SALT LAKE COUNTY PUBLIC WORKS

DIVISION OF FLOOD CONTROL & WATER QUALITY

RIPARIAN ZONE MANAGEMENT PLAN

FOR THE SALT LAKE VALLEY TRIBUTARIES

DECEMBER, 1985

draft

SALT LAKE COUNTY DEPARTMENT OF PUBLIC WORKS

DIVISION OF FLOOD CONTROL & WATER QUALITY

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Steven F. Jensen, M.P.A.
December, 1985.

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I. INTRODUCTION

The purpose of a specific action plan for Riparian Zone management is to isolate important stream reaches where natural values should be conserved. These stream reaches occur along Big Cottonwood, Little Cottonwood, and Millcreek between the canyon mouths and the Jordan River. It has been estimated that significant economic, social, and environmental benefit can be realized through protection and enhancement of natural creeks running through Salt Lake Valley.

Conserved streamside (Riparian) vegetation, trails, banks and fishery habitat could provide leisure sightseeing, jogging, picnicking, bicycling, and fishing activities at an estimated annual dollar benefit of $3.1 million. The largest share of this annual economic benefit is in fishing, sightseeing, and picnicking. Initial expenditures for recreational activities are multiplied four times through the local economy in support goods and services. It is possible that an urban greenway system along the valley's coldwater creeks could net an annual $12.6 million benefit by the year 2000.

The lack of coordination between agencies that manage some aspect of the streams demands a coordinated approach if greenways are to be set aside and conserved for the benefit of man and nature. Public agencies which safeguard wildlife population such as harvestable ducks and endangered species, manage flood control, provide recreation, and protect public health all have a role in protecting these streams. Private citizens living next to the streams have a direct vested financial interest in addition to deriving numerous aesthetic and recreational benefits. The valley creeks are complex, connected, continuous systems that must be managed in total. No single person or agency has a right to damage downstream use or users.

As creek characteristics were inventoried, surveyed, and studied, the physical, biological, and chemical traits became clear. Many creek segments have been damaged, altered, and changed beyond our limits to correct them. Many segments offer unique values that must be conserved or lost forever. In all liklihood, if local taxpayers do nothing to recapture these resources, local taxpayers will be those who lose. As the County grows toward the million mark, the demand on these resources to provide valuable leisure time will grow. We can plan to conserve and benefit from stream resources, or we can neglect them with no benefit--but increased liablity. Waterborn disease--such as Steptococcus bacteria--is known to exist in high levels during storm periods, and will increase the population it affects if pollution control is ignored.

This plan is a proposal to move toward a positive program of recapturing multiple stream benefits that may be lost if ignored. It estimates relative resource values for each creek reach, and combines them to paint a picture of future environmental productivity. The plan outlines steps toward attaining higher levels of beneficial use on the streams, while reducing the cost to taxpayers in "maintaining" them. Low maintenance cost of recreation opportunities should be considered a strong advantage of streamside activity to that offered in typical public parks.

Much of the improvement to creek conditions has occurred indirectly through flood damage repair efforts. These efforts established practices and standards of repair that will guage future maintenance and replacement efforts. They provide building blocks toward revegetation, aesthetic value and wildlife habitat restoration. Much remains to be done.

OBJECTIVES

The objectives of the Riparian Zone Management Plan are:

1. To review briefly the benefits to be derived from such a program.
2. To develop a method of assigning relative values to stream reaches for the purpose of prioritizing and targeting management actions.
3. To develop an implementation strategy framework for state and local agencies to pursue.

The flow chart diagrams on pp. 5-6 indicate the planning tasks completed and the direction of the management plan.

ANTICIPATED BENEFITS DERIVED FROM GREENWAY DEVELOPMENT.

The ultimate benefits for the restoration of valley streams are economic. These benefits will accrue in recreational days and dollars, as estimated in the recent report Assessment of Salt Lake Valley Tributaries: Recreational Use Impairment & Opportunities (July, 1985). Even peicemeal implementation of urban stream greenways can be expected to yield community benefits, because the physical, chemical, and biological differences in stream reaches lend themselves to incremental protection. A review of various benefits to the community include water quality, flood control, recreation, and wildlife.

1. Water Quality. The quality of creek water flowing toward the Jordan River is gradually degraded between the Canyon mouths and River confluences. The physical character of the streams--such as gradient--are to blame for much of this condition. Upper reaches are steeper with greater natural oxygenation, while lower reaches tend to be nutrient enriched and less oxygenated, particularly during evenings. The density, diversity, and productivity of aquatic animals are limited by such conditions.

Bacterial organisms of different species also find such nutrient enriched conditions suitable for reproduction, and in fact produce much of the oxygen demand along such reaches. Increases in bacterial population has a direct impact on human health. The combined length of the creeks is about 28 miles, winding through an adjacent population of about 6000 people or 1800 households. The potential of waterborn disease spreading from this exposed population is substantial.

The existence of toxic substances, such as zinc, cadmium, lead, and mercury have been documented in all three creeks. Although bound up in sediments, they are available to bottom-dwelling macroinvertebrates which provide food for larger organisms--mainly fish. Ingestion of organisms containing toxic metals results in a bio-accumulation of the metals in fish and on up the food chain in humans. It is not known how much metal fish contain in the valley creeks (FDA standards are 50 ug/kg). Additional study should be conducted to determine the level of risk. Carp and sucker in the Jordan River are known to be well below FDA standards, but concentrations in fish that predate on these species could bio-accumulate at higher levels.

Sediment concentrations in the creeks have historically been quite high. These concentrations are likely to fall with stabilization of stream banks, and reduction in stream bottom disturbing activities, such as flood control dredging. Sediment, although no in-stream standard exists, has been found to be a major pollutant because of the demand it creates for increased flood control maintenance. This trend appears to be on the downswing in view of recent bank stabilization efforts.

2. Flood Control. As mentioned, the type of flood control activity directly affects the use of the streams. Annual dredging, together with unnecessary removal of streamside vegetation, directly impacts virtually every physical and biological factor that maintains aquatic life. The following factors are drastically altered by instream sediment removal:

A. Stream size, width, depth. Creates even shallows by spreading stream volume and reducing rates of reaeration.

B. Stream Gradient. Alters pool/riffle ratios. Eliminates resting & feeding areas for aquatic organisms. Drops available oxygen.

C. Temperature. Removal of vegetation alters temperature beyond tolerance of many-particularly coldwater-species.

D. Sedimentation. The natural fluvial processes in streams distibute organisms and their habitat gradually. Removal of bottom armoring may increase erosion in both stream bottom and banks, and increase velocity which unnaturally accellerates instream erosion. This effect was observed many times on the Jordan River immediately after upstream dredging operations. This erosion impacts downstream riparian density by creating unstable stands of overstory vegetation such as historically stable streamside trees.

E. Biological Population. Potential reductions in macroinvertebrate population and fishery population.

F. Dissolved Oxygen. Sediment disturbance produces short-term oxygen deficits, because it tends to be an oxygen-consuming factor in great concentrations.

G. Toxicants. Sediment disturbance instream may release heavy metal concentrations previously stabilized in sediment deposition. The same may be true of nitrogen and phosphorus.

In summary, instream maintenance serves single-use, short-term objectives. It does not enhance multiple use and economic return to the community. It should be closely re-evaluated by the community in terms of the cost and benefit as compared with sediment stabilization or trapping.

The flood restoration efforts of 1983-85 resulted in the stabilization of approximately 8000 linear bank feet along Millcreek (20% of the total), 23,000 bank feet along Little Cottonwood Creek (43%), and 16,000 feet along Big Cottonwood Creek (34%). In total, about one-third of the total combined stream lengths have been structurally stabilized by the public flood control agency. Private stabilization, although not engineered professionally, nor constructed to engineering specifications, probably provide a substantial measure of stabilization not accounted for in these estimates.

Any further stabilization activity on the creeks should include habitat conservation or enhancement in order to regain any values lost during construction.

3. Recreation. As previously noted, the recreational benefits of stream zone conservation could be economically significant. Based on levels of activity on the Jordan River Parkway, the visits to urban stream greenways could exceed almost one quarter million by the year 2000, with an estimated annual value of $3.1 million. Most of this streamside recreation will be low maintenance when compared to traditional park uses, in addition to providing unique recreational experience demanded in dense urban settings, but not normally provided.

4. Wildlife Habitat. The initial value in riparian zone conservation is in bird and associated communities. No data on related sightseeing value has been obtained, although some measure of the sightseeing benefit could be assigned to birdwatching. Fishery value has been estimated at a potential $1.2 million annual contribution for all three creeks combined by the year 2000.

METHODOLOGY FOR ASSIGNING RELATIVE VALUES.

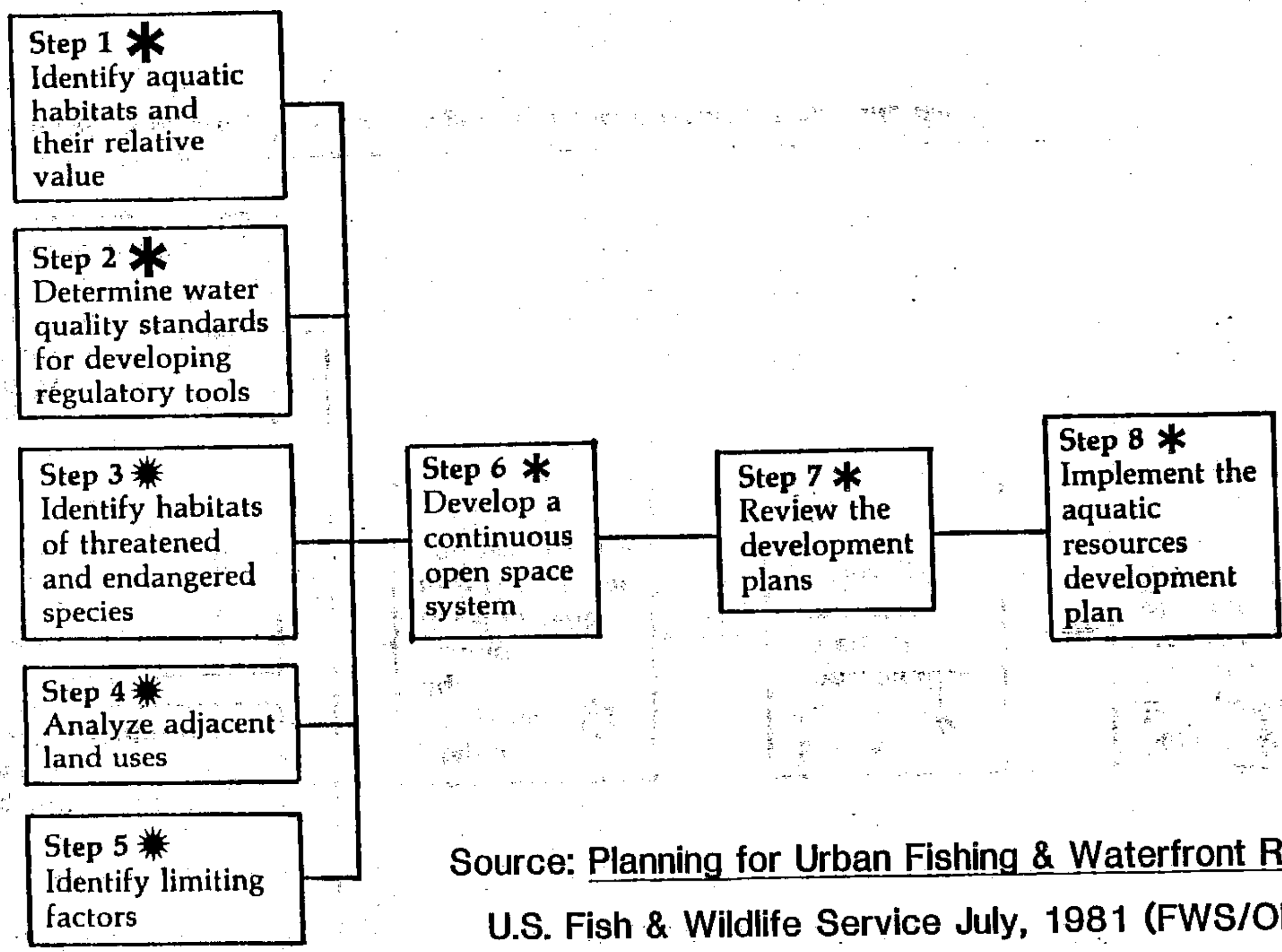
Three primary groups of data were compiled in the Assessment of Valley Tributaries: Hydrology, Land Use, and Riparian Vegetation/Habitat.

Each group was broken down into measurable data factors and values determined from a combination of literature values and questionairres. Stream reaches were then identified and factor values applied. Total weighted values were determined for each stream for each individual set of factors, and composite values were displayed for all three streams. This forms the basis for targeting or prioritizing stream reaches where conservation strategies should be applied.

IMPLEMENTATION STRATEGY FRAMEWORK.

Conservation alternatives were reviewed and a set of specific strategies selected based on available and most applicable authority at federal, state, and local levels. The set of strategies is applied to highest priority stream reaches. This format provides readily useable guidelines for allocated capital improvement or cooperative project funding.

