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Southern Nevada effluent wetlands: A Proposed cooperative venture between the Bureau of Reclamation & City of Las Vegas

Bureau of Reclamation

SOUTHERN NEVADA EFFLUENT WETLANDS:

A PROPOSED COOPERATIVE VENTURE BETWEEN THE

BUREAU OF RECLAMATION & CITY OF LAS VEGAS

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CITY OF LAS VEGAS / BUREAU OF RECLAMATION

PROPOSED SOUTHERN NEVADA WETLANDS PROJECT

Background

Throughout North America there is a growing interest in constructed wetlands, both as relatively inexpensive, low-maintenance systems for removing nutrients from wastewater, and as a means of using municipal wastewater to enhance wildlife habitat and create public use opportunities. Because wetlands appear to have good potential as a component in the overall management of scarce water resources, the Bureau of Reclamation (Reclamation) has undertaken several cooperative research and demonstration projects to evaluate their effectiveness in a variety of local environments.

While a number of projects have demonstrated that wetlands can be beneficially employed to improve water quality, few such projects have been constructed in the Southwest. The potential for high evaporative loss of water or concentration of salts are special challenges facing wetland managers in this region. Reclamation is uniquely suited to investigate wetland functions peculiar to the desert Southwest because of its long history of research and project implementation to improve water quality and conserve water. The southern Nevada wetland project would complement similar cooperative Reclamation efforts underway in southern Arizona and southern California.

In southern Nevada, Reclamation has two major interests in wetlands: 1) from the point of view of how they might ultimately affect the water quality of Las Vegas Wash, Lake Mead, or the Colorado River system, and 2) as a model for the development of wastewater-based wetlands elsewhere in the arid West. Wetlands in the Las Vegas Valley could have multiple uses, including: eutrophication control through nutrient removal and storage, creation of valuable wildlife habitat in an desert environment, and as "green space" in an arid urban landscape.

Discussions with City of Las Vegas (City) staff make it clear that interest in these potential benefits is shared. Questions remain regarding the degree of treatment to be expected, of habitat sustainability, and of the consumptive use of water in constructed wetlands. In order to answer these questions, we are proposing to carry out a pilot scale study in cooperation with the City at the Water Pollution Control facility adjacent to Las Vegas Wash.

Objectives

(1) Quantify the efficiency of effluent nutrient removal by constructed wetlands.

(2) Measure water consumption occurring through evapotranspiration.

(3) Evaluate the concentration of salts or trace elements.

(4) Determine the potential for creating, and sustaining, wetland wildlife habitat.

(5) Evaluate the potential for effluent wetlands as educational or recreational community resources.

Facility

Seven wetland cells with three wetland habitat types are proposed to accomplish study objectives (Figures 1 through 4). Design criteria, habitat features, plant communities, water requirements, and environmental considerations are covered briefly in the following sections.

Discussions with wildlife agencies indicate that a mixture of submersed vegetation, shallow water emergent vegetation, and deeper water emergent vegetation would be desirable for wetlands in southern Nevada. The pilot study would, therefore, utilize three different wetland plant communities, corresponding to three different water depth ranges:

(1) Shallow water, emergent vegetation (water depth = 1-3 inches)

(2) Medium depth, emergent vegetation (water depth = 1.5-2.0 feet)

(3) Deep water, submersed vegetation (water depth = 3-4 feet)

Each of these three plant communities, or habitat types, will be studied separately, in a pair of replicate cells. All six cells should be lined with either a membrane or compacted clay in order to eliminate groundwater interactions. This will allow determination of evapotranspiration water losses and salinity or trace element concentrations by a simple inflow-outflow water balance. The surface area of each of these smaller ponds will be one acre, for a total of 6 acres.

A seventh, unlined, 7-acre cell combining all three habitat types into one system would bring the total wetland area on the study site to 13 acres. The larger feature would be

used to validate results from the smaller cells, and to evaluate the effects of integrating depths and habitats.

The remainder of the approximately 36-acre site will be landscaped in native upland vegetation to complement the wetland habitat. Other landscape features will include knolls, trails, and view points to enhance the educational use of the study site.

Design Criteria

(1) The six smaller cells are each one acre in surface area and identical in shape (Fig. 2).

(2) All six of the smaller cells are to be lined with either a synthetic membrane or compacted clay. The cells would be overexcavated, lined, and then backfilled with at least one foot of screened fill for planting substrate.

(3) The larger cell is 7 acres in surface area. This cell should combine two acres each of the three vegetation types (shallow emergent, mid-depth emergent, and deep water submersed) plus one acre of open water. This cell will be unlined.

