4.4 Procedures for Assessment of Structural Controls for Retrofitting Water Quality Features

The CDPS Municipal Stormwater Discharge Permit for the City states,

> *"Existing structural control projects shall be evaluated to determine if retrofitting the structure to provide for additional pollutant removal from stormwater is feasible."*

1. The permittee shall develop procedures to be used in evaluating existing structural controls. The evaluation procedures shall be complete within 36 months of the permit effective date, and a report on this submitted to the Division.
2. Existing structural controls shall be evaluated for potential retrofitting of the structure to provide additional pollutant removal from stormwater in conjunction with developing each new DBPS [Drainage Basin Planning Study]."

The purpose of this document is to outline the procedures for these evaluations. These procedures would then be utilized in conjunction with developing each new DBPS to determine the potential and feasibility for retrofitting existing structural controls (detention/retention basins).

The analysis of the structures involves three possible levels of review. The first is a qualitative review to determine if retrofitting of the structure is acceptable. The second element is quantitative to determine the pollutant removal effectiveness of the structure, both with and without water quality elements. Total Suspended Solids (TSS) will normally be the only constituent evaluated, unless other pollutants of concern are specified by City Engineering, based on site-specific information. A third element of review involves developing a cost estimate for retrofitting to determine the economic feasibility.

A qualitative assessment evaluates the changes that would occur if the flood-control detention facility was modified for water quality purposes, and determines the extent to which the changes would affect these functions, and if these changes in function are acceptable. The detention pond must first be acceptable under the qualitative criteria, or the evaluation will conclude and not continue to the second level of review. A quantitative analysis involves a determination of whether the percent removal of TSS (or other specified constituent of concern) is significant. For purposes of this assessment, a significant change is defined as the percent removal of the constituent after retrofitting the detention pond is estimated to be at least 20 percent greater than the percent removal of the constituent for the detention pond without the water quality element incorporated. If a significant change is estimated, then the third element of analysis, a cost estimate of the economic feasibility, is conducted. If a significant change is not estimated, then the option to retrofit the detention pond is eliminated.

Retrofit Screening – Qualitative Criteria

Qualitative criteria were developed based on the functions and operations of the existing structural controls. The criteria are:

1. Are there any environmental concerns associated with the retrofitting of the structure? If so, can the concerns be mitigated cost effectively. (Examples of this include the filling in or destroying of wetlands, habitat alteration or elimination, disturbance of contaminated sediment.) Items that would result in an immediate determination of an infeasible retrofit, would include a determination that modifications would impact a threatened or endangered species or that mitigation measures would be more costly than construction of the water quality improvements.
2. Is there a history of maintenance or operational problems with the structure? Can equipment access the site? Examples would include frequent sediment removal or overtopping of the structure. If the basin is not functioning properly, the inclusion of water quality elements could result in little or no effect or even aggravate the situation. A pond with operational problems is not a good candidate for retrofitting. Such retrofitting would be considered infeasible.
3. Can the structure be modified without compromising the flood control function of the structure? It is still important to have the ability to detain the required size storms. The question is whether there is sufficient additional capacity to include detention for storm water quality or if cost effective modifications can be made to incorporate water quality elements and still meet flood control requirements. Retrofitting which compromises its flood protection capabilities would be considered infeasible.
4. Are hazards created by retrofitting the structure? It is important to ensure that the addition of volume to the pond or standing water will not present an unacceptable risk or safety hazard. Examples of risks and hazards to be analyzed include steepness of slopes, depth of standing waters, or adequacy of overflow/outlet/inlet devices.
5. Will the modifications be acceptable to the community? Will the inclusion of the water quality elements eliminate the dual use of a basin for recreational purposes such as a baseball or football field? Are there unacceptable aesthetic or nuisance conditions that will occur? Will the facility "fit" with the location? Will the modifications result in an increase in the presence of mosquitoes or other undesirable insects? Public input on these issues will be necessary during the Drainage Basin Planning Study process and used as a part of the decision-making process.
6. Will future plans for development be impacted? Will the modifications result in the inability of a nearby landowner to develop his land?
7. Are there any effects on water rights that would preclude retrofitting? Incorporation of water quality elements usually results in the longer containment of waters and water loss due to infiltration or evaporation. A pond which affects water rights is not a good candidate for retrofitting. Retrofitting would be considered infeasible.

For each of these items it will need to be determined whether there is a problem, and if so, can it be mitigated. If any one of the above concerns can not be mitigated then the structure is considered not to be feasible for retrofitting and the evaluation will end.

Quantitative Assessment

The second stage of the process is to evaluate the effectiveness of the modifications. This involves the review of the current pollutant removal capacities of the structure compared to the increase in removal from the addition of water quality elements. One procedure for conducting the quantitative analysis is provided below. Other methods and procedures are available or likely to be improved on in the future. Such assessment methods and procedures may be used if adequate documentation of procedures and reliability is provided and accepted by the City. This flexibility will allow for improvements to be made to the assessment procedures as conditions and technical enhancements change in the future.

1. Determine the expected runoff quality. This is done by looking at the land uses in the watershed, determining the approximate acreage dedicated to the different uses, and obtaining a weighted average. Unless specific information is available on the quality of the runoff, the following default concentrations can be used for TSS. This data resulted from wet weather monitoring conducted by the City of Colorado Springs as part of its Municipal Stormwater Discharge Permit Application.

   - Industrial Land Use — 408 mg/L
   - Commercial Land Use — 565 mg/L
   - Residential Land Uses — 472 mg/L
   - Rural Land Uses — 400 mg/L

2. Calculate the removal efficiencies expected from the existing detention pond. The following equation should be used.

   $$E_c = (k_t * k_d * E_I) * (1 - r_{pf})$$

   Where:

   E_c = average annual constituent's event mean concentration (EMC) downstream of the facility, mg/L

   E_I = average annual constituent's EMC in the runoff inflow to the system, mg/L

   r_{pf} = fraction of the average annual runoff volume from the watershed that flows through the basin. It is equal to the Volume of the basin (VB)/ mean storm runoff volume (VR). VR = V*R_v*Area* 3630 where V is the mean storm event in inches, R_v is the runoff coefficient and the Area is that which is tributary to the basin in acres.

   k_d = fraction of the original constituent in the runoff that remains in the overflow water. This value is based on actual monitoring data where available. In lieu of actual data, a value of 0.3 to 0.5 should be used. These values are based on literature.

   k_t = coefficient of the report constituent EMC that represents the "post-first-flush" fraction of the average EMC in stormwater runoff. This value is usually based on a review of monitoring data. In lieu of actual data a literature value of 0.7 to 0.9 is recommended.

The percent removal to be expected is:

$$\% \text{ Removal} = [(E_I - E_c)/E_I]*100$$

It should be noted that if the pond size exceeds the mean storm event volume, VB/VR > 1, then the pond retains the storm event, since this would be equivalent to 100 percent removal of the pollutant and retrofitting the pond is not desired.

3. <u>Calculate the removal efficiencies from the pond with the desired water quality element incorporated</u>. One of the following equations should be used depending on whether the element is incorporated on- or offline.

For online BMPs: $E_c = (k_t*k_d* E_I)*(1-r_{pf}) + (E_f * r_{pf})$

For offline BMPs: $E_c = (k_t* E_I)*(1-r_{pf}) + (E_f * r_{pf})$

Where:

E_c = average annual constituent's EMC downstream of the facility, mg/L

E_I = average annual constituent's EMC in the runoff inflow to the system, mg/L

E_f = average annual constituent concentration in the effluent from the water quality element. $E_f = E_I*(1-R_{bmp})$ where R_{bmp} is the value from the following table divided by 100.

TABLE ND-3
BMP Removal Ranges for TSS (%)

BMP	Literature Reported Range (LRR)	Expected Probable Range (EPR)
Grass Buffer	10 – 50	10 – 20
Grass Swale	20 – 60	10 – 40
Extended Detention Basin	50 – 70	55 – 75
Constructed Wetland Basin	40 – 94	50 – 60
Retention Pond	70 – 91	80 – 90
Sand Filter Extended Detention	8 – 96	80 – 90
Constructed Wetland Channel*	20 – 60	30 –50

From Table SQ-6, "*Urban Storm Drainage Criteria Manual* – Volume 3: Best Management Practices", Urban Drainage and Flood Control District, Denver, Colorado, September 1, 1999

LRR – Literature reported range. EPR – expected probable range of annual performance by Volume 3 BMPs.

* Assumes the wetland surface area is equal or greater than 0.5% of the tributary total impervious area.

r_{pf} = fraction of the average annual runoff volume from the watershed that flows through the basin. It is equal to the volume of the basin (VB)/mean storm runoff volume (VR). VR = V*R_v*Area* 3630 where V is the mean storm event in inches, R_v is the runoff coefficient and the area is that which is tributary to the basin in acres.

k_d = fraction of the original constituent in the runoff that remains in the overflow water. This value is based on actual monitoring data where available. In lieu of actual data, a value of 0.3 to 0.5 should be used. These values are based on literature.

k_t = coefficient of the report constituent EMC that represents the "post-first-flush" fraction of the average EMC in stormwater runoff. This value is usually based on a review of monitoring data. In lieu of actual data a literature value of 0.7 to 0.9 is recommended.

The percent removal to be expected is:

$$\% \text{ Removal} = [(E_I - E_c)/E_f]*100$$

4. Determine if the increase in % removal is significant. A comparison is made of the % removal anticipated before and after the inclusion of water quality elements. If the estimated percent removed increases in absolute value by greater than 20 percent by incorporating a water quality element, the change is deemed significant (e.g. % removal goes from 55 percent to 76 percent). A cost estimate will then be prepared to determine the economic feasibility of the project. If the change is less than 20 percent, the potential retrofitting is deemed to be impractical. Retrofitting will not be required.

Economic Feasibility

If the qualitative and quantitative analyses result in a potential feasible and practical retrofit, a cost estimate for a retrofitted structural control option will be developed. The cost will be evaluated in conjunction with overall water quality benefits, the level of benefit in relation to the overall area affected by the retrofitted structural control, and other factors. In addition, the economic feasibility should consider other options such as the need for new structural controls that may be able to provide similar overall pollutant removal effectiveness at lower total costs. When comparing a retrofit option vs. a new structural control option, protection of water quality in the intervening stretch between the old and new structural control shall be one factor given consideration.

Final Alternative Selection

The final alternative selection process for drainage improvement options in any new Drainage Basin Planning Study is based on the evaluation of many factors including costs, safety, environmental issues including water quality, public input, etc. If the selected alternative includes retrofitting structural controls to provide additional pollutant removal, responsibility for implementation would need to be outlined in the study. If the responsibility was determined to be a public (City) responsibility, consideration for funding any such drainage improvement project would be made by the City Council during its annual budget approval process in conjunction with all other budget requests. If the responsibility was determined to be a private development responsibility, City Engineering would decide when implementation would be required in conjunction with the timing of future developments