FIGURE # A



Source: Planning for Urban Fishing & Waterfront Recreation

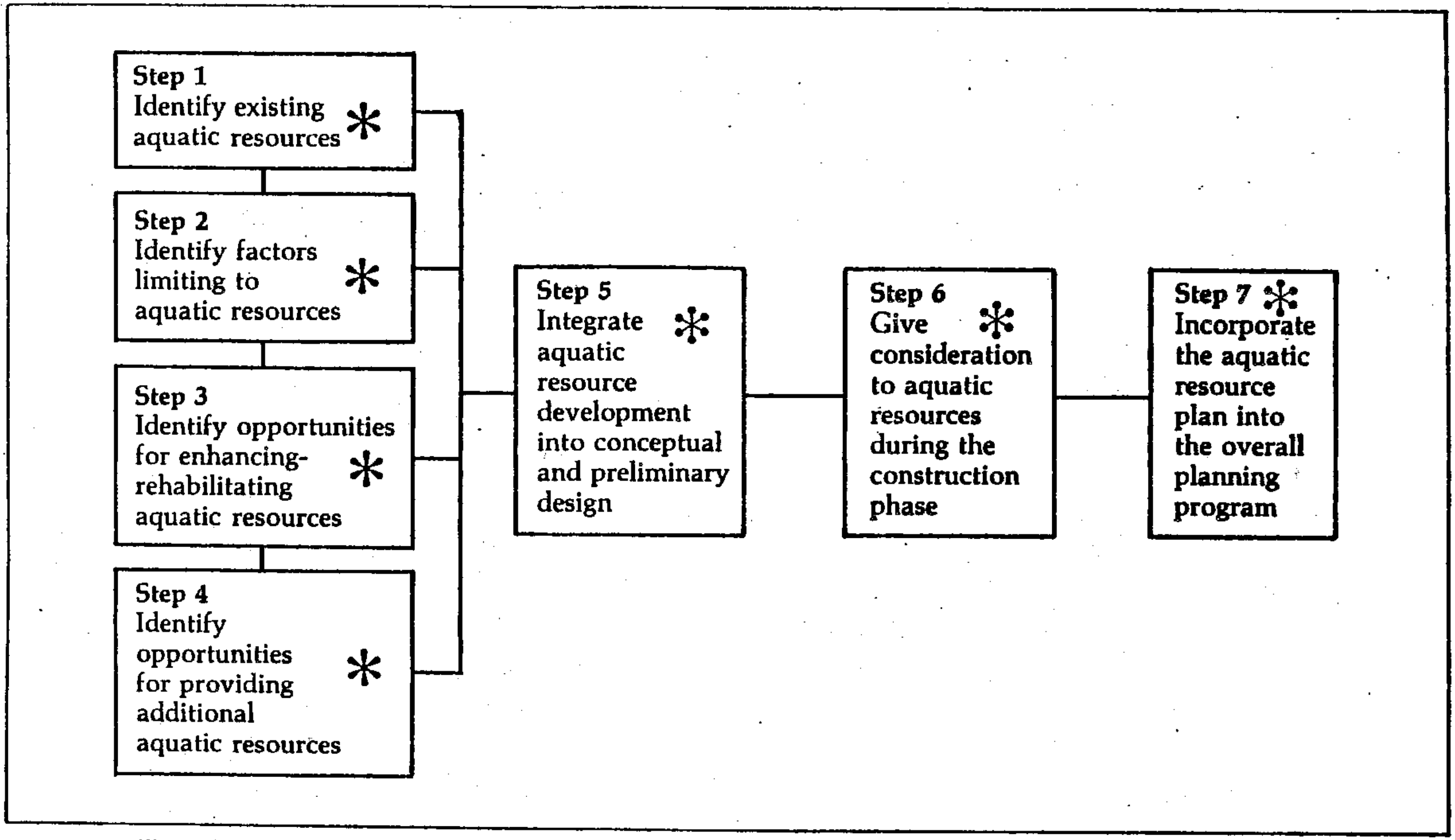
U.S. Fish & Wildlife Service July, 1981 (FWS/OBS-80/35)

Flow diagram of basic aquatic resource planning procedures at regional and municipal levels

✹ Completed via Assessment of Valley Tributaries

✱ Objective of Riparian Zone Management Plan

FIGURE # A1.



Flow diagram of procedures for integrating aquatic resources into site design.

II. COMPOSITE STREAM VALUES: WEIGHTING/RANKING ALTERNATIVES

METHOD EMPLOYED IN VALUE ASSESSMENT

In order to target and prioritize specific stream reaches for plan implementation, it was necessary to assign some relative value to factors which constrain or enhance opportunities for greenway conservation.

Three general groups of factors or values were selected: Hydrology (both the quantity and quality of stream water), Land Use (relating to access of the resource for human enjoyment), and Riparian characteristics (mainly streamside vegetation and aquatic production). These general groups are further divided into categories which carry weights of greater or lesser importance.

The groups and their attendant values were adapted from several previously published sources. The Assessment of Valley Tributaries[1] provided a summation of base data on existing conditions in the creeks. Land Use conditions, Riparian vegetation, and most hydrologic conditions were described in that report. The Water Quality Standards Regulations finalized by the U.S. Environmental Protection Agency[2] provided guidelines for determining impairment of stream uses based on physical, chemical, and biological parameters. Flows needed for various instream uses were documented by the Instream Flow Group in a report published jointly by the U.S. Fish & Wildlife Service and State of Utah[3]. Habitat Evaluation Programs (HEP models) generated by Binns & Eisermann and others[4] identify numerous factors to estimate resource values and opportunities, and the U.S. Fish & Wildlife Service formats the final planning process in Planning for Urban Fishing & Waterfront Recreation (July, 1981).[5]

Weights for the various resource factors were derived from stream measurements and estimates and reviewed by several engineers and planners in the County Public Works Department. Their preferences produced point values which were totaled, mean values determined, and weight ranges established based on the relative values. Hydrologic factors received the highest value range, followed by streamside vegetation and land use. The results are summarized in Table One, Stream Reaches are described in Figure A.

INDIVIDUAL FACTORS AND RELATIVE POINT ASSIGNMENTS.

Hydrology: Quantity and Quality. Both literature and questionnaire respondents agree that instream flow and its quality are the primary limiting factors to instream use. Other factors that impact the potential use of the stream for fishing or other recreation follow with slightly diminishing importance.

1. Streamflow @ 5 c.f.s.[6] Creek flow is seasonally dewatered on Big & Little Cottonwood at the upper reaches, but all creeks gain sufficient groundwater and irrigation exchange flow to provide minimum flow maintenance downstream year-round. Millcreek is not dewatered beyond biotic support limits. Point credit was assigned to areas receiving minimal groundwater discharge during the year.

2. Seasonal Flows Allowing Float Recreation.[7] Although spring flood flows are dangerous and inadvisable for floating recreation, the creeks do receive some floating activity when flood flows recede. This range of flow is roughly between 50-300 c.f.s. Stream segments seasonally dewatered were given credit for recreational floating potential. These segments provide both access and are characterized by open channels with few or no obstructions, and are wide enough to provide escape for overturned floaters.

TABLE ONE. POINT RATINGS FOR SELECTED RIPARIAN ZONE WEIGHTING VALUES.

WEIGHTED FACTORS	RELATIVE POINT VALUE
Hydrology: Quantity and Quality	
1. Stream Flow-Minimum 5 c.f.s.	10 Pts. Seasonal/Dewatered
	50 Pts. Sustained Annually
2. Stream Flow-Peak "Flotable"	20 Pts. Seasonal
3. Flood Control Maintenance	10 Pts. Annual Maintenance
	50 Pts. 5-year periodic "
4. Water Quality	10 Pts. Pollution-Impaired
	50 Pts. High Quality
5. Floodplain-100 year	20 Pts. Undeveloped
6. Channel Stability	50 Pts. Excellent
	40 Pts. Good
	30 Pts. Fair
	20 Pts. Poor
7. Bottom Composition	50 Pts. Good
	30 Pts. Fair
	10 Pts. Poor
8. Erosion Potential	50 Pts. Slightly Erosive
	30 Pts. Moderately Erosive
	20 Pts. Moderately Erosive
Land Use: Accessability	
1. Parks/Open Space/Vacant/Agriculuture	20 Pts.
2. High Density Residential	15 Pts.
3. Sand/Gravel Excavation	15 Pts.
4. Commercial/Industrial	10 Pts.
5. Low Density Residential	5 Pts.
Riparian Conditions	
1. Riparian Streamside Vegetation	50 Pts. Expansive/Dense
	25 Pts. Moderate/Dense
	15 Pts. Minimum/Thinned
	10 Pts. Sporadic/Thinned
	0 Pts. Little/Absent
2. Fishery Production	10 Pts. Known Coldwater
	5 Pts. Known Warmwater
	0 Pts. Dewatered

FIGURE #B

COMPOSITE STREAM REACHES

SEGMENT #	BIG COTTONWOOD CREEK	SEGMENT #	LITTLE COTTONWOOD CREEK	SEGMENT #	MILL CREEK
BC-1	Jordan River - I-15	LC-1	Jordan River - I-15	MC-1	Jordan River - I-15
BC-2	I-15 - State Street	LC-2	I-15 - State Street	MC-2	I-15 - State Street
BC-3	State Street - 4500 South	LC-3	State Street - 5300 South	MC-3	State Street - 700 East
BC-4	4500 South - Van Winkle	LC-4	5300 South - 5600 South	MC-4	700 East - 900 East
BC-5	Van Winkle - 900 East	LC-5	5600 South - 900 East	MC-5	900 East - Highland Drive
BC-6	900 East - 1300 East	LC-6	900 East - 6600 South	MC-6	Highland Drive - 2000 East
BC-7	1300 East - 4800 South	LC-7	6600 South - Ft. Union Blvd.	MC-7	2000 East - 2700 East
BC-8	4800 South - Kings Row Drive	LC-8	Ft. Union Blvd. - 1300 East	MC-8	2700 East - I-215
BC-9	Kings Row Drive - Highland Dr.	LC-9	1300 East - 2000 East	MC-9	I-215 - Cyn. Mouth
BC-10	Highland Drive - Arbor Lane	LC-10	2000 East - Creek Road		
BC-11	Arbor Lane - Cottonwood Lane	LC-11	Creek Rd - Water Treat Plant		
BC-12	Cottonwood Lane-6200 South	LC-12	WTP-Wasatch Blvd.		
BC-13	6200 South - 3000 East	LC-13	Was. Blvd. - LC Road		
BC-14	3000 East - Debris Basin				
BC-15	Debris Basin - Canyon Mouth				

WP Doc #127F

3. Undeveloped 100-year Floodplain.[8] The existence of undeveloped floodplains within the 100-year frequency boundary is rare, but some land parcels adjacent to the creeks still exist. Extensive floodplains were credited with 20 points while smaller constricted undeveloped floodplains were credited 10 points. The assumption for positive point assignment was made that future development would be required to set back far enough to maintain an undeveloped open space corridor between new construction and stream banks.

4. Flood Control Maintenance.[9] Maintenance is defined as the removal of any solid waste material from the creek channels which may inhibit the safe passage of annual spring flood flows. Typically this involves sediment removal from the stream bottom.

This activity removes macroinvertebrate and aqauatic plant populations supporting fish. It destroys important pool and riffle ratios which oxygenate the stream, and radically disrupts the depth and cover variables important to fish habitat. It often resuts in the removal of streamside vegetation which controls water temperature, habitat cover, and bank stability.

Because the composite value matrix is based on positive or aggregate values, those stream reaches known to be dredged on an annual basis receive only 10 points. Lesser frequency up to five years is credited up to 50 points. Some intermediate maintenance frequency occurs on a needs basis, so intermediate point values are assigned.

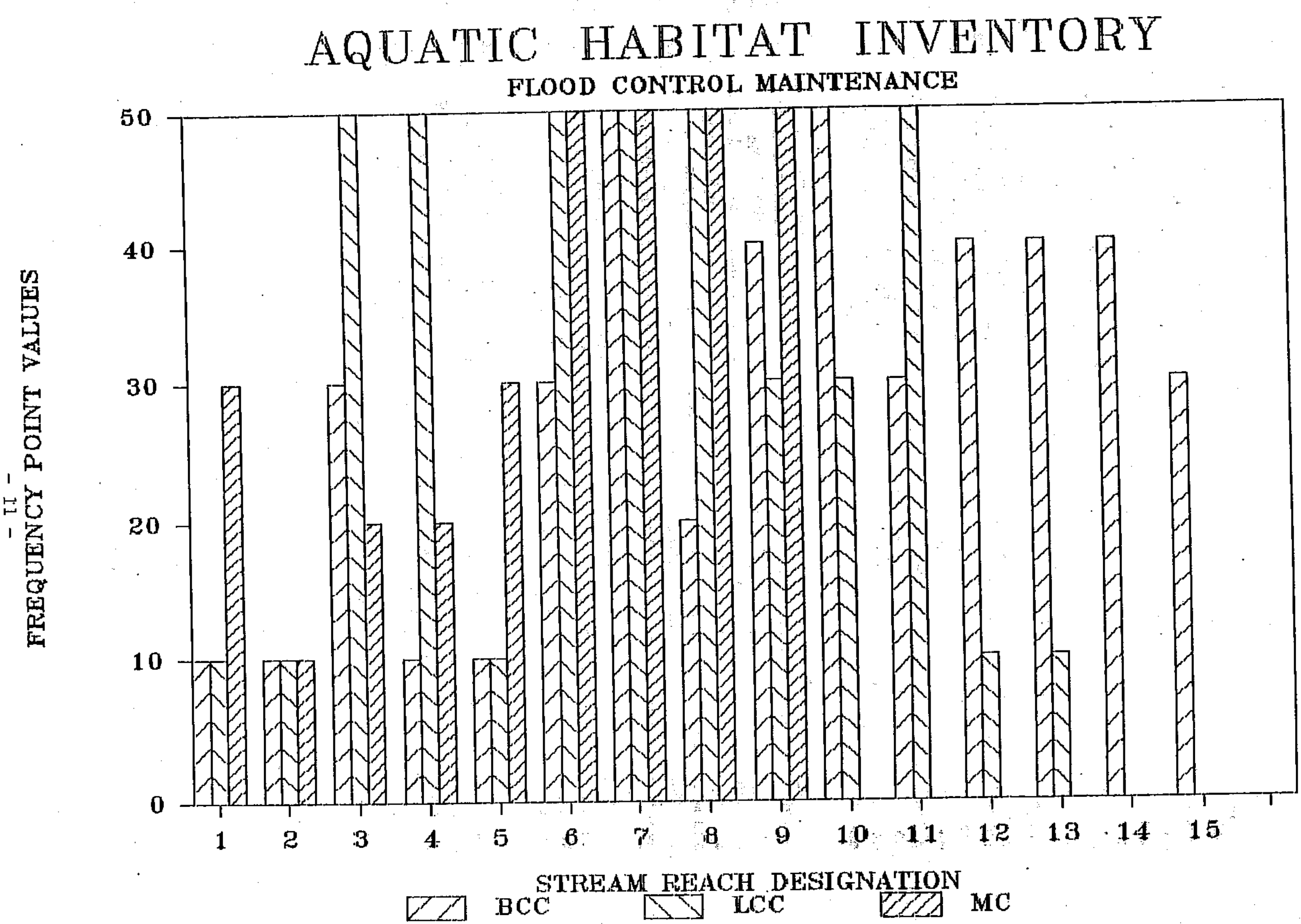
Because of continuing bank stabilization activity on the creek banks, dredging impact and activity is expected to decline as the major source of channel sediment diminishes. Some sediment can be expected to be eroded from stream bottoms as banks are stabilized, but this sediment is necessary in the channel to provide habitat for food-chain organisms, such as macro invertebrates and other benthos.

