City of Austin Riparian Zone Restoration Site Prioritization
SR-12-13, August 2012

Alex Duncan, Staryn Wagner, Mateo Scoggins

City of Austin
Watershed Protection Department
Environmental Resource Management Division

Abstract

Riparian zone restoration is a commonly applied management strategy designed to improve water quality and quantity in the streams of the City of Austin. In order to maximize ecological benefits at the least economical cost it is imperative to accurately prioritize sites in need of restoration. By combining current literature recommendations with field investigation and verification, the City of Austin Watershed Protection Department (WPD) has developed a riparian restoration site selection framework. Results suggest that combining regional water quality and biological data with site specific evaluations of existing soil and vegetation composition is an appropriate method for allocating restoration resources. Due to the small budget, large size, and public land status of most WPD riparian restoration projects, stakeholder support has also been identified as a key component in guiding site selection. Without the ability to pragmatically and objectively select sites to receive riparian restoration there is a risk of losing internal and external support for this important ecological solution.

Introduction

The City of Austin Watershed Protection Department Environmental Resource Management Division (WPD) has recently expanded focus to include more proactive solutions that address water quality and quantity concerns. Meehan et al. (1977), Swanson et al. (1982), Gregory et al. (1991), and Kaufmann et al. (1997) describe the riparian zone as a three dimensional interaction between the physical, chemical, and biological constructs of the aquatic and terrestrial environment that play a vital role in providing essential ecosystem services. Healthy riparian buffers function to store and filter water, minimize erosion, reduce flooding, provide wildlife habitat, and provide an aesthetic amenity to the community. With proper pre-site evaluation and monitoring the City of Austin will be able to promote maximum ecosystem function through riparian restoration at reduced economic cost.

Site Selection

When selecting sites to receive riparian restoration it is critical to adopt a systematic, transparent approach that is both fair to the community and a sensible use of city resources. The WPD approach combines regional water quality data with a GIS-scale review and then site specific evaluations, and finally stakeholder involvement. The specific steps involved in selecting a site are as follows:

1. Environmental Integrity Index (EII) problem score data is used to identify watershed reaches that are in need of riparian restoration. A high need reach is determined as having poor water quality, sediment stability, and riparian vegetation scores. These three scores are compiled to obtain an overall reach score ranging between 0-300 (Table 1). A score of 300 would be considered highest priority for riparian restoration.

2. Once high priority reaches have been selected a GIS exercise is performed to select potential city owned properties within the identified reach that may be suitable for restoration (Table 1). Available land area and existing riparian vegetation is used to select appropriate sites.
3. Once locations have been mapped, Riparian Site Evaluations are performed to identify if restoration is warranted and feasible. On-site evaluations combine channel measurements (entrenchment ratios), soil compaction and moisture, riparian zone width, and vegetation structure, composition, and hydrologic associations (Table 2). These variables are then compiled to obtain an onsite score ranging between 0-30. Sites that receive a score of 15 or below are considered a high priority for riparian restoration.
4. Finally, WPD staff consider if any stakeholder support has been expressed, or there are organized groups who would be interested in riparian restoration. Stakeholder support is vital for the success of these restoration projects. Steps to build partnerships with existing groups or encouraging new members to take an interest should be taken before any restoration activities are scheduled. Priority will be given to sites that have established and organized groups able to provide volunteer hours to the restoration effort. With the small budget and large educational impact of these projects, volunteer effort and support is critical.

Table 1: Initial restoration site evaluation score. Calculation based on most recent City of Austin Environmental Integrity index (EII) data. Combines EII reach riparian, stability, and water quality (WQ) scores to identify regional restoration priorities.

Site Name	EII Reach	No mow Acres	Rip Veg	Stability	WQ	Overall Score	WQ CIP Priority
Bartholomew Park	TAN3	5.55	94	91	100	**285**	Very High
Dottie Jordan	LWA1	0.91	44	95	69	**208**	High
Gillis Park	EBO2	0.23	97	52	58	**207**	Very High
Blunn @ Terrace	BLU2	2.32	80	49	59	**188**	Moderate
Tarrytown Park	JOH1	0.17	90	56	37	**183**	High
Boggy @ 10th	BOG1	1.2	82	59	39	**180**	Moderate
Commonsford Park	CMF	6.56	70	57	52	**179**	Moderate
Givens Park	TAN1	3.82	52	65	56	**173**	Very High
Battle Bend	WMS2	0.38	79	52	36	**167**	Low
Shoal @ Shoal Edge	SHL3	3.5	52	52	62	**166**	Moderate
Buttermilk Greenbelt	BMK2	0.43	100	54	7	**161**	Very High
Reed Park	TYS1	0.95	36	43	45	**124**	Low
Dittmar Park	SBG2	2.38	19	65	30	**114**	Moderate
Northstar Green Belt	WLN4	1.72	44	36	32	**112**	Low
Robert E. Lee Trib	BAR1	1.52	46	11	39	**96**	Low
Bull District Park	BUL2	2.58	0	0	35	**35**	Low

Restoration Methods

Completion of the Site Evaluation field sheet (Appendix 1) will assist in determining the type of restoration that should be implemented. Being able to accurately diagnose a potential restoration site prior to implementation can increases chances of success and lower project costs (Holl and Aide 2010). Establishment of passive grow zones is recommended for sites where a rare natural disturbance event (extreme flood, drought, excessive rain, disease, etc) has occurred or where a temporary (e.g., construction) or easily modified (e.g. mowing) human disturbance has taken place (Duncan 2012). Often altering or removing a management disturbance may set an ecosystem on a successional trajectory towards improved ecosystem function (Kauffman et al. 1997). Active restoration (e.g. revegetation) is recommended for degraded sites where the primary disturbance is naturally reoccurring or a human alteration that the community is unable or unwilling to remedy (Duncan 2012).

The following are types of riparian restoration projects currently in use by WPD:

a. Grow Zones – This method can work as a complete technique or a precursor to a more active approach. Simple and cost effective, it involves changing the maintenance practice to exclude mowing in an area adjacent to a stream. This enables the natural process of restoration to occur. The result will be limited to the plants that are already established and whatever seed stock is naturally available.
    i. This option is ideal when there are few resources available and the ability of the riparian zone to support plantings is low.

b. Riparian Revegetation – When conditions dictate that a more active approach to revegetation is required, containerized plants (transplants) and seeding with a temporary irrigation system will be installed.
    i. This option is desirable when the hydrology, hydraulics and geomorphology are all functional or incapable of being altered. There also need to be resources and infrastructure available to keep transplants alive. It also helps to have an active community with an interest in seeing the plant community prosper in this location.
    ii. The planting plan is based on the eco-region of the stream reach and limitations may be imposed by flood restrictions or neighborhood desires. When possible a three tiered plant scheme is assembled including native grasses and wildflowers, understory trees and canopy trees.

c. Active Channel Alteration – In some situations where there appears to be sufficient baseflow year round it is possible to expect good results from a stream bank and bottom alteration. This method would include adding grade control structures, meanders, riffle/run/pool units, multiple flood stages, and vegetation to the reach.
    i. This option fits where stream channel erosion has stabilized but left the banks steep and incised, hydrology to the stream reach includes a source of baseflow and the disturbance will not significantly set back the natural successional process of the established vegetation.
    ii. Stream channel alterations are based on hydrology and hydraulics within the reach.

The following are beneficial environmental impacts associated with the above restoration methods:

- Thicker, taller, healthier vegetation
    - Increases groundwater infiltration
    - Reduces suspended solids
    - Reduces water temperature
    - Reduces erosion
    - Improves biotic conditions
    - Creates wildlife habitat
- Woody debris in channel
    - Creates pools for water storage
    - Construct stream functional units (riffle, run, pool)
- Bank modification
    - Create multiple stage channel
    - Increase hydrostatic pressure in soil
    - Improve benthic substrate/instream habitat

- Maintenance Modification
    - Reduction in amount of mowing
    - Change to more specialized landscaping methods (edge mowing, manual weed control, mulching, etc.)
- Improved Hydraulics
- Denitrification
- Reduction in atmospheric carbon
- Lowered heat island effect

Cost Estimate

Costs will vary based on the type of restoration performed. Passive restoration such as the Grow Zones that have been implemented in parks are low cost. Passive approaches often are coupled with some active planting in the form of seedlings and native grass and wildflower seeds, which can be done for approximately $300-$800 per acre.