(4) All seven cells should be constructed with at least one foot of freeboard to allow for water level fluctuations.

(5) Materials excavated from cell areas would be deposited as berms in the areas shown on the grading plan and conceptual design layout. Exact height of berms is not critical, but berm heights of 3 to 5 feet would be desirable. One berm by the larger cell should be highest, offering an overall view of the site.

(6) The trail is to be four feet wide, and could be either paved or covered with gravel, depending on vehicular access needs. Trails should provide access to the inlets and outlets of all seven cells.

(7) A first approximation of a gravity-flow effluent distribution/collection system is attached (Fig. 3). This layout assumes that discharge from the study facility will be allowed to enter Las Vegas Wash as a separate discharge from the main effluent of the treatment plant. The layout provides for separate (parallel) supply of effluent to each of the ponds.

Approach to Accomplish Objectives

When the seven cells have been constructed and planted, one full year will be dedicated to vegetation establishment before any hydraulic manipulations or water chemistry monitoring is done. Biological monitoring of the efficacy of plant establishment (Objective 4) will begin during this period and will continue for the remainder of the study.

After the initial year allowed for plant establishment, Objectives 1 through 3 will be accomplished by monitoring both inflow and outflow discharge and water chemistry on each of the seven cells. Effluent high in ammonia concentration is proposed for use as source water for the constructed wetlands. Retention time, hydraulic and nutrient loading, and water depth will be monitored to test nutrient removal efficiencies. Water balances will be calculated to determine the loss due to evapotranspiration. Total dissolved solids and trace element concentrations in the inflows and outflows will be compared to determine if salinization or concentration of trace elements is taking place within the cells.

Interim reports will be produced throughout the study, which is estimated will last for approximately 5 years after completion of the initial planting of the cells. These reports may take the form of progress reports, briefings, or technical publications. Data analysis and interpretation will be an on-going process, and cooperators will be kept up to date on the progress of the study. The final product of the study will be a comprehensive completion report, including recommendations as to the efficacy of wetlands at achieving water quality, habitat, educational or public use goals (Objective 5), and potential costs and benefits which would be associated with large scale wetland development.

Wildlife Use

The proximity of the proposed constructed wetland demonstration site to Las Vegas Wash will assure use by a large pool of wildlife. Bird visitation may be exceptionally noteworthy. Each of the three types of experimental vegetated wetlands as well as adjacent areas to be vegetated with riparian and upland plants will attract some component of this community. The nature of the mammalian, reptilian, and amphibian communities that might use the facility will be a function of those that use the adjacent Las Vegas Wash. Boxes could be installed to attract bats, which aid in the control of flying insects without affecting the aquatic forms preyed upon by birds.

Only one pond is specifically intended to attract vertebrate wildlife: the 7-acre wetland will combine areas of emergent and submersed plants surrounding a 1-acre open water pond designed to provide food and shelter for wintering waterfowl. Although the abundance of birds that will be accommodated by the facility is likely to be small because

of the small extent of habitat to be created, the diversity of bird species found on the site could be quite high.

One of the goals of the project will be to determine the value of the three wetland types, separately and in combination, to specific wildlife species. Another, equally important goal will be to determine the extent to which the presence of a particular species or species group affects system functioning with respect to the principal purpose of tertiary treatment of wastewater.

Plant Communities

The 36-acre site is currently covered with a dense stand of saltcedar (*Tamarix ramosissima*) which will have to be removed prior to earth work on the site. Saltcedar is difficult to eradicate, but other projects throughout the Southwest have provided Reclamation engineers and scientists with considerable experience in saltcedar control using mechanical or herbicidal means.

Three different wetland plant community types are proposed to determine whether a certain type is more effective in water quality improvement using City treatment plant effluent. Water depth in the cells will help to maintain the desired plant communities. The existing wetland seed bank would probably not provide the proper species or number of plants necessary for water quality improvement, so it will be necessary to plant the cells with the desired type of vegetation. Proposed plant species will provide wildlife food or cover, be indigenous to the area, will be capable of thriving in constructed wetlands, will be available in bulk, and will not be considered noxious weeds. It is likely that soils on the proposed site have high salt concentrations. Therefore, the plants discussed below are considered tolerant of saline conditions.

Shallow areas will provide a suitable habitat for species such as common spikerush or dwarf spikerush (*Eleocharis palustris* or *E. parvula*), water smartweed, marsh smartweed, or Pennsylvania smartweed (*Polygonum amphibium*, *P. muhlenbergii*, and *P. pennsylvanicum*). The medium depth cells will provide a suitable habitat for species such as hardstem bulrush (*Scirpus acutus*), Olney's bulrush (*S. Olneyi*), and three-square bulrush (*S. americanus*). Deep cells would be suitable habitat for species such sago pondweed (*Potamogeton pectinatus*) and widgeongrass (*Ruppia maritima*).

The 7 acre pond will contain water depths varying from 1 inch to 6 feet and would include all of the plant species planted in the other six cells. Beneficial wildlife plants which might be considered for planting around the wet margins of the cells include seaside arrowgrass (*Triglochin maritima*) and barnyard grass (*Echinochloa crusgalli*).

Other local species could be used if available. Local donor marshes will be utilized as much as is practical to provide plant material for these cells. If donor marsh material

is not available, native species will be purchased from commercial wetland plant producers.

Two alternatives for upland planting are foreseen, with combinations of these alternatives also possible. In natural settings, wetlands often border stands of woody riparian vegetation. Trees such as cottonwood (*Populus fremontii*), willow (*Salix gooddingii*), or mesquite (*Prosopis glandulosa*) could be planted to provide an oasis landscape resembling that which is likely to have existed prior to the development of the Southwest. This would demonstrate the potential value of reclaimed water in providing high quality wildlife habitat. Another alternative would emphasize water conservation by the planting of desert wash vegetation. Desert willow (*Chilopsis linearis*) and saltbush (*Atriplex lentiformis* or *A. polycarpa*) are examples of native shrubs which would emphasize this theme, although wildlife and aesthetic benefits would not be as great as with riparian trees.

Water Requirements

In addition to delivering approximately 1 mgd of effluent water from the Water Pollution Control Facility through the seven cells, it will be important to be able to manipulate the water flow and depth during certain times of the year to encourage plant growth and propagation. This would also be important in attracting wildlife to the site.

Water volumes for the proposed wetland are relatively small, but there are exacting needs for water management that must be considered. Precise control structures must be installed on each of the experimental wetland areas and accurate continuous flow monitoring equipment must be installed at each inlet and outlet. The purpose of this equipment is to closely control water deliveries as well as to provide data for a reliable water budget to quantify evapotranspiration rates from each of the wetland types.

A five day water retention time is desirable, given the size of experimental cells proposed. The following is a summary of wetland size and volume projections for the wetland development:

Depth (ft)	Area (a)	Volume (cf)	Sites (n)	Flow (cfs)
4.00	1	174,240	2	0.80
1.50	1	65,340	2	0.30
0.25	1	10,890	2	0.05
Mixed	7	700,940	1	0.80
			TOTAL WATER NEEDED	1.95

These figures are only approximations; actual requirements will likely be somewhat greater due to evapotranspiration and seepage from the unlined cell. The City has proposed delivering 1-2 mgd to the site. This would offer a flow of about 1.5-3.0 cfs, so requirements of this preliminary plan approximate the amount of effluent which is potentially available.

Environmental Considerations

Discussions between Reclamation and City staff have revealed several issues relating to the environmental impacts of the proposed constructed wetland. In this section, a preliminary evaluation of these issues is made to aid Reclamation and City decision makers in their reviews of the proposed project.

Federal involvement would necessitate that projected impacts of the proposed wetland project be assessed under the National Environmental Policy Act (NEPA). Part of this process is likely to involve regulatory and public review of the proposed project. Reclamation and the City may wish to consider forming a wetlands interest group for assistance with design concepts, refining goals, resolving permit issues, etc. Clearly, the following issues will be more closely evaluated in the project planning and design process.

Wetlands: There appear to be two pertinent questions related to wetland regulations. First, would project development affect wetlands associated with Las Vegas Wash? Although saltcedar, which dominates the proposed effluent wetland site, is a plant that occurs in wetlands of the Intermountain Region, it is doubtful that the proposed site has the hydrological and soil characteristics of a jurisdictional wetland. Second, would project implementation create a wetland that would hinder future alternate City land use at the site? Communications with Environmental Protection Agency personnel indicate that wetlands created for wastewater treatment are not considered "waters of the United States," and therefore Federal regulations do not govern their use. Thus, impacts to existing wetlands appear unlikely, as does the possibility for creating a jurisdictional wetland.

National Polluntant Discharge Elimination System Permit: The City's NPDES permit could require modification to accommodate the diversion and discharge of a small amount of effluent through the constructed wetland. Discussions with Nevada Department of Environmental Protection personnel indicated that such a modification would be a minor matter. Unforeseen problems with the permitting process might make it necessary to pump discharge from the wetland site back to the Water Pollution Control facility, but City staff feel that this too would be simple to accomplish.