The new volume of bottom-generated sediment will not require annual maintenance because it represents a marginal proportion of previously dredged totals. Bottom erosion will also enlarge flood channel capacity rather than impair it. Care should be taken during dredging operations and the installation of bank stabilization measures to avoid stripping the natural armor-plate bottom from the creek channel. Doing so will unnecessarily promote additional sedimentation and erosion problems.

The section to follow on conservation strategies will outline where future bank stabilization and dredging activities are expected to occur, where bank stabilization projects have been completed, and what additional measures are needed to safeguard habitat and riparian values.

Figure One compares stream reaches of each major tributary that are impacted by annual dredging activity. The bars on the extreme downstream reaches are indicative of extremely regular dredging activity, while many segments in the mid-reaches escape annual disturbance. This figure does not take into account projects under way which will stabilize sediment problems. Examples are detention basins under construction such as Scott Avenue and 550 East on Millcreek. Reaches below these basins should require little--if any--dredging activity in the future.

FIGURE # 1


AQUATIC HABITAT INVENTORY
FLOOD CONTROL MAINTENANCE
FREQUENCY POINT VALUES
0
10
20
30
40
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STREAM REACH DESIGNATION
BCC
LCC
MC

5. Water Quality.[10] Documented pollution impairment was credited with 10 points. Marginal or very little pollution was credited up to 50 points. Research over the past ten years concludes that the quality of water in the valley segments of Big/Little Cottonwood and Millcreek decreases as it flows toward the Jordan River. Upper reaches are seasonally dewatered with an attendant drop in point value. Lower reaches are nitrogen enriched to the extent that aquatic plant transpiration produces evening oxygen deficits that cannot be tolerated by most fish species. Sediment is a serious form of pollution, because its presence requires damaging measures to remove it.

Other creek pollutants collected near the Jordan River include ammonia, phosphorus, heavy metals such as cadmium, lead, mercury and zinc, and oil and grease. Further investigation on each creek is necessary to quantify specific source and location of these pollutants. The U.S. Geological Survey, in cooperation with Salt Lake County, indicates in reports published for the Nationwide Urban Runoff Program (NURP) that pollution constituent means can be attributed to urban development area or acreage. It is possible to weight each creek reach according to the total load of pollutant contributed based on contributory urban (impermeable) acreage. Such an undertaking should be conducted as part of an overall waste load analysis.

The source of various constituents should be determined and measures taken to reduce their concentrations. Oil and grease from automobiles may not lend itself to urban runoff chemical treatment, but may be trapped and removed as part of the storm drain maintenance process. Lead deposition from automobiles is proceeding toward strict control through requirements for standardizing non-leaded gasoline. Sediment can be trapped in catch basins designed to accumulate sediment to be removed later on. Other artificial means are available to increase biological conditions in the streams.

Lack of oxygenation could be artificially mitigated on the lower reaches through provision of drop structures, windmills, pumps, or other apparatus; Sedimentation can be reduced through source stabilization (See Section on Conservation Strategies).

The primary source of documented pollution impairment was the 303e Hydrologic Basin Study.[11] This report identifies the lower reaches of all three valley tributaries to exceed standards of quality for oil & grease, BOD, coliform bacteria, nitrates, and other constituents. Reports compiled by Hydroscience[12] document increases of pollution between canyon mouths and confluence with the Jordan River. These results were confirmed by studies conducted during the NURP[13] between 1980 and 1983.

6. <u>Channel Stability Index</u>. Sediment Source Studies by the Utah Geological and Mineralogical Survey[14] and Channel Stability Evaluations by Salt Lake Soil Conservation District[15] provide the basis for channel stability index values. Rated from 20-50 points, this index is an accurate but qualitative description of channel conditions.

The Sediment Source analysis reviewed geologic data in Wasatch canyons and Salt Lake Valley to determine relative erodibility. Conclusions from this study are that the majority of sediment reaching the Jordan River is from valley tributary rather than canyon reaches.

The Channel Stability Evaluation performed by the Salt Lake Soil Conservation District was taken from a watershed inventory procedure developed by the U.S. Forest Service[16] and applied with certain modifications to the valley tributaries. Factors described include upper bank landform slope, mass wasting, debris jam potential; lower bank channel capacity, bank rock content, flow deflectors, cutting and deposition; stream bottom rock angularity, brightness, particle packing, distribution, scouring, and aquatic vegetation. The values shown for each stream reach are an average of all these factors combined.

7. <u>Bottom Composition</u>. This data is compiled from the Channel Stability Evaluation referenced above. An optimum stream bottom composition consists of evenly distributed materials ranging from boulders sized between 1'-3' and fine gravels between .1" and 1". Some inclusion of sand, silt, clay or muck can be tolerated. This even distribution provides for a range of biological organisms that comprise basic food chains for larger aquatic animals like fish and even terrestrial animals.

A bottom composition dominated by large boulders with little gravel or only sand, silt, clay, or muck will support little density, diversity, and productivity of macroinvertebrate species, nor provide spawning for fish. Balanced mix of large cobble to sand is credited with 50 points. A fair rating reflects a composition of excessive gravels and/or boulders. Poor rating results from mostly sand/silt/gravel bottoms,

8. <u>Erosion Potential</u>. The Salt Lake Soil Survey[17] provides basis for estimating erodibility on upper Big Cottonwood and other creeks. Site-specific samples by Chen & Associates as part of the Montgomery Engineering Bank Stabilization plan on Big Cottonwood[14] is the source for that creek below Highland Drive. Erosion of the channel and its banks form the basis for determining sedimentation and bank failure during floods. Highly erosive reaches should be targeted for immediate stabilization. Slightly erosive segments should be lower priority for stabilization.

The last three factors relating to channel stability have been summarized for each creek reach in Figure Two. This figure suggests specific reaches requiring corrective action, i.e. bank stabilization.

FIGURE # 2-A

STREAM STABILITY INDEX

LITTLE COTTONWOOD CREEK

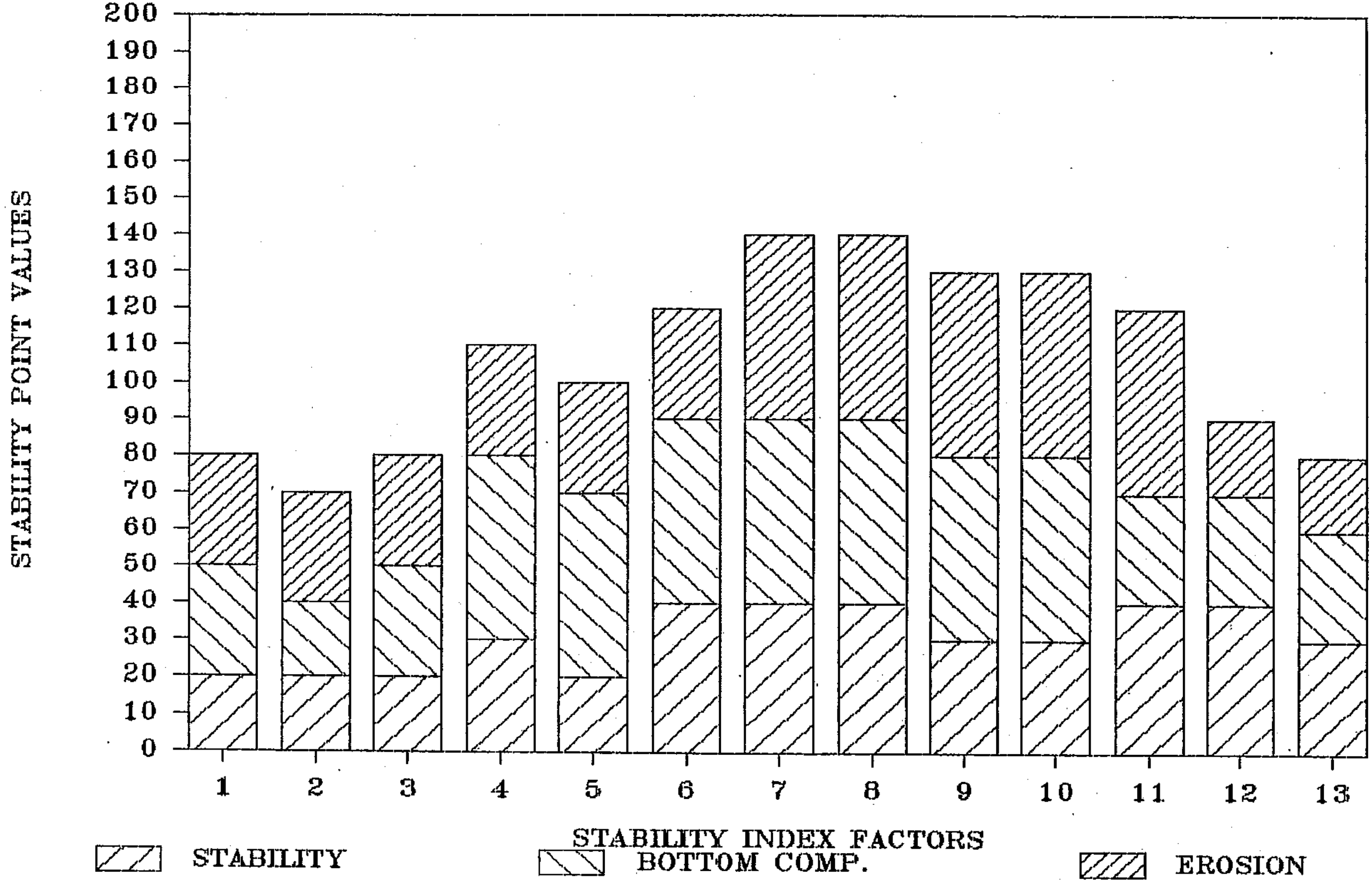
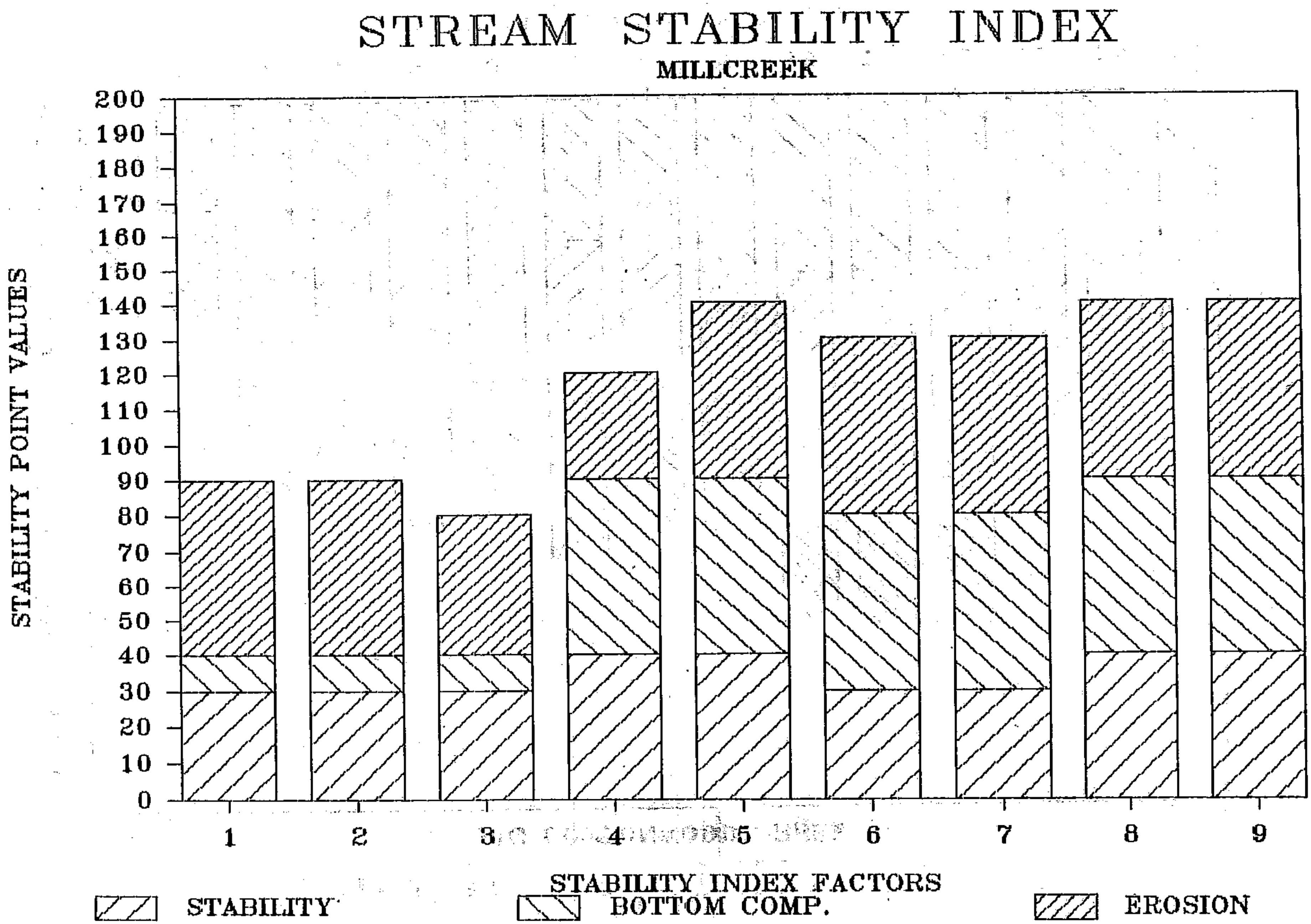


FIGURE # 2-B


STREAM STABILITY INDEX
MILLCREEK
STABILITY POINT VALUES
200
190
180
170
160
150
140
130
120
110
100
90
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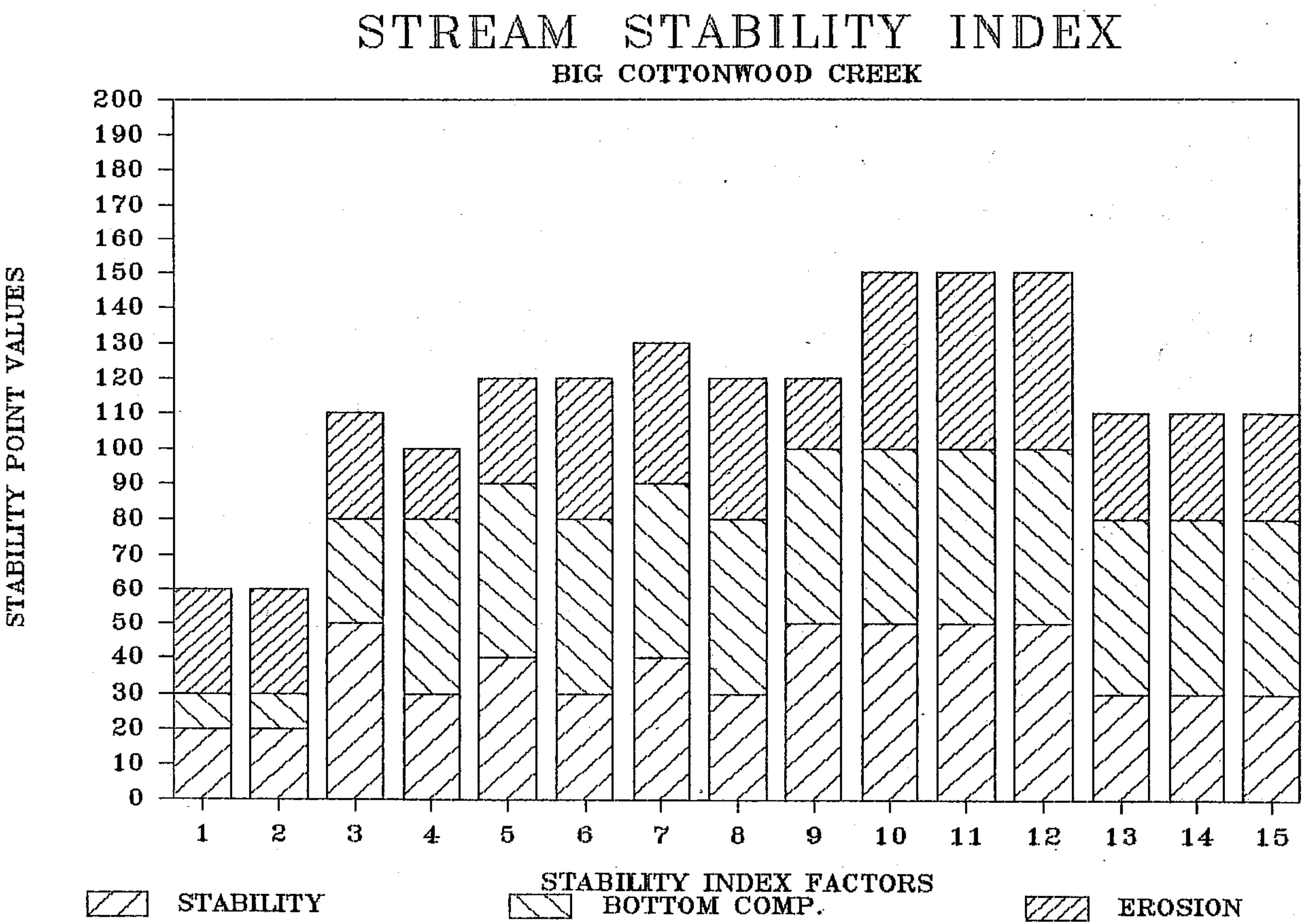
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
STABILITY INDEX FACTORS
STABILITY
BOTTOM COMP.
EROSION

FIGURE # 2-C


STREAM STABILITY INDEX
BIG COTTONWOOD CREEK
STABILITY POINT VALUES
200
190
180
170
160
150
140
130
120
110
100
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70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STABILITY INDEX FACTORS
STABILITY
BOTTOM COMP.
EROSION

Land Use: Accessibility.[18] Predominating land use dictates the extent to which creeks are accessible for recreational use. Figure Three summarizes predominating land uses along each stream reach, and provides for comparison of use patterns for all three creeks.

1. Parks, Vacant, Agricultural land. Based on review of present land use patterns adjacent to valley creeks, Public Parks or facilities (including schools), vacant property and agricultural land provide the least inhibitions to public access (20 points). This land use category is most likely to draw the attention of many varieties of stream recreationists, from fishermen to joggers. Time availability is conducive to recreationists which would be restricted from use during off-working hours in residential streamside use. Parks, vacant land, and school areas are accessible during non-working hours, thus allowing for optimum recreation opportunity.

2. Sand/Gravel Excavation. Adjacent sand & gravel operations occur off the stream banks for some distance--particulary along upper reaches of Big Cottonwood Creek. Where these uses occur, access to the creek is generally uninhibited (15 points).

3. High Density Residential. (15 Points) Clustered housing provides for open space corridors along streambanks, but all clustered housing proposals do not provide uniformity in open space design. Type of ownership may constrain access if corridors exist. Condominium ownership is more restictive than single landlord ownership. This form of housing--because of open space corridor design and ownership--provides greater access than low density subdivision type housing, due mainly to larger concentrations of people who will utilize the corridors for leisure activity.

4. Commercial/Industrial. (10 Points) This type of land use is typically not in use during recreation periods (weekends) and non-working hours and does not present access restriction by dwellers. Access is generally more tolerated, although many businesses take great effort at security measures such as fencing, guard dogs, and alarms. Existing streamside fencing may actually inhibit use of creeks for even fishing, not to mention trail-type recreation.

5. Low Density Residential. (5 Points) Private ownership adjacent to creeks by non-commercial or non-corporate individuals is the most access-restrictive use. Ownership is platted to the stream center and the stream itself is incorrectly considered under the control and authority of the landowner. Other authority by public entities precludes exclusive private control. Privacy is enforced by fencing and posting. For purposes of public recreation, these uses restrict fishing and floating unless access easements are provided. Use of the creek is confined to a local "substitution market" of recreationists who live next to the creek or are associated with creekside residents.

Figure three reviews the predominant land use patterns adjacent to valley streams. The presence of those uses offering less access restriction are credited with more point values, while use more restrictive to access receive less point value.

FIGURE #3-A

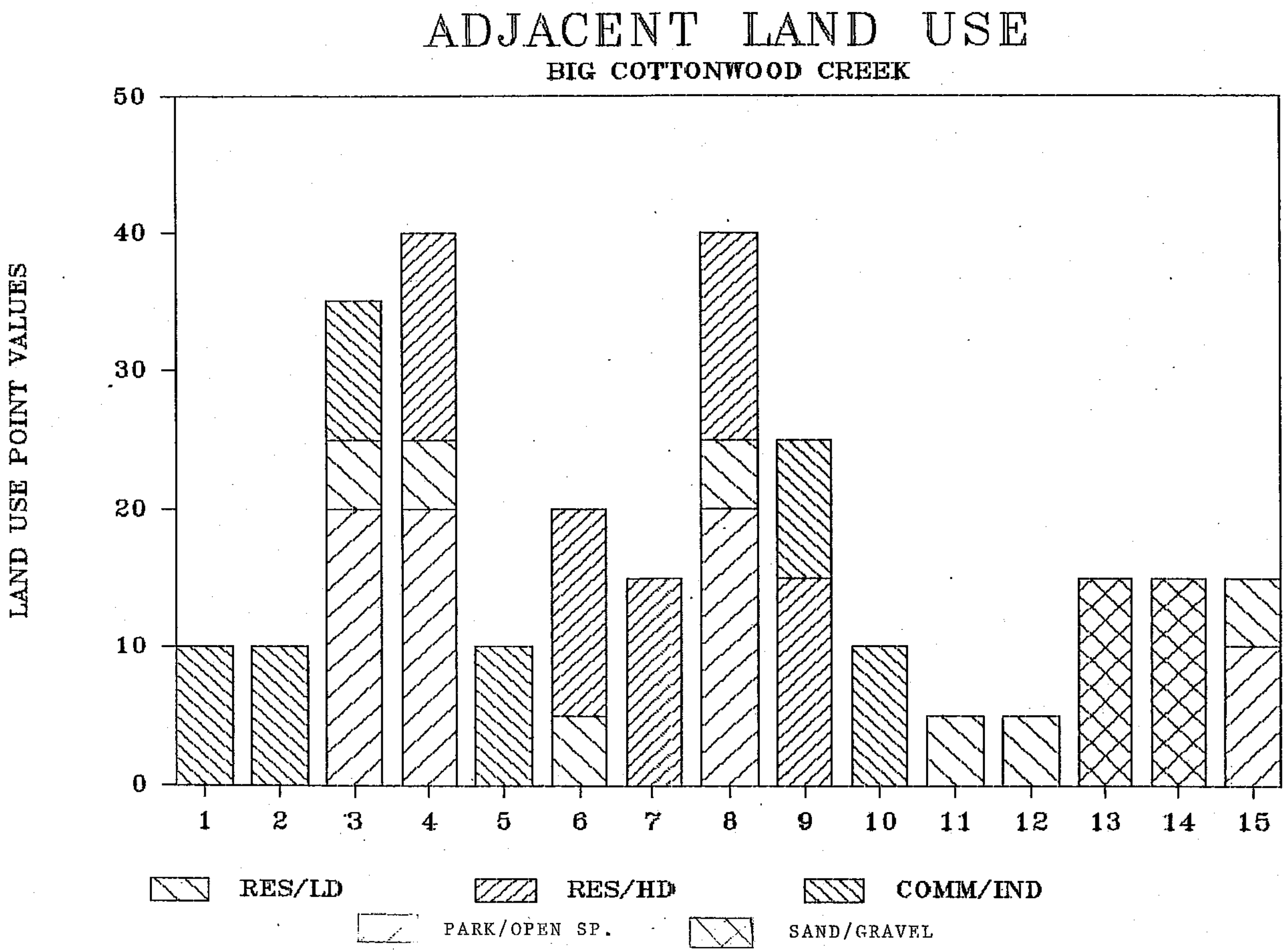

ADJACENT LAND USE
BIG COTTONWOOD CREEK
LAND USE POINT VALUES
0
10
20
30
40
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
RES/LD
RES/HD
COMM/IND
PARK/OPEN SP.
SAND/GRAVEL

FIGURE # 3-B

ADJACENT LAND USE

LITTLE COTTONWOOD CREEK

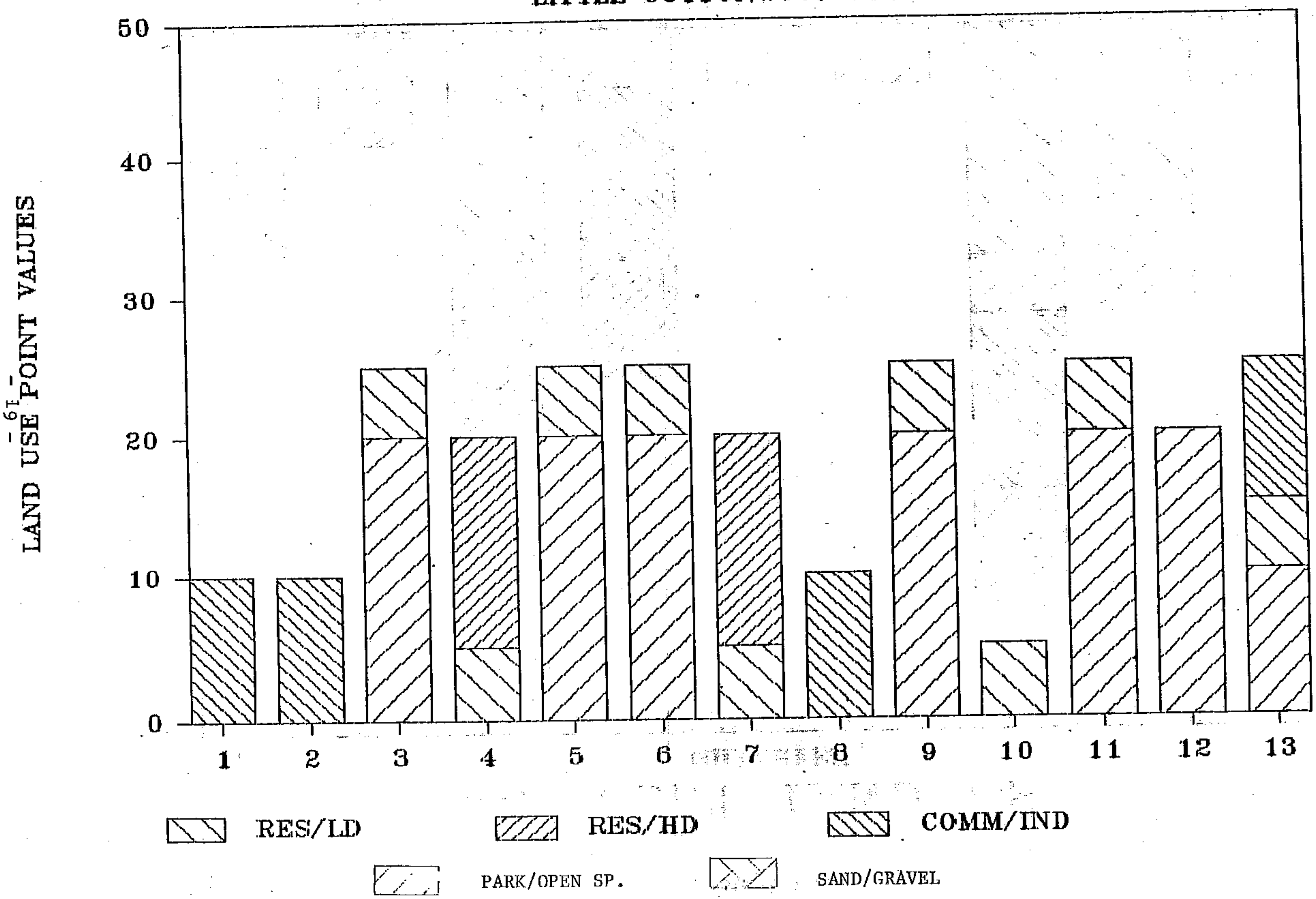
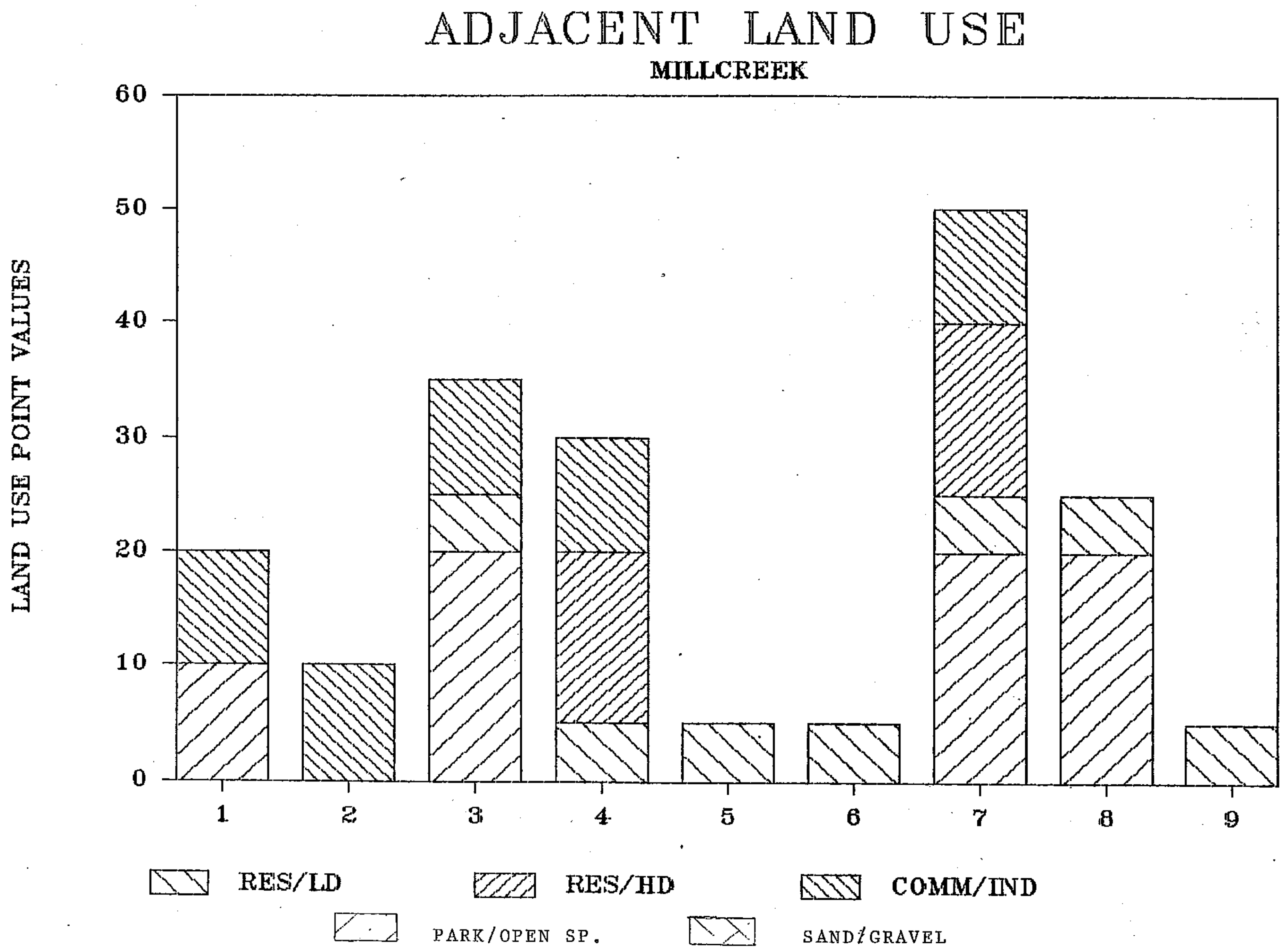


FIGURE # 3-C



ADJACENT LAND USE
MILLCREEK
LAND USE POINT VALUES
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
RES/LD
RES/HD
COMM/IND
PARK/OPEN SP.
SAND/GRAVEL

Riparian Characteristics.

1. Streamside Vegetation.[19] Expansive riparian vegetation, consisting of cottonwoods, willows, birch, tamarisk, Russian olive, dogwood, elderberry, serviceberry, or other native tree/shrub species is that which extends beyond the immediate streamside environment. A good example is the Walker Lane area near Big Cottonwood Creek (Highland Drive upstream to 3000 East). Aesthetic and diverse terrestrial wildlife values comprise an additional value to the recreationist. Such areas receive the highest point value.

Moderately dense vegetation extending only a few feet beyond the bank are credited with 25 points; Minimum vegetative cover streamside receives 10 points; and lack of substantive vegetative cover is pointless.

2. Fishery Production.[20] Stream segments known to produce trout (coldwater species requiring high dissolved oxygen and generally higher environmental quality) are credited with 10 points. Segments supporting mostly omnivores or warmwater fish (Carp, Sucker, Chubs, Dace, Sunfish, Bass, etc.) may indicate a reduced environmental condition for both water quality and riparian values (5 Points). Dewatered segments receive 0 points for fishery production.

Figure four summarizes those stream reaches possessing riparian vegetation and fishery production values.

FIGURE #4-A

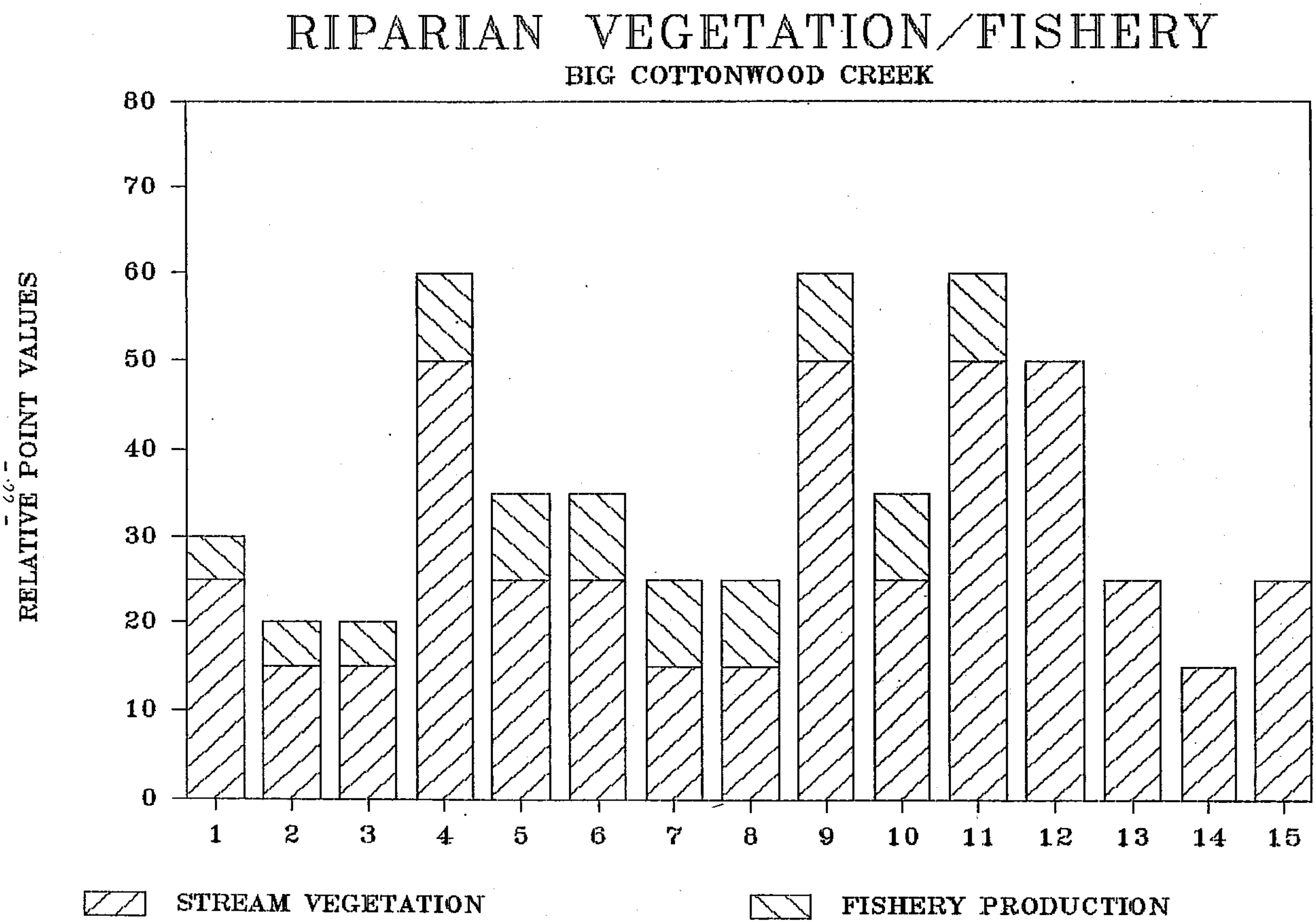

RIPARIAN VEGETATION/FISHERY
BIG COTTONWOOD CREEK
RELATIVE POINT VALUES
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STREAM VEGETATION
FISHERY PRODUCTION

FIGURE # 4-B

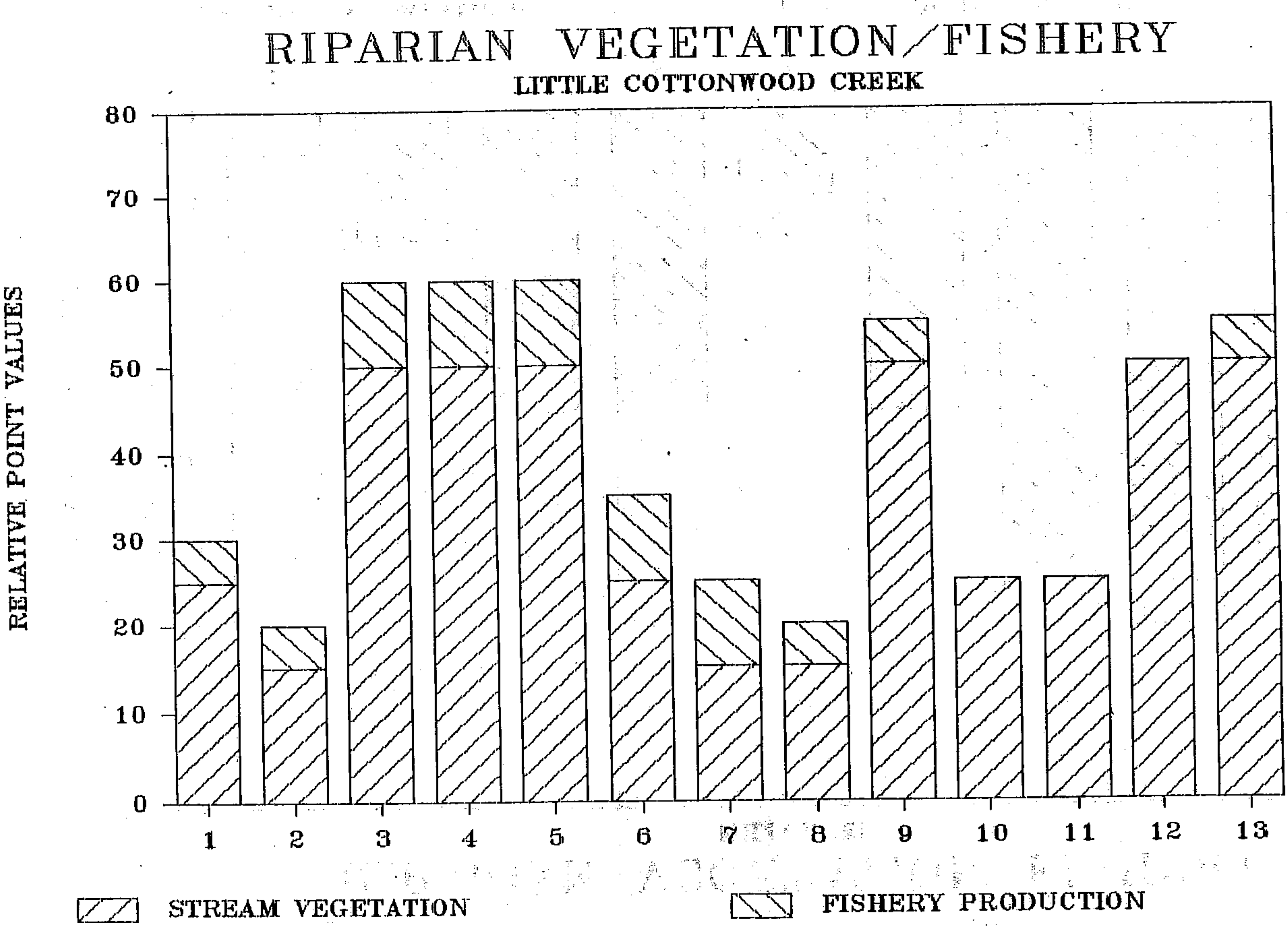
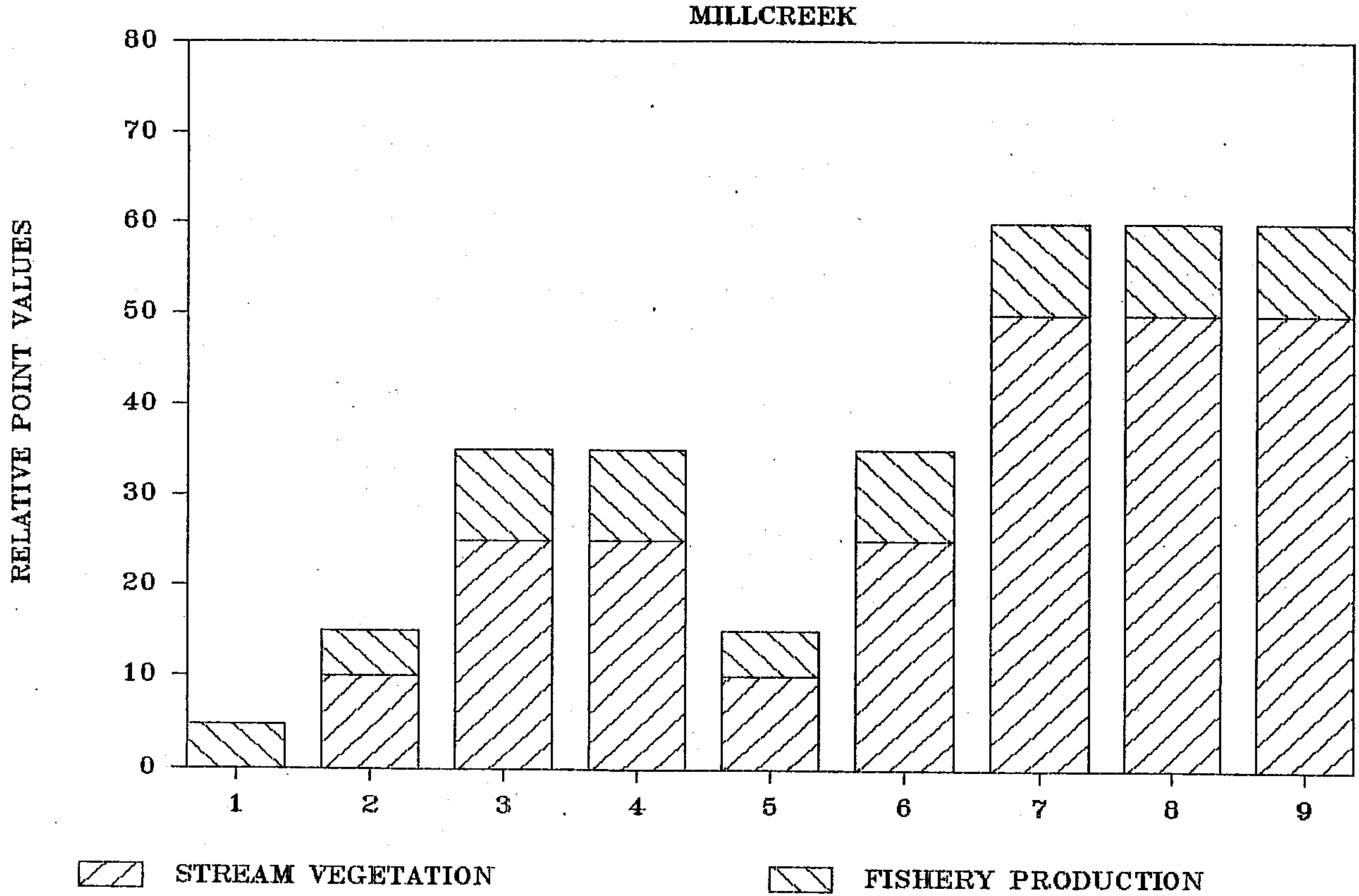

RIPARIAN VEGETATION/FISHERY
LITTLE COTTONWOOD CREEK
RELATIVE POINT VALUES
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
STREAM VEGETATION
FISHERY PRODUCTION

FIGURE # 4-C

RIPARIAN VEGETATION/FISHERY



PRIORITY RANKING OF STREAM REACHES

Tables one, two, and three summarize the point values allocated to each stream reach, while figure five shows the composite stream value totals for all three creeks combined.

Values are generally less at the lower reaches and at the extreme upper reaches. Management strategies for these extreme reaches should include a stepped-up effort toward non-point and point source pollution control on lower reaches, with instream flow measures implemented along upper reaches.

Point and non-point pollution control programs on the lower creeks should include a wide range of source controls including detention basins, bank stabilization, drop structures, artificial oxygenation, and measures to intercept street runoff in modified catch basins prior to discharge to creeks.

Instream flow measures on upper reaches should include construction of storage facilities to insure downstream flows during winter, purchase of water rights held by Salt Lake City or other water companies, or negotiation to lease minimum flows of 5 c.f.s. during off-peak seasons with provision to release the flows during winter.

Specific program implementation strategies for greenway acquisition are summarized in the following discussion

TABLE #2

AQUATIC HABITAT INVENTORY
RELATIVE STREAM REACH VALUES
BIG COTTONWOOD CREEK

WEIGHTING FACTORS	STREAM REACH BY STATION														
HYDROLOGY: QUANTITY/QUALITY															
1. Minimum Flows @ 5 c.f.s.	50	50	50	50	50	50	50	50	50	50	50	10	10	10	10
2. Seasonal Flows over 50 cfs	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
3. Flood Control Maintenance	10	10	30	10	10	30	10	20	40	50	30	40	40	40	30
4. Water Quality	10	10	10	40	50	50	50	50	50	50	50	10	10	10	10
5. Undeveloped Floodplain	0	0	10	20	0	0	0	20	0	0	0	0	20	20	20
6. Channel Stability Index	20	20	50	30	40	30	40	30	50	50	50	50	30	30	30
7. Stream Bottom Composition	10	10	30	50	50	50	50	50	50	50	50	50	50	50	30
8. Erosion Potential	30	30	30	20	30	40	40	40	20	50	50	50	30	30	30
LAND USE: ACCESS RESTRICTION															
1. Park/Open Space	0	0	20	20	0	0	0	20	0	0	0	0	0	0	10
2. Low Density Residential	0	0	5	5	0	5	0	5	0	0	5	5	0	0	5
3. High Density Residential	0	0	0	15	0	15	15	15	15	0	0	0	0	0	0
4. Commercial/Industrial	10	10	10	0	10	0	0	0	10	10	0	0	0	0	0
5. Sand & Gravel Excavation	0	0	0	0	0	0	0	0	0	0	0	0	15	0	15
RIPARIAN CONDITIONS															
1. Streamside Vegetation	25	15	15	50	25	25	15	15	50	25	50	50	25	15	25
2. Fishery Production	5	5	5	10	10	10	10	10	10	10	10	0	0	0	0
TOTAL COMPOSITE VALUE	190	180	285	340	295	315	300	345	365	365	365	285	250	225	235
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

* LOWER REACH * MIDDLE REACH * UPPER REACH *

TABLE #3

AQUATIC HABITAT INVENTORY
RELATIVE STREAM REACH VALUES
LITTLE COTTONWOOD CREEK

WEIGHTING FACTORS	STREAM REACH BY STATION												
HYDROLOGY: QUANTITY/QUALITY													
1. Minimum Flows @ 5 c.f.s.	50	50	50	50	50	50	50	50	30	30	10	10	30
2. Seasonal Flows over 50 cfs	20	20	20	20	20	20	20	20	20	20	20	20	20
3. Flood Control Maintenance	10	10	50	50	10	50	50	50	30	30	50	10	10
4. Water Quality	10	10	30	30	40	50	50	50	50	50	10	10	50
5. Undeveloped Floodplain	0	0	10	0	20	10	0	0	10	10	10	20	0
6. Channel Stability Index	20	20	20	30	20	40	40	40	30	30	40	40	30
7. Stream Bottom Composition	30	20	30	50	50	50	50	50	50	50	30	30	30
8. Erosion Potential	30	30	30	30	30	30	50	50	50	50	50	20	20
LAND USE: ACCESS RESTRICTION													
1. Park/Open Space	0	0	20	0	20	20	0	0	20	0	20	20	10
2. Low Density Residential	0	0	5	5	5	5	5	0	5	5	5	0	5
3. High Density Residential	0	0	0	15	0	0	15	0	0	0	0	0	10
4. Commercial/Industrial	10	10	0	0	0	0	0	10	0	0	0	0	0
5. Sand & Gravel Excavation	0	0	0	0	0	0	0	0	0	0	0	0	15
RIPARIAN CONDITIONS													
1. Streamside Vegetation	25	15	50	50	50	25	15	15	50	25	25	50	50
2. Fishery Production	5	5	10	10	10	10	10	5	5	0	0	0	5
TOTAL COMPOSITE VALUE	210	190	330	340	325	360	355	340	350	300	270	230	295
	1	2	3	4	5	6	7	8	9	10	11	12	13

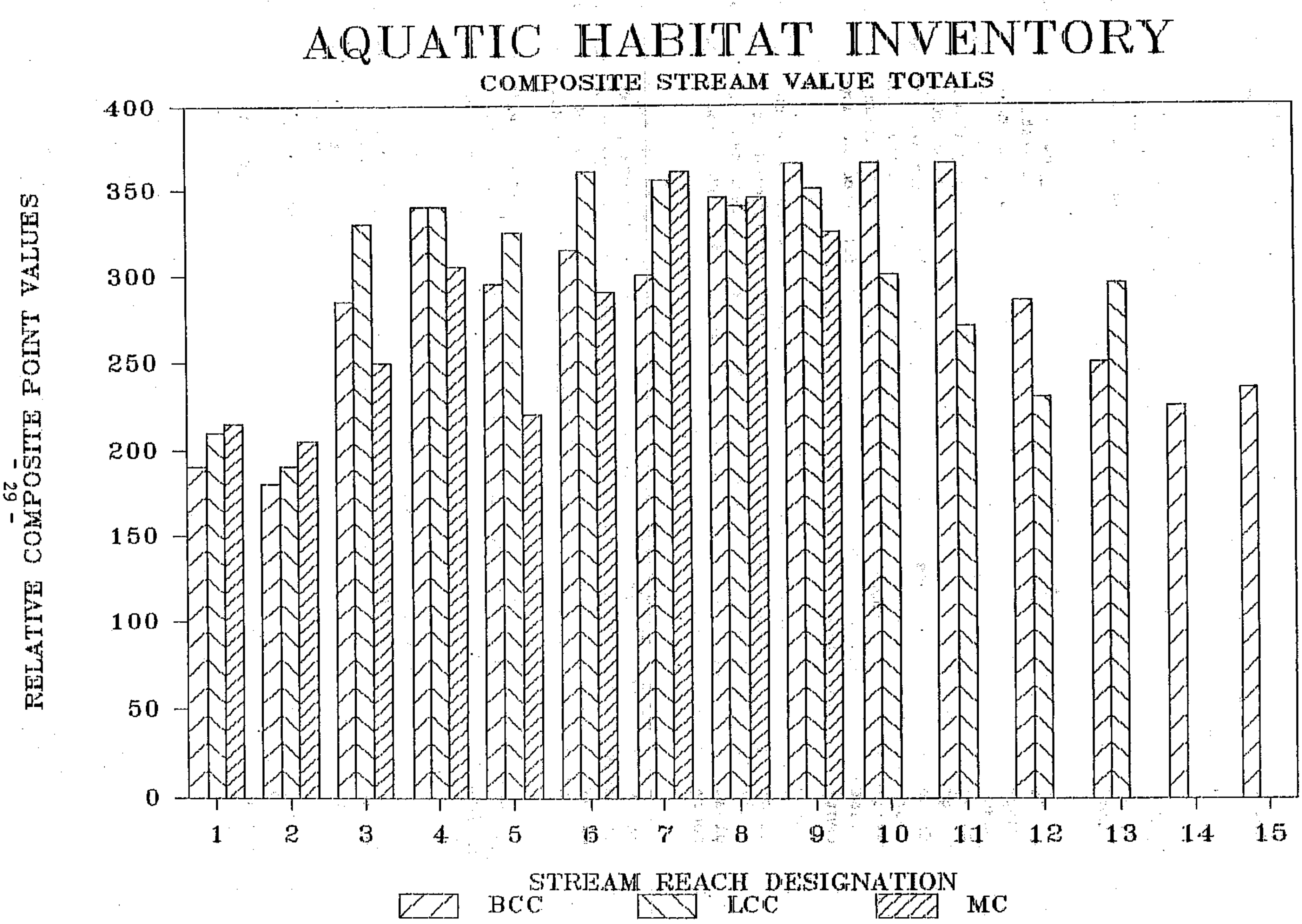
* LOWER REACH * MIDDLE REACH * UPPER REACH *

TABLE #4

AQUATIC HABITAT INVENTORY
RELATIVE STREAM REACH VALUES
MILLCREEK

WEIGHTING FACTORS	STREAM REACH BY STATION								
HYDROLOGY: QUANTITY/QUALITY									
1. Minimum Flows @ 5 c.f.s.	50	50	50	50	50	50	50	50	50
2. Seasonal Flows over 50 cfs	20	20	20	20	20	20	20	20	20
3. Flood Control Maintenance	10	10	20	20	30	50	50	50	50
4. Water Quality	10	10	10	30	50	50	50	50	50
5. Undeveloped Floodplain	10	0	0	0	0	0	0	0	0
6. Channel Stability Index	30	30	30	40	40	30	30	40	40
7. Stream Bottom Composition	10	10	10	50	50	50	50	50	50
8. Erosion Potential	50	50	40	30	50	50	50	50	50
LAND USE: ACCESS RESTRICTION									
1. Park/Open Space	10	0	20	0	0	0	20	20	0
2. Low Density Residential	0	0	5	5	5	5	5	5	5
3. High Density Residential	0	0	0	15	0	0	15	0	0
4. Commercial/Industrial	10	10	10	10	0	0	10	0	0
5. Sand & Gravel Excavation	0	0	0	0	0	0	0	0	0
RIPARIAN CONDITIONS									
1. Streamside Vegetation	0	10	25	25	10	25	50	50	50
2. Fishery Production	5	5	10	10	5	10	10	10	10
TOTAL COMPOSITE VALUE	215	205	250	305	220	290	360	345	325
	1	2	3	4	5	6	7	8	9
	* LOWER REACH			*MIDDLE REACH*			UPPER REACH *		

FIGURE #5


AQUATIC HABITAT INVENTORY
COMPOSITE STREAM VALUE TOTALS
RELATIVE COMPOSITE POINT VALUES
400
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STREAM REACH DESIGNATION
BCC
LCC
MC

III. CONSERVATION STRATEGY & ALTERNATIVES.

Strategies have been previously summarized in the Valley Tributary Assessment.[1] Of numerous programs available for greenway implementation, a few offer greater advantages. Within federal authority, the programs most applicable to valley streams are:

1. The Corps of Engineers Section "404" program which is overseen by EPA. This is probably the most effective tool for controlling effects of development and in-stream activities. Requires permits & extensive opportunity for inter-agency and public review.

2. Environmental Protection Agency NPDES Regulations which require individual permits of stormwater discharges. This regulation requires implementation of "Best Management Practices" by 1987 to meet effluent discharge permits for stormdrains dumping into protected streams, and appears to be the primary regulation that would govern non-point pollution control programs as well. All three valley creeks are protected for coldwater fisheries, which require more stringent water quality standards to be met. Best Management Practices most often employed are detention basins that settle incoming sediment and trap flotable material such as trash and oil & grease, together with development requirements for erosion and sediment control during construction.

Several detention basins have been planned, with three on Millcreek alone. However these are mostly "On-Line" basins constructed directly on the creek for flood purposes. Basin design is being integrated with wetland planting that will enhance riparian values and provide new kinds of passive recreation and educational opportunities.

3. Floodplain Ordinances (FEMA) require development to be set back so as not to infringe on designated floodways. In many cases these floodways go to the existing stream bank, but in every case restrict the type of development allowed within the floodplain. Development cannot encroach so as to produce a cumulative one foot or more rise in the design flood water elevation.

Figure seven indicates the location of basins-both existing and proposed-that offer enhancment of riparian resources, and downstream stabilization. Most of the basins are being constructed with provision for recreational use, either passive or active.

The most beneficial state programs include:

1. Application of the "Historic High Water Mark" doctrine that asserts ownership of streams up to the historic high water mark on the banks. This mark includes, in some cases, extensive floodways off the main stream, and should be used in coordination with FEMA floodplain identification procedures. The principal criteria for applying this doctrine is "avulsion" or how the stream changes. Sudden catastrophic changes in the bed would result in state maintaining streambed ownership. If the change is gradual, original ownership moves where the stream moves. This program is administered by the State Land Board.

2. The Jordan River Parkway Program. Recent state legislation provides for the establishment of urban greenways and/or parkways where conservation or hazard easements are identified. Under this program, some funds are available to restore flood damage and to enable the acquisition of permanent easements in such areas. The program is under the administration of State Parks & Recreation, and also provides for donation of property to the state for parkway implementation. Where parkway interests are identified, the state will provide a 50/50 capital improvement match for park-related facilities.

3. Acquisition of critical habitat by the State Division of Wildlife Resources requires that strict criteria be met. Usually it involves a biological resource of statewide interest or one identified on the Endangered Species list. Funds must be appropriated by the State Legislature for specific habitats.

The most promising local strategies that have been successfully used include:

1. Land Use Policies such as zoning or conditional use setbacks. These opportunities exist only for new development, and offer few advantages for present land use patterns. But for new streamside development, planning commissions have broad discretionary authority to restrict construction within the riparian corridor. Planned Unit or cluster development offers many chances to group open spaces in and around natural amenities.

Stipulation of open space corridors in Restrictive Covenants has been used, together with dedication where a direct public benefit can be shown to accrue from the development, or where the development places new burden on public services.

2. Flood Control Bank Stabilization Programs are often administered on a cost-share basis, with the landowner paying 50% of the cost. Stabilization consists of either: A. Structural stabilization, or B. Revegetation.

Rip-rap or gabion construction reduces the expensive need to dredge streams annually and improves biological productivity-so long as riparian values are conserved. Needless destruction of streamside vegetation often occurs, but may be mitigated with revegetation or tree planting.

Where revegetation has been neglected, or trees removed, local interest group programs can invest time and dollars into donation and planting of natural streamside plant species. All participants in streambank stabilization should invest some effort into native plant revegetation.

Emphasis should be placed on the conservation of trees and native vegetation during construction of streambank stabilization projects.

Figure Six indicates the percentage of stream segment length that has been stabilized to date as a result of flood control bond restoration or 50/50 program implementation, and figure seven compares stability completed to that remaining. This forms the basis for estimating future stabilization priorities.

3. Easements. Most easements obtained to date along creeks are flood control easements to provide access to bank improvements. Easements are almost always used in conjunction with bank stabilization activities. Connection of these easements can provide extensive trail or access opportunities. Expanding the flood easement function to recreation purposes may require the use of: A. Trade or exchange agreements, or B. The use of fee title purchase or leases. Trade/Exchange agreements are typically used for new development, where existing areas and ownership may be more suited toward leasing or purchase.

FIGURE #6

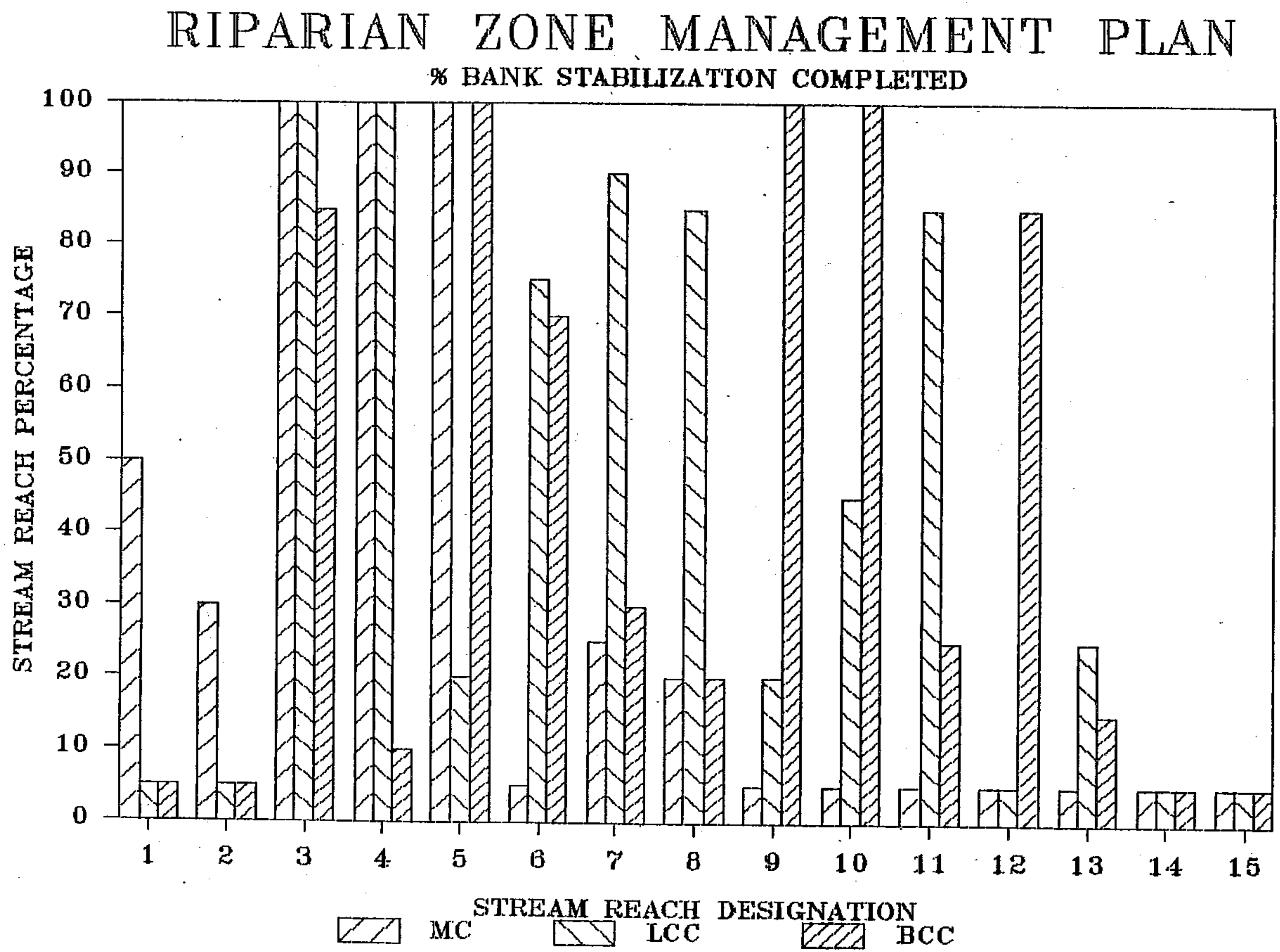

RIPARIAN ZONE MANAGEMENT PLAN
% BANK STABILIZATION COMPLETED
STREAM REACH PERCENTAGE
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STREAM REACH DESIGNATION
MC
LCC
BCC

FIGURE #7-A

STABILITY COMPLETE VS REMAINING

LITTLE COTTONWOOD CREEK

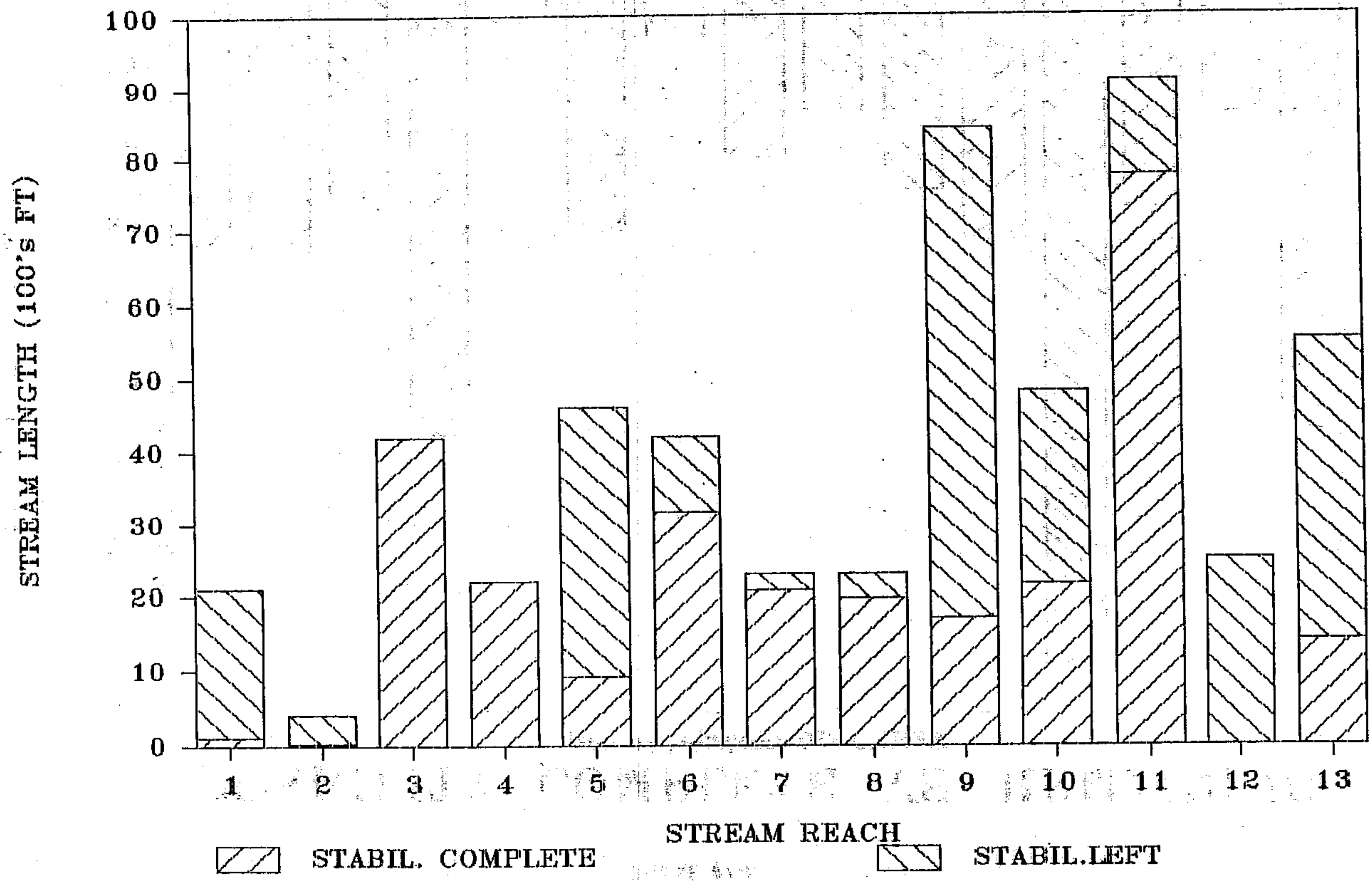


FIGURE #7-B

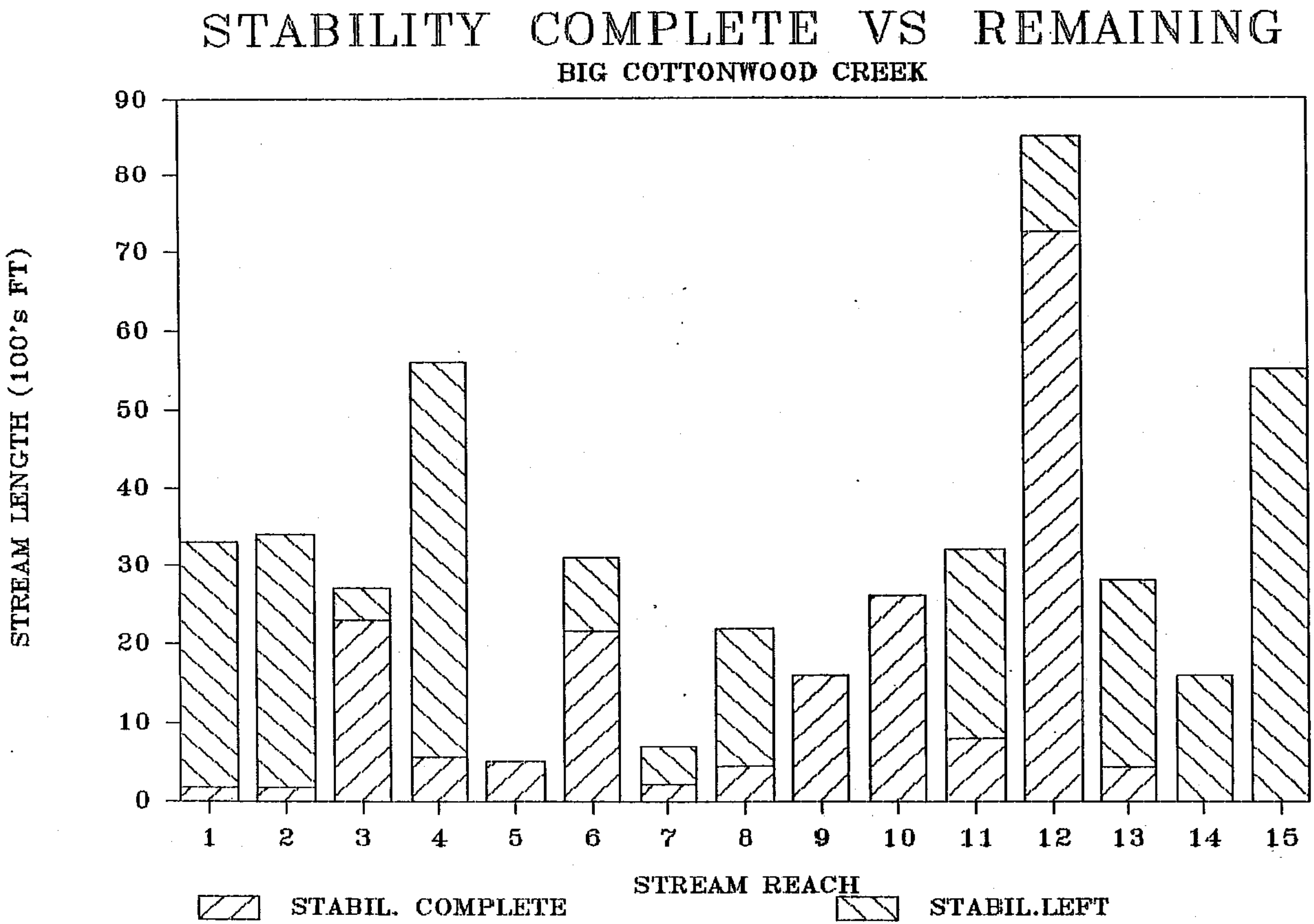
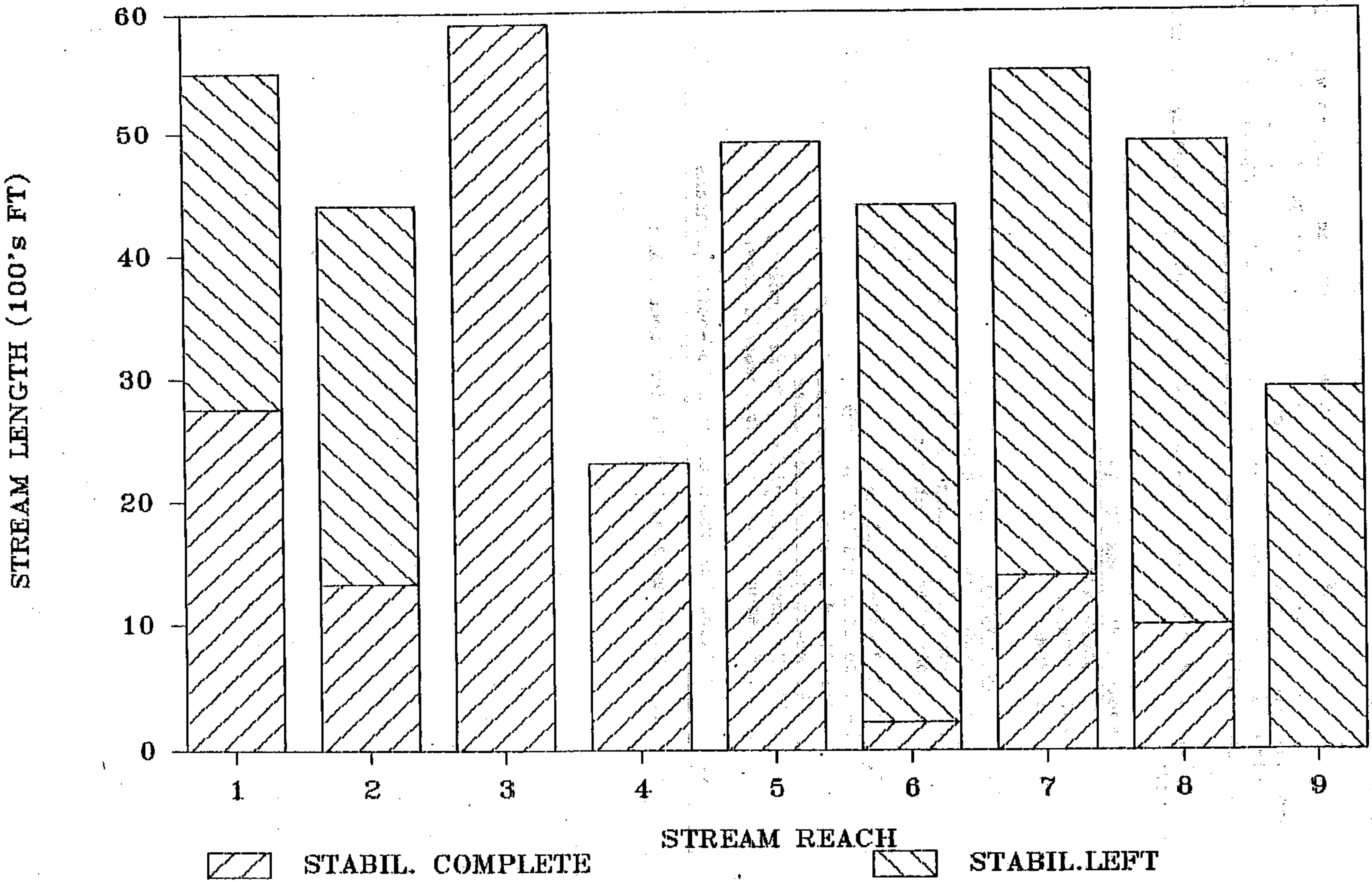

STABILITY COMPLETE VS REMAINING
BIG COTTONWOOD CREEK
STREAM LENGTH (100's FT)
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STREAM REACH
STABIL. COMPLETE
STABIL.LEFT

FIGURE #7-C

STABILITY COMPLETE VS REMAINING

MILLCREEK



STREAM SEGMENT STRATEGIES

Figure Seven identifies each stream segment according to which individual or set of strategies should be used to acheive greenway or riparian zone conservation. Strategies are prioritized according to need, i.e. based on composite stream values, segment length, and segments still requiring structural stabilization (based on stream stability index).

Strategies are coded according to the level of authority and the specific method:

1. Federal Programs (F) 1-3.
   F-1: Corps 404
   F-2: NPDES/BMP
   F-3: FEMA

2. State Programs (S) 1-3.
   S-1: High Water Mark Doctrine
   S-2: Parkway Foundations
   S-3: DWR Critical Habitat

3. Local Programs (L) 1-3.
   L-1: Conditional Use Setback
   L-2A: Flood Control Structural Improvement
   L-2B: Revegetation/Tree Conservation
   L-3A: Easement Acquisition: Trade/Exchange
   L-3B: Easement Acquisition: Lease/Purchase

4. NPS: Water Pollution Control Non-point programs

5. ISF: Instream Flow Negotiation/Procurement

FIGURE #8-A

STREAM SEGMENT CONSERVATION STRATEGY--BIG COTTONWOOD CREEK.

Opportunities for conservation strategies are based on hydrologic, land use, and riparian characteristics. The number of strategies applicable may provide a prioritization for stream reaches possessing the greatest conservation assets to the community. Upstream and downstream reaches require instream flow and increased pollution control efforts, while mid-reaches possess excellent conditions requiring careful conservation efforts.

CODE	STREAM REACH: BIG COTTONWOOD CREEK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
F-1	X			X				X						X	X
F-2	X	X	X	X	X		X					X	X	X	X
F-3	X			X				X				X			X
S-1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
S-2	X			X									X	X	X
S-3	X			X				X			X	X	X	X	X
L-1	X			X		X							X	X	X
L-2A	X	X		X		X		X					X	X	
L-2B	X			X	X	X			X	X	X	X	X	X	X
L-3A	X			X		X							X	X	X
L-3B		X	X		X		X	X	X	X	X	X			
NPS	X	X		X				X		X			X	X	X
ISF												X	X	X	X
TOTAL	11	5	3	11	4	5	3	7	3	4	4	7	10	11	11

FIGURE #8-B

STREAM SEGMENT CONSERVATION STRATEGY--LITTLE COTTONWOOD CREEK.

Opportunities for conservation strategies on this creek should focus on instream flow augmentation on upper reaches, together with pollution control efforts below 900 East. Stream setbacks have been successfully employed along developing reaches and should be continued.

CODE	STREAM REACH: LITTLE COTTONWOOD CREEK												
	1	2	3	4	5	6	7	8	9	10	11	12	13
F-1	X		X		X			X	X				X
F-2	X	X	X	X	X	X	X	X					X
F-3	X				X				X				
S-1	X	X	X	X	X	X	X	X	X	X	X	X	X
S-2	X	X	X	X	X	X			X	X	X	X	X
S-3						X			X	X			X
L-1	X				X				X	X			X
L-2A	X				X				X	X			X
L-2B	X	X			X	X	X	X	X	X	X	X	X
L-3A	X				X			X	X	X			X
L-3B		X	X	X		X					X	X	
NPS	X	X	X	X	X	X		X	X				X
ISF										X	X	X	X
TOTAL	10	6	6	5	10	7	3	6	10	8	5	5	11

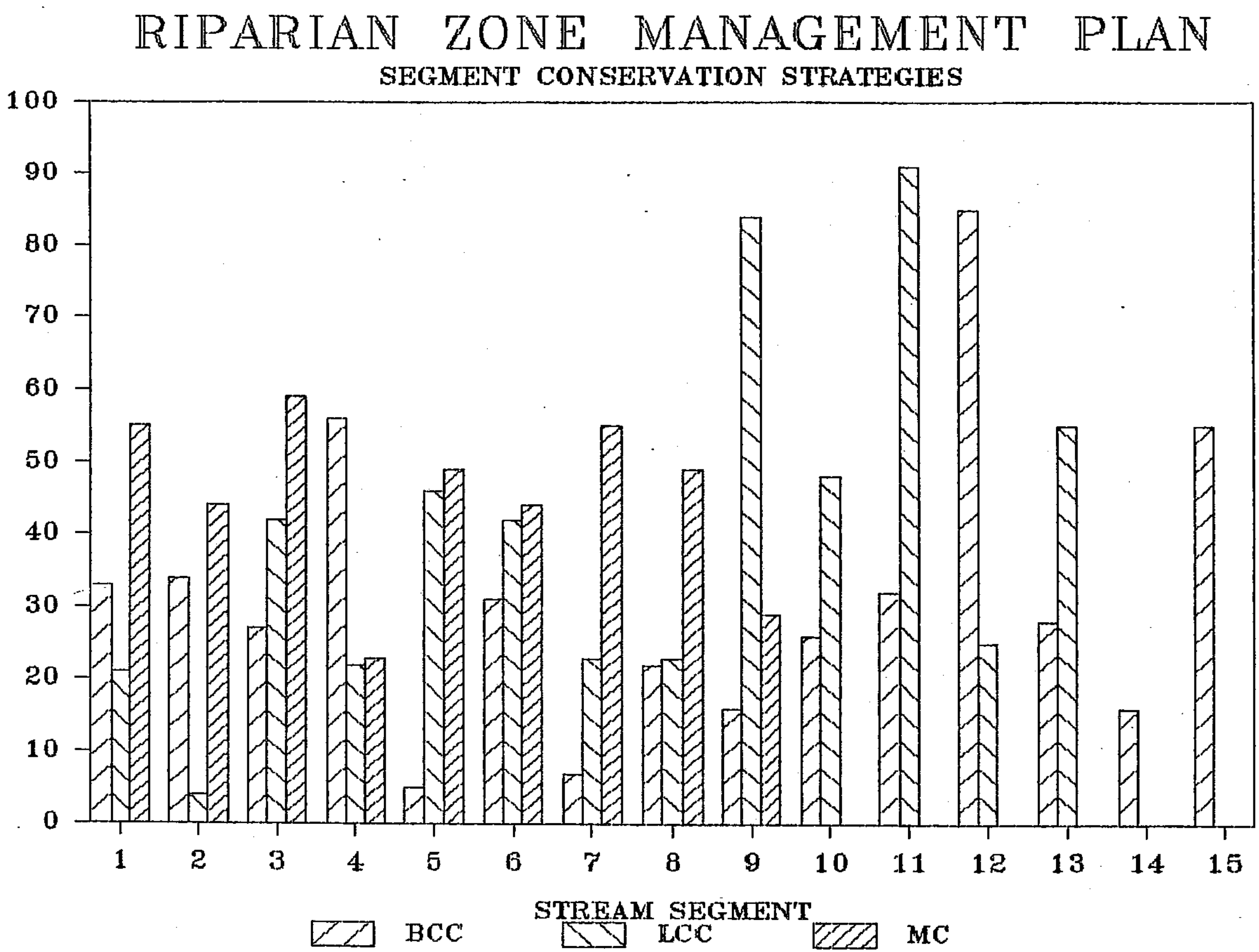
FIGURE # 8-C

STREAM SEGMENT CONSERVATION STRATEGY--MILLCREEK.

Millcreek is very unique in the level of both disturbed and undisturbed reach characteristics. It is also closest to optimum conservation attainability. Lower stream reaches still require additional pollution control effort.

CODE	STREAM REACH: MILLCREEK								
	1	2	3	4	5	6	7	8	9
F-1	X		X	X					
F-2	X	X	X	X		X	X		
F-3									
S-1	X	X	X	X	X	X	X	X	X
S-2	X	X	X	X				X	
S-3			X	X					
L-1	X		X		X				X
L-2A	X	X			X	X	X	X	X
L-2B	X	X	X	X		X	X	X	X
L-3A	X			X					
L-3B		X	X		X	X	X	X	X
NPS	X	X	X	X	X	X	X	X	X
ISF									
TOTAL	9	7	9	8	5	6	6	6	6

FIGURE #9



RIPARIAN ZONE MANAGEMENT PLAN
SEGMENT CONSERVATION STRATEGIES
SEGMENT LENGTH (100'S FT.)
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
STREAM SEGMENT
BCC
LCC
MC

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[20]Utah State Department of Natural Resources, Fishery Inventory and Classification for Big Cottonwood, Little Cottonwood, and Mill Creeks in Salt Lake County, by Blaine Dabb et.al., Division of Wildlife Resources, 1973-75.