When a full planting occurs that includes an irrigation system and longer-term maintenance, the cost is estimated at $40,000 per acre. If there are going to be infrastructure changes or channel work then the costs will go up based on scope of work.

Outreach

The Watershed Protection Department supplies a range of technical, outreach and material support to all partner stakeholders. These groups include neighborhood associations, Parks and Recreation Department staff, the Field Operations Division (WPD), Keep Austin Beautiful (KAB), the Austin Parks Foundation, The Trail Foundation (TTF), People Organized in Defense of EaRth (PODER), surrounding businesses, service groups, University of Texas classes, Capitol Area Master Naturalists and anyone else that requests information.

Results

A total of 1,330 City of Austin parcels comprising 45,850 acres and located within 50 ft. from a stream channel were analyzed using Geographic Information System (GIS) software. Each parcel was scored using City of Austin Environmental Integrity Index (EII) problem score (water quality, sediment stability, and riparian vegetation scores) and existing riparian vegetation. Adjacent parcels were combined to form sites and a GIS assessment of vegetation cover and land availability was performed. Sites consisting of reduced vegetation cover (≤ 40% canopy cover) that had minimal bordering infrastructure (houses, roads, utility easements, etc…) and appropriate land area to perform restoration (≥ 25 ft. from bank of stream) were selected as potential riparian restoration locations. A total of 82 sites fit the above mentioned criteria (Appendix B). Sixteen of the 82 selected riparian locations were agreed upon by the Watershed Protection and Parks and Recreation Departments to receive riparian zone restoration (Table 1). These 16 locations then received on site evaluations of entrenchment ratios, soil compaction and moisture, riparian zone width, and vegetation structure, composition, and hydrologic associations. These on-site values were combined with EII water quality and diatom data and nine field measured values to generate an overall priority score (Table 2). Scores between 0-7 received a ranking of poor, 8-15 receive a marginal ranking, 16-22 receive a suboptimal ranking, and scores ≥ 23 receive a ranking of optimal. The majority of current sites (12 out of 16) scored in the Marginal or lower ranking and are thus considered a restoration priority. Tarrytown, Commonsford, Northstar, and Bull District Parks ranked in the suboptimal category and should be considered a lower priority for riparian restoration. However, due to stakeholder interest and education and outreach opportunities and relatively low cost, these parks should remain in the Riparian Zone Restoration Program. The site evaluation protocol will likely be routinely updated as additional data and site evaluation information is gathered.

Table 2: Site Evaluations for current City of Austin Environmental Resource Management Division riparian restoration sites. WQ = EII water quality score, DI = EII diatom Index, E = entrenchment ratio, C = soil compaction, M = soil moisture, RW = riparian zone width, VC = vegetation cover, DT = dominant tree, IC = invasive cover, HP = hydrophytic plants.

	WQ	DI	E	C	M	RW	VC	DT	IC	HP	Overall
Gillis Park	1	2	0	0	0	0	2	2	2	2	**11**
Robert E. Lee Trib	2	3	3	0	0	0	0	0	3	0	**11**
Dottie Jordan	2	3	0	0	2	0	1	1	1	2	**12**
Buttermilk Greenbelt	2	3	2	1	1	0	0	0	3	0	**12**
Dittmar Park	2	2	1	0	2	0	2	1	0	2	**12**
Boggy @ 10th	2	3	0	0	1	0	2	1	3	1	**13**
Shoal @ Shoal Edge	2	2	1	0	0	0	2	2	1	3	**13**
Bartholomew Park	2	3	1	0	1	0	1	1	3	2	**14**
Givens Park	2	3	2	0	1	0	1	3	1	1	**14**
Blunn @ Terrace	2	3	0	0	1	0	2	2	2	2	**14**
Reed Park	2	2	2	0	0	0	2	0	3	3	**14**
Battle Bend	3	3	3	0	0	0	1	1	2	2	**15**
Tarrytown Park	1	2	3	0	2	0	2	1	3	2	**16**
Commonsford Park	3	3	3	1	2	0	1	2	3	2	**20**
Northstar Green Belt	2	3	3	0	3	0	1	3	3	2	**20**
Bull District Park	2	3	3	3	3	0	2	1	3	2	**22**

Conclusions

WPD has developed a systematic, transparent approach for prioritizing riparian zone restoration projects throughout the City of Austin. By combining citywide Environmental Integrity Index data with local site evaluations and stakeholder interest, this system provides an objective assessment of restoration opportunities. This approach is designed to maximize improvements to ecosystem function at the least economic cost by focusing restoration resources on the most environmentally degraded locations.

Recommendations

1. Incorporate the above methodology for ranking all future riparian zone restoration projects.
2. Routinely update the site evaluation data sheet as additional data and evaluation information become available.
3. Develop a more quantifiable approach to ranking stakeholder interest.

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Appendix A.

CITY OF AUSTIN RAPID RIPARIAN FUNCTIONAL ASSESSMENT

SITE EVALUATION

Site Location:	Date:	Time:	Staff:

Photos:

Stakeholder Interest: Yes/ No **Info/ affiliation:**

Additional site info:

1. Water Quality– Record the most recent City of Austin Environmental Integrity Index (EII) Water Quality score for the associated reach on the Scoresheet.

Reach:______________________________ **Water Quality Score:**_____________________________________

2. Diatom Index- Record the most recent City of Austin Environmental Integrity Index (EII) Diatom Index score for the associated reach on the Scoresheet.

Reach:______________________________ **Diatom Index Score:**_____________________________________

3. Entrenchment- Throughout the entire stream reach measure channel entrenchment; once in the upper, middle, and lower section of the reach. The entrenchment ratio is determined by dividing the width of the flood prone area (F) by the bankfull width (B). The flood prone area is defined by measuring the width of the channel at twice bankfull depth. Depth should be taken at the stream thalwag (T) (deepest section of the channel). Bankfull corresponds to the start of the floodplain and is indicated by a break in slope from the channel, a change in vegetation from bare surfaces or annual wetland species to perennial water-tolerant or upland species, and from a change in the size distribution of surface sediments.

Upper	Middle	Lower	Site Average
B_______T_______F_______	B_______T_______F_______	B_______T_______F_______	________

4. Soil Compaction– In the center of each vegetation sampling plot (see #7) take three soil compaction measurements. Measurements should be taken approximately 15 ft from the stream bank using a soil penetrameter. Apply even downward pressure on both handles of the penetrameter to keep the shaft and tip penetrating the soil at a slow even pace. The tester shaft is marked at three inch intervals for easy depth measurement. As the tester's shaft penetrates the soil, the gauge reading at the 3 inch depth should be recorded (be sure to use the correct scale for the size tip that you are using as indicated on the dial).

Upper	Middle	Lower	Site Average
#1______ #2______ #3______	#1______ #2______ #3______	#1______ #2______ #3______	________psi

5. Soil Moisture– In the center of each vegetation sampling plot (see #7) take three soil moisture measurements. Measurements should be taken approximately 15 ft from the stream bank using a soil moisture probe. The soil probe tester plates must be chemically cleaned prior to use by rubbing with conditioning film. Soften soil in spot to be tested, break up pieces if it's hardened, and remove grass, leaves, pebbles and other debris. Insert soil tester so metal plates are fully covered and press the soil tightly around the tester so that the metal plates are in close contact with the soil. Press the button until value stabilizes to read soil moisture.

Upper	Middle	Lower	Site Average
#1______ #2______ #3______	#1______ #2______ #3______	#1______ #2______ #3______	________%

6. Riparian Zone Width– Measure the riparian zone width in the upper middle and lower section of the stream reach.. Consider the riparian zone to begin at the stream bank and the edge is often dictated by a human structure (e.g. house, road) or management activity (e.g. mowing) that inhibits natural plant growth.

Upper	Middle	Lower	Site Average
________ft	________ft	________ft	________ft

7.Vegetation Cover - Once in the upper, middle, and lower portion of the stream reach; estimate the percent cover (the shadow cast by a particular layer) provided by the groundcover (gc), understory (us), and canopy (cp) vegetation layers in the riparian zone. Select a representative area and visualize a 33 by 33 foot plot beginning from the edge of the stream bank extending perpendicular into the riparian zone. The canopy layer is >15ft high, the understory is 1.5 to 15ft high, and the ground cover is <1.5ft high. Average all three layers together to obtain an overall site average. The surveyors should walk the plot focusing on 1 vegetation category at a time and then agree on one value to record. Running a measuring tape to better define the study plot or dividing transect into smaller units can help to obtain a more accurate estimation.

Upper	Middle	Lower	Site Average
cp_____% us_____% gc_____%	cp_____% us_____% gc_____%	cp_____% us_____% gc_____%	_________%

8. Dominant Tree- Throughout the entire stream reach determine the presence or absence of multiple age classes of the dominant native tree (most overall site canopy cover).

Dominant Species_______________________: **Circle age classes present:** seedling, sapling, mature, snag.

9. Invasive Cover- Throughout the entire stream reach estimate the percentage of overall vegetation cover occupied by non-native invasive plant species.

Species:____

10. Hydrophytic Plants- Record the presence or absence of hydrophytic vegetation in the upper, middle and lower portions of the study transect. Circle sections occupied and record species name.

Circle transect sections containing hydrophytic vegetation: Upper, Middle, Lower

Species:____

SCORESHEET

	Optimal	Suboptimal	Marginal	Poor
1. Water Quality	Score >75	Score 75-51	Score 50-25	Score >25
	3	2	1	0
2. Diatom Index	Score >75	Score 75-51	Score 50-25	Score >25
	3	2	1	0
3. Entrenchment	Ratio > 2.20	Ratio 2.20-1.85	Ratio 1.84-1.40	Ratio < 1.40
	3	2	1	0
4. Soil Compaction	0-100 psi	101– 200 psi	201-300 psi	> 300 psi
	3	2	1	0
5. Soil Moisture	>75%	75-61	60-45	< 45%
	3	2	1	0
6. Riparian Width	Width >100 ft	Width 100-61 ft	Width 60-26 ft	Width < 25 ft
	3	2	1	0
7. Vegetation Cover	>50% plant cover	50-38% plant cover	37-25% plant cover	<25% plant cover
	3	2	1	0
8. Dominant Tree	All age classes	3 age classes	2 age classes	0-1 age class
	3	2	1	0
9. Invasive Cover	< 5% cover	5-20% cover	21-40% cover	> 40% cover
	3	2	1	0
10.Hydrophytic Plants	all sections have hydrophytic plants	2 sections have hydrophytic plants	1 section has hydrophytic plants	No hydrophytic plants
	3	2	1	0
Overall Site Score*	**Optimal ≥ 23**	**Suboptimal 16-22**	**Marginal 8-15**	**Poor 0-7**

***Sites with an overall score in the Marginal and Poor categories should be considered high priority for riparian restoration.**

Appendix B. Ranking of all prioritized COA parcels and their associated stream reach (82) using GIS, EII and available reach scale data.

Site Name/Stream Reach	Acres	WPD Score	Longitude	Latitude
BOG3B	1.11	***	3123987.340	10079727.507
WLR3D	0.59	***	3120490.271	10091440.626
WLR3E	1.28	***	3120081.535	10090575.263
WMS2B	2.11	***	3093987.921	10053338.623
LWA1A	0.80	271	3137998.107	10084459.141
LWA1B	1.14	271	3136625.199	10086965.078
LWA1C	2.99	271	3135622.402	10087896.686
TAN3A	0.38	267	3122418.319	10089365.531
TAN3B	0.86	267	3125767.105	10085977.902
FOR2A	0.70	266	3133680.430	10081129.827
FOR2B	1.20	266	3133890.641	10084046.752
FOR1A	1.79	264	3134135.040	10069725.895
BOG3A	0.73	261	3123513.710	10082407.865
TAN1A	1.15	253	3131398.474	10071358.475
TAN1B	1.61	253	3132301.464	10070420.949
TAN1C	0.73	253	3131699.001	10077090.242
TAN1D	0.62	253	3130870.580	10074790.892
TAN1E	2.75	253	3127385.653	10077306.999
JOH1A	0.34	252	3107397.824	10077695.007
JOH1B	0.40	252	3108638.722	10081061.942
JOH1C	0.23	252	3108761.281	10081982.605
BMK2A	3.78	247	3127881.377	10095174.559
EBO2A	0.23	239	3109308.088	10060645.556
WLR3A	1.96	236	3122925.539	10095692.387
WLR3B	2.30	236	3121172.566	10092065.325
WLR3C	0.50	236	3118859.000	10085177.500
BOG2A	0.92	229	3122903.729	10071488.472
BOG2B	1.14	229	3123761.208	10070556.496
BOG2C	3.21	229	3124147.943	10071766.780
BOG2D	0.45	229	3124129.024	10072675.421
BOG2E	1.00	229	3124768.774	10074049.561
BOG2F	3.80	229	3124129.024	10072675.421
WBO2A	0.24	209	3107639.690	10063171.825
TAN2A	0.57	207	3131580.317	10079155.052
TAN2B	8.63	207	3129891.877	10083574.453
SHL2A	5.05	201	3112048.384	10086975.399
SHL2B	3.90	201	3111906.672	10083593.159
SHL2C	22.90	201	3112361.130	10080268.025
SHL2D	0.70	201	3112058.741	10084223.975
SBG2A	2.30	200	3093069.751	10041509.139
SBG2B	3.00	200	3086473.345	10043504.392
SBG2C	0.81	200	3088579.364	10042403.928

Site Name/Stream Reach	Acres	WPD Score	Longitude	Latitude
SHL1A	0.90	199	3111817.330	10074085.369
SHL1B	1.50	199	3111341.634	10070963.954
SHL1D	0.80	199	3111391.986	10072895.181
SHL1E	1.15	199	3111627.035	10072168.343
SHLAC	1.03	199	3111478.565	10071376.424
GIL6	14.40	196	3137983.614	10145560.805
HRS2	4.00	196	3147294.719	10123517.142
LWA3A	2.00	195	3119928.800	10109553.519
LWA3B	5.70	195	3127367.593	10106350.717
BLU2A	24.74	193	3114122.130	10062997.689
BOG1A	2.70	183	3127422.137	10072285.131
BOG1B	0.18	183	3125525.425	10069348.031
BOG1C	0.50	183	3125287.406	10069297.721
BOG1D	1.46	183	3124681.760	10068740.378
BOG1E	1.10	183	3127816.005	10068009.067
BOG1F	1.84	183	3132274.802	10068567.317
CAR1A	0.95	177	3130406.944	10056966.348
SHL3A	0.57	174	3110150.405	10106758.062
SHL3B	0.50	174	3114668.998	10101894.190
SHL3C	5.00	174	3112528.736	10100930.579
SHL3D	0.77	174	3112757.113	10098929.327
SHL3E	1.72	174	3114252.668	10101443.053
LAW2A	2.06	169	3133451.307	10096406.595
BER1A	2.24	168	3079584.158	10028546.143
GIL2A	0.72	168	3154554.679	10100067.349
WMS2A	10.00	159	3079540.986	10050876.345
CCW2A	9.60	154	3115464.087	10053422.677
FOR3A	0.60	151	3131812.494	10084675.477
FOR3B	0.16	151	3131835.540	10084296.853
SLA3A	3.72	143	3060842.933	10047694.601
DRE2A	6.88	141	3143925.001	10029388.975
DKR3A	2.30	137	3152456.923	10101465.450
BAR4A	7.50	112	3057419.062	10080067.561
TYN1A	0.86	109	3108833.121	10092370.927
WLR2A	0.61	108	3114687.400	10080687.483
SLA1A	0.62	106	3093479.985	10035795.922
SLA1B	1.14	106	3084462.813	10040600.026
DKR2A	4.60	100	3148587.587	10091003.290
North Star	2.30	76	3127732.239	10116470.702
WLN4A	2.30	76	3113104.271	10125961.896

Higher scores indicate higher priority of a scale of 0-300. *** indicates sites selected prior to or aside from the prioritization method.