Return Flows: Concern has been expressed for how large-scale wetlands development might affect the return flow credits used to calculate Nevada's Colorado River water

allocation. Additionally, wetlands could affect the salt loading provisions of the return flow credit, as well as water reuse agreements among local agencies.

Reclamation's March 25, 1992 meeting to discuss the potential for wetlands in the Las Vegas Wash vicinity was attended by representatives of the Southern Nevada Water System, Nevada Division of Water Resources, and the Colorado River Commission. There appeared to be a consensus that a wetland designed to treat approximately 1 mgd of effluent would not impose a meaningful evapotranspiration loss on Nevada's return flows. Constructed wetlands evapotranspiration would be insignificant relative to the estimated 12,000 af per annum consumptive use attributed to Las Vegas Wash. Moreover, Reclamation's proposal to study wetland evapotranspiration and salinity budgets should be regarded positively by those charged with improving estimates of wetland water use and salt loading.

Adjacent Land Use: The proposed site for the wetland development is surrounded by undeveloped land in three directions and by the City Water Pollution Control facility to the north. General area land use is for open space, recreation (golf course), or industrial development. The project area is zoned "RE," a designation that should permit the proposed wetland construction.

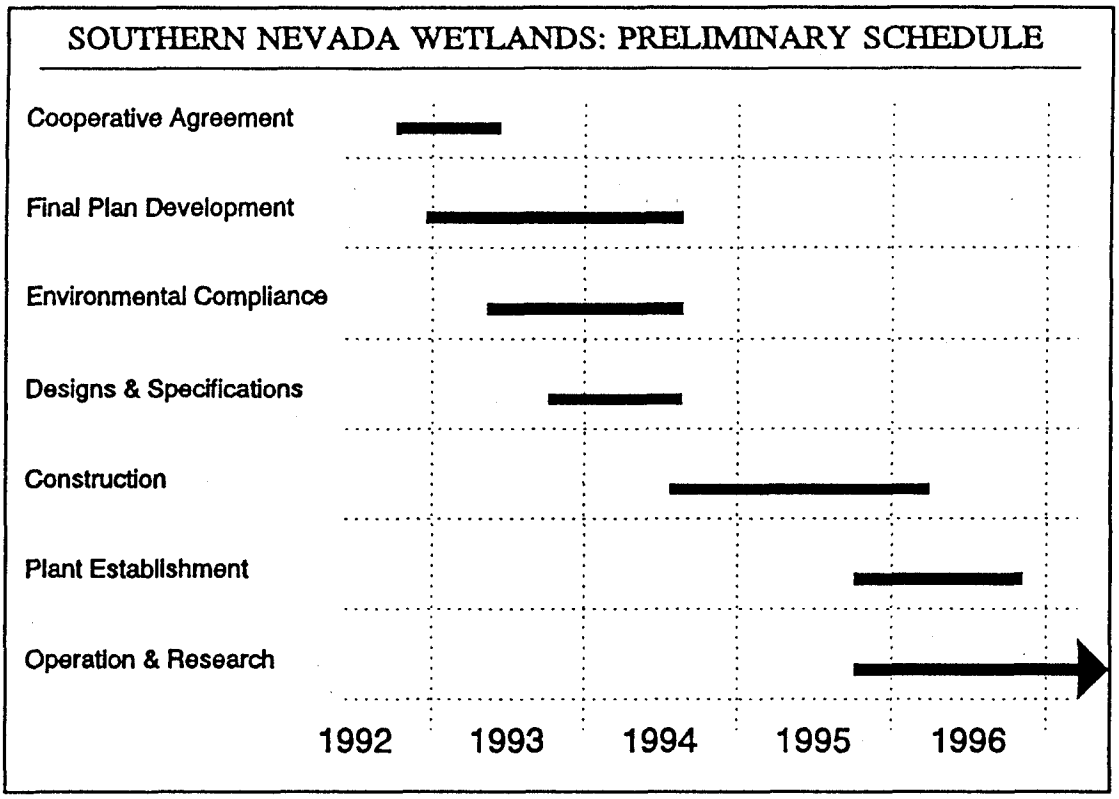
Odor is not expected to be a problem in the experimental wetland cells. Short water retention times and the ability to manipulate the hydraulics of the cells to avoid overloading should insure that anaerobic processes leading to disagreeable odors are minimized.

Estimated Costs and Schedule

Schedule and Funding: Reclamation envisions cooperative funding for a project with a mid-range construction cost on a basis similar to the following:

Calendar Year	1993	1994	1995	1996	1997	1998	1999
Cost (X $1,000)	150	200	900	600	200	200	200

We anticipate a schedule of activity related to the southern Nevada wetland project approximating that outlined on the next page. The first scheduled task is the drafting and signing of a cooperative agreement which would include arrangements for sharing costs and services between the City and Reclamation.



Preliminary Coordination: Reclamation estimates that one full time equivalent (FTE) or approximately $100,000 would be required for coordination and compliance activities during each of the two years preceding construction. Efforts during 1993 and 1994 would be directed at developing a final plan, completing environmental compliance and permitting, and developing designs and specifications (see construction cost estimate) for wetlands construction. Total cost for this phase would be approximately $350,000.

Construction: Low (ca. $1 million) and high (ca. $1.6 million) appraisal level estimates of the costs of the proposed project are provided on the next page. The estimates differ in the type of lining which would be used on the six, one acre ponds (compacted clay versus geotextile membrane) and the sophistication of the water discharge and quality monitoring system which would be installed.

The investment of the City and Reclamation in this wetland demonstration facility would clearly warrant protection from flooding. Because of the City's ongoing plans to extend flood protection to that portion of its facility encompassing the proposed wetland site, this feature is not included in the estimate below.

Las Vegas Wash Wetlands Study Appraisal Estimates for Wetland Development		
ITEM	**LOW**	**HIGH**
1. Grubbing & Stump Removal	$90,000	$90,000
2. Excavation	169,998	169,998
3. Clay Sealer (Materials)	74,970	N/A
4. Backfill & Compact Clay Sealer (Labor)	19,992	N/A
5. Membrane Liner 100 mil(Labor & materials)	N/A	280,000
6. Sorted Earth Material (Labor & materials)	76,338	76,338
7. Backfill & Compact Sorted Earth (Labor)	65,061	65,061
8. Pathway (Labor & materials)	16,800	16,800
9. Vegetation (wetland)	55,000	55,000
10. Vegetation (upland)	80,000	80,000
11. SUBTOTAL	$648,159	$833,197
12. Mobilization & Demobilization (3%)	19,445	24,996
13. Contingency (25%)	162,040	208,299
14. Overhead/Profit (25%)	162,040	208,299
15. SUBTOTAL	$991,684	$1,274,791
16. Monitoring System	29,736	380,000
17. SUBTOTAL	$1,021,420	$1,654,791
18. Design & Contract (10%)	102,142	165,479
GRAND TOTAL	**$1,123,562**	**$1,820,270**

Operation, Demonstration, and Research: One of the major advantages to wetland water treatment processes is their low maintenance requirements. It is expected that operation and maintenance costs will be minimal, partly due to the short term of the wetlands research project. The proximity of the City wastewater facility should also ensure low operation costs. Routine maintenance and security might best be handled by City staff. It is estimated that about $50,000 per year or 0.5 FTE would need to be allocated to operation and maintenance.

The presence of City staff and laboratory facilities on site would help ensure that research costs are reasonable. Reclamation's laboratory and technical staff in Boulder City are in close proximity to the proposed project site as well. It is anticipated that University researchers would be sought to carry out investigations that are compatible with overall wetland project objectives. While difficult to predict and likely to vary over time, it is estimated that wetland research activity would require one FTE or about $100,000 annually.

Interest in the wetland facility as a educational resource would also demand the allocation of personnel and funds. It is presently uncertain what level of public attention the wetland project is likely to generate. Given the agencies' strong interest in promoting wetlands as a water management tool, allocation of $50,000 (0.5 FTE) to a public outreach program seems reasonable.

Obviously, routine maintenance, research, and education do not have to be mutually exclusive. To the degree that these tasks could effectively be combined, savings would occur. Currently, we estimate that approximately $200,000 per year would need to be dedicated by Reclamation and the City to operation, research, and public outreach. Coordination, environmental compliance, planning, research, and public outreach could all benefit from both a quality and a cost standpoint with the involvement of local environmental groups and agencies. Where the City and Reclamtion deem such involvement appropriate, avenues for outside participation should be encouraged.

Conclusion

Reclamation and the City are in a unique position to share funds and services to construct and operate demonstration wetlands in the Las Vegas Wash vicinity. This type of project is likely to be of great educational value to southern Nevada residents and visitors alike. Not only would questions regarding water quality enhancement be answered, but information on salinity and consumptive use of water would also be developed. This type of information is critical to the planned expansion of wetlands for water quality improvement or wildlife habitat throughout the Southwest.