the City of Glenwood Springs at elevation 5,700 feet. At the confluence with the Colorado River, the Roaring Fork River has a 1,460 square mile drainage basin.

The Fryingpan River is a major tributary to the Roaring Fork River with a 290 square mile drainage basin. The Roaring Fork River above the Fryingpan River confluence has a 510 square mile drainage basin.

The Town of Basalt is located between Aspen and Glenwood Springs around the Roaring Fork River and Fryingpan River confluence at elevation 6,600 feet. At this elevation, flood flows on the Roaring Fork River typically result from rapid melting of the mountain snowpack during the period from May to early July. Throughout the year, snowmelt and stormwater runoff periodically inundate the Town of Basalt from the surrounding mountains and local drainageways.

Land use patterns are particularly important for the evaluation of stormwater runoff water quality and hydrology. A color fold-out Land Use map from the Basalt Master Plan, prepared by Rock Creek Studios, is located at the end of this report. By correlating drainage basins with land use, the potential pollutants from urban stormwater runoff can be predicted.

3.2 Study Reach Description

Major Basins

There are numerous sub-drainage basins that direct stormwater runoff and snowmelt throughout the Town and ultimately into the Roaring Fork and Fryingpan Rivers. The three major drainage basins are:

1. Basalt Mountain, north of Old Town
2. “B” Mountain east of Town with the water tank
3. Light Hill south of Town, between Snowmass and Sopris Creeks

Each of these major drainage basins are further subdivided into sub-basins to identify stormwater runoff at specific locations through Town. This report specifically examined eleven stormwater basins through the Town of Basalt.

Sub-Basins

There are eleven well-defined runoff outfall points, covering most of the Town’s runoff area, which are described in this report. These outfall points provide opportunities for future monitoring during stormwater events. A detailed map of existing stormwater discharge points, their corresponding drainage areas, topographic relief, and land use practices is shown at the end of this report (see fold-out map pocket). Below is a brief description of the sub-basins:

1. **Sub-Basin (1) - Main Old Town Basalt:** The largest runoff area in the Town of Basalt is collected at this point. A total of 192 acres drain to a wet pond west of Town. The drainage basin includes the entire Old Town portion of Basalt, including downtown. Runoff concentrates along Midland Avenue and then flows in a ditch along Two Rivers Road. The runoff passes under the road through a 24-inch culvert into a pond just west of town, which discharges directly into the Roaring Fork River.

2. **Sub-Basin (2) – Elk Run Subdivision:** The northeast side of the Town of Basalt, which also corresponds to the Pitkin County portion of the Town, drains a total of 50 acres to an outfall on the Wix property. The main source of runoff is the Elk Run subdivision. The outfall is a 24-inch culvert under Two Rivers Road that discharges into the Roaring Fork River.

3. **Sub-Basin (3) - Pueblo Bridge:** Runoff from the steep hillside east of Town flows through the residential neighborhood to the north of Elk Run and outfalls in an open ditch that enters the Fryingpan River immediately downstream from the Pueblo Bridge. Within this basin, there is a small detention pond that accumulates runoff from 67 acres of tributary hillside and upper neighborhood area, and transfers it into the lower neighborhood. A total of 115 acres are tributary to this outfall.

4. **Sub-Basin (4) - Cottonwood Drive:** The elementary and middle school campuses, and surrounding area and streets, drain into an 18-inch culvert that outfalls north of the intersection of Cottonwood Lane and Two Rivers Road. A total of 29 acres are tributary to this outfall. Runoff from the culvert enters the Fryingpan River just upstream from the Green Bridge on Two Rivers Road.

5. **Sub-Basin (5) - Swinging Bridge:** The River Cove and Cottonwood Acres Subdivisions drain into a recently renovated open ditch and then into an 18-inch culvert along with a 15-inch culvert that enters the Fryingpan on the east bank, just upstream from the Swinging Bridge. A total of 3.8 acres of residential neighborhood are tributary to the outfall. The Sub-Basin 3 outfall is poorly defined, and may overflow into Sub-Basin 5 during heavy runoff events.

6. **Sub-Basin (6) - Basalt Center Circle:** The Basalt Center Circle Subdivision includes a gas station, supermarket, hotel, restaurant, retail shops, and a number of commercial offices. Runoff from the 6.6-acre drainage basin enters the Fryingpan River on the west side, through a pipe just upstream from the Two Rivers Road Green Bridge.

7. **Sub-Basin (7) - Old Town Basalt East:** The residential part of Old Town that is on the lower slopes of Basalt Mountain north of the intersection of Sopris and Cedar Drives is drained by a gully leading down the hill to Fryingpan Road. The roadway along the hillside has altered the drainage pattern, and runoff flows in an informal drainage system along a residential lot. An existing culvert is full of sediment and will have to be dug out so that water will flow under the road and into the Fryingpan River. A total of 44 acres are tributary to this outfall.

8. **Sub-Basin (8) - Basalt Business Center West:** The area south of Highway 82 is a rapidly growing commercial and industrial site in Basalt. At the outfall west of the Basalt Mini-Storage complex, the tributary area is 1774 acres. However, much of the runoff from this basin is typically intercepted in irrigation ditches during normal storm events. This Sub-Basin includes runoff from the hillside of Light Hill, irrigated pasture, recent residential development, and commercial and industrial property.

9. **Sub-Basin (9) - Highway 82 East:** Runoff from the Roaring Fork Club's Golf Course and hillsides combine with runoff from Highway 82 and flows into the Roaring Fork River, just upstream from the Waterman Bridge. A total of 201 acres are tributary to this culvert under Highway 82.

10. **Sub-Basin (10) - Highway 82 West:** Southwest of the Town of Basalt, along Highway 82, is another concentrated outfall for stormwater runoff. A wildlife underpass / drainage culvert is located about a mile southwest of Basalt, at the Emma Open Space. The culvert discharges runoff both from the highway and from the agricultural fields located south and east of the highway. A total of 298 acres of mountains and irrigated fields are tributary to this outfall.

11. **Sub-Basin (11) - Planned Development:** This new development parcel, known as the "Riverwalk" property, is located just downstream from the Pueblo Bridget. It contains 2.8 acres which historically have an outfall directly to the Fryingpan River. Currently, the site is open space with tall cottonwood trees.

The Sub-Basins described above do not include every drainage basin within the Town of Basalt, but are the most significant for stormwater runoff. These basins represent the key areas for monitoring stormwater quality and quantity during runoff periods, and for addressing stormwater management practices.

3.3 Climate

Historical Precipitation Data

Precipitation varies widely throughout the Roaring Fork Basin. On the continental Divide, near Independence Pass, the average annual precipitation is 26.3 inches, with 17.5 inches occurring during the winter months (November through April). Lower in the Valley at Glenwood Springs, the average annual precipitation is only 60% of the total received on the high passes.

Two weather stations in the Roaring Fork Valley have a long history of weather data. The **Glenwood Springs Weather Station** has recorded temperature and precipitation data since 1900. The average annual precipitation is 16.2 inches, with 8.2 inches occurring in the winter months November through April. The average annual snowfall in Glenwood Springs is 55 inches.

The **Aspen Weather Station** also has weather records dating back to 1900. The Aspen weather station was moved in 1980 from an elevation of 7,910 feet to a new location at elevation 8,161 feet. Using the longer period of data at the old location, the average annual precipitation is 18.9 inches, with 10.1 inches occurring in the winter months November through April. The average annual snowfall at the Aspen weather station is 136.6 inches.

The Basalt area at elevation 6,620 feet had a weather station from 1965 through 1973. Since this period of record is too short to develop statistically meaningful historical averages, the precipitation data for the Basalt area was interpolated by relative elevations using the Glenwood Springs and Aspen weather data. Near Basalt, the average annual precipitation is approximately 17.2 inches, with 8.7 inches occurring during the winter months November through April. The estimated average annual snowfall is 84 inches. Table 1 summarizes the average annual precipitation data for the Glenwood Springs, Aspen and Basalt areas on a monthly basis.

TABLE 1
ROARING FORK RIVER VALLEY
MEAN PRECIPITATION
(All Values in Inches)

	MONTHLY PRECIPITATION (inches)		
Region	**Glenwood**	**Aspen**	**Basalt**
Period of Record	**1900-1997**	**1900-1979**	**Interpolated***
Elevation (feet)	**5,900**	**7,910**	**6,620**
January	1.43	1.81	1.57
February	1.25	1.63	1.39
March	1.38	1.80	1.53
April	1.54	1.68	1.59
May	1.38	1.48	1.42
June	1.05	1.16	1.09
July	1.24	1.44	1.31
August	1.44	1.72	1.54
September	1.43	1.58	1.48
October	1.42	1.48	1.44
November	1.08	1.48	1.22
December	1.26	1.69	1.41
Annual	16.19	18.93	17.17

	MONTHLY SNOWFALL (inches)		
Region	**Glenwood**	**Aspen**	**Basalt**
Period of Record	**1900-1997**	**1900-1979**	**Interpolated***
Elevation (feet)	**5,900**	**7,910**	**6,620**
January	16.4	24.8	19.4
February	10.9	22.5	15.1
March	6.1	22.6	12.0
April	1.7	11.5	5.2
May	0.3	3.1	1.3
June	0.0	0.7	0.3
July	0.0	0.0	0.0
August	0.0	0.0	0.0
September	0.0	1.5	0.5
October	1.1	5.9	2.8
November	4.9	17.8	9.5
December	13.5	23.0	16.9
Annual	55.0	136.6	84.2

* Precipitation for Basalt interpolated between data from Glenwood Springs and data from Aspen based upon relative elevations.

Hydrologic Data for Stormwater Runoff

Data on precipitation from the ***National Oceanic and Atmospheric Administration's Atlas 2, Volume III - Colorado***, dated 1973, indicate that in the Basalt area, a 24-hour storm would produce the following precipitation for different storm recurrence intervals:

Storm Event	24-Hour Precipitation (inches)
2 - Year	1.4
5 - Year	1.8
10 - Year	2.0
25 - Year	2.4
50 - Year	2.6
100 - Year	2.8

Temperature and precipitation within the Roaring Fork River drainage basin are important variables in stormwater runoff and flooding conditions. They vary greatly by location and season. Above normal spring temperatures can cause early and heavy runoff. Records from the Aspen weather station indicate that the month of January has the highest normal total precipitation for the year at 1.81 inches. The month of March follows closely with 1.80 inches of total precipitation. The first month with a normal spring temperature above the freezing point is April with a mean monthly temperature of 38.5 ° Fahrenheit.

3.4 Maps and Surveys

At the time of this study, no complete topographic mapping was available for the Town of Basalt and surrounding drainage basins. A combination of maps was used to delineate the drainage basins and prepare the Stormwater Evaluation Plan map. The following maps were used in this study:

1. Eagle County Topographic Mapping – Eagle County recently completed 2-foot contour interval topographic mapping, however, since the Eagle/Pitkin County line crosses through the middle of Basalt, this information only was available for the north half of Basalt.
2. Floodplain Topographic Mapping - Floodplain topographic mapping at 2-foot contour interval was available for the river corridor only. This mapping developed by Greenhorne & O'Mara, extends from the Garfield/Eagle County line through the Wingo Bridge, and included structures and land forms.
3. USGS Topographic Mapping - USGS 40-foot contour interval topographic mapping was available for the entire area, and was especially helpful for the Pitkin County area. The coarse mapping was used to delineate the drainage sub-basins for the hillsides above Town and in South Side.
4. Aerial Photography – Black & white aerial photography was obtained from a 1997 flight by the Roaring Fork Railroad Holding Authority. The Town of Basalt was a difficult area to compile. A complete picture of the area was developed by fitting four pictures together and rectifying the imagery to the USGS mapping in UTM coordinates. Unfortunately, due to the topographic relief in the area and the low altitude flight frames, the imagery could not be precisely rectified for the Town under this study.

SECTION 4 – BASALT HYDROLOGY

The following information was used to determine the hydrology (flow rates) for the Town of Basalt:

1. Basin Delineations

Each of the drainage basins for the proposed stormwater sample points are delineated on the fold-out Drainage Basin Map. The name of each basin is shown on the top of the label circles, which refer to the sample point number. Sub-basins are basins contained within the major basin delineations. Sub-basins provide hydrologic information at key locations within a basin, such as at a detention pond or storm drain inlet. The basin size, in acres, is shown in the lower left corner. The composite runoff Curve Number used in the Technical Release 55, Soil Conservation Service hydrologic calculations are shown in the lower right corner.

2. Off-site Basins

Off-site basins are drainage basins feeding into the areas of interest. The hillsides above Basalt are "off-site" basins which contribute runoff water into the Town.

3. Soil Types

Four soil groups, labeled "A" through "D", are used in determining hydrologic soil-cover complexes for estimating rainfall and snowmelt runoff as described below:

A. Low runoff potential. Soils have high infiltration rates, and are typically composed of sands and gravels.
B. Moderate runoff potential. Soils having moderate infiltration rates and consist chiefly of moderately fine to moderately coarse textures.
C. High runoff potential. Soils having slow infiltration rates and are typically fine grained or tight soils, such as clays.
D. Very high runoff potential. These are rock outcrops and tight clay soils.

The hillside north of Basalt (Basalt Mountain) is primarily Type B hydrologic grouping soils with moderate infiltration and moderate runoff potential. The established pinyon pine and grass understory vegetation growth promotes infiltration and stabilizes the hillsides.

The ridge east of Basalt ("B" Mountain) is composed almost exclusively of hydrologic grouping type D soils, which have the highest runoff potential. The surface soils are rocky and formed in residuum and colluvium derived dominantly from sandstone shale and basalt. Runoff is rapid, and the hazard of water erosion is severe.

The hillside above Southside (Light Hill) is comprised of a mixture of type B, C and D soils. Runoff is very rapid and the hazard of water erosion is moderate, except on the steep slopes where the threat of water erosion is severe. The vegetation is composed mainly of grasses, mountain brome, elk sedge, Gambel oak and saskatoon serviceberry, which helps to stabilize the slopes.

4. **Land Use**

Land use is very import in determining the hydrology of a drainage basin and the type of pollutants that may occur in the stormwater runoff. As the imperviousness of a basin increases due to development (roofs, roads, driveways), runoff is more rapid. Land use classifications were used to determine the hydrology and recommendations for water quality sampling.

5. Stormwater Outfalls

There are eleven point outfalls analyzed in this study. The outfalls are numbered 1 through 11 and are described in this report and shown on the Basalt Stormwater Evaluation Plan map.

6. Discharges

Table 2 is a summary of the approximate peak discharge for each of the drainage basins during the 2-Year, 5-Year, 10-Year, 25-Year, 50-Year and 100-Year storm events. A more precise Rational Method Hydrology Calculation should be computed for the drainage basins before design of infrastructure improvements.

TABLE 2
APPROXIMATE HYDROLOGY FOR THE TOWN OF BASALT

Sample / Design Point	Contributing Basins	Area	Weighted Curve Number (CN_W)	Peak Discharge					
				Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
	1A	9.7	80	1	3	4	6	7	8
	1B	67.3	67	1	3	4	11	16	21
	1C	66.8	60	0	1	2	4	5	8
	1D	12.3	62	0	0	0	1	1	2
	1E	36.1	74	1	5	8	14	17	21
1	1A,B,C,D,E	192.2	66	2	6	10	25	36	48
2	2A	50	76	4	10	14	24	29	34
	3A	48.2	72	2	5	8	16	20	24
	3B	44.1	80	7	15	19	29	34	40
	3C	23.1	65	0	1	1	3	5	6
3	3A, B, C	115.4	71	3	10	16	33	42	52
4	4A	29	81	4	9	11	17	20	23
5	5A	3.8	83	1	1	2	2	3	3
6	6A	6.6	93	4	6	7	10	11	12
7	7A	43.7	86	14	24	30	42	48	54
8	8A	1774	72	37	121	190	361	463	564
9	9A	201	72	5	15	23	45	57	70
	10A	170.7	69	3	9	17	38	50	64
	10B	50.9	60	0	0	1	2	3	5
	10C	77.4	68	1	3	5	12	17	22
10	10A, B, C	298	67	2	8	13	31	43	56
11	11A	2.8	80	1	2	2	3	3	4

7. Potential Pollutants Based on Land Use

Urban stormwater runoff contains materials from various different land use types, such as residential, commercial and industrial sites. Urban stormwater runoff has been documented to contain a variety of constituents. When certain constituents are present in sufficient quantities, the potential exists for adverse effects on receiving waters.

Impacts on receiving waters from urban stormwater pollutants can include:

- Sedimentation/Siltation from disturbed lands which affects fish spawning habitat and the macro-invertebrates that support the fish population
- Increased Biological Oxygen Demand (BOD) from organic pollutants which deplete the oxygen in the stream system
- Pathogens such as bacteria from waste which infect and kill aquatic life
- Toxicity such as oils, grease, metals and herbicides which kill aquatic life
- Nutrients from fertilizers and other pollutants which cause algae growth and other changes in species composition
- Temperature changes from surface runoff such as stormwater flowing over parking lots that alters the aquatic life

Studies such as the Nationwide Urban Runoff Program (EPA, 1983) and the Denver Regional Urban Runoff Program (DRCOG, 1983) have documented concentrations of various constituents in urban stormwater.

Table 3 summarizes the urban runoff pollutants, describes the sources of these pollutants, and lists the effects of the urban pollutants to receiving waterways such as the Roaring Fork and Fryingpan Rivers. Table 4 outlines various urban land uses and identifies associated typical pollutants found in stormwater runoff.

To understand the potential pollutant loading from urban stormwater runoff, the United States EPA under the Nationwide Urban Runoff Program (NURP) compared urban runoff water quality with raw sewage and treated sewage discharges. Surprisingly, urban runoff can contain a similar loading of total suspended solids and zinc, an increased loading of lead, and a much higher loading of fecal coliform than raw sewage. Urban runoff has a similar chemical oxygen demand as secondary treated sewage. Table 5 summarizes the comparison of urban runoff with domestic wastewater.

Table 3
Urban Runoff Pollutants

Constituents	Sources	Effects
Sediments – TSS, Turbidity, dissolved solids	Construction sites Urban/agricultural runoff Landfills, septic fields	Habitat changes, stream turbidity, recreation and aesthetic loss, contaminant transport, bank erosion
Nutrients – Nitrate, Nitrite, Ammonia, Organic Nitrogen, Phosphate, Total Phosphorus	Lawn/Agricultural runoff, Landfills, Septic fields, Atmospheric deposition, Erosion, Carried within sediment loading	Algae blooms, Ammonia Toxicity, Nitrate Toxcity
Pathogens – Total and Fecal Coliforms, Fecal Streptococci Viruses, E. Coli, Enteroccus	Urban/Agricultural Runoff, Landfills septic systems	Dissolved oxygen depletion, odors, fish kills
Organic Enrichment – BOD, COD, TOC and DO	Urban/Agricultural Runoff, Pesticides/Herbicides, Underground storage tanks, Hazardous Waste Sites, landfills, illegal disposals, industrial discharges	Toxicity to humans and aquatic life, bioaccumulation in the foodchain
Salts – sodium chloride	Urban runoff snowmelt	Contamination of drinking water, harmful to salt intolerant plants

Data Source: Handbook: Urban Runoff Pollution Prevention and Control Planning, 1993

Table 4
Activities and Associated Pollutants

Data Source: Handbook: Urban Runoff Pollution Prevention and Control Planning, 1993

Category	Nutrients	pH	Sediment	Organic Enrichment	Pathogens	Toxic Organics	Toxic Metals	Oil and Grease	Salts (TDS)	Hydrologic Alterations	Thermal Alterations	Pesticides
Agriculture												
Cropland	X		X									X
Pastureland	X		X	X	X							
Animal Holding Areas	X		X	X	X							
Animal Waste Storage	X		X	X	X							
Hayland	X		X	X	X							
Wash and Processing Water	X	X	X	X	X			X				X
Waste Application Areas	X		X	X	X		X					
Construction												
Highways, Bridges, Roads			X		X	X		X	X	X	X	
Land Development			X		X			X		X	X	

Table 4, continued
Activities and Associated Pollutants

Data Source: Handbook: Urban Runoff Pollution Prevention and Control Planning, 1993

Category	Nutrients	pH	Sediment	Organic Enrichment	Pathogens	Toxic Organics	Toxic Metals	Oil and Grease	Salts (TDS)	Hydrologic Alterations	Thermal Alterations	Pesticides
Urban Land												
Stormwater sewers, combined sewers, surface runoff-pavement	X		X	X	X	X	X	X	X	X	X	X
Surface runoff-turf areas	X				X			X				
Infiltration walls and basins	X				X	X		X	X			
Land Disposal												
Wastes, sludge, septage	X	X	X	X	X	X	X	X	X			
Landfills	X	X	X	X	X	X	X	X	X	X	X	X
In-situ Waste - water systems	X											
Hazardous Waste Areas	X	X			X	X	X	X	X			X

Table 4, continued
Activities and Associated Pollutants

Data Source: Handbook: Urban Runoff Pollution Prevention and Control Planning, 1993

Category	Nutrients	pH	Sediment	Organic Enrichment	Pathogens	Toxic Organics	Toxic Metals	Oil and Grease	Salts (TDS)	Hydrologic Alterations	Thermal Alterations	Pesticides
Hydrologic Modification												
Earthfills, Channelization			X							X		
Dam Construction / Reconstruction	X	X	X	X						X	X	
Other Sources												
Atmospheric Deposition	X	X				X	X					
Underground Storage Tanks						X	X	X				X
Illegal disposal and dumping, release of contaminants	X	X	X	X	X	X	X	X	X			X
Highway / Bridge maintenance			X			X	X	X	X			X

Table 4, continued
Activities and Associated Pollutants

Data Source: Handbook: Urban Runoff Pollution Prevention and Control Planning, 1993

Category	Nutrients	pH	Sediment	Organic Enrichment	Pathogens	Toxic Organics	Toxic Metals	Oil and Grease	Salts (TDS)	Hydrologic Alterations	Thermal Alterations	Pesticides
Auto Salvage						X	X	X				
Washing and Processing Area	X	X	X	X	X	X	X	X	X		X	X
Snow dumping areas	X		X	X	X	X	X	X	X			
Utility ROWs			X							X	X	X
Gasoline Station						X	X	X				
In-place sediments	X	X	X	X	X	X	X	X	X	X		
Sewer leaks, domestic/wild birds and mammals	X			X	X							
Natural vegetation (leaves, fallen trees)	X		X	X	X							

Table 5
Comparison of Urban Runoff Versus Domestic Wastewater

Pollutant	Urban Runoff Concentration (mean, mg/L)	Raw Wastewater Concentration (mg/L)	Secondary Sewage Effluent Concentration (mg/L)
Chemical Oxygen Demand	75	500	80
Total Suspended Solids	150	220	20
Total Phosphorus	0.36	8	2
Total Nitrogen	2	40	30
Lead	0.18	0.10	0.05
Copper	0.05	0.22	0.03
Zinc	0.20	0.28	0.08
Fecal Coliform (Count/100 Mil)	Up to 50×10^3	Up to 1×10^8	200

Data Source: USEPA National Urban Runoff Program

SECTION 5 – EXISTING ORDINANCES AND REGULATIONS

The Town of Basalt does not have a formal Drainage Criteria Manual, and has few existing ordinances and regulations for specifically for drainage. Most current regulations are focused on river setbacks or construction site erosion control measures. Only a few regulations pertain to post-construction permanent drainage controls.

5.1 River Set-Backs

Development set-backs promote better water quality of stormwater runoff by maintaining separation from development and the receiving waterways. Ordinance No. 7, Series of 1999, of the Board of Trustees of Basalt, Colorado, New Article XXI to Chapter 16 of the Municipal Code of the Town of Basalt concerns development in or around rivers, wetlands, and Environmentally Sensitive Areas (ESA), as summarized below:

River and Stream Setbacks

- Development and removal of riparian or wetland vegetation is prohibited within 50 feet, measured horizontally, from the identifiable high water line on each side of the Roaring Fork River, Fryingpan River, and other watercourses.
- A greater setback may be required when slope equals or exceeds 30%, sparsely vegetated or rapidly eroding soils are present, or riverine erosion areas or potentially erodable areas exist that warrant a larger setback.

Riparian and Wetland Areas

If development is permitted/exemption granted in a riparian or wetland area:

- Any disturbed vegetation adjacent to wetland or riparian areas shall be re-vegetated as soon as possible.
- Adequate erosion control measures shall be incorporated in any development site plans. These measures shall include minimization of runoff velocities, diversion of runoff from areas with disturbed soil, development of drainage systems to handle concentrated or increased runoff, grading and construction sequencing to minimize soil exposure, and use of BMP’s for construction site control.
- No activity shall be allowed which will increase stream sedimentation and suspension loads. Development shall maintain the minimum water quality standards established by CDPHE WQCC, Regulation No. 33, Classifications and Numeric Standards for the Upper Colorado River Basin and the North Platte River Basin.

5.2 Construction Site Erosion Control Measures

The Roaring Fork Conservancy and the Town of Basalt are reviewing the Town’s existing soil erosion control and stormwater criteria presently used to address non-point source pollution. Existing Town policies address the use of Best Management Practices in construction site management. Grading permits are required to monitor and control earthwork activities which could lead to water erosion. Permanent stormwater management practices that have been implemented in the Town of Basalt include dry wells and retention ponds, as well as single and double chambered septic systems. Construction management stormwater programs include sequencing of earthwork activities to minimize runoff, use of straw bales and silt fencing to retard sediment movement, and revegetation of disturbed sites.

The following permit applications and regulations developed for the Town of Basalt are used in regulating construction activities. These regulations seek to minimize the transport of sediment and pollutants caused by off-site stormwater runoff:

- Excavation and Grading Permit Application
- Excavation and Grading Permit – Application Checklist
- Construction Site Management – Checklist
- Construction Site Management Criteria

These control measures address the Colorado Department of Public Health and Environment's requirement to have a stormwater management plan for any development disturbing more than five acres. This requirement under the Phase I NPDES regulations will soon apply to development of one acre or more under the Phase II program.

Management of construction site stormwater runoff pertains to implementation of ***Best Management Practices***, or BMP's, as discussed later in this report under Section 6 - Recommendations. BMPs represent the best available approaches to minimize site erosion and the level of the sediment and other pollutants leaving the site.

5.3 Post-Construction Drainage Criteria

Development increases the imperviousness of a site, which generally increases the frequency and peak discharge of stormwater runoff. These factors can cause harmful impacts to downstream property and receiving waterways. Therefore, municipalities implement stormwater controls to mitigate potential offsite impacts from development.

Section 17-39 of the **Basalt Subdivision Criteria** – *Drainage easements, site grading and improvements* – describes the Drainage Plan that the Town of Basalt currently requires for new development. The Drainage Plan generally describes requirements for detention facilities and conveyance facilities. It also mandates that new development discharge the **10-year storm** runoff at historical rates, which is most commonly achieved through use of detention ponds to hold the peak runoff to *undeveloped* rates. To detain the amount of excess peak runoff generated in a 10-year storm, detention ponds are usually 2 to 5% of the overall developed land area, but may be as large as 10% of the developed area.

An important issue regarding effective detention ponds is the entrapment of sediment, trash and debris in stormwater runoff. A functioning detention/water quality pond will accumulate sediment, which must be cleaned periodically. To define the effectiveness of water quality treatment in a detention pond, the maintenance program must be defined. The Basalt Subdivision Criteria states that: "Responsibility for maintenance of detention areas shall be determined as a part of the subdivision agreement."

Basalt Subdivision Criteria further require drainage conveyance facilities to have enough capacity to safely handle the 10-year storm. However, the Criteria further state that, "…where potential damage to residences or other property exists…[conveyance facilities] shall be designed on the basis of a 100-year storm." This Stormwater Evaluation Plan for the Town of Basalt noted many potential areas of localized flooding from storm events, and therefore, most development in Basalt should plan to safely convey the 100-year storm event off-site to the receiving waterway.

Regarding stormwater quality, the Basalt Subdivision Criteria simply states, "The developer shall make all practical efforts to assure that the water quality of the post-development runoff is not less than the pre-development runoff."

5.4 NWCCOG Water Quality Protection Standards

The Northwest Colorado Council of Governments developed ***Water Quality Protection Standards*** to be used by small mountain communities. As stated in the document, "The *Water Quality Protection Standards* are a comprehensive state-of-the-art model ordinance for the protection of water quality from negative impacts of land development. It is a preventative approach to protect water quality and is intended to be used by all local governments within a watershed. This model ordinance is meant to be a single, stand alone section of a local government's land development code.

The *Water Quality Protection Standards* are organized into nine specific topic areas:

1. Control of Erosion and Sedimentation;
2. Post-Construction Stormwater & Urban Runoff;
3. Slope Limitations;
4. Waterbody Buffer System;
5. Hazardous Materials Management;
6. Snow Storage;
7. Wastewater System Standards;
8. Water Quality Protection Standards Applicable Within Watershed District or Sensitive Area Overlay District; and
9. Enforcement and Penalties.

A copy of the document is included in its entirety in the Appendix of this report for consideration by the Town of Basalt.

SECTION 6 – RECOMMENDATIONS

There is an opportunity to improve the management of stormwater runoff in Basalt. A drainage infrastructure master plan should be developed to reduce the Town's susceptibility to periodic flooding and ice build-up, and improve the quality of stormwater runoff.

6.1 Basalt Stormwater Opportunities

- ✓ **Improved Drainage Conveyance (Pipes & Culverts)**
- ✓ **Better Erosion Control during construction**
- ✓ **Stormwater Detention Ponds to prevent injury to downstream properties caused by upstream development**
- ✓ **Water Quality Treatment Ponds to improve the quality of stormwater runoff from urban areas**

6.2 Axioms for Urban Runoff Quality Controls

To integrate an improved stormwater system into the Town of Basalt, the following six axioms should be considered:

- Most effective stormwater controls reduce both peak rate and volume by promoting infiltration through a reduction in impervious surfaces.
- Next most effective controls reduce peak rates by temporarily storing runoff in detention ponds.
- The design of water quality facilities should manage smaller, more frequent storm events. This is part of the "First Flush Doctrine" where most pollutants are carried in stormwater runoff by the first half-inch of runoff.
- Encourage sediment deposition to the extent possible in stormwater runoff. Many pollutants have an affinity for sediments and are bound easily on the suspended sediment particles.
- The most obnoxious urban runoff pollutants are settleable. Nutrients and dissolved metals may require other treatment.
- Stormwater quality controls are in their infancy, which offers an opportunity to try new techniques.

6.3 Pollutant Removal Mechanisms

Planning urban stormwater controls requires matching the treatment method with the type of pollutants anticipated. A combination of appropriate pollutant removal or immobilization mechanisms should be used to treat stormwater runoff for water quality enhancement. The following is a brief overview of available proven mechanisms:

1. Sedimentation: Particulate matter is, in part, settled out of urban runoff. Sedimentation is the primary pollutant removal mechanism for most structural BMPs.

2. Filtering: Particulates are removed from water, in part, by filtration. Filtration removes particles by attachment to small-diameter collectors such as sand.

3. Infiltration: Pollutant loads in surface runoff are removed or reduced as surface runoff infiltrates or percolates into the ground. Particulates are removed at the ground surface by filtration, while soluble constituents can be adsorbed into the soil, at least in part, as the runoff percolates into the ground. Site-specific soil characteristics, such as permeability, cation exchange potential, and depth to groundwater or bedrock limit the number of sites where this mechanism can be used effectively.

4. Biological Uptake: Plants and microbes require soluble and dissolved constituents such as nutrients and minerals for growth. In addition, certain biological activities can reduce toxicity of some pollutants and/or possible adverse effects on higher aquatic species.

5. Straining: Grasses strain out particulates when sheet flow is directed to flow slowly over vegetated areas.

Given the above generally accepted approaches toward management of stormwater runoff, specific opportunities for improved management in the Town of Basalt fall into five categories:

- Erosion control
- Improvement of stormwater conveyance
- Integration of detention facilities into land use planning
- Installation of water quality treatment controls
- Education of the community on management of stormwater runoff

Table 6 is a BMP planning tool for stormwater management. Table 7 compares the effectiveness of these stormwater controls for water quality treatment.

Table 6

BMP Planning Section

Construction BMP's - Erosion Control

BMP Planning For Construction

Surface Roughening	Mulching or Blankets	Revegetation	Roads and Soils Stockpiles

Construction BMP's - Sediment Control

Vehicle Tracking	Slope Diversion Dike	Roads and Roadslide Swale	Terracing	Slope Drain	Straw Bale Barrier	Silt Fence
Filter Strip	Sediment Basin	Waterway Crossing	Temporary Channel Diversion	Outlet Protection	Inlet Protection	

Structural BMPs

BMP Planning For New Development/ Redevelopment

Grass Buffer	Grass Swale	Modular Block Porous Pavement	Porous Pavement Detention	Porous Landscape Detention
Extended Detention Basin	Constructed Wetland Basin	Retention Pond	Constructed Wetland Channel	

Structural BMPs

BMP Planning For Industrial/ Commercial

Covering of Storage/ Handling Areas	Spill Containment & Control

Non-Structural BMPs

Good House-keeping	Preventative Maintenance	Spill Prevention And Response	Painting Operations Control	Above Ground Storage Tank Control	Loading and Unloading Control
Fuel Operations Control	Outside Material Storage Control	Vehicle and Equipment Washing Control	Wastes and Toxics Control	Pesticides, Herbicides, and Fertilizer Control	

Data Source: Urban Drainage & Flood Control District Criteria Manual, Volume 3

Table 7

Comparative Pollutant Removal of Urban Runoff Quality Controls

(Data Source: Schueler 1987).

BMP	SUSPENDED SEDIMENT	TOTAL PHOSPHORUS	TOTAL NITROGEN	OXYGEN DEMAND	TRACE METALS	BACTERIA	OVERALL REMOVAL CAPACITY
EXTENDED DETENTION POND	·	·	·	·	·	⃠	**MODERATE/HIGH**
WET POND	·	·	·	·	·	⃠	**MODERATE**
INFILTRATION TRENCH	·	·	·	·	·	·	**MODERATE**
INFILTRATION BASIN	·	·	·	·	·	·	**MODERATE**
POROUS PAVEMENT	·	·	·	·	·	·	**MODERATE**
WATER QUALITY INLET	O	⃠	⃠	⃠	⃠	⃠	**LOW**
FILTER STRIP	·	O	O	O	·	⃠	**LOW/MODERATE**
GRASSED SWALE	O	O	O	O	O	⃠	**LOW**

O- 0 – 20% Removal
·- 20 – 80% Removal
·- 80 – 100% Removal
⃠ Insufficient Knowledge

6.4 Categories of Stormwater BMPs for the Town of Basalt

Stormwater improvements can be integrated into the community through local site controls and/or through regional planning. Local site controls are the responsibility of each landowner or developer to manage the quantity and quality of stormwater leaving the site. Regional controls must be master-planned into the community to manage stormwater before it outfalls into the major drainageways of the Roaring Fork or Fryingpan Rivers. BMPs can also be thought of as non-structural or structural in nature. Non-structural BMPs refer to new or revised stormwater management ordinances, while structural BMPs refer to specific infrastructure recommendations. Finally, BMPs can be either permanent structural improvements, or improvements for construction activities. Examples of each of the subcategories are described below:

- Site Controls:
  - Minimize Directly-Connected Impervious Area (DCIA)
  - Utilize Swales and Biofilters
  - Reduce Site Imperviousness by Porous Pavement and Parking Blocks
  - Promote Infiltration Through Trenches and Holding Basins

- Regional Controls:
  - Wet or Dry Stormwater Detention for Flood Control
  - Extended Detention for Water Quality Treatment of Stormwater Runoff

- Non-Structural BMPs include the subcategories of pollution prevention BMPs and source control BMPs. Non-structural source controls are often methods to isolate pollutants from stormwater and may include enclosing potential pollutants to prevent mixing with stormwater. For example, drums of oil and grease may be kept in sheds to prevent stormwater from washing away pollutants. Other non-structural BMP's may include:
  - Administrative programs
  - Development set-backs from receiving waterways
  - Ordinances regulating development of steep slopes where erosion can be prevalent
  - Stormwater ordinances
  - Routine street sweeping
  - Modified street maintenance practices to remove potential contaminants
  - Employee-training with attention to improving runoff water quality
  - Careful material handling practices

- Structural BMPs include facilities constructed to passively treat urban stormwater runoff before it enters the receiving waters. Structural BMPs are facilities used to reduce runoff and/or remove constituents from runoff. Examples of structural BMPs include:
  - Water quality detention (both dry basins and wet ponds)
  - Wetlands
  - Porous pavement, and the use of vegetated zones
  - Snow storage facilities.

- Temporary Construction BMPs refer to site controls that are implemented to manage stormwater runoff from disturbed lands. These measures are temporary and may include:
  - Sedimentation basins
  - Silt fencing
  - Straw bales
  - Inlet protection
  - Vehicle gravel tracking pads

6.5 Recommended Temporary Construction BMPs

Control of construction activities is a critical activity within stormwater runoff management. During the relatively short period of time when land is converted from undeveloped to urban uses, a significant amount of sediment can erode from a construction site and be transported to adjacent properties and to receiving waters. If measures are not taken to reduce erosion and to capture sediment in runoff from construction sites, damage can occur to offsite areas and to aquatic habitats in the receiving water system. Figure 1 is a “BMP Toolbox” developed by Wright Water Engineers for NWCCOG. It provides a number of options for construction site stormwater controls. Basic construction stormwater controls should address the following:

1. Minimize Erosion on the Site.
   - Phase construction
   - Install erosion and sediment control measures before site grading
   - Soil stabilization
   - Temporary and permanent revegetation

2. Minimize sediment leaving the site.
   - Manage stormwater runoff flows
   - Minimize sediment and mud from leaving the construction site
   - Protect adjacent properties from sediment laden runoff
   - Protect storm sewer inlets from entry of sediment-laden water
   - Divert off-site runoff around the construction site

3. Detention and Treatment
   - The water quality outlet of the sediment basin should be designed to empty the storage volume of a half-inch of runoff in no less than 12 hours. The basin’s length should be no less than twice the basin’s width.
   - The 10-Year detention volume outlet should release stormwater at the rate that would occur in an undeveloped setting.

VTC	VEHICLE TRACKING PAD	A gravel pad, located at the points of vehicular ingress and egress on a construction site, to reduce the mud transported onto roads and paved areas.
STB	STRAW BALE BARRIER	A temporary sediment barrier composed of anchored straw bales placed across or at the toe of a slope to intercept and detain sediment and decrease flow velocities from small drainage areas; applicable where sheet and rill erosion potential is low to moderate.
SBB	SANDBAG BARRIER	Temporary stabilization of ditches by placement of sandbags perpendicular to flow. Accompanied by a depression upstream for sediment retention. Good for use where soils are difficult to excavate, in areas of shallow bedrock, and in steep drainages.
SF	SILT FENCE	A temporary sediment barrier constructed of posts, filter fabric and, in some cases, a wire support fence, placed across or near the toe of a slope or in a minor drainageway to intercept and detain sediment and decrease flow velocities from drainage areas of limited size; applicable where sheet and rill or small concentrated flows may be a problem.
ST	SEDIMENT TRAP	A small ponding area, formed by constructing an earthern embankment with a gravel outlet across a drainage swale, to detain sediment-laden runoff from small disturbed areas for enough time to allow most of the sediment to settle out.
SB	SEDIMENT BASIN	A basin with a controlled stormwater release structure, formed by constructing an embankment of compacted soil across a drainageway, to detain sediment-laden runoff from disturbed areas greater than 5 acres for enough time to allow most of the sediment to settle out. Can be constructed only where there is sufficient space and appropriate topography. Temporary unless designed as a permanent pond.
BB	BRUSH BARRIER	A temporary sediment barrier composed of limbs, weeds, vines, root matter, soil, rock and other cleared materials pushed together to form a berm; located across or at the toe of a slope to intercept and detain sediment and decrease flow velocities during grading operations and removed at the time of final grading.
CD	CHECK DAM	Small, temporary berms constructed across drainageways to reduce the velocity of concentrated flows, reducing erosion of the swale or ditch. Limited to use in small open channels which drain small areas; should not be used in live streams.
TP	TREE PRESERVATION & PROTECTION	Protecting existing trees from mechanical and other injury during land disturbing and construction activity to insure the survival of trees where they are effective for erosion and sediment control and provide other environmental and aesthetic benefits.
GS	GRASS LINED SWALE	The establishment of appropriate vegetation in constructed channels to limit channel erosion and stabilize channel bottom.
PS	PERMANENT SEEDING	Establishment of perennial vegetative cover by planting seed on rough-graded areas that will not be brought to final grade for an extended time or where permanent, long-lived vegetative cover is needed on fine-graded areas. Used in conjunction with heavy mulching.
PP	PERMANENT PLANTING	Establishment of woody vegetation on rough-graded areas that have been permanent seeded or sodded where permanent, long-lived vegetative cover is desired on fine-graded areas. Used in conjunction with mulching.
TM	TEMPORARY MULCHING	Use of crimped straw, wood chips, sawdust, etc., to cover the denuded surface shortly after clearing and grubbing, grading, and construction activities. Mulching is the most effective and important erosion control practice to be used.
PM	PERMANENT MULCHING	Use of wood chips, stone, bark etc., to cover the finished graded surfaces after construction activities. Mulching within 3 days of operations to eliminate erosion and conserve moisture for plantings to enhance growth. Part of the final landscaping including drainageways, swales, etc. Used with permanent planting.
IP	INLET PROTECTION	The installation of various kinds of sediment trapping measures around inlets, culverts and structures prior to permanent stabilization of the disturbed area; limited to small drainage areas and not intended to control large, concentrated stormwater flows.
DD	DIVERSION DIKE	A ridge of compacted soil located at the top or base of a sloping disturbed area to divert off-site runoff away from unprotected slopes to a stabilized outlet, or to divert sediment-laden runoff to a sediment trapping structure.
WB	WATER BAR	Small berm and ditch combination approximately 18 inches in height and laid across a slope at 45° to 60° to reduce the velocity of concentrated flows, reducing erosion of a slope, swale or ditch. For use as a semi-permanent structure on trails, ski runs and seasonal access roads.
FB	FILTER BERM	A temporary berm or ridge constructed of loose gravel, stone, or crushed rock which slows and filters flow. May be used to direct runoff to a stable outlet, or filter stormwater in high traffic areas.
GM	GEOTEXTILE MATTING	Strong man-made mattings used to stabilize the flow on high velocity channels and swales and recently planted slopes. Also used as a reinforcement between courses on road work over soft areas. Recommended for use in retaining wall and fill slope construction as a tie-back into native materials.
NM	NATURAL MATTING	Biodegradeable materials, such as straw and excelsior bound in netting and impregnated with seed, are used on slopes where rill and sheet erosion may be a problem and where seed and mulch will not be effective. Can be utilized in temporary and permanent seeding solutions as necessary.
SC	TEMPORARY STREAM CROSSING	A temporary structural span across a stream to provide vehicular access to construction activity on either side of stream while keeping sediment out of the stream and preventing damage to the channel and banks. Used in conjunction with other measures to avoid sedimentation of the receiving water.
SR	SURFACE ROUGHENING	Grading practices such as stair-stepping, grooving slopes or leaving slopes in a roughened condition by not fine-grading them. Reduces runoff velocity, provides sediment trapping and increases infiltration; all of which facilitate establishment of vegetation on exposed slopes.
FCS	FLUSH CUT STUMPS	During timber removal operations trees are cut close to the ground to allow for crossing by vehicles and persons while leaving the root mass in place to retain the soil. Applicable on steep slopes and where fine grading and landscaping are not required. Used in conjunction with mulching, matting and seeding to further control erosive forces.
SL	SLOPE DRAIN	A flexible conduit, used before permanent drainage structures are installed; intended to convey concentrated runoff safely from the top to the bottom of a disturbed slope without causing erosion on or below the slope.
DV	PERMANENT DIVERSION	A permanent channel with a ridge on the lower side constructed across a slope to reduce slope length and intercept and divert stormwater runoff to a stabilized outlet to prevent erosion on the slope.
OP	OUTLET PROTECTION	The installation of paved or rip-rap channel sections and/or stilling basins below storm drain outlets to reduce erosion from scouring at outlets and to reduce flow velocities before stormwater enters receiving channels below these outlets.
RR	RIP-RAP PROTECTION	A permanent, erosion-resistant ground cover of large, loose, angular stone installed wherever soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that soil may erode under design flow conditions.
CRS	CONSTRUCTION ROAD STABILIZATION	Temporary stabilization with stone high traffic areas prone to erosion immediately after grading to reduce erosion potential damage caused by vehicles during wet weather and to prevent having to regrade permanent roadbeds between initial grading and final stabilization.
DC	DUST CONTROL	Reducing surface and air movement of dust during land disturbance, demolition or construction activities in areas subject to dust problems in order to prevent soil loss and reduce the presence of potentially harmful airborne substances. Includes the covering of soil stock piles and construction materials.
TSP	TOPSOIL PROTECTION	Stripping, stockpiling and protecting topsoil for later use in permanent landscape activities. Stockpiles are covered with sheeting, mulch and/or seed and surrounded by a containment berm to protect them from erosive forces. Periodic "turning" of the piles is required to maintain endemic microbial soil organisms.
LS	LEVEL SPREADER	An outlet for dikes and diversions consisting of an excavated depression constructed at near zero grade across a slope to convert concentrated, sediment-free runoff to sheet flow and release it onto areas of undisturbed soil stabilized by existing vegetation.
CWD	CLEAR WATER DIVERSION	A temporary re-routing of a watercourse through a sluice or tube to reduce the amount of clean water collecting sediments from active construction operations.
INF	INFILTRATION TRENCH	A semi-permanent sub-surface drain that allows for storm water to be absorbed by the ground in a ponded area. Typically a rock and fabric lined trench on the down gradient side of a road fill or in an open area away from the roadway.
SD	SUB-SURFACE DRAINS	A perforated conduit installed beneath the ground to intercept and convey groundwater. Prevents sloping soils from becoming excessively wet and subject to sloughing.
WDS	WATERWAY DROP STRUCTURE	A permanent structure or series of structures designed to "step" water flow down a slope without causing channel erosion; applicable in natural or man-made channels with long, relatively steep reaches.

NOTE: ADDITIONAL PRACTICES NOT SHOWN HERE CAN BE IMPLEMENTED BASED ON FIELD OBSERVATIONS AND ADJUSTMENTS FOR WEATHER, SEASON AND UNFORESEEN SITE CONDITIONS. CONTACT YOUR LOCAL PLANNING OFFICE FOR SPECIFIC SITE RECOMMENDATIONS AND FURTHER ASSISTANCE.

USE THESE CONVENIENT SYMBOLS AND DESCRIPTIONS WHEN DEVISING AN EROSION CONTROL PLAN FOR THE INTENDED PROJECT. THE SYMBOLS ARE NATIONALLY ACCEPTED WHILE THE DESCRIPTIONS ARE TAILORED FOR MOUNTAIN DRIVEWAY CONSTRUCTION.

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700

DESIGN -
DRAWN CMC
CHECK JKC/KAL
DATE 4/99

MOUNTAIN DRIVEWAY EROSION and SEDIMENT CONTROL
BEST MANAGEMENT PRACTICES
"EROSION CONTROL TOOLBOX"

FIGURE ONE

6.6 Recommended Permanent Stormwater BMPs

Basic permanent stormwater controls for developed sites should include the following:

1. Avoid direct discharge of stormwater to streams or other waterbodies.
   - Direct runoff from a ½-inch into stable, vegetated areas.
   - Attain on-site treatment of stormwater through use of Best Management Practices designed to detain or infiltrate the runoff and approved as part of the Stormwater Quality Control Plan.
   - Discharge stormwater to a conveyance structure designed to accommodate the flows with water quality treatment prior to discharge to a receiving waterway.

2. Minimize Directly-Connected Impervious Areas to allow pollutants to settle or be filtered out of stormwater runoff by:
   - Daylight roof drains to grassy areas
   - Daylight storm pipes to grassy open channels
   - Grass swales for stormwater conveyance

3. Detain and Treat Runoff. Detention can be either on-site or regional in nature.
   - Design detention for the 2-year and 25-year storm events.
   - Design conveyance facilities for the 100-year event.
   - Stabilize channels for the 25-year event.
   - Achieve removal of pollutants by sizing dry detention basins to incorporate a 40-hour emptying time for a design precipitation event of 0.5 inches in 24 hours, with no more than 50% of the stored water being released in 12 hours. For drainage from parking lots, vehicle maintenance facilities, or other areas with extensive vehicular use, this practice may require the additional use of a sand and oil grease trap or similar practice.
   - Maintain on-site detention facilities and drainage infrastructure.

4. Manage Snow Removal and Storage
   - Snow removal accumulates sand, oil and grease, metals, trash, pet wastes, and other pollutants found in urban stormwater. An area should be set aside for snow storage with controls to capture pollutants.

The following pictures and Basalt Stormwater Evaluation Plan map showcase recommended BMPs for the Town of Basalt:

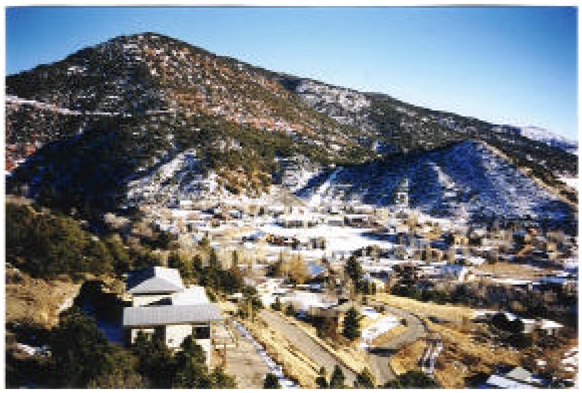

Figure 1: Off-site runoff from the hillsides surrounding Basalt must be safely conveyed through town to avoid localized flooding problems. Opportunities exist for additional drainage infrastructure and water quality treatment.

Figure 2: Localized ponding occurs throughout Basalt due to inadequate drainage infrastructure. Storm drains could be constructed to minimize ponding problems, or the area could be regraded.

Figure 3: This roadside swale along Two Rivers Road with stabilizing vegetation provides excellent water quality treatment of stormwater runoff.

Figure 4: This existing pond receives stormwater runoff from Old Town. There is an opportunity to reconstruct this into a regional water quality pond.

Figure 5: This sedimentation pond in the Elk Run Subdivision creates an opportunity for water quality treatment by constructing a multi stage outlet.

Figure 6: This sedimentation pond creates an opportunity for detention and water quality treatment by enlarging the pond and constructing a multi stage outlet.

Figure 7: A multi-stage outlet may look like this structure in a detention/water quality pond in Denver. The perforated pipe slowly releases runoff for water quality, the circular opening provides 10-year detention, and the grate on top provides 100-year detention with available freeboard.

Figure 8: This retention pond at the Basalt High School manages stormwater runoff and treats stormwater runoff water quality. This outlet is designed to release the major storm event (100-year) before it can overtop the embankment. The grate should have been set below the level of the embankment.

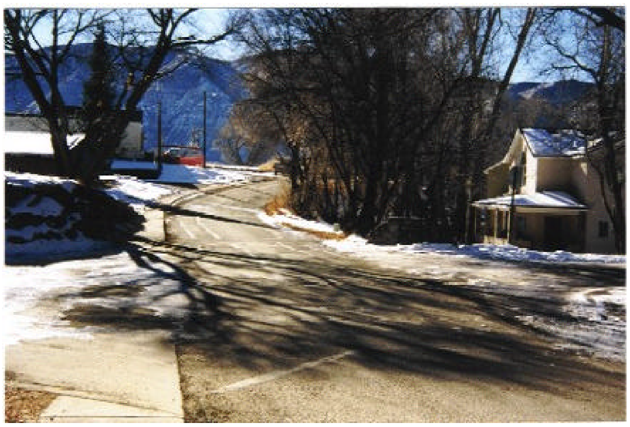

Figure 9: A total of 115 acres are tributary to this outfall for Sample Point 3. The existing culverts are inadequate to convey runoff from a major storm event and no formal outfall exists.

Figure 10: This is the Sample Point 3 outfall described in Figure 9. Icing and ponding will occur until new a storm drain is constructed. This intersection will flood in a major storm event.

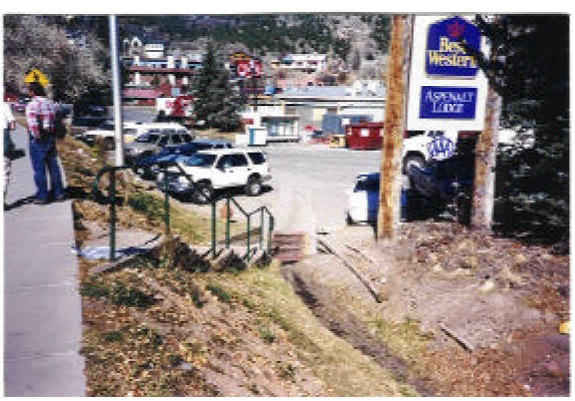

Figure 11: This storm outfall for the Basalt Center Circle is Sample Point 6. Stormwater runoff from the commercial operations within this 6.6-acre basin can introduce pollutants into the Fryingpan River.

Figure 12: 29 acres are tributary to this inter-section at Cottonwood Drive and Two Rivers Rd. The intersection is prone to local flooding, and a cross pan is needed along with a new culvert.

Figure 13: This storm drain outfall for the Basalt Center Circle provides some water quality benefit by disconnecting the impervious surfaces with this grass swale. Regular maintenance is necessary to remove deposited sediment and debris. A pond would provide better treatment.

Figure 14: This steep run-down can carry a high sediment load into the Roaring Fork River. The slope should be stabilized against further erosion.

Figure 15: This newly constructed road and swale above the Roaring Fork Club is a good example of construction BMP's. The site is well stabilized using a series of check dams, along with seed and mulch, to prevent erosion of the construction site.

Figure 16: The Roaring Fork Stewardship Committee identified protection of the river water quality as a key issue. Proper management of stormwater runoff from urban areas is paramount to protecting water quality in the Roaring Fork and Fryingpan Rivers.

6.7 Summary of Stormwater Recommendations

In summary, the following is a condensed list of drainage recommendations by the Northwest Colorado Council of Governments, and then a specific recommendations list for the Town of Basalt:

Northwest Colorado Council of Governments Recommendations

1. Development prepare "Stormwater Quality Control Plans"
2. Disconnect Impervious Surfaces and Promote Infiltration
3. Discharge 2 &25-Year Storm at Undeveloped Rates
4. Safely Convey 100-Year Storm Event
5. Capture the first ½" of runoff and release over a 40-hour period
6. Stabilize channels against the 25-year event
7. Sweep Streets – Especially in Spring
8. Dedicate Holding Areas for Snow Removal

Basalt Recommendations

1. Construct Regional Detention Ponds downstream of Developed Areas (i.e., Levinson Pond)
2. Require New Development to Construct On-Site Detention and Water Quality Ponds, and Safely Convey Stormwater Runoff to Receiving Waterways (i.e., South Side)
3. Route Off-Site Runoff Around Town
4. Modify Existing Detention Pond Outlets for Water Quality
5. Develop a Drainage Infrastructure Master Plan
6. Hire a Regional Full-Time Erosion Control Inspector
7. Monitor Stormwater Runoff Water Quality
8. Adopt NWCCOG Stormwater Ordinances
9. Maintain Existing Stormwater Facilities

Recommended Stormwater BMPs by Category
for the Town of Basalt

Site • Disconnect impervious surfaces • Require detention/water quality ponds • Promote infiltration on-site	**Regional** • Formalize the regional stormwater treatment pond south of Two Rivers Road west of Town • Enlarge existing detention ponds and modify outlets for water quality treatment of first ½ inch of runoff • Acquire and develop land for regional stormwater ponds at outfalls to the rivers
Non-Structural • Adopt all or part of NWCCOG Water Quality Standard Ordinances • Sweep streets, especially in spring before big thaw • Unclog culverts and maintain stormwater ponds • Educate the community on stormwater pollution prevention	**Structural** • Improve drainage conveyance system to handle a 100-year storm event • Utilize porous pavement and other pervious surfaces in development
Construction • Hire a regional erosion control inspector for the Valley • Require a stormwater quality control plan for new development • Maintain erosion control measures	**Permanent** • Require treatment of “First Flush” • Require detention for 2, 10, 25 and/or 100-year storm events

SECTION 7 – WATER QUALITY SAMPLING POINTS

Urban stormwater runoff contains pollutants. These pollutants degrade the receiving waters (Roaring Fork and Fryingpan Rivers) and reduce the quality of the pristine environment in Basalt. Just as Basalt would not allow raw sewage to be dumped into the rivers, the community should not allow direct runoff of stormwater from developed property without stormwater controls.

Exhaustive nation-wide studies on urban stormwater runoff by the EPA's National Urban Runoff Program (NURP) has concluded the following:

- The concentrations of pollutants in runoff from residential and commercial developments are roughly equivalent.
- The degree of basin imperviousness is correlated with pollutant loading.
- Seasonal variations are important (spring and winter pollutant concentrations are highest in snowy climates; the "first flush" from a half-inch of runoff contains the highest concentrations of pollutants in more arid regions).

Typical concentrations of pollutants for various land uses are shown in Table 8. These figures were developed through extensive water quality monitor programs in the Denver Metropolitan area. The Town of Basalt likely has similar pollutant loading in its stormwater runoff.

Stormwater Runoff Monitoring Sites

In order to get a more specific idea of pollutant types and degree of loading in the Basalt area, future monitoring of stormwater runoff in Basalt is proposed. As previously described in the report, there are eleven well-defined runoff points, covering most of the Town's runoff area, which can be tested during storm events. The outfall locations are shown on the Basalt Stormwater Evaluation Plan map in the fold-out map pocket. Brief descriptions of the prospective monitoring points are as follows:

1. **Main Old Town Basalt:** Runoff passes under Two Rivers Road through a 24-inch culvert into a pond just west of town. The testing point would be where runoff exits the culvert into the pond.
2. **Wix Property:** The northeast side of the Town of Basalt drains to this point. Overflow from the pond and street runoff are directed to the south side of Two Rivers Road, across from the Villas Subdivision. The testing point is represented by a 24-inch culvert that discharges water into the Roaring Fork River.
3. **Pueblo Bridge:** Runoff from the residential neighborhood to the north of Elk Run Subdivision enters the Fryingpan River just downstream from the Pueblo Bridge.
4. **Cottonwood Drive:** Runoff from this area enters the Fryingpan River just upstream from the Green Bridge.
5. **Swinging Bridge:** Runoff enters the Fryingpan on the east bank, just upstream from the Swinging Bridge.
6. **Basalt Center Circle:** The Basalt Center Circle runoff enters the Fryingpan River on the west side, through a pipe just upstream from the Green Bridge.

Table 8
Land-Use Average Storm Runoff Event Mean Concentrations of Runoff in the Denver Metropolitan Area

Data Source: Urban Drainage & Flood Control District Criteria Manual, Volume 3

Constituent	Units	Industrial	Commercial	Residential	Undeveloped
Total Suspended Solids	(mg/L)	399	225	240	400
Total Dissolved Solids	(m/L)	58	129	119	678
Biochemical Oxygen Demand	(mg/L)	29	33	17	4
Chemical Oxygen Demand	(mg/L)	232	173	95	72
Total Nitrogen	(mg/L)	2.7	3.3	3.4	3.4
Total Kjeldahl Nitrogen	(mg/L)	1.8	2.3	2.7	2.9
Nitrate plus Nitrite	(mg/L)	0.91	0.96	0.65	0.50
Total Phosphorus	(mg/L)	0.43	0.42	0.65	0.40
Dissolved Phosphorus	(mg/L)	0.20	0.15	0.22	0.10
Cadmium, Total Recoverable	(µg/L)	3	1	Below Detection	Below Detection
Copper, Total Recoverable	(µg/L)	84	43	29	40
Lead, Total Recoverable	(µg/L)	130	59	53	100
Zinc, Total Recoverable	(µg/L)	520	240	180	100

7. **Old Town Basalt East:** In order to test this runoff at the Fryingpan Road location, an existing culvert will have to be dug out so that water will flow under the road and into the Fryingpan River.
8. **Basalt Business Center West:** There is the possibility of testing runoff at a treatment vault within the Basalt Mini-Storage complex. There is a high groundwater table in this area, which contributes to diluted flows, making the stormwater analysis more difficult. At Basalt Business Center West, it may be necessary to take dip samples because the identified testing site is in a treatment tank under a manhole cover.
9. **Highway 82 East:** A testing point for this runoff is at a pipe on the south side of Highway 82, just up-valley from the Waterman Bridge.
10. **Highway 82 West:** Southwest of the Town of Basalt, along Highway 82, a culvert is built into the wildlife underpass, on the north side of the highway. This is the best point to monitor agricultural constituents that flow from fields during storm events. Both of the Highway 82 testing points will provide opportunities to measure for de-icing agents such as magnesium chloride.
11. **Sub-Basin (11) - Planned Development:** This new development parcel contains 2.8 acres which historically have an outfall to the Fryingpan River. Currently, the site is open space with tall cottonwood trees. No culverts currently exist for monitoring in this basin and sampling of concentrated sheet flow would be required.

The sites described above represent the best points within the Town of Basalt to monitor storm-water quality and quantity during runoff periods.

Monitoring Plan

The stormwater runoff monitoring plan will incorporate the testing of runoff at some or all of the sites described above during storm events of various magnitudes. Depending on the time of year, the runoff will be generated by rain or by snowmelt. Precipitation data will assist in determining when to monitor the size of the storm event, the dilution factor, and the stormwater discharge rate and quantity.

Grab samples will be taken at each selected site and analyzed at a lab. Samples will be analyzed for constituents including suspended sediments, bacteria, nitrogen, phosphorus and dissolved metals. Monitoring will occur throughout the year. Some areas are strongly influenced by the rivers and by irrigation ditch runoff, therefore there may also be more frequent monitoring during the spring runoff period.

SECTION 8 – NEXT STEPS

Improved Stormwater Management

Once the evaluation of the Town of Basalt's stormwater runoff has been completed, the next step will be to assess the effectiveness of existing stormwater management and to recommend new and improved Best Management Practices. Such improvements may include development of more and better detention and treatment facilities, use of wetland and riparian buffer systems, establishment of a stormwater quality control program, and the incorporation of new stormwater drainage ordinances.

The following items should be undertaken to improve the quality of stormwater discharges and prevent periodic flooding and damage caused by stormwater runoff:

1. Develop a **Drainage Infrastructure Master Plan** that specifically identifies deficiencies in the drainage system and proposes new infrastructure.
2. **Prioritize** the proposed infrastructure improvements.
3. Develop a **Budget and Funding** mechanism to implement the Drainage Infrastructure Master Plan.
4. **Educate** the community on the implications of urban stormwater runoff and better stormwater management techniques.

Education

The environmental education program initiated by the Roaring Fork Conservancy during the 1997/1998 school year has been expanded to include water monitoring activities and more in-depth focus on riparian and wetlands ecology. The Conservancy is implementing additional water quality monitoring activities and programs that focus on maintaining healthy aquatic and riparian ecosystems. Monitoring, which is based on the River Watch (Colorado Division of Wildlife Rivers of Colorado Water Watch Network) protocol, is addressing potential stormwater runoff constituents, such as suspended solids, nitrogen, phosphorous, bacteria, and dissolved metals. These monitoring activities are providing students with hands-on experience in measuring the effects of development. The River Watch monitoring protocol, which covers testing of pH, dissolved oxygen, total alkalinity, and hardness, is generating data for the evaluation of water quality in stormwater conduits. Additionally, the project will educate the general public about practices that minimize or improve stormwater runoff.

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