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U.S. Army Corps of Engineers
Los Angeles District

in cooperation with
The City of Tempe

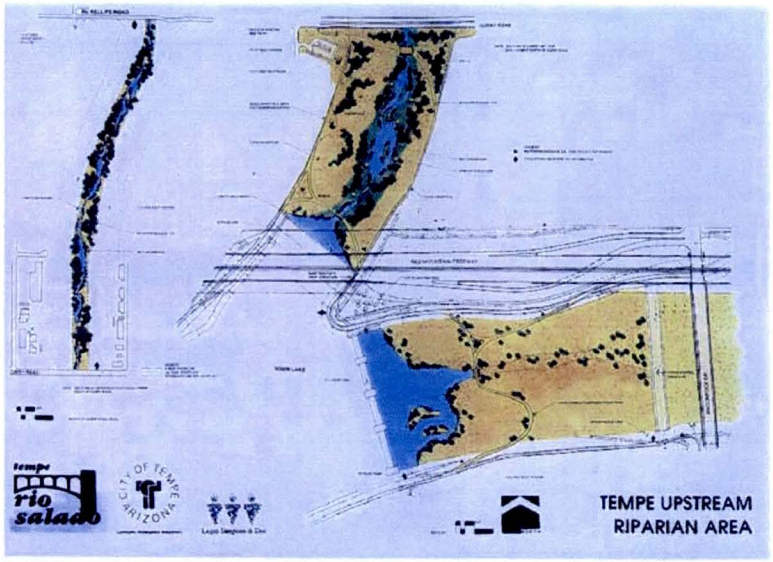
Rio Salado Environmental Restoration Project
Tempe Reach: Indian Bend Wash
Tempe, Arizona

Design Documentation Report
Final Design Submittal

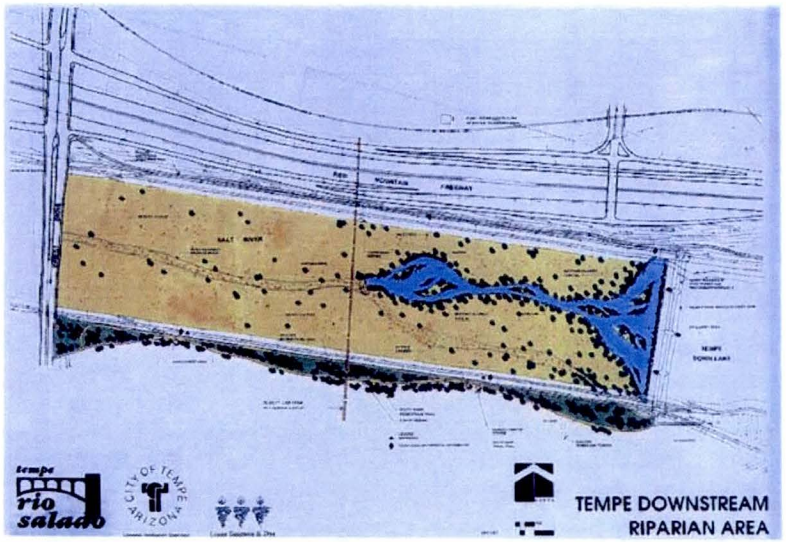
September 2002

Prepared by
McGann & Associates / Novak Environmental, Joint-Venture

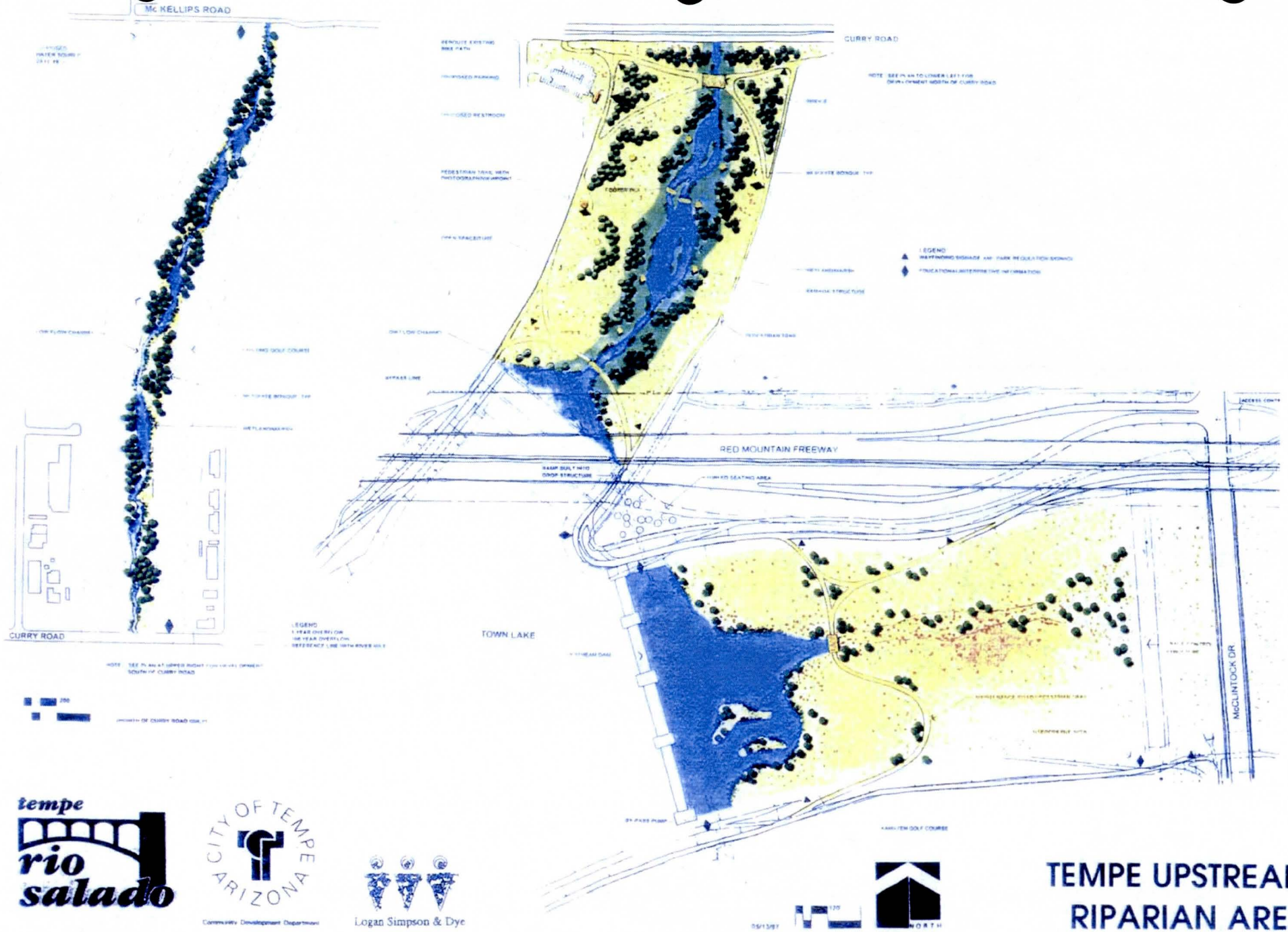
Indian Bend Wash Habitat



Salt River
Upstream Habitat



Salt River
Downstream
Habitat

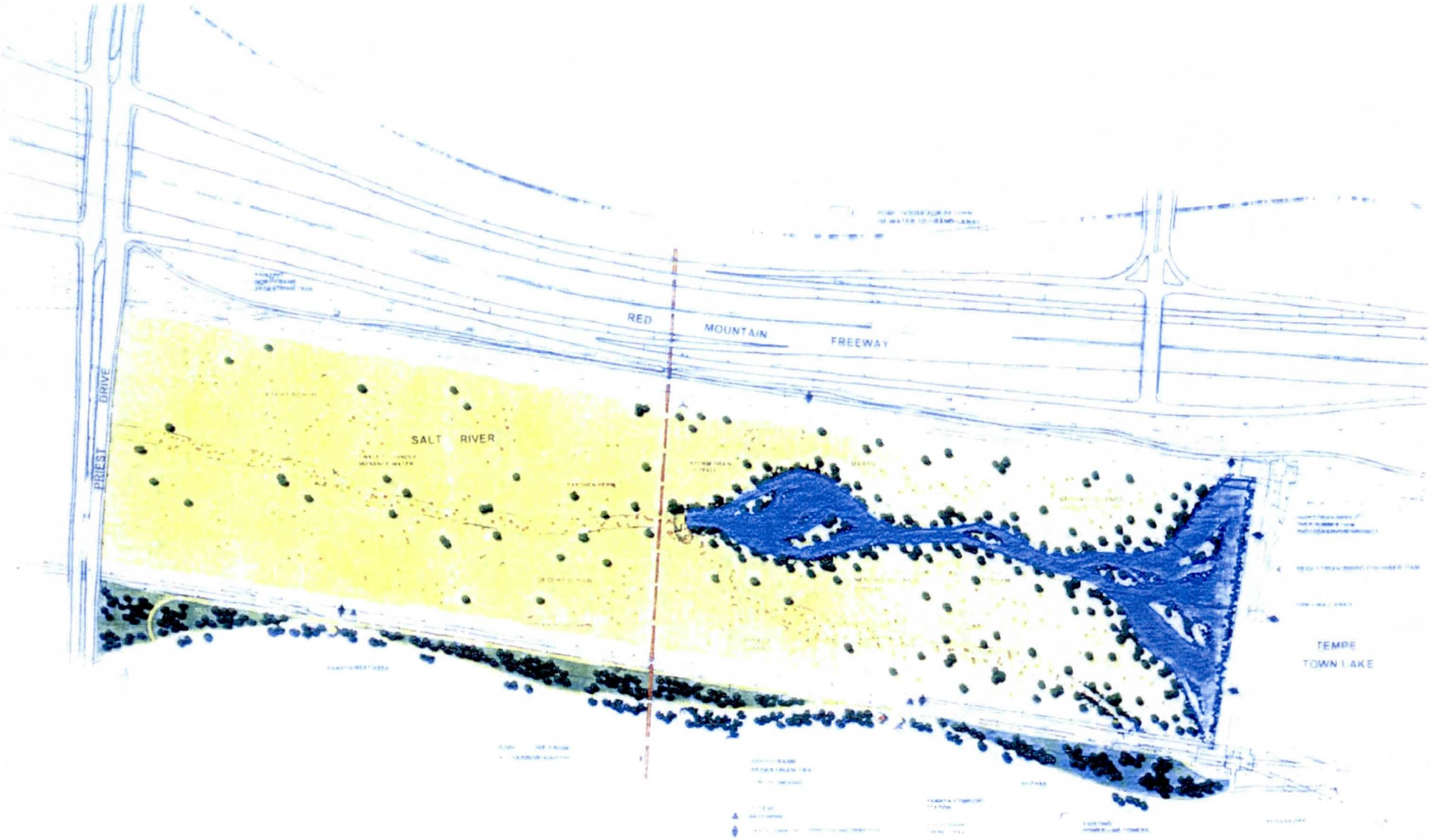


tempe
rio salado

CITY OF TEMPE
ARIZONA
Community Development Department

Logan Simpson & Dye

TEMPE UPSTREAM RIPARIAN AREA



tempe rio salado

CITY OF TEMPE ARIZONA

Logan Simpson & Dye

NORTH

TEMPE DOWNSTREAM RIPARIAN AREA

Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area

Aerial Photo
Project Site

0 150 300 NORTH

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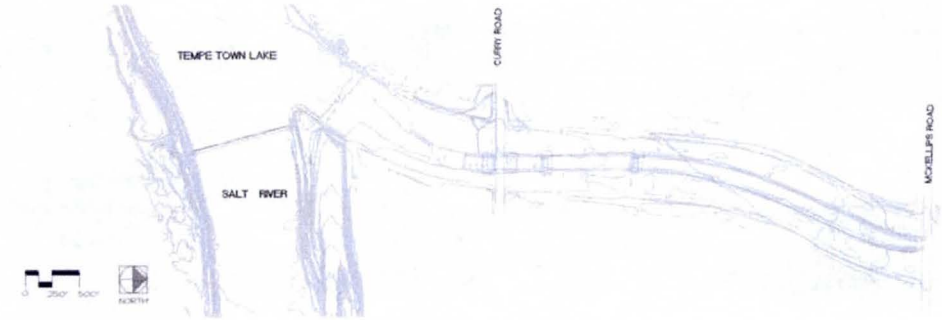
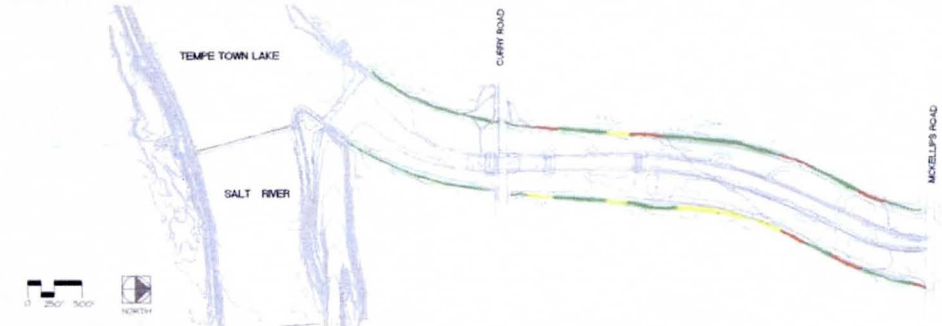
Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area

Alternative A:
Baseline / Existing Conditions



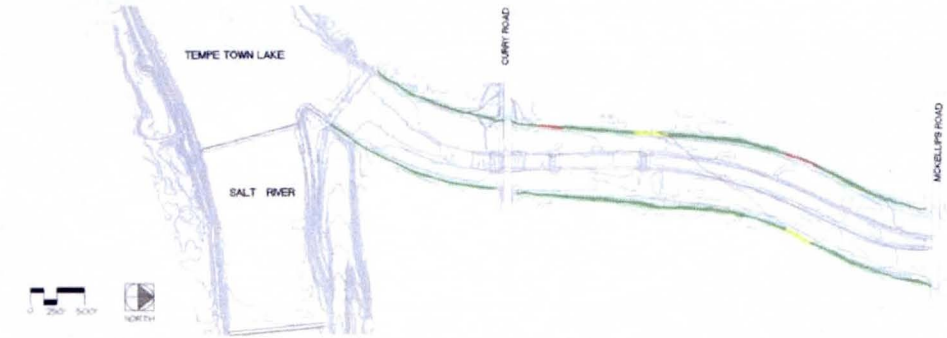
Habitat Distribution - Existing Conditions

LEGEND (HABITAT)
- Aquatic Strand
- Wetland Marsh
- Mesquite Bosque
- Cottonwood / Willow
- Open Space



Freeboard Conditions Based on 30,000 CFS / 2.5' Min. Freeboard (Corps of Engineers)

LEGEND (FREEBOARD)
- Freeboard ≥ 2.5 feet
- Freeboard ≥ 1.5 < 2.5 feet
- Freeboard < 1.5 feet



Freeboard Conditions Based on 20,000 CFS / 3.0' Min. Freeboard (M.C.F.C.D.)

LEGEND (FREEBOARD)
- Freeboard ≥ 3.0 feet
- Freeboard ≥ 2.0 < 3.0 feet
- Freeboard < 2.0 feet

SUMMARY:

HABITAT TYPE	TREE DENSITY PER ACRE	"N" VALUE USED IN HYDRAULIC MODEL	ACRES	HABITAT UNITS PER ACRE	HABITAT UNITS
COTTONWOOD - WILLOW	100 - 150	0.08	0	0.7	0
MESQUITE BOSQUE	LESS THAN 100	0.07	0	0.5	0
WETLAND MARSH	NOT APPLICABLE	0.03	0	0.6	0
AQUATIC STRAND	NOT APPLICABLE	0.03	0	0.7	0
OPEN SPACE	NOT APPLICABLE	0.03	0	0.3	0
HABITAT TOTAL			0		0
GOLF COURSE TERRACE		0.035			

U.S. Army Corps of Engineers
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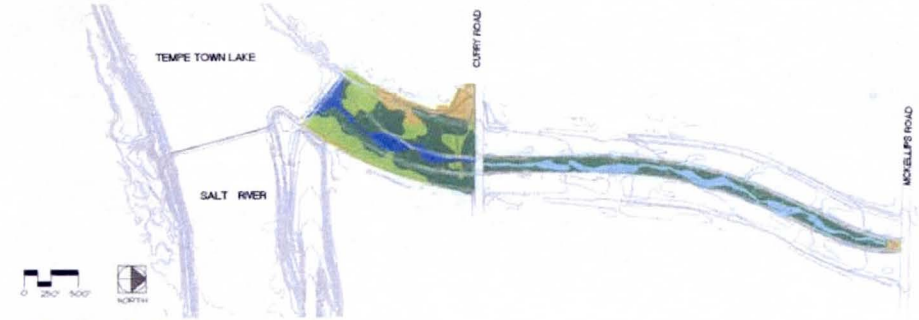
Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area

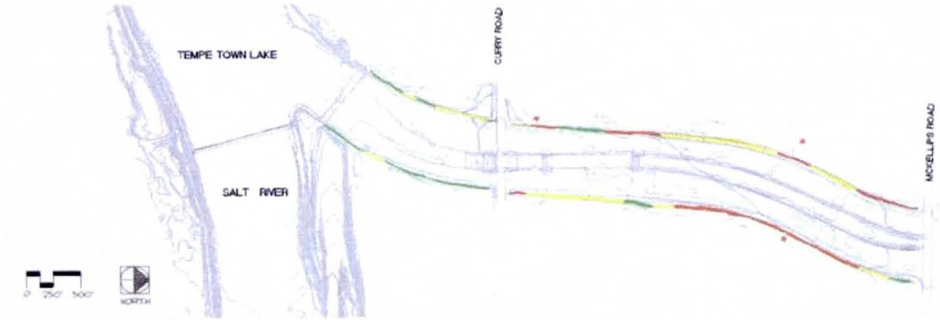


Habitat Distribution - Feasibility Study

LEGEND (HABITAT)

- Aquatic Strand
- Wetland Marsh
- Mesquite Bosque
- Cottonwood / Willow
- Open Space

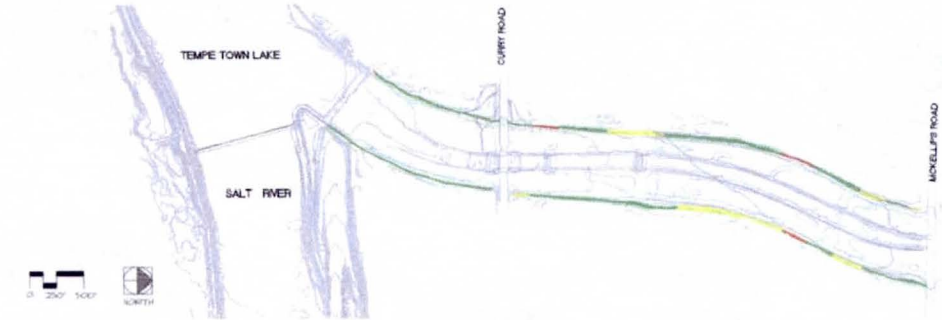
Alternative B: Feasibility Study



Freeboard Conditions Based on 30,000 CFS / 2.5' Min. Freeboard (Corps of Engineers)

LEGEND (FREEBOARD)

- Freeboard ≥ 2.5 feet
- Freeboard ≥ 1.5 < 2.5 feet
- Freeboard < 1.5 feet



Freeboard Conditions Based on 20,000 CFS / 3.0' Min. Freeboard (M.C.F.C.D.)

LEGEND (FREEBOARD)

- Freeboard ≥ 3.0 feet
- Freeboard ≥ 2.0 < 3.0 feet
- Freeboard < 2.0 feet

SUMMARY:

HABITAT TYPE	TREE DENSITY PER ACRE	"N" VALUE USED IN HYDRAULIC MODEL	ACRES	HABITAT UNITS PER ACRE	HABITAT UNITS
COTTONWOOD - WILLOW	100 - 150	0.08	0	0.7	0
MESQUITE BOSQUE	LESS THAN 100	0.07	29.31	0.5	14.66
WETLAND MARSH	NOT APPLICABLE	0.03	3.3	0.6	1.98
AQUATIC STRAND	NOT APPLICABLE	0.03	3.91	0.7	2.74
OPEN SPACE	NOT APPLICABLE	0.03	3.95	0.3	1.19
HABITAT TOTAL			40.47		20.57
GOLF COURSE TERRACE		0.035			

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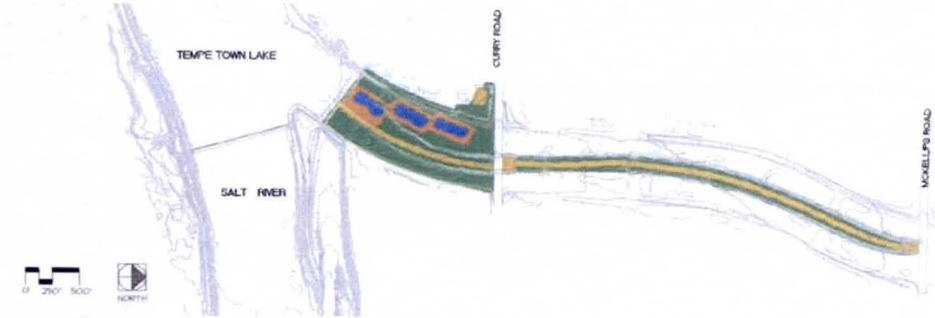
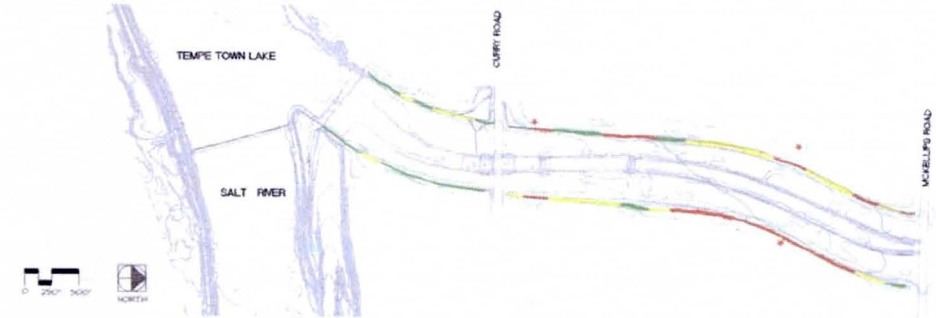
Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area



Habitat Distribution - Recommended Alternative

LEGEND (HABITAT)

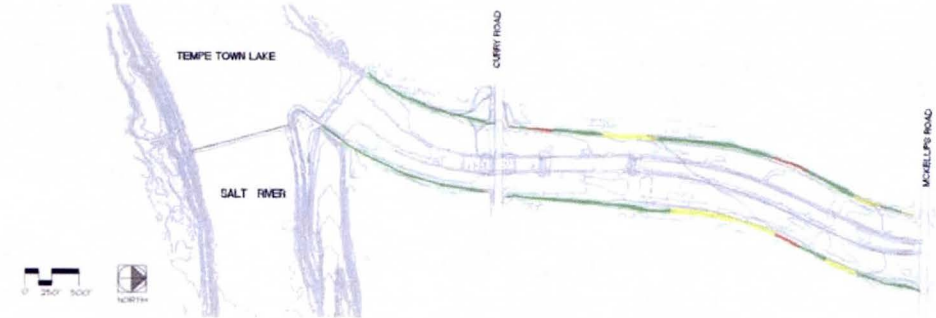
- Aquatic Strand
- Wetland Marsh
- Mesquite Bosque
- Cottonwood / Willow
- Open Space



Freeboard Conditions Based on 30,000 CFS / 2.5' Min. Freeboard (Corps of Engineers)

LEGEND (FREEBOARD)

- Freeboard ≥ 2.5 feet
- Freeboard ≥ 1.5 < 2.5 feet
- Freeboard < 1.5 feet



Freeboard Conditions Based on 20,000 CFS / 3.0' Min. Freeboard (M.C.F.C.D.)

LEGEND (FREEBOARD)

- Freeboard ≥ 3.0 feet
- Freeboard ≥ 2.0 < 3.0 feet
- Freeboard < 2.0 feet

Alternative C:
Recommended Alternative

SUMMARY:

HABITAT TYPE	TREE DENSITY PER ACRE	"N" VALUE USED IN HYDRAULIC MODEL	ACRES	HABITAT UNITS PER ACRE	HABITAT UNITS
COTTONWOOD - WILLOW	100 - 150	0.08	3.62	0.7	2.53
MESQUITE BOSQUE	LESS THAN 100	0.07	27.33	0.5	13.67
WETLAND MARSH	NOT APPLICABLE	0.03	2.01	0.6	1.21
AQUATIC STRAND	NOT APPLICABLE	0.03	0	0.7	0
OPEN SPACE	NOT APPLICABLE	0.03	7.50	0.3	2.25
HABITAT TOTAL			40.47		19.66
GOLF COURSE TERRACE		0.035			

U.S. Army Corps of Engineers
Los Angeles District

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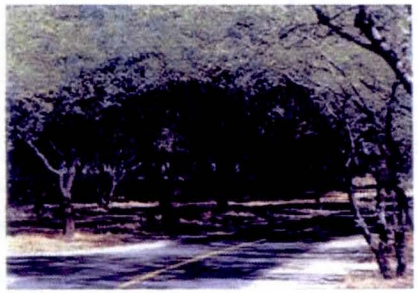
Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area




Photos of Mesquite Bosque
(Planting density = 90 trees/acre)



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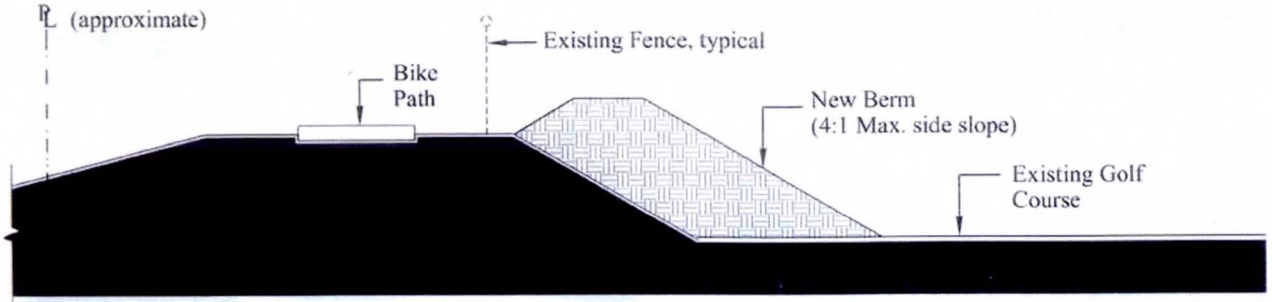
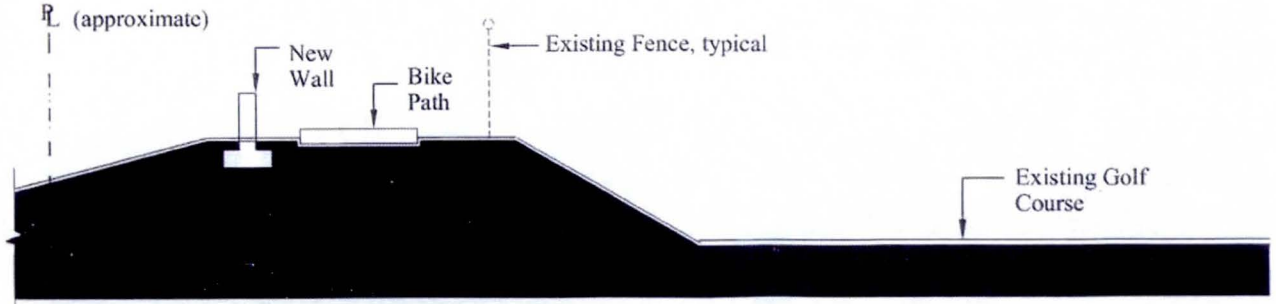
Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area

Alternatives for Raising Levee Elevation



Berm used to raise levee height (N.T.S.)



Wall used to raise levee height (N.T.S.)

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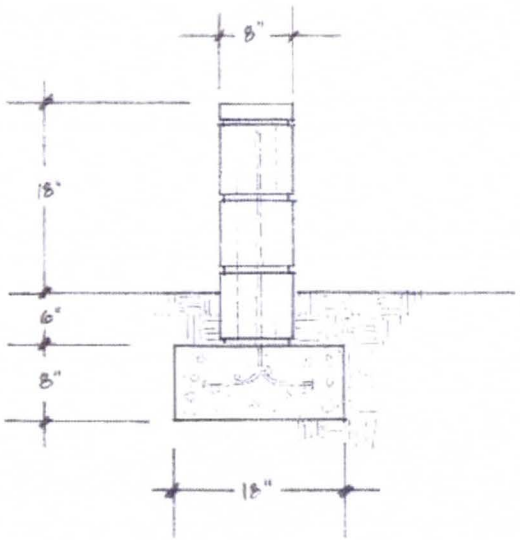
Rio Salado Environmental Restoration Project - Tempe Reach
Indian Bend Wash Project Area

Levee Wall Order-of-Magnitude Cost Estimate



ORDER-OF-MAGITUDE COST ESTIMATE
CMU WALL AT TOP OF LEVEE - 1,000 LINEAR FEET

FOOTING EXCAVATION	65	C.Y.	@	$5.70	PER C.Y.	$370.50
CONCRETE (FOOTING)	37	C.Y.	@	$71.00	PER C.Y.	$2,627.00
CONCRETE PLACEMENT	37	C.Y.	@	$21.00	PER C.Y.	$777.00
MASONRY	2000	S.F.	@	$6.35	PER S.F.	$12,700.00
SUBTOTAL						$16,474.50
MARK-UP FOR ADDITIONAL REINFORCING (25%)						**$4,118.63**
ESTIMATED COST PER 1,000 L.F. WALL						**$20,593.13**
ESTIMATED COST PER LINEAR FOOT OF WALL						**$20.60**

Data from Means 2001 Site Work and Landscape Cost Data

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Rio Salado Environmental Restoration Project
Tempe Reach: Indian Bend Wash
Tempe, Arizona

Design Documentation Report
Final Design Submittal

September 2002

Prepared by
McGann & Associates / Novak Environmental, Joint-Venture

1.1 Project:

This Design Documentation Report (DDR) was prepared in conjunction with the Final Design Submittal for the Indian Bend Wash segment of the Rio Salado Environmental Restoration Project, Tempe Reach. Work was performed under contract DACW09-00-D-0006, Task Order 0001.

1.2 Project Location:

The project site is located along Indian Bend Wash in Tempe, Arizona. The Indian Bend Wash section of the project extends from Tempe Town Lake on the south to McKellips Road on the north. (See Figure 1-A).

Between the Tempe Town Lake and Curry Road, the project extends the full width of the Indian Bend Wash (IBW) channel. Between Curry Road and McKellips Road, an existing golf course is present on the terraces within the overall IBW channel. The golf course will not be modified by this project. Habitat plantings will be installed within the low flow channel, between the terraces. A low flood control wall will be constructed on the levee, outside of the terraces.

1.3 Authorization:

This project is being conducted under the authority given in Public Law 761, Seventy-fifth Congress, known as Section 6 of the Flood Control Act of 1938 as appropriated under the 1994 Senate Energy and Water Development Bill. This authority, dated June 28, 1938, states "the Secretary of War (now the Secretary of the Army) is hereby authorized and directed to cause preliminary examinations and surveys .... at the following localities: ... Gila River and tributaries, Arizona... ."

A Feasibility Report and an Environmental Impact Statement (EIS) were previously prepared for the Rio Salado - Tempe Reach Environmental Restoration project. The report found that the "... selected plans are feasible and .... provide environmental restoration benefits that serve the public interest." Detailed plans, specifications, and cost estimates are currently being prepared as to allow for implementation of the selected plan.

1.4 Project Phasing

The habitat and related improvements proposed for the Tempe Reach of the Rio Salado project will be developed in two or more phases. The current project involves the design of improvements for the Indian Bend Wash segment of the project, only. Improvements to reaches of the Salt River, upstream and downstream of Tempe Town Lake, will be constructed as part of subsequent project phases. (See Figure 1-A).

1.5 Purpose of Design Documentation Report:

This Design Documentation Report (DDR) was prepared to provide back-up and supporting information related to the design drawings submitted as part of the Final Design Submittal. It includes an overview of the project scope, a discussion of project issues, a summary of proposed project elements, calculations supporting the final design, and copies of related documents and reports that were used in the preparation of the final plans.

1.6 Related Studies and Reports

The following reports were utilized in conjunction with the preparation of the final design submittal documents.

- Rio Salado (Salt River), Arizona. Feasibility Report and Environmental Impact Statement (U.S. Army Corps of Engineers, Los Angeles District, April 1998)
- Hydraulic and Hydrologic Design Analysis Report for Indian Bend Wash Flood Control Improvements (McGann & Associates / Novak Environmental Joint Venture, Revised June 2002)
- Final Geotechnical Investigation Report, Rio Salado Habitat / Environmental Restoration Project, Tempe, Arizona (AMEC Earth and Environmental, Inc., January 2001)
- Habitat Criteria Report - Rio Salado Environmental Restoration Project, Tempe Reach (Aspen Environmental Group, March 2001)

1.7 Related Work by Others

The habitat improvements for the Indian Bend Wash project segment will require a supply of water for the wetland ponds and for the project irrigation system. The source of water will be a new well to be developed at the southwest quadrant of the IBW and Curry Road. The design of the well and all associated water storage and pumping facilities is being performed by the URS Corporation under separate contract with the U.S. Army Corps of Engineers, Los Angeles District. Accordingly, detailed information regarding the design and engineering of the well and the pumping / storage facilities is not included in this Design Documentation Report.

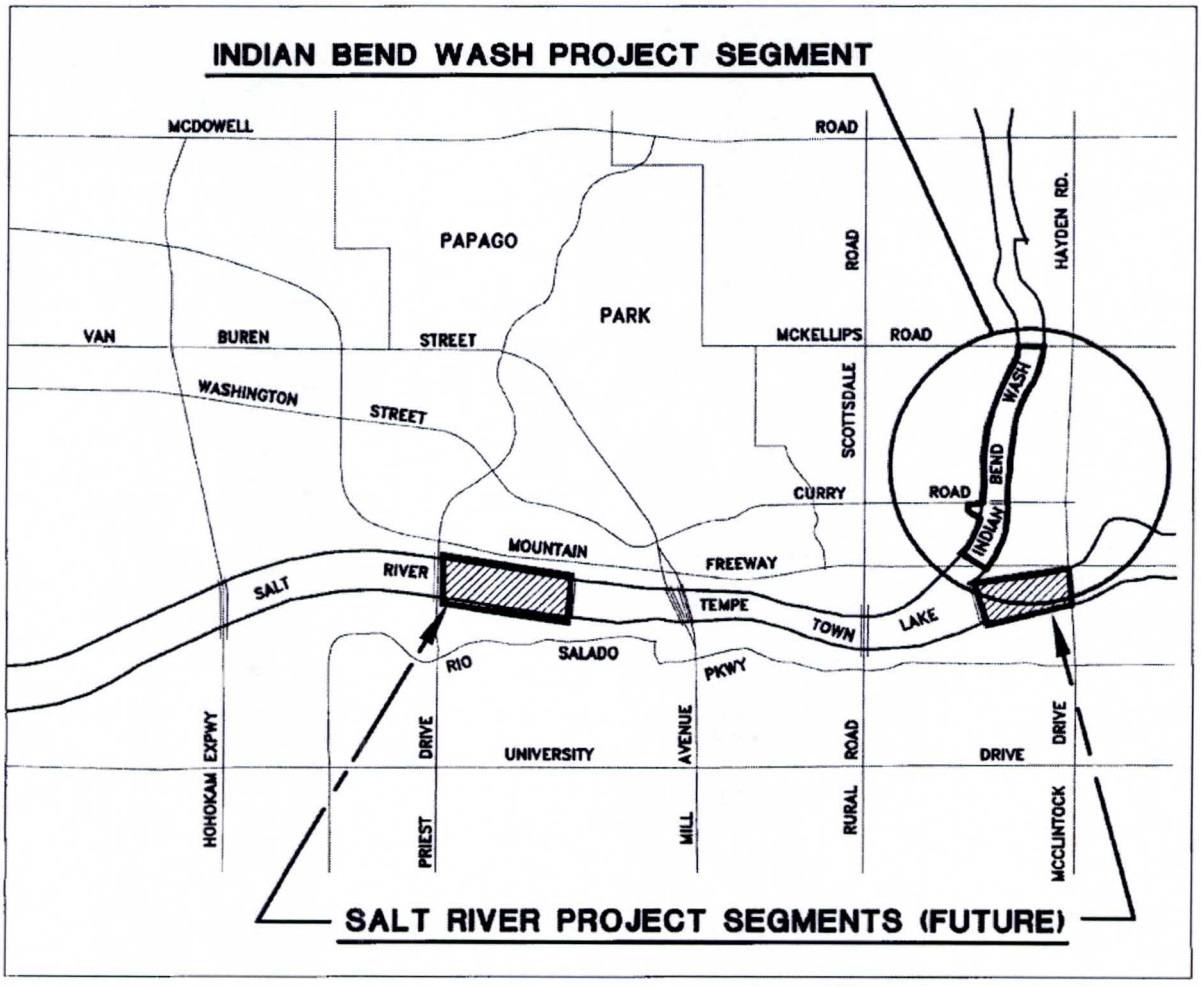


Figure 1-A: Project Location

2.1 Introduction

The Indian Bend Wash (IBW) project area consists of portions of the IBW channel between the Tempe Town Lake and McKellips Road. Improvements proposed for this project area include; habitat plantings, a new water supply, an automatic irrigation system, a public access drive, a thirty-four space parking lot, an overlook plaza with ramada, and minor flood control improvements. The scope and character of these improvements are outlined below.

2.2 Habitat Improvements

The Feasibility Report for the Rio Salado Environmental Restoration project identified several habitat types to be developed (or re-developed) along the Salt River in Phoenix and Tempe. An additional habitat type was subsequently added for those areas that are within close proximity to Sky Harbor Airport. The proposed habitat types include:

- Wetland - Marsh Habitat
- Cottonwood - Willow Habitat
- Mesquite Bosque Habitat
- Aquatic Strand Habitat
- Open Space - Open Edges Habitat
- Lower Sonoran Habitat (For areas near Sky Harbor Airport)

Within the Indian Bend Wash project area, conditions were found to be appropriate for four of the six habitat types. These four habitat types are: Wetland - Marsh, Cottonwood - Willow, Mesquite Bosque, and Open Space - Open Edges. Through planting and site development, each of these habitat types will be developed within the scope of the Indian Bend Wash project. Additional information related to habitat development is included in Section 3 of this Design Documentation Report.

2.3 Water Supply and Irrigation Improvements

To support the proposed habitat development, a new water supply well will be developed. This well will supply water to the wetland ponds and to the automatic drip irrigation system that will be constructed as part of this project. These improvements are described in Section 4 of the DDR.

2.4 Public Access Improvements and Public Use Facilities

Limited public use of the proposed habitat improvements within the Indian Bend Wash area was anticipated and is supported by the approved Feasibility Report. To facilitate public access to the site, a new entry drive and parking lot will be constructed as part of this project. These improvements will be located at the southwest quadrant of the Indian Bend Wash and Curry Road. The proposed parking lot will allow users to access the existing bicycle path along the levee on the west side of the IBW. It will also facilitate public access to the proposed overlook plaza.

A small overlook plaza will be constructed adjacent to the existing bike path, south of Curry Road. This facility will allow visitors to the site to observe the wetland ponds and the surrounding habitat areas. It will allow visitors to view birds and other wildlife using the site while at the same time creating discrete physical barriers that prevent users from disturbing the natural resources present.

Development at the proposed overlook plaza will include a ramada for general public use and for educational and interpretive programs. Opportunities for the subsequent installation of interpretive displays will also be developed. Additional information related to the proposed public access improvements and public use facilities is included in Section 7 of this document.

2.5 Flood Control Improvements

An evaluation of the impacts of the proposed habitat improvements on the capacity of the Indian Bend Wash channel to convey storm flows was conducted as part of this project. This evaluation found that the elevation of portions of the existing levees on the east and west sides of the Indian Bend Wash, within the project area, need to be raised to provide the minimum freeboard required by Corps of Engineer standards.

To address this need, minor flood control improvements are included in the scope of this project. These improvements consist of low walls that raise the elevation of the levee as needed to provide the required freeboard. See Section 8 of this DDR.

2.6 Operations and Maintenance Improvements

Within the site, access routes will be provided for small maintenance vehicles. These routes will allow maintenance personnel to gain access to the wetland ponds and the habitat planting areas for routine and periodic maintenance. The storage of vehicles, equipment, and supplies used to maintain the project will occur at City of Tempe off-site facilities. Accordingly, new maintenance buildings and storage yards will not be developed as part of this project.

3.1 Introduction

The habitat types to be developed within the Indian Bend Wash project area of the Rio Salado - Tempe Reach project include the following:

- Wetland-Marsh Habitat
- Cottonwood-Willow Habitat
- Mesquite Bosque Habitat
- Open Space - Open Edges Habitat

Each of these habitat types is described below.

3.2 Wetland - Marsh Habitat

The Wetland - Marsh habitat is a combination of three microhabitats: open water, submerged and emergent vegetation, and muddy shoreline. Each of these microhabitats create specific habitat niches. Open water provides a resting area for migrating waterfowl; submerged vegetation provides food and cover; and the muddy shoreline attracts shorebirds for foraging.

Plant species composition within the Wetland Marsh is distributed along a gradient of water depth, from shallow, through intermediate, to deep waters. Reeds and cattails are the dominant emergent vegetation in the shallow to intermediate waters. Open water areas support submerged and floating aquatic macrophyte species. Though not an easily accessible food source for most aquatic birds, submerged aquatic plants can help to control algae concentrations that may develop in the proposed wetland marshes.

Wetlands are important habitat for a wide range of bird species, as well as aquatic vertebrates and invertebrates. In this arid region, areas of open water such as Wetland-Marshes are extremely valuable and increasingly rare. Providing Wetland-Marsh habitat within the project not only improves the overall habitat mosaic of the project, but also provides a valuable educational resource for the community.

The project area selected for the development of wetland marshes is located within the Indian Bend Wash (IBW) channel, south of Curry Road. Two marshes will be constructed on the channel terrace, west of the low flow channel (LFC).

The advantages of this location include the following:

- It provides sufficient room for the construction of reasonably sized marshes (+/- 1 acre each).
- It allows for maintenance access from the proposed public parking lot at Curry and Miller Roads.
- It is outside the LFC and, as-such, will not be impacted by the run-off from frequent, low-discharge storm events.
- It is in close proximity to the bike / multi-use path and will allow visitors to get close to the marshes for plant and wildlife viewing purposes.

The construction of the wetland marshes will necessitate the excavation and export of existing soil from the project site. The construction of raised embankments will not occur so as to prevent adverse impacts on the channel's capacity to convey storm water.

3.3 Cottonwood - Willow Habitat

Cottonwood - Willow habitat typically occurs along the banks of a river channel and within the associated active flood plain terrace. As the name implies, dominant canopy species include cottonwood (*Populus fremontii*) and willows (*Salix goddingii, S. exigua*). Other important canopy species include ash (*Fraxinus velutina*) and elderberry (*Sambucus mexicana*) in mesic areas and mesquite (Prosopis velutina) in drier areas.

The Cottonwood - Willow habitat provides valuable nesting sites for birds. It supports the greatest density and diversity of breeding bird species in the southwest. Cottonwood - Willow habitat along the bank of a river channel protects the bank from erosion and helps to stabilize the bank during flood events. The tree canopy provides shade to the river or wetland area, lowering the temperature of the water. This improves the in-channel habitat for fish and other aquatic vertebrates and invertebrates. The shade and lower water temperatures also lower evaporation losses from the channel.

Native Cottonwood - Willow forests occur where ground water is within a few feet of the ground surface. Although shallow ground water may have been historically present along the Indian Bend Wash, this is no longer the case. The current depth to ground water within the project area is more than fifty feet. To

overcome this condition, saturated soils near the ground surface that replicate the natural conditions needed for Cottonwood - Willow habitat development will need to be created.

One alternative was the application of sufficient irrigation water to continuously maintain the required high soil moisture content. This approach was rejected because of the large volume of water that would have been required to saturate the highly porous granular soils present within the Indian Bend Wash.

Alternatively, an approach was developed for this project that mimics naturally occurring conditions along streams in the southwest where lenses of fine grained soils restrict infiltration and create perched water tables at or near the ground surface. On this project, a buried soil liner with low permeability will be utilized to maintain saturated soil conditions around the wetland marshes where Cottonwood - Willow habitat will be developed. Additional information on the proposed buried soil liner is included in an appendix to this Design Documentation Report.

3.4 Mesquite Bosque Habitat

The Mesquite Bosque is a winter deciduous woodland primarily found on the upper terraces of southwestern flood plains. It is an integral component of a complete riparian ecosystem. Dominant canopy species in this habitat type include the following: velvet mesquite (*Prosopis velutina*) and screwbean mesquite (*P. pubescens*). Understory species include the following: vine-mesquite grass (*Panicum obtusifolium*), and careless weed (*Amaranthus palmeri*).

The Mesquite Bosque provides important vertical structure within a riparian habitat. It provides cover and habitat for migratory birds, and supports a high density of breeding birds. The Mesquite Bosque is also prime habitat for mammals, reptiles, and amphibians because of the abundance and high nutritional value of available foods and the structural diversity of the vegetation. This habitat also provides refuge for inhabitants of the lower flood plain in the event of flooding. The canopy of the trees shields the ground from rain-splash erosion, while roots of the understory vegetation help reduce sheet and rill erosion. Mesquite Bosque habitats offer significant aesthetic value and are an important part of the historical southwestern riparian landscape.

Mesquite Bosque habitats occur where soil conditions are moist because of frequent flooding and/or high ground water levels. The plant species that naturally occur within this habitat type can, however, withstand drier periods when soil moisture conditions are low. Within the Indian Bend Wash project area, storm water flows periodically saturate surface soils, but a water table at or near the ground surface is not present. As a result, a drip irrigation system that can create the soil moisture conditions needed for a healthy Mesquite Bosque development will be installed as part of this project.

3.5 Open Space - Open Edges Habitat

Open Space habitat is defined as those areas along the edges and between patches of other various habitat types. Open space is used by wildlife for foraging and hunting and can serve as a buffer between the adjoining habitat types. It is most effective when it is interspersed with other habitats that provide cover for wildlife. Open space may include an understory of plants that serve as wildlife food sources. Edges, or the interface between various habitats and open space provide niches that are important to many birds and other wildlife species.

Open space habitat will occur in many locations within the Indian Bend Wash site. One such area is the 50' wide corridor within the Low Flow Channel that will not be planted with trees. Additional areas will include edges of the low flow channel and, south of Curry Road, the edges of the overall Indian Bend Wash channel.

3.6 Summary of Habitat Types and Values

The table below summarizes the acres of each habitat type to be developed within the Indian Bend Wash segment of the project and the value, or number of habitat units, generated by the Indian Bend Wash phase of the Rio Salado - Tempe Reach project.

Habitat Type	Value (Habitat Units per Acre per Feasibility Report)	Acres within the Indian Bend Wash Project Area (Rounded)	Habitat Units Created within the Indian Bend Wash Project Segment
Wetland - Marsh	0.7	2	1.4
Cottonwood - Willow	0.7	2	1.4
Mesquite Bosque	0.5	28	14
Open Space - Open Edges	0.3	8	2.4
Totals		40	19.2

4.1 Introduction

To successfully construct and maintain the proposed habitat improvements, a reliable supply of water will be required. Provided below is information on the proposed water source and the anticipated demand that the supply will need to meet.

4.2 Proposed Water Source

The proposed water source for the Indian Bend Wash (IBW) segment of the project is a new well that will be developed at the southwest quadrant of the IBW and Curry Road. This new well will supply all of the water required for the IBW section of the project. It will not, however, be used for those portions of the project along the Salt River. This is due to the constraints to water conveyance caused by the Tempe Town Lake, the lake's upstream dam, and the Loop 202 Freeway Corridor. The source of water for the Salt River sections of the project has not been finalized but may be water drawn directly from Tempe Town Lake.

Prior to selecting a new well as the IBW water source, various alternatives were considered. These included water from an existing well at McKellips Road and water from an existing golf course well within the Indian Bend Wash channel. These sources were rejected for a variety of reasons and, ultimately, the alternative of a new well was selected. Factors that supported this alternative include:

- The ability of the new well to provide an adequate supply of water.
- The ability of the new well to supply water of a quality suitable for the intended project uses without well-head treatment.
- A well location that was outside the limits of designated Salt River Project (SRP) lands.
- The ability of the Corps of Engineers and the City of Tempe to secure required Arizona Department of Water Resources (ADWR) permits for the new well.
- Convenient and cost effective delivery of required water to the project improvements.

4.3 Well, Water Storage, and Pumping Facility Design

The proposed new well, and the associated water storage and pumping facilities, are being designed by the URS Corporation under separate contract with the U.S. Army Corps of Engineers. Accordingly, detailed information related to the design and engineering of these facilities is not included in this DDR. A separate DDR and/or other supporting information will be provided as part of the well design project.

Coordination between the design of habitat improvements and the design of the well and pumping facilities was conducted to establish water demand and delivery requirements.

4.4 Components of the Project Water Demand

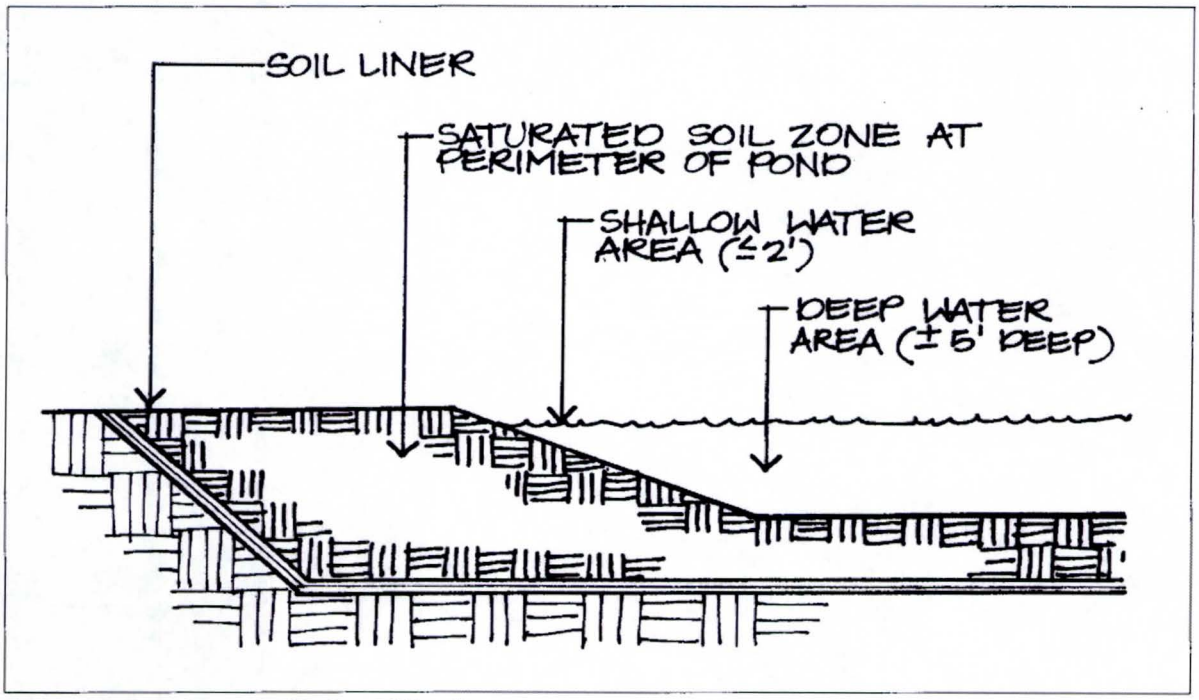
The overall water demand for the Indian Bend Wash segment of the project consists of:

- Water required for the wetland marsh system
- Water required for the project irrigation system

The design assumptions and calculations used to establish these two component demands are described below.

4.5 Components of Wetland Marsh Water Demand

The proposed concept for wetland marsh development calls for a soil liner that is buried below the bottom of the marsh and that extends beyond the perimeter of the marsh. This approach creates a saturated soil zone surrounding the marsh with soil conditions that are suitable for Cottonwood - Willow habitat development. The proposed concept is illustrated below.



Cross Section through Wetland Marsh

The volume of water needed to sustain the wetland marsh system will be equal to the sum of the loses that result from:

- Infiltration of soil through the soil liner
- Evaporation from the wetland marsh surface
- Transpiration by plants growing within the marsh and soil liner

To estimate infiltration rates for the proposed wetland marshes, data pertaining to infiltration rates at the Tempe Town Lake were reviewed. The Town Lake was constructed with a fine grained soil liner without special amendments to reduce infiltration. City of Tempe records indicate that the initial infiltration or seepage rate at the bottom of the Lake was approximately 61.21 feet per year or 2 inches per day. Over time, siltation and consolidation of the soil liner reduced this rate to approximately 38 feet per year or 1.25" per day.

The proposed wetland marsh system within Indian Bend Wash will utilize a similar soil liner. A sustained seepage rate of 1.25" per day was, however, considered unacceptable and the decision was made to specify a soil amendment that reduced infiltration. The project specifications call for the use of a natural polymer product that forms an aqueous emulsion that attaches to the soil particles closing the voids, significantly reducing the rate of infiltration. The proposed product is marketed by Soil Science International (P.O. Box 5429, Glendale, Arizona 85312) as SS-13. It has been used throughout central and southern Arizona to reduce infiltration through soil-lined ponds and lakes. This non-toxic soil amendment has been used under similar conditions and has reduced seepage to approximately 7.6 feet per year or 0.25" per day. Allowing for possible damage to the soil liner or inconsistencies in its construction, a seepage rate of 0.4" per day or 12' per year was used to estimate water loss through infiltration. Using this rate, the anticipated losses due to infiltration were calculated as follows.

	125,000 SF	(Approximate area of soil liner below marshes and wetted perimeter)
x	12.0 Ft. / Yr.	(Estimated infiltration / seepage rate)
=	1,500,000	Cubic Feet per Year, or
	11,220,750	Gallons per Year, or
	30,741	Gallons per Day

Evaporation will also be a component of the water lost from the wetland marsh system. Data from the Tempe Town Lake was used to estimate the losses due to evaporation. The rate of evaporation from the Town Lake has been monitored since its construction and found to be approximately 96 inches or 8 feet per year. Using this rate, evaporation from the marshes was calculated to be as follows.

	55,000 S.F.	Approximate Surface Area of Marshes
x	8 Ft.	Evaporation / Year
=	440,000	Cubic Feet per Year, or
	3,291,420	Gallons per Year, or
	9,017	Gallons per Day

Transpiration will occur within the planted areas at the wetted perimeter of the marshes. Based on data included in the project Feasibility Report and Environmental Impact Statement, transpiration will occur at a rate of approximately 100 inches or 8.33 feet per year. Losses due to transpiration were calculated as follows:

	70,000 S.F.	Approximate Surface Area of Wetted Perimeter
x	8.33 Ft.	Transpiration / Year
=	583,100	Cubic Feet per Year, or
	4,361,880	Gallons per Year, or
	11,950	Gallons per Day

Lastly, the wetland marsh system has been designed to allow for some bleed-off of the water in the marsh. This will prevent increasing concentrations of salts in the marshes as water is lost due to evaporation. For purposes of this estimate, a bleed-off rate of 1% of the total volume of water in the marshes was used. (The actual rate needed to maintain appropriate water quality in the marshes will need to be determined as part of the Adaptive Management Plan implementation). Calculations were as follows:

	1,300,000 Gal.	Volume of Marshes
x	1%	Bleed-off Rate
=	13,000 Gal.	Daily Bleed-off Allowance

4.6 Summary - Wetland Marsh Water Demand

To offset the losses outlined above, an average of (+/-) 65,000 gallons of water will be required each day to offset losses in the wetland marsh system. The losses and corresponding demand are summarized below.

Component:	Volume Required to Offset Losses: (All volumes rounded)
Infiltration	31,000 gpd
Evaporation	9,000 gpd
Transpiration	12,000 gpd
Bleed-Off	13,000 gpd
Total	**65,000 gpd**

4.7 Irrigation Water Demand Calculations

An estimate for the irrigation water demand for all plantings within the Indian Bend Wash segment of the project was conducted to establish the overall project water demand. This estimate was based on:

- The calculated water demand for individual plant specimens
- The estimated quantities of plants per acre for each habitat type
- The total number of acres of each habitat type within the IBW project area.

Plant water demand is based on several environmental factors including solar radiation, temperature, wind, atmospheric dryness (vapor pressure deficit), and soil moisture. It is also based on biological factors including the type, size, and species of plant being irrigated. These various factors are combined to calculate the irrigation requirements of a single plant.

The environmental factors listed above are used to compute Evapotranspiration (Et_o), which is the loss of water from a vegetative surface through the combined processes of plant transpiration and soil evaporation. Et_o data for locations throughout Arizona, including locations near the Rio Salado site, are available from AZMET, the Arizona Meteorological Network. AZMET provides daily calculations of Et_o and makes this information available on an internet website.

The biological factors used to calculate plant water demand are more subjective but important none-the-less. Empirical evidence suggests that many plant species can survive on a wide range of irrigation regimes. This is particularly true with Sonoran Desert natives, some of which can survive with either no supplemental irrigation or with significant daily applications of water. The relative drought tolerance of species is important, however, and must be considered when calculating plant water demand.

The formula used to estimate plant water demand for this project was developed by the University of Arizona Cooperative Extension Service (Waterfall, P. 1998) as a means to develop generalized estimates of the volume of water required for irrigated ornamental landscapes. The formula is:

Demand = (ET_o x Plant Factor) x Area x 7.48

Where: Demand is plant water demand in gallons per month

- Et_o is Monthly Evapotranspiration in feet per month
- Plant Factor is the relative drought tolerance of the species (.13 to .64)
- Area is the canopy, or the overall area covered by the plant's branches, at the time of interest (typically at maturity) in square feet.
- And 7.48 is a factor to convert from Cubic Feet to Gallons

The Plant Factor is a function of the species in question with values ranging from 0.13 to 0.64. It acknowledges that some species transpire at a much higher rate than others. Values suggested by the Cooperative Extension Service are as follows:

Plant Type	Plant Factor Range
Drought Tolerant / Low Water Use	0.13 to 0.26
Medium Water Use	0.26 to 0.45
High Water Use	0.45 to 0.64

This formula was utilized to calculate the peak and average plant water demand for several representative species proposed for use in conjunction with the habitat restoration. The results are as follows:

Estimated Water Demand for Mature Cottonwood (40' Diameter Canopy)

Month	ET o (Inches)	ET o (Feet)	Plant Factor	Plant Area (SF)	Conversion Factor (CF to Gal.)	Demand Per Month (Gal./Mo.)	Days Per Month (Gal.)	Demand Per Day (Gal.)
January	2.62	0.22	0.64	1256	7.48	1312	31	42
February	3.44	0.29	0.64	1256	7.48	1723	28	62
March	5.56	0.46	0.64	1256	7.48	2785	31	90
April	7.66	0.64	0.64	1256	7.48	3838	30	128
May	9.62	0.80	0.64	1256	7.48	4820	31	155
June	10.38	0.87	0.64	1256	7.48	5201	30	173
July	9.99	0.83	0.64	1256	7.48	5005	31	161
August	8.17	0.68	0.64	1256	7.48	4093	31	132
September	7.34	0.61	0.64	1256	7.48	3670	30	122
October	5.76	0.48	0.64	1256	7.48	2886	31	93
November	3.47	0.29	0.64	1256	7.48	1738	30	58
December	2.42	0.20	0.64	1256	7.48	1212	31	39
Average								104

Estimated Water Demand for Mature Willow (30' Diameter Canopy)

Month	ET o (Inches)	ET o (Feet)	Plant Factor	Plant Area (SF)	Conversion Factor (CF to Gal.)	Demand Per Month	Days Per Month (Gal.)	Demand Per Day (Gal.)
January	2.62	0.22	0.64	700	7.48	732	31	24
February	3.44	0.29	0.64	700	7.48	961	28	34
March	5.56	0.46	0.64	700	7.48	1553	31	50
April	7.66	0.64	0.64	700	7.48	2139	30	71
May	9.62	0.80	0.64	700	7.48	2686	31	87
June	10.38	0.87	0.64	700	7.48	2899	30	97
July	9.99	0.83	0.64	700	7.48	2790	31	89
August	8.17	0.68	0.64	700	7.48	2281	31	74
September	7.34	0.61	0.64	700	7.48	2050	30	68
October	5.76	0.48	0.64	700	7.48	1609	31	52
November	3.47	0.29	0.64	700	7.48	969	30	32
December	2.42	0.20	0.64	700	7.48	675	31	22
Average								58

Estimated Water Demand for Mature Mesquite (25' Diameter Canopy)

Month	ET o (Inches)	ET o (Feet)	Plant Factor	Plant Area (SF)	Conversion Factor (CF to Gal.)	Demand Per Month (Gal.)	Days Per Month (Gal.)	Demand Per Day (Gal.)
January	2.62	0.22	0.45	490	7.48	360	31	12
February	3.44	0.29	0.45	490	7.48	473	28	16
March	5.56	0.46	0.45	490	7.48	764	31	25
April	7.66	0.64	0.45	490	7.48	1053	30	35
May	9.62	0.80	0.45	490	7.48	1322	31	43
June	10.38	0.87	0.45	490	7.48	1427	30	48
July	9.99	0.83	0.45	490	7.48	1373	31	44
August	8.17	0.68	0.45	490	7.48	1123	31	36
September	7.34	0.61	0.45	490	7.48	1009	30	34
October	5.76	0.48	0.45	490	7.48	792	30	26
November	3.47	0.29	0.45	490	7.48	477	30	16
December	2.42	0.20	0.45	490	7.48	333	31	11
Average								29

Estimated Water Demand for Mature Palo Verde (20' Diameter Canopy)

Month	ET o (Inches)	ET o (Feet)	Plant Factor	Plant Area (SF)	Conversion Factor (CF to Gal.)	Demand Per Month (Gal.)	Days Per Month (Gal.)	Demand Per Day (Gal.)
January	2.62	0.22	0.45	314	7.48	231	31	7
February	3.44	0.29	0.45	314	7.48	303	28	11
March	5.56	0.46	0.45	314	7.48	490	31	16
April	7.66	0.64	0.45	314	7.48	675	30	22
May	9.62	0.80	0.45	314	7.48	847	31	27
June	10.38	0.87	0.45	314	7.48	914	30	30
July	9.99	0.83	0.45	314	7.48	880	31	28
August	8.17	0.68	0.45	314	7.48	720	31	23
September	7.34	0.61	0.45	314	7.48	646	30	22
October	5.76	0.48	0.45	314	7.48	507	30	16
November	3.47	0.29	0.45	314	7.48	305	30	10
December	2.42	0.20	0.45	314	7.48	213	31	7
Average								18

Estimated Water Demand for Mature Riparian Shrub (8' Diameter Canopy)

Month	ET o (Inches)	ET o (Feet)	Plant Factor	Plant Area (SF)	Conversion Factor (CF to Gal.)	Demand Per Month (Gal.)	Days Per Month (Gal.)	Demand Per Day (Gal.)
January	2.62	0.22	0.64	50	7.48	52	31	1.7
February	3.44	0.29	0.64	50	7.48	69	28	2.5
March	5.56	0.46	0.64	50	7.48	111	31	3.6
April	7.66	0.64	0.64	50	7.48	153	30	5.1
May	9.62	0.80	0.64	50	7.48	192	31	6.2
June	10.38	0.87	0.64	50	7.48	207	30	6.9
July	9.99	0.83	0.64	50	7.48	199	31	6.4
August	8.17	0.68	0.64	50	7.48	163	31	5.3
September	7.34	0.61	0.64	50	7.48	146	30	4.9
October	5.76	0.48	0.64	50	7.48	115	30	3.7
November	3.47	0.29	0.64	50	7.48	69	30	2.3
December	2.42	0.20	0.64	50	7.48	48	31	1.6
Average								4.2

4.8 Representative Plant Water Demand Values

Based on the tables above, representative plant water demand values were developed for the various species and types of plants proposed for use on the project. These estimated values are as follows:

Plant Type	Average Daily Demand	Peak Daily Demand
Cottonwood	100	175
Willow	60	100
Mesquite	30	50
Palo Verde	20	30
Shrub	4	7

These values were developed for the purpose of establishing a water budget for the project. Actual values will be lower when the plants are less than their mature size. A review of irrigation applications and appropriate adjustments will be necessary as part of the Adaptive Management Program.

4.9 Estimated Irrigation Demand Per Acre for Proposed Habitat Types

Using the water demand values for each plant type and the estimated quantities of plants per acre, an order-of- magnitude estimate of water demand per acre was developed. This estimate is summarized below:

Peak and Average Water Demand Per Acre for Various Habitat Types

Plant Type / Species	Estimated Plant Quantity Per Acre	Peak Water Demand Per Plant (gpd)	Peak Water Demand Per Acre (gpd)	Average Water Demand Per Plant (gpd)	Average Water Demand Per Acre (gpd)
Cottonwood - Willow Habitat					
Cottonwood	45	175	7,875	100	4,500
Willow	40	100	4,000	60	2,400
Mesquite	5	50	250	30	150
Ash / Hackberry	10	50	500	30	300
Shrubs	150	7	1,050	4	600
Totals			13,675		7,950
Total (Rounded)			**14,000**		**8,000**

Plant Type / Species	Estimated Plant Quantity Per Acre	Peak Water Demand Per Plant (gpd)	Peak Water Demand Per Acre (gpd)	Average Water Demand Per Plant (gpd)	Average Water Demand Per Acre (gpd)
Mesquite Bosque Habitat					
Mesquite	80	50	4,000	30	2,400
Desert Willow	4	50	200	30	120
Palo Verde	2	30	60	20	40
Hackberry	4	30	120	20	80
Shrubs	150	7	1,050	4	600
Totals			5,430		3,240
Totals (Rounded)			**5,500**		**3,500**

4.10 Summary - Estimated Irrigation Water Demand

Utilizing the per acre irrigation water demand rates noted above, the total projected demand for the irrigation within the Indian Bend Wash project area is summarized as follows:

Habitat Type	Estimated Area within IBW (Acres)	Peak Water Demand per Acre (gpd)	**Peak Water Demand for IBW Area (gpd)**	Average Water Demand per Acre (gpd)	**Average Water Demand for IBW Area (gpd)**
Wetland - Marsh	2	0	**0**	0	**0**
Cottonwood - Willow	2	14,000	**28,000**	8,000	**16,000**
Mesquite Bosque	27	5,500	**148,500**	3,500	**94,500**
Open Space - Open Edges	9	0	**0**	0	**0**
Totals	**40**		**176,500**		**110,500**

4.11 Total Water Demand - Indian Bend Wash Project Segment

The total water demand for the Indian Bend Wash segment of the project is summarized as follows:

Demand Component	Demand (gpd)
Wetland Marsh System Demand	65,000 gpd
Habitat Irrigation System Demand (Peak)	176,500 gpd
Total	241,500 gpd
Contingency (10%)	24,150 gpd
Subtotal	265,650 gpd
Total - Rounded	**266,000 gpd**

5.1 Introduction

The proposed wetland marshes, while creating high value habitat for a variety of wildlife species, also have the potential to support mosquito populations. Given the proximity of the site to residential areas and the potential for mosquitos to be vectors for various diseases, the wetland marshes were designed to facilitate mosquito control.

5.2 Techniques Utilized to Suppress Mosquito Populations in Constructed Wetlands

Based on research conducted at the Tres Rios wetlands project in Maricopa County (Arizona) and at other constructed wetland sites, several approaches have been found to be effective in controlling mosquitos. One of these is to keep water moving through each of the wetland marshes. A residence time of three days or less will significantly reduce the potential for mosquito development.

A second operational strategy that has been found to be effective in controlling mosquitos is the daily variation of water levels within the marshes. Mosquito larvae tend to attach to the stalks and stems of emergent vegetation at the surface of the water. By varying the water level, larvae may attach to the emergent vegetation at the water surface, but they are then subjected to being above or below the water surface elevation as the water level is varied. This regular change in water level has been found to suppress mosquito breeding within the marsh.

A third strategy is to limit the width of the areas which support emergent vegetation and to provide open water areas within the marshes. The open water allows the marsh to support populations of larvivorous fish. By limiting the width of the emergent vegetation, access to the mosquito larvae by the larvivorous fish is enhanced.

5.3 Residence Time within the Proposed Wetland Marshes

To maintain a residence time of less than three days within each wetland marsh, it is necessary to introduce into the system each day, or recirculate within the system each day, a volume of water equal to one-third the total volume of water in that marsh. To accomplish this, new well water could be introduced and allowed to

flow through the proposed series of two marshes. This approach, however, requires the supply of a large volume of water each day. It also creates the need for the discharge of an equal volume of water. Water from the marshes could be discharged into the Indian Bend Wash low flow channel. This approach, however, was considered to be an inefficient use of limited water resources and was rejected.

Rather than introducing all new water into the marshes and discharging water from the marshes into Indian Bend Wash, the proposed wetland marsh system will have a recirculation pumping system. This system will draw water from the south end of the lower marsh and pump it to the north end of the upper marsh. The recirculated water will be allowed to flow through the upper marsh and then into and through the lower marsh where it will again be recirculated. The pumping system will have the capacity to move, each day, not less than one-third the volume of water in each marsh, thereby maintaining a residence time of less than three days. Some bleed-off will be provided to prevent the build-up of salts in the marsh water.

5.4 Water Level Fluctuation in the Proposed Wetland Marshes

In addition to maintaining a three-day maximum residence time in the marshes, the recirculation pumping system will also result in daily fluctuations in the water surface elevation. When the pumping cycle begins, the water level in each marsh will be in a static condition. As water is pumped out of the lower marsh, the water level in this marsh will drop. As water is discharged into the upper marsh, the water level in this marsh will rise. For a period of time, the water level in each marsh will have been changed by several inches.

Water will then be metered out of the upper marsh at rate slower than it was pumped in. When the pumping cycle is completed, the pumped water will slowly drain back into the lower marsh returning the water surface elevation in each marsh to the original static condition.

5.5 Maintenance of Open Water Areas

The maintenance of open water areas within the marshes is a function of water depth. The proposed marshes will be constructed with a shelf that is approximately two feet (2') wide. Water depth along the shelf will be between one and two feet. Beyond the shelf, the water level will increase to a depth of five feet (5'). This increased water depth will prevent the growth of emergent vegetation and create open water areas within each of the two marshes.

6.1 Introduction

The pumping system for the wetland marshes will move water from the lower marsh to the upper marsh to maintain water movement through the system. This movement of water will reduce the potential for mosquito related problems. The components of the pumping system and the proposed sequence of operation are as follows.

6.2 Recirculation Intake

The intake will supply water to the recirculation pump station and will consist of a 12 inch diameter, C-900 PVC pipe with a 45 degree bend turned up and capped with a stainless steel coarse screen. The flow line of the 12 inch inlet drain will be 0.5 feet above the bottom of the lower wetland marsh (Marsh Number Two).

6.3 Recirculation Pumps

A duplex pump station is proposed. This station will utilize submersible pumps and a wet well. Each of the pumps will have a 7.5 HP motor with a capacity of 1000 gpm at a discharge pressure of 20' TDH (9 psi). The pumps will operate alternately.

6.4 Recirculation Force Main

The interconnecting piping between the pump station and the discharge point will be PVC C-900 pipe. Pipe size will be 10-inches in diameter. Water will be discharged into the upper marsh (Marsh Number One) via a 10 inch diameter riser and gooseneck. The water will discharge on to a grouted rip-rap structure. An air gap will be provided that will be a minimum of 2 pipe diameters above the dynamic water level.

Water from Wetland Marsh Number One will flow into Wetland Marsh Number Two via an 8-inch diameter C-900 PVC pipe. A gate valve will control the rate of flow. The inlet of the pipe will be submerged within Wetland Marsh Number One and will consist of a 45 degree elbow with a coarse stainless steel screen. The water will be discharged into Marsh Number Two via an 8-inch diameter riser and gooseneck. The invert of the gooseneck will be at the same elevation as the static level of Marsh Number One. The water will discharge on to a grouted rip-rap structure. An air gap will be provided that will be a minimum of two pipe diameters above the dynamic water level of Marsh Number Two.

6.5 Makeup Water

Makeup water will be provided to offset losses in the wetland marshes due to seepage, evaporation, and vegetation uptake from the ground water well. The force main will be an 8-inch diameter C900 PVC pipe. This pipeline will deliver water to either of the two wetland marshes.

The water will be discharged into either marsh via an 8-inch diameter riser and gooseneck. Water will discharge onto a grouted rip-rap structure. An air gap will be provided that is two pipe diameters above the dynamic water level of each wetland marsh.

6.6 Bleed-off Lines

Both marshes will be equipped with 8-inch diameter bleed-off lines. These bleed-off lines will enable the periodic release of water that has accumulated a high salt content. The bleed-off lines will also allow for the draining of the marshes for maintenance or other purposes. The intakes of both lines will be submerged and will consist of 45-degree elbows with coarse stainless steel screens. Water from the wetland marshes will be released into the Indian Bend Wash by manually opening a valve on each line. Water will discharge onto grouted rip-rap structures.

6.7 Overflows

Overflow structures will be provided at each marsh. The overflow structures will be grouted rip-rap channels. Wetland Marsh Number One will discharge into Wetland Marsh Number Two once the dynamic level of Marsh Number One is reached. Wetland Marsh Number Two will discharge into Indian Bend Wash when the high water level of Wetland Marsh Number Two is exceeded.

6.8 Controls and Sequence of Operation

The control panel will be located at the well water delivery pump station. This duplex pump panel will include a main disconnect switch, starters for both pumps, hand off/auto switches, run indication pilot lights, and miscellaneous interlock logic components and timers. An automatic alternation relay will be provided to enable only one pump to run in automatic mode at a time. When both pumps are switched to the automatic mode, a different pump will run during each sequence.

A weatherproof irrigation timer will be mounted adjacent to the pump panel. Maintenance personnel will be able to adjust the start and duration times of the recirculation and fill sequences without entering the pump control panel.

Two solenoid activated control valves located elsewhere will enable automatic filling of each wetland marsh. An underground ductile iron standpipe between the two marshes will provide a mounting location for a high level switch for Wetland Marsh Number One. High and low level switches for Wetland Marsh Number Two will be mounted within the pump vault.

To fill both Wetland Marshes, the operator will configure the irrigation timer in Manual Mode so that Output One is on, and make sure that both the hand valves upstream of the make-up valves are open. Each make-up valve will close automatically when the corresponding marsh is full. For automatic mode, the irrigation timer should be set up to enable Output Two to run one pump long enough to pump the desired volume from Marsh Two to Marsh One.

The automatic fill sequence can be programmed to occur at any time, independent of the recirculation sequence. The proposed configuration will enable the marshes to fill after enough time has elapsed following the recirculation cycle, to allow Marsh Number One to drop back to its normal, static high level. The resulting sequence will be as follows:

1. Half of the daily recirculation volume is pumped from Wetland Marsh Number Two to Wetland Marsh Number One.
2. Marsh Number One drains back into Marsh Number Two during the recirculation, and continues to drain into Marsh Number Two until Marsh Number One has dropped to its static level. A gate valve will control the rate of flow from Marsh Number One to Marsh Number Two.
3. After enough time has elapsed to ensure that step two above has been completed, both marshes will be at their static levels.
4. The sequence of steps 1 through 3 will be repeated 12 hours later.

6.9 Electrical Service

All electrical panels will be wall mounted on the interior wall of the Pumping Station Yard. A 480V 3 phase 4 wire feeder will be run from the Pump Station service entrance section to a 100A panelboard "PL". (Pump Station service entrance section by others). Panel "PL" will serve the lighting circuit and sump pump motors. Panel "PL" will also subfeed a Sq. D minipower zone panel "MPZ-1", which is a panelboard with an integral 480V to 240/120V stepdown transformer. Panel "MPZ-1" will provide power to the Marsh Level Control Panel and the irrigation controller receptacle.

6.10 Marsh Water Level Control

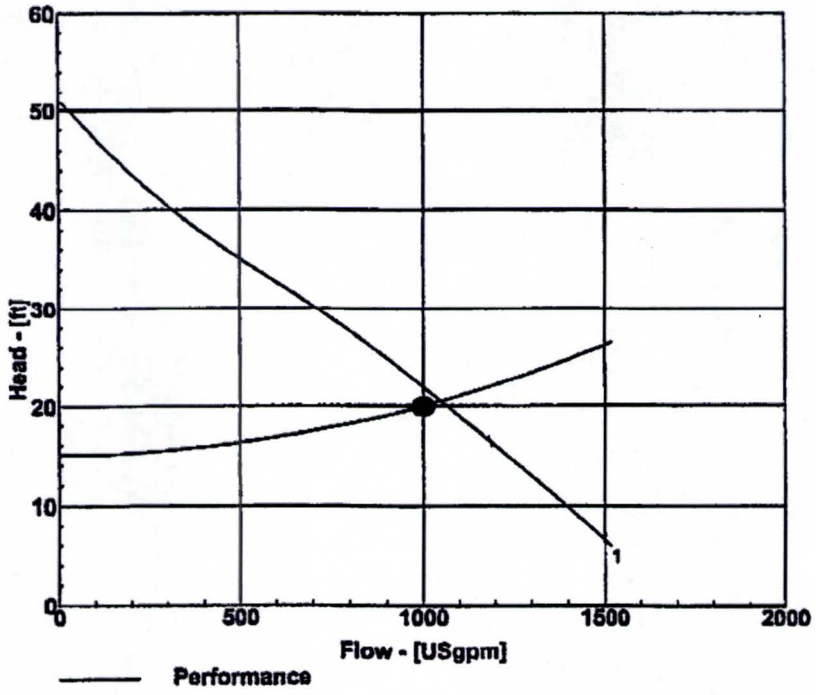
The marsh water levels will be alternately raised and lowered to provide vector control of mosquito populations. The marsh water make-up will be controlled by a feedback control system. The system consists of marsh water level sensors which report back to the Marsh Level Control Panel. The Marsh Level Control Panel will actuate solenoid valves as necessary to make-up water lost to evaporation and bleed-off.

6.11 Pump Curve for Recirculating Pumps

Provided on the following page is a plotted Duty Analysis - Performance Curve for the proposed wetland marsh recirculating pump(s).

Duty Analysis - Performance curves

Project: RIO SALADO WETLANDS PONDS
Created by:: BRUCE P. LORING, P.E.



1. NP 3127 - 63-422-00-2210 7.5 hp 188 mm

7.1 Introduction

The scope of the improvements to be constructed within the Indian Bend Wash segment of the Rio Salado - Tempe Reach project include miscellaneous public access and public use facilities. These improvements include a new entry drive, a thirty-four space parking lot, an improved maintenance / multi-use path, a small overlook plaza, and a shade ramada. These facilities have been designed to accommodate both recreational and operations-and-maintenance activities.

7.2 Proposed Entry Drive

A short entry drive is proposed for public and maintenance access to the site. The entry drive will connect to Miller Road south of its intersection with Curry Road. This entry drive will provide public access to the new parking lot. It will also provide access to; the new water supply well, the water storage and pumping facilities, the wetland pond recirculation pumping system, and the habitat improvements south of Curry Road. The proposed entry drive will be constructed of asphaltic concrete with the pavement section being in accordance with the recommendations included in the Geotechnical Investigations Report. (See Appendix B).

7.3 Parking Lot

A thirty-four space parking lot will be constructed at the southwest quadrant of Curry Road and the Indian Bend Wash. This parking lot will allow for improved public access to the existing multiple-use path that follows the levee on the west bank of the Indian Bend Wash channel. Handicapped spaces and ADA compliant access to the multi-use path will be provided in accordance with applicable standards.

Dusk to dawn lighting will be provided within the parking lot in accordance with City of Tempe development standards. The parking lot will be paved with asphaltic concrete and will have concrete curbs. The pavement section will be in accordance with the recommendations included in the Geotechnical Investigations Report.

7.4 Maintenance / Multi-Use Path Improvements

The construction of the parking lot and entry drive will necessitate the realignment of a portion of the existing maintenance / multi-use path. The subject section of path will be removed and replaced. The width of the new path will be twelve feet (12') per City of Tempe standards.

In addition to the portion of the existing path that is impacted by parking lot construction, there is a section of path along the levee, south of the proposed parking lot, that will also be replaced. The section to be replaced is paved with asphaltic concrete and is in disrepair. It will be replaced with portland cement concrete pavement that will support required maintenance vehicle traffic as well as bicycle and pedestrian traffic. The new path will be 12' wide per City of Tempe standards.

7.5 Overlook Plaza

A small overlook will be constructed along the bicycle / multi-use path south of Curry Road. This overlook will be in the vicinity of the new wetland marsh ponds. It will provide visitors with an accessible location where they can observe riparian plants, birds, and other wildlife. The proposed overlook plaza will match the grade of the improved multi-use path on the west and be slightly above channel grade on the east. A railing along the eastern edge of the overlook will discourage visitors from walking through the sensitive habitat area surrounding the new wetland ponds. Improvements to be constructed or installed at the overlook include; benches (with arms), bicycle racks, a drinking fountain, planting, and a shade ramada. The overlook will include space for future interpretive signs and exhibits.

7.6 Ramada

A 20' x 20' ramada is proposed for the small overlook plaza. This structure will serve visitors who have come to the site to view the habitat improvements. It will also serve as a rest area for individuals walking or biking along the adjacent multi-use path. The ramada will be a steel frame, pre-engineered structure with a metal roof. The roof panels will have a permanent, colored, Kynar finish to eliminate the need for painting. The ramada floor and surrounding plaza will be paved with colored, precast concrete unit pavers. Benches will be provided below the ramada for interpretive / educational programs and for recreational use. All benches will have arms between the individual seating units. A dusk to dawn security light will be provided at the ramada.

7.7 Retaining Wall System

A series of two, low retaining walls will be constructed as part of the overlook development. A dry-stacked, keyed masonry system will be used to construct these walls. The bottom of each wall will extend below grade, to a depth below the existing levee armoring. Geo-grid tie-backs will be utilized for the lower of the two walls.

8.1 Introduction

When the original Indian Bend Wash project was developed by the U.S. Army Corps of Engineers, it was designed to meet Corps standards for conveyance capacity and for minimum freeboard. The original engineering design did not, however, anticipate the development of habitat improvements as currently proposed. Accordingly, one of the initial tasks associated with the current project was to evaluate the impacts of the proposed habitat improvements on channel hydraulics.

The "Hydraulic and Hydrologic Design Analysis Report" (McGann & Associates / Novak Environmental Joint Venture, Revised - June 2002) found that:

- Modifications to the channel, after its initial construction by the Corps, had created conditions where the freeboard during the Q = 100 year storm event did not meet Corps of Engineers standards.
- The proposed habitat improvements had the effect of raising the water surface elevation during the Q = 100 year storm event, creating additional areas where the freeboard would be deficient relative to Corps standards.
- Modifications to raise the effective elevation of the levee, through the construction of low walls, could correct the pre-project deficiencies while at the same time creating sufficient freeboard to allow for the development of the habitat improvements proposed by the current project.

The Corps of Engineers and City of Tempe (the project's local sponsor) have established a method for funding the required flood control improvements and have expanded the scope of the current A-E contract to include the engineering and design of these facilities.

The hydraulic water surface profile for the Corps' 30,000 cfs (including 2.5 feet of freeboard) design discharge, which was developed and presented in the Hydraulic and Hydrologic Design Analysis Report (Rev. June 2002) was used to set the top of wall heights.

8.2 Design Considerations

The following items were considered in the design of the proposed flood control improvements.

- The cost of the improvements.
- The impact of the improvements on existing facilities (bike path, light poles, landscape plantings, utility structures, etc.).
- The impact of the proposed improvements on the golf course located within the IBW channel between Curry Road and McKellips Road.
- Maintenance of sufficient channel conveyance capacity in Indian Bend Wash by limiting restrictions within the channel cross-section.
- Maintenance of an unobstructed clear-zone adjacent to the existing and future bicycle / multi-use path along the west bank of the Indian Bend Wash.
- Maintenance of access to the golf course on the east bank of Indian Bend Wash.

8.3 Proposed Improvements - West Levee Bank

Along the west bank, the improvements proposed to correct the existing freeboard deficiency and to provide the additional freeboard required for this project will consist of a low wall in selected locations. Approximately 2,850 linear feet of wall will be required.

The subject wall will be constructed on the golf-course side of the existing bike path. Consideration was given to construction of the wall on the west side, but steep grades on the west side sloping away from the bike path would have resulted in the need for a substantially higher structure.

The proposed wall will be constructed with a four foot (4') offset from the edge of the existing bike path. The offset will allow for the future widening of the path by two feet while providing the two-foot clear zone required by the Arizona Department of Transportation's "Arizona Bicycle Facilities and Planning Design Guidelines."

When the multi-use path is widened in the future, portions of the existing chain-link fence separating the path from the golf course will need to be removed and replaced. To minimize potential impacts on the golf course, the new (relocated fence) will be installed on top of the flood control wall.

The City of Tempe was presented with three alternative designs for the proposed flood control wall. They included a split-face CMU wall, a CMU wall with stucco finish and reveal for art (by others), and a cast-in-place concrete wall. The City of Tempe selected the split-face CMU alternative.

8.4 Proposed Improvements - East Levee Bank

Along the east bank, a golf cart path has been constructed along the top of the levee. In some locations, tall screens have been constructed adjacent to the golf course and driving range to stop errant golf balls. The relocation of these screens was not feasible.

To provide the required increase in levee elevation, a low wall will be constructed at selected locations. Wherever possible, the wall will be constructed on the east side of the existing cart path so as to minimize impacts on the golf course. Approximately 2,600 linear feet of wall will be required in this area.

Openings in the wall will be provided to allow maintenance vehicle access

- From the existing golf course maintenance facility to the course
- From the golf cart storage area to the course, and
- From the parking lot to the club house and course.

In locations where there will be an opening, the elevation of the cart path will be raised to provide the required freeboard.

8.5 Flap Gates on Storm Drain Outlets

Within the project limits there are several storm drains that discharge into the Indian Bend Wash channel. These drains are not equipped with flap gates. At the request of the Flood Control District of Maricopa County, flap gates will be installed at each outfall structure to prevent storm water from backing up into the storm drain system. The flap gates will be installed by the City of Tempe as part of a separate contract.

8.6 Protection of Existing Levee Armoring

The original construction of the Indian Bend Wash flood control levees through the project site included the installation of buried rock armoring on the channel side of the levee. This rock armoring will be retained-in-place. When the armoring is encountered during the construction of project improvements, it will be restored to its original condition by the construction contractor. Inspections of all repaired, replaced, or modified levee armoring (by the Corps and the Flood Control District of Maricopa County), to ensure proper installation of the armoring material, are required by the project specifications.

9.1 Introduction

The scope of the project includes new lighting for the public access parking lot. A dusk-to-dawn light fixture will also be installed at the new ramada.

9.2 Parking Lot Lighting

The project parking lot will be illuminated with new light fixtures to be installed as part of this project. The lighting will comply with applicable City of Tempe standards and ordinances. Features of the proposed parking lot lighting system include:

- Shielded fixtures / luminaires.
- High-Pressure Sodium lamps
- Twenty-five foot (25') fixture mounting height
- Polycarbonate, vandal-resistant lense shields
- Maintained illumination levels of +/- 2 foot candles within parking stalls and adjacent pedestrian areas.

Additionally, the proposed light pole / fixtures locations were coordinated with the location of the proposed landscape plantings to prevent future shading of illuminated areas by trees or other vegetation.

9.3 Ramada Lighting

A single light fixture will be installed under the roof of the proposed ramada. This fixture will be on from dusk to dawn to enhance public safety during the early evening hours. The light will also serve to discourage loitering at the ramada late at night and during the early morning hours. The moderate level of lighting provided by this fixture will also serve to minimize the impact of new lighting on the proposed habitat improvements.

Features of the proposed ramada light include:

- Vandal-resistant fixture / luminaire
- High-Pressure Sodium lamp
- Polycarbonate, vandal-resistant lense shield

9.4 Existing Multi-Use Path Lighting

The existing light fixtures adjacent to the multi-use path on the west levee of Indian Bend Wash will be retained. One of these fixtures, located at the south end of the underpass below Curry Road, will be removed to accommodate the new multi-use path. The area where the existing light fixture is to be removed will be illuminated by the new parking lot lighting system.

Appendix A:
Site Survey Information

TETRA TECH, INC.
INFRASTRUCTURE SOUTHWEST GROUP
4801 E. Washington St., Ste. 260, Phoenix, AZ 85034-2004
Phone 602.682.3300 • Fax 602.682.3315

INDIAN BEND WASH PROJECT
RIO SALADO
TEMPE, ARIZONA

TASK:

1. To obtain new topographic detail along the boundaries of the Maricopa County Flood Control Channel between McKellips Road and Curry Road, including drainage structures on both ends.
2. Incorporate City of Tempe GIS Data, by converting from NAD27 to NAD 83 and from NGVD29 to NAVD88 (if needed).
3. Combine Existing Lidar topo with new topo to create new surface and contour information.
4. Pick up existing culture on the SW (SE? – SW is a parts place) quadrant of Miller Road and Curry Road for proposed rest room and parking lot site.

CONTROL & SURVEYING METHODS

We used 4 GDACS monuments which are available on the NGS site, with valid X,Y & Z data to orient our RTK Javad Receivers. These monuments had AZ State Plane Coordinates in NAD83. North American Vertical Datum Elevations for these points were obtained from the published GDACS sheet for Maricopa County available on the MCDOT website.

Our chosen control points were PAB1, 1BH1, 1CI1, AND COT1. These control points were chosen because of their exterior location to the project, being nearly equidistant and in all four quadrants.

Our initial calibration on the GDACS control produced error ellipses less than 0.01 feet in both the horizontal and vertical datum. We then measured the City of Tempe Control located at the quarter-section corners nearest to the project. This allowed us to obtain NAD83 horizontal positions and NAVD88 elevations for the City of Tempe Control (which was already NGVD29. As we compared differences in elevation between any two City of Tempe monuments and differences in our NAVD88 measurement of the same, we saw differences of less than 0.02 feet.

We measured with conventional instrumentation between the City of Tempe monuments to obtain a valid ground distance. When compared to the NAD83 (reduced to ground) measurements obtained by GPS we again came to a very close tolerance of ±0.03'.

METHODS (cont.)
Since we now had strong confidence in our local control and it was on NAD83/NAVD88, we set subsequent control stations for occupation by both conventional surveying instruments and GPS, and took topographic measurements of the designated areas, periodically checking into said control.

MANIPULATION OF CITY OF TEMPE DATA
It was observed that there was no necessary vertical component of the City data. Once NAD88 positions were determined for the City control, the City of Tempe data was rotated and scaled using Autocad. Checks made on common points other than those used for rotation and scaling revealed close matches within ±0.05 feet.

USE OF LIDAR (ARMY CORPS) DATA
It was observed that the Lidar contour data came with a statement of derivation claiming that the measurements were NAD83 US Foot. Arizona State Law requires NAD83 measurements to be in the International Foot. Since the monuments calibrated on by Earth Data were in International feet we feel this was probably a typographic error. To obtain US Survey foot data probably would have required an override of the measuring device or a conversion from already legal data which there would have been no reason to perform. When the existing lidar data was placed under our NAD83 control and topography the fit appeared to be seamless. It was also evident by the X and Y position that this data had not been reduced to "ground" horizontally. A ground to grid reduction will move the coordinates about 200 feet in the X axis and 600 feet in the Y axis. The existing Lidar data appeared to juxtaposition with our NAD83 grid measurements. Thus, we used the Lidar data as is and kept our measurements at AZSPC Grid.

USE OF MARICOPA FLOOD CONTROL DISTRICT BOUNDARY DATA
Jim Cristea of Tempe provided us with the MCFCD boundary plan for this portion of Indian Bend Wash. Using located quarter section corners, this plan was input to the drawing and resides under the Boundary layer. Since the measurements of this survey are at ground there is a probable error of ±.10 feet every thousand feet of length. It was felt by this surveyor that for the purposes of this project that will be sufficient. Various monuments found on the project, as well as fences and walls conformed very well to this boundary.

CREATION OF SURFACE
The original Lidar contours were used to create a surface by Land Development ACAD2002. The new topography points were also used to create a surface. These two surfaces were then combined to produce a new set of contours. Especially noticeable in this new set of contours are the concrete faces of the bridge structures to the south, where the contour lines run up the face of the structure. We created a contour set at 0.5 foot intervals which is the same as the original Lidar. We also created a contour set of 2 feet

CREATION (cont.)
which should be much easier to work with, and probably sufficient. Both are existent in the supplied data.

CULTURE AND BOUNDARY AT MILLER ROAD AND CURRY ROAD
All existing culture was picked up at Miller road and Curry Road. It was noted that a large business occupied the originally stated area (SW quadrant) and it was likely that the SE quadrant was the desired area. However we picked up detailed culture for both the NE quadrant and the SE quadrant. No survey monuments were found in either of these areas even though we had the legal descriptions. It appears construction has probably removed much of the monumentation.

Please contact me at 603-682-3378 with questions or problems and we will quickly and efficiently resolve any issues that might arise.

Respectfully,

TETRA TECH, INC.
Infrastructure Southwest Group

Bradley W. Sargent, RLS

Appendix B:
Geotechnical Investigation Report for Proposed Parking Lot

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Final Geotechnical Investigation Report
Rio Salado Habitat Environmental Restoration Project
Tempe Reach
Tempe, Arizona

Submitted to:

McGann & Associates –
Novak Environmental Joint Venture
Phoenix, Arizona

Submitted by:

AMEC Earth & Environmental, Inc.
Phoenix, Arizona

9 January, 2001

AMEC Job No. 0-117-001135

amec

9 January, 2001
AMEC Job No. 0-117-001135

Mr. Donald K. McGann
McGann & Associates - Novak Environmental Joint Venture
6814 North Oracle Road
Suite 210
Tucson, Arizona 85704

Dear Mr. McGann:

Re: Final Geotechnical Investigation
Rio Salado Habitat Environmental
Restoration Project
Tempe Reach
Tempe, Arizona

Submitted herewith is our Geotechnical Investigation Report for the above referenced project. Included are the results of test drilling and recommended criteria for foundation design, site grading and on-site paving.

Should you have any questions concerning the recommendations presented in this report, please do not hesitate in contacting us.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

Daniel N. Fréchette, Ph.D., E.I.T.

Reviewed by:

Registered Professional Engineer (Civil) CERTIFICATE NO. 13873 LAWRENCE A. HANSEN 1/9/01

Lawrence A. Hansen, Ph.D., P.E.
Senior Vice President

G:\Engineering-Development\2000Projects\0-117-001135 Rio Salado Habitat Restoration\Rio Salado Habitat Tempe.doc

c: Addressee (3)

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LIST OF APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation performed by AMEC Earth & Environmental, Inc. (AMEC) for the Rio Salado Habitat Environmental Restoration Project - Tempe Reach located at the southeast corner of Curry Road and Miller Road in Tempe, Arizona. The purpose of the investigation was to examine the geotechnical profile beneath the site and to evaluate the engineering properties of the subsurface materials. This information was used to provide criteria for the design of foundations and to prepare recommendations related to site grading, excavation and other aspects of the project where soil properties or behavior should be considered.

2.0 PROJECT DESCRIPTION

Details of the project were provided in a memorandum dated November 1, 2000 from Mr. Donald K. McGann of the McGann & Associates/ Novak Environmental Joint Venture. Elements of the project for the present phase of the work include a restroom building and an associated parking lot. These facilities will be located at the southeast corner of Curry Road and Miller Road in Tempe, Arizona.

3.0 INVESTIGATION

3.1 Subsurface Exploration

Three test borings were advanced by auger methods to depths of 10 to 18 feet below existing site grades. The borings were advanced using a CME-75 drill rig equipped with a 6 5/8-inch O.D. hollow stem auger. Standard penetration testing and open-end drive sampling were performed at selected intervals in the borings. The soils encountered during the investigation were continuously examined, visually classified and logged.

Results of the field investigation are presented in Appendix A, including a site plan showing the boring locations and logs of the borings. The field investigation was supervised by Daniel N. Fréchette, Ph.D., E.I.T., of this firm.

4.0 SITE CONDITIONS AND GEOTECHNICAL PROFILE

4.1 Site Conditions

The site is located at the southeast corner of Curry Road and Miller Road. The northern portion of the site is approximately 10 feet below Curry Road and relatively flat. The southern portion of the site gently slopes upwards to the southeast. The site is bordered by businesses along the south side and by an elevated access road to the east. As shown on the site plan, an existing concrete sidewalk that passes through the site.

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4.2 Geotechnical Profile

The geotechnical profile underlying the site can be generalized as a three-strata system as follows:

- Stratum A: Predominantly fine-grained material that consists of clayey sand, sandy silt, sandy clay, and clay extends from the ground surface to a depth of 5.5 to 8 feet. The soils in this stratum range from soft to very firm with the softer zones having a higher water content.

- Stratum B: Predominantly granular material that consists of sand and silty sand was encountered below the Stratum A soils and extended to a depth of 15.5 feet. The soils in this stratum are characterized as generally nonplastic and medium dense.

- Stratum C: Sand, gravel and cobbles underlie Stratum B and extended to the full depth of the borings. These materials are very dense and may contain boulders up to about 18 to 24 inches in diameter.

4.3 Groundwater and Soil Moisture Conditions

No free groundwater was encountered in the excavations. The moisture contents of the soils varied from 4 to 27 percent, with the finer-grained material of Stratum A having higher moisture contents.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Discussion

The near-surface soils encountered in the test borings have the potential for being soft and somewhat moisture-sensitive. In order to use shallow spread-type foundations at the intended location of the restroom, overexcavation and recompaction of the soils beneath foundations, floor slabs and exterior pavements is recommended. The upper 2.0 feet of soils in Stratum A or 2.0 feet below the base of footings, whichever is deeper, should be overexcavated and replaced with properly compacted structural fill. The upper 1.0 foot of Stratum A soils, or 1.0 foot below the base of slabs or pavements, whichever is deeper, should be overexcavated and replaced with properly compacted structural fill. All cut surface, pavement and slab subgrade areas, and areas to receive fill, should be scarified in the upper 8 inches, brought to within 2 percent of optimum moisture and compacted to at least 95 percent of maximum dry density in accordance with ASTM D698.

5.2 Spread-Type Foundations

Design criteria for shallow spread-type or mat-type foundations are presented in the following subsections.

5.2.1 Design Criteria for Downward Loads

Where footings bear on Stratum A soils, the following design bearing pressures should not be exceeded:

Loading Conditions	Recommended Soil Bearing Pressure (psf)
Dead loads	1,700
Dead plus normal live loads (static condition)	2,500
Dead plus normal live loads plus transient wind or seismic loads	3,750

These pressures should be considered as the net soil bearing pressure at the footing base.

The footings should be extended to a minimum depth of 1.5 feet below the lowest adjacent finished. Recommended minimum widths for square and continuous footings are 2.0 and 1.33 feet, respectively.

5.2.2 Resistance to Lateral Loads

The passive soil resistance of properly compacted backfill or Stratum A soils against the edges of spread-type foundations, stem walls and similar vertical foundation elements should be considered as being equal to the forces exerted by a fluid of 300 pounds per cubic foot (pcf) unit weight. A coefficient of friction of 0.40 is recommended for computing the lateral resistance between the bases of foundations and the underlying soils when analyzing lateral loads.

5.2.3 Estimated Settlement

It is estimated that the settlement of footings designed in accordance with the recommendations of Section 5.2.1 will be a maximum of 1 inch for soil moisture contents in the existing soils at the time of test excavations. Significant increases in moisture content within the supporting soils could cause additional settlements.

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5.3 Site Grading

5.3.1 Surface Preparation

All vegetation and debris should be removed from areas designated for pavements, slabs and structures. All concrete paving and slabs presently on-site should be removed from areas designated for buildings, exterior slabs or walkways, and paving.

The exposed surfaces upon which fill, building pads, exterior slabs or pavements are to be placed should be scarified in the upper six inches, brought to within the range of two to plus three percent of optimum moisture content and compacted to at least 95 percent of maximum dry density as determined by ASTM D698.

The surfaces exposed by overexcavation should be observed by a representative of the geotechnical engineer to verify that all soft zones of Stratum A have been removed. Overexcavation beyond the limits discussed in Section 5.1 may be required based on the conditions encountered.

5.3.2 Structural Fill

All structural fill utilized on the property should be free of vegetation, debris and other deleterious material, and should contain no particles larger than six inches in diameter. All structural fill should be compacted to within the range of one percent below to three percent above the optimum moisture content and to a density of at least 95 percent of maximum dry density as determined by ASTM D698.

In general, structural fill should have no more than 50 percent by weight passing the no. 200 sieve and should have a plasticity index of no more than 15 when tested by ASTM D4318. It appears that the Stratum A soils will not meet the above criteria.

5.3.3 Granular Base

Granular base, when used, should meet the following gradation requirements as determined by ASTM D422:

Sieve Size (square openings)	Percent Passing by Weight
1 1/8 inch	100
No. 4	38-65
No. 8	25-60
No. 30	10-40
No. 200	3-12

The plasticity index of the fraction of material passing the no. 40 sieve should not exceed 5 when tested by ASTM D4318. The coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM C131), of no greater than 45. Granular base should be free of excessive vegetation, debris and other deleterious materials.

All granular base should be compacted to at least 95 percent of maximum dry density, as determined by ASTM D698.

5.4 Concrete Slabs Cast-On-Grade

5.4.1 Slab Support

Where structural fill is maintained at or below compaction water contents, it will afford as firm or firmer slab support as would be provided by granular base course. Thus, the use of granular base is not necessary for structural support of slabs. However, granular base may provide a more desirable working surface, minimize capillary rise of moisture to slabs, and aid in proper curing of concrete. If its use is desired for these purposes, a 4-inch course of material meeting the requirements of Section 5.3.3 is recommended.

5.4.2 Structural Design of Slabs

Slabs bearing on either structural fill should be designed using a modulus of subgrade reaction (k) of 300 pounds per cubic inch. These values are recommended for the structural design of concrete slabs cast-on-grade, provided site grading is completed as recommended in Section 5.3.

5.4.3 Moisture Protection of Slabs

Granular base would tend to act as a capillary barrier to moisture, but would not provide a positive barrier against the rise of moisture through the slabs. If impervious or otherwise moisture-sensitive floor coverings are used, an impervious membrane vapor barrier is recommended.

5.5 Site Drainage and Moisture Protection

Positive site drainage should be provided during construction and maintained thereafter. Where possible, asphaltic pavement or concrete slabs should immediately adjoin the structure. Otherwise, the ground surface should be sloped away from the perimeter of the structure at a minimum grade of 2 percent for a distance of 15.0 feet.

Roof runoff should be carried away from the structure by nonerosive devices at the ground surface, and in no case should long-term ponding of water be allowed near the building during or after construction.

The possibility of moisture infiltration beneath the structure in the event of plumbing leaks should be considered in the design and construction of underground water and sewer conduits.

5.6 Pavements

Pavement design analysis was performed for on-site paving based on a correlation between grain-size analysis and Atterberg limits test data, current Arizona Department of Transportation (ADOT, 1989)* design methods which have been sanctioned for use by municipalities belonging to the Maricopa Association of Governments (MAG), and this firm's experience with similar projects.

Recommendations for conventional asphaltic concrete over granular base and full thickness asphaltic concrete for on-site paving are provided in Sections 5.6.1 and 5.6.2, respectively. The recommended pavement sections are contingent on a minimum thickness of 12 inches of compacted subgrade.

All recommended asphaltic concrete pavement sections are also contingent upon the application of a seal coat to the finished surface of the asphaltic concrete within a period of one month to a year following new pavement construction. It is our experience that application of a seal coat prior to one month after placement can be detrimental to the curing of newly constructed asphaltic concrete.

5.6.1 Asphaltic Concrete Over Granular Base

The following conventional asphaltic concrete over granular base pavement structures are recommended:

Area	Asphaltic Concrete	Granular Base
Passenger Car Traffic	2 inches	4.5 inches
Heavy Truck Traffic	3 inches	4.5 inches

5.6.2 On-Site Full Thickness Asphaltic Concrete

The following full thickness asphaltic concrete pavement sections are recommended:

*References are listed at the end of this report.

Area	Asphaltic Concrete
Passenger Car Traffic	3.5 inches
Heavy Truck Traffic	4 inches

5.6.3 Materials Quality and Construction Requirements

The materials quality and construction requirements should conform to the following sections of the current 'Uniform Standard Specifications for Public Works Construction' (1998) sponsored and prepared by the Maricopa Association of Governments:

Item	Section(s)
Untreated Base	310 & 702.2
Bituminous Prime Coat	315
Asphaltic Concrete	321 & 710

The type of seal coat should be determined based on construction performance.

5.6.4 Asphaltic Concrete

A type C19 mineral aggregate or approved alternate should be utilized. The job mix formula should be established using the Marshall method of mix design (ASTM D1559), with design parameters determined by MAG Section 710. The following criteria should be used in the mix design:

Oil Type - PG70-10
Number of blows, each end of specimen - 75
Stability, pounds - 1,800 minimum
Percent air voids - 3 to 5
Percent voids in mineral aggregate - 14 minimum
Index of retained strength, % - 60 minimum

The stripping potential of the job mix formulation should be determined in accordance with MAG Section 710. The type and quantity of anti-strip additive, if required, should be assessed to meet local agency specification requirements.

6.0 REFERENCES

Arizona Department of Transportation (ADOT), Materials Group, 1989, Preliminary Engineering and Design Manual.

Maricopa Association of Governments, 1998, Uniform Specifications for Public Works Construction.

APPENDIX A

FIELD INVESTIGATION

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TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8-inch O.D., 3 1/4-inch I.D. hollow stem auger or 4 1/2-inch solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Cummins diesel engines capable of delivering about 11.4 kN-m torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 90 kN (20,000 pounds) downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or river-run material or harder bedrock, which require other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42-inch diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP-1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9-inch O.D. by 6-inch I.D. or 6 5/8-inch O.D. by 4-inch I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1-foot increments, as noted on the boring logs. Standard penetration tests or 2.42-inch diameter ring samples taken are noted on the boring logs.

Core Boring Rock core samples are retrieved using a CME-75 drill rig, SAITECH GH 3 rig or Burley 2500, 4500 or 4000. The GH 3 is a portable hydraulic core drill. The GH 3 is powered by a Kohler two-cylinder 25-horsepower engine. The hydraulics motor which feeds a two-speed transmission and powers the BW spindle. This unit has a 3-foot stroke and is hand-fed with a 2,000 pound push-pull capability. The GH 3 has the capability of drilling with either B- or N-size core steel using standard or wireline systems. N-size core is the preferred size and it has a nominal O.D. of about 2 inches. The Burley 2500 and 4500 series are portable hydraulic core drills. The 4500 series is capable of a track-mounted or skid-type chassis. The Burley 2500 and 4500 series are powered by 44 and 75 HP power units, respectively, provide up to 2,000 foot-pounds (ft.-lbs.) of torque and in excess of 1,000 revolutions per minute (RPM) of spindle speed. Both rigs are capable of retrieving either N- or H-sized core using wireline systems. The N-size core has a nominal O.D. of about 2 inches and the H-size of about 2.4 inches. The Burley 4000 is a track-mounted core drill.

The CME-75 utilizes a wireline core drilling system that takes N-size cores. Using the NQ wireline system, core is recovered quickly by retrieving the core-laden inner tube through the drill string.

TEST DRILLING EQUIPMENT & PROCEDURES (Cont.)

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance. Undisturbed samples of firmer soils are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samples in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

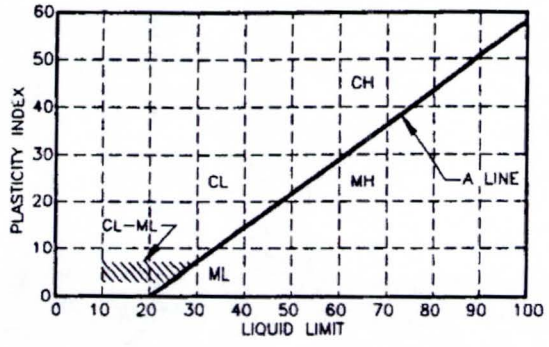
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" ASTM Designation: D2487.

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures or sand-gravel-cobble mixtures.
					GP	poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS (LIMITS PLOT ABOVE "A" LINE & HATCH ZONE ON PLASTICITY CHART)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% & 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in. to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

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TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

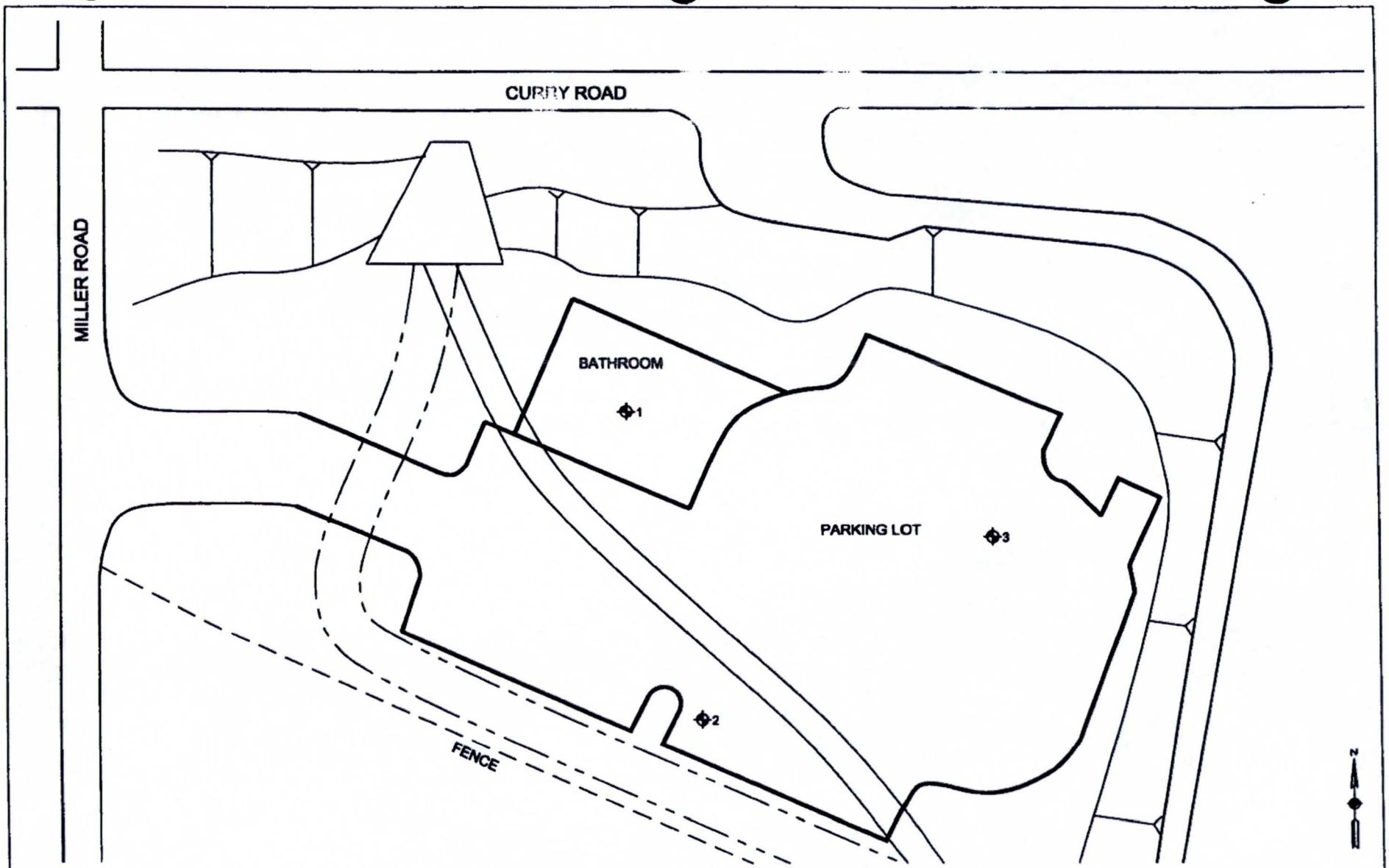
N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard



EXPLANATION

1 BORING LOCATION AND NUMBER

JOB NO.	0-117-001135
DESIGN:	DNF
DRAWN:	DJL
DATE:	01/01
SCALE:	1" = 40'

SITE PLAN SHOWING BORING LOCATIONS

TEMPE, ARIZONA
RIO SALADO HABITAT

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PROJECT Rio Salado Habitat
Environmental Restoration Project
Tempe Reach

JOB NO. 0-117-001135 **DATE** 12/7/00

LOCATION See Site Plan
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count / % Recovery	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	16-18-15		6	SC	slightly moist to moist very firm	**CLAYEY SAND**, some gravel, medium grained sand, weakly lime cemented, low to medium plasticity, brown
				U	44	99	8	CL	slightly moist stiff	**CLAY**, trace of fine grained sand, low to medium plasticity, brown
5				S	7-9-7		6	ML	slightly moist firm	**SANDY SILT**, predominantly fine grained sand, low plasticity, brown
								SP	slightly moist medium dense	**SAND**, trace of silty & gravel, predominantly medium grained, nonplastic, brown
10				S	7-8-8					
15				S	12-16-9			GP	slightly moist very dense	**SAND, GRAVEL & COBBLES**, medium to coarse grained sand, well graded gravel, rounded to subrounded gravel & cobbles, nonplastic, brown
20				S	50/1" NR					Auger refused at 18' Sampler refused at 18'1"
25										

BORING LOG 01171135.GPJ AGRA_PHX.GDT 1/9/01

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
CS - Continuous Auger

LOG OF TEST BORING NO. 1

PROJECT Rio Salado Habitat
Environmental Restoration Project
Tempe Reach

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JOB NO. 0-117-001135 **DATE** 12/7/00

LOCATION See Site Plan
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV.
DATUM

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	4-4-8			ML	slightly moist to moist soft to moderately firm	**SANDY SILT**, trace of fine grained gravel, predominantly fine grained sand, weakly lime cemented, low plasticity, dark brown
				S	6-6-5		18			
5				U	7	92	27			
								CL	slightly moist to moist moderately firm	**SANDY CLAY**, medium to fine grained sand, medium plasticity, brown
								SP-SM	moist to slightly moist medium dense	**SAND TO SILTY SAND**, trace of fine grained gravel, predominantly medium grained, nonplastic, brown
10				S	6-7-9		4			
										Stopped Auger at 9'6" Stopped Sampler at 11'
15										
20										
25										

BORING LOG 01171135.GPJ AGRA_PHX.GDT 1/5/01

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
C - California sample

LOG OF TEST BORING NO. 2

APPENDIX B

LABORATORY TEST RESULTS

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PROJECT:	RIO SALADO HABITAT RES. PROJECT	**JOB NO:**	0-117-001135
LOCATION:	TEMPE, ARIZONA	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE SAMPLED:**	12/15/00

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

				Silt or	SAND								GRAVEL								COBBLES		
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**
PERCENT PASSING BY WEIGHT																							
#1 @ 0-1.5	SC	27	8	48	55	63	64	67	72	75	77	80	82	86	88	96	100	100	100	100	100	100	1
#1 @ 2.5-3.5	CL	30	8	90	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	2
#1 @ 4.5 - 6.0	ML	26	4	58	82	94	96	98	100	100	100	100	100	100	100	100	100	100	100	100	100	100	3
#2 @ 2.5 - 4.0	ML	26	4	76	91	94	95	95	96	97	97	97	98	99	100	100	100	100	100	100	100	100	6
#2 @ 4.5-5.5	CL	45	25	89	93	95	96	98	99	99	100	100	100	100	100	100	100	100	100	100	100	100	7
#2 @ 9.5 -11.0	SP-SM	NV	NP	5.4	12	43	63	81	95	97	98	99	99	100	100	100	100	100	100	100	100	100	8
#3 @ 0-1.5	ML	22	3	56	70	80	81	85	92	95	96	98	99	100	100	100	100	100	100	100	100	100	10
#3 @ 2.5 - 4.0	CL-ML	29	7	80	94	96	97	97	99	99	99	99	100	100	100	100	100	100	100	100	100	100	11

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PROJECT:	RIO SALADO HABITAT RES. PROJECT	**JOB NO:**	0-117-001135
LOCATION:	TEMPE, ARIZONA	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE SAMPLED:**	12/15/00

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

				Silt or	SAND								GRAVEL								COBBLES		
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**
PERCENT PASSING BY WEIGHT																							
#3 @ 4.5 - 6.0	CL	30	8	66	74	77	79	83	86	87	87	88	89	90	90	90	90	100	100	100	100	100	12

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PROJECT: RIO SALADO HABITAT RES. PROJECT
LOCATION: TEMPE, ARIZONA
MATERIAL:
SAMPLE SOURCE:

JOB NO: 0-117-001135
WORK ORDER NO: 1
LAB NO:
DATE SAMPLED: 12/15/00

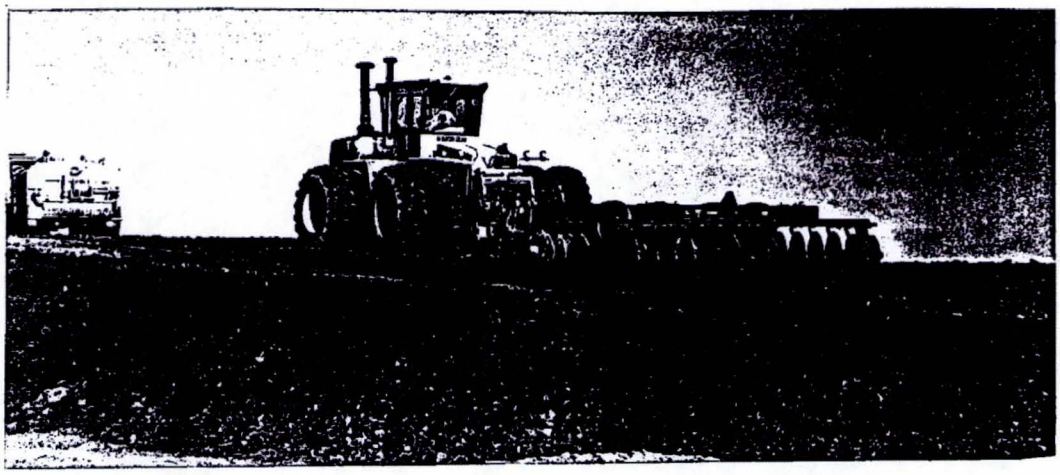
MOISTURE CONTENT OF SOIL (ASTM D2216)

LAB #	BORING	DEPTH RANGE	WET WT. (gram)	DRY WT. (gram)	MOISTURE CONTENT
1	#1	0-1.5	203.2	192.4	5.6%
2	#1	2.5-3.5	357.7	332.5	7.6%
3	#1	4.5-6.0	280.1	264.6	5.9%
6	#2	2.5-4.0	335.4	284.6	17.8%
7	#2	4.5-5.5	382.6	301.0	27.1%
8	#2	9.5-11.0	323.1	311.3	3.8%
10	#3	0-1.5	253.0	240.8	5.1%
11	#3	2.5-4.0	301.2	277.6	8.5%
12	#3	4.5-6.0	260.1	234.6	10.9%

Appendix C:
Wetland-Marsh Pond Soil Liner Additive Product Information

SOIL SCIENCE INTERNATIONAL

ECONOMICAL SOIL ADDITIVES FOR CONTAINMENT AND STABILIZATION



LAGOONS • LAKES • LANDFILLS • MINING • STABILIZATION

INTRODUCTION TO SS-13

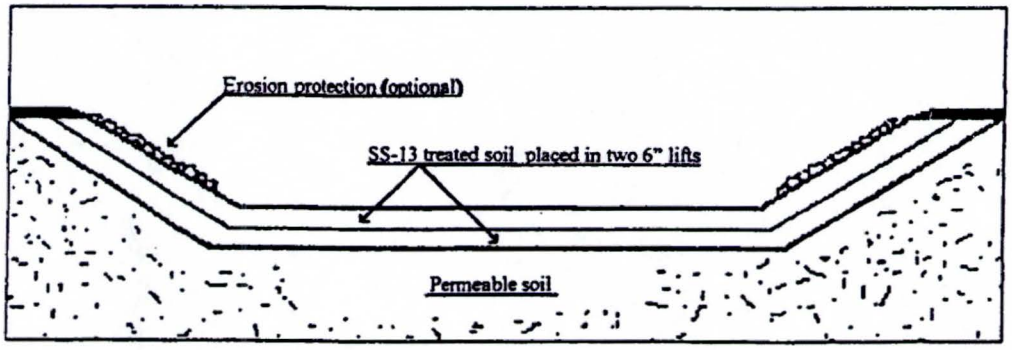
Modifying soils to meet your needs-

Soil Science International is the manufacturer of SS-13 PERMEABILITY CONTROL EMULSION. Developed and proven over 35 years ago, SS-13 treated and compacted soil liners provide an excellent alternative to FML's, GCL's, and other known soil additives.

SS-13 is a concentrated dispersion of polymers and modifiers emulsified in water. This additive readily attaches itself to soil particles, closing the voids to prevent passage of liquids through the soil. WA-13 is a wetting agent used in conjunction with SS-13 to stabilize and compact otherwise unstable and expansive soils. Together, SS-13/WA-13 treatment permits the soil to achieve much higher densities than the same untreated soil. Not only does the higher density reduce permeability, but it also increases load bearing capacity which can be successfully utilized for road subgrade stabilization (eliminating the need and cost of imported aggregates, lime, or cement).

Benefits of using SS-13 to amend soils:

- Low cost.
- Reduces soil permeabilities by one to three orders of magnitude.
- Increases p.s.i. and shear strength of soil.
- Reduces surface cracking of soils caused by moisture and temperature changes.
- Can be used with a wide range of soil types.
- Very easy to install (no special equipment required).
- Eliminates or greatly reduces the need for imported soils.
- Reduces the amount of effort required to achieve maximum soil density.
- Product is easily stored at project site in bulk tanks or drums.



ADDITIONAL SERVICES

Methods and Personnel to get the job done right-

The methods and the patented additives available to you through Soil Science International have been used with satisfaction for more than 30 years. Our qualified engineers and construction personnel are available for each individual project. In addition, our laboratory for testing soils and writing specifications is fully equipped and specializes in soil amendments. Please note that the use of these products and methods cannot be warranted or guaranteed to solve any specific problem without complete information concerning the specific problem to be solved.

TECHNICAL DATA

SS-13 is a concentrated dispersion of polymers and modifiers in water-

GENERAL USE:

SS-13 mixed into the water in an existing pond, lake, canal, or lagoon is carried into the soil and reduces seepage. Soil treated with SS-13 and compacted, forms a low permeability layer for excellent control of seepage.

PHYSICAL & CHEMICAL PROPERTIES:

Solids Content:	10%
Solvent:	Water
pH:	9.0 min.
Density:	0.93 Kg/liter (7.75 LB/gal)

An aqueous emulsion
Non-flammable
Non-toxic

STORAGE:

SS-13 is a aqueous emulsion and must be protected from freezing. The product should be stored under cover and out of direct sunlight

DILUTION:

SS-13 can be diluted to any concentration in the vicinity of 1.2 parts per 1,000 for water treatments, and 2.5 parts per 1,000 for treating soil directly. Special procedures may be required where Calcium, Sodium or suspended solids content of the water is excessive. Where water temperature is below 7°C (45°F), it is advisable to predilute to about 1 part in 5 parts water before adding to a lake, pond or lagoon.

SOIL TYPES:

SS-13 can be used in nearly all soil types. In the finer soils, mixing the SS-13 directly into the soil, then compacting the soil, produces very low permeability. In more open sands the greatest percentage of permeability reduction is achieved through waterborne treatment.

COMPACTION:

The greater the density of a soil liner, the lower the permeability. This is true for both treated and untreated liners.

SUGGESTED APPLICATIONS:

- New Lakes and Existing Lakes
- Reservoirs
- Cattle Tanks
- Settling Ponds
- Stabilization Ponds
- Landfill Caps & Liners
- Road Subgrade
- Canals
- Sewage Lagoons
- Tailings Thickeners

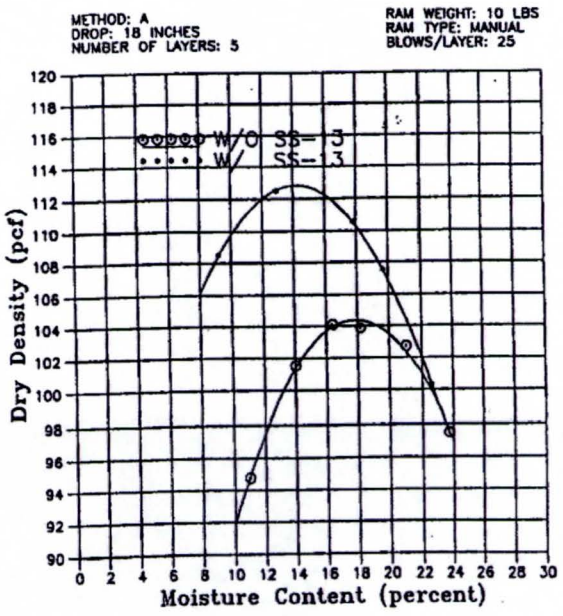
CAUTION:

Though non-toxic, SS-13 in water will kill fish by suffocation. The permeability of the fish's gills is reduced.

SHIPPING INFORMATION:

Bulk or 55 gallon drums
0.309 m3 (10.9 cu.ft.) per drum
211 Kg. (465 lb.) per drum
Freight Classification: Petroleum Sizing Class 55

This is a typical shift in a proctor curve when SS-13 is added to a soil. These results were obtained from a ASTM D 1557 test. →



RECOMMENDED INSTALLATION EQUIPMENT

SS-13 can be properly installed with conventional earth-moving equipment by a licensed grading contractor-

1. Water truck -- for applying SS-13, WA-13, and water.
2. Large, all-wheel drive tractor and off-set disc -- for mixing products into soil.
3. Self - loading scraper -- for on-site hauling of mixed soil.
4. Crawler-type bulldozer or motor grader -- for spreading and placing mixed soil.
5. Segmented foot compactor or equal -- for achieving 95% compaction of mixed soil.

PROJECT EXPERIENCE

SS-13 treated soils can be incorporated in a wide variety of projects-

Representative golf course projects: (partial list, over 100 golf course projects completed)

Sunridge Canyon G. C., Fountain Hills, AZ • Gold Canyon Ranch G. C., Gold Canyon, AZ • Kierland G. C., Scottsdale, AZ • T. P. C. at Las Vegas, Summerlin, NV • Lake of Las Vegas G. C., Henderson, NV • Sun City - Roseville, Roseville, CA • La Rinconada C. C., Los Gatos, CA • Thanksgiving Point G. C., Lehi, UT • Manito C. C., Spokane, WA • Oakwood Hills C. C., San Antonio, TX

Representative decorative lake projects: (partial list, over 50 projects completed)

The Islands, Gilbert, AZ • Estrella Ranch, Goodyear, AZ • Disneyland (California Adventure), Anahiem, CA • Eastlake, Chula Vista, CA • Riverlakes, Bakersfield, CA • Lakeside, Buena Park, CA • Menifee Village, Menifee, CA • Desert Shores, Las Vegas, NV • The Lakes at West Sahara, Las Vegas, NV • Mountain Shadow Lake, El Paso, TX • Lakes of Parkway, Houston, TX

Representative industrial projects: (partial list, over 50 projects completed)

Sewage lagoons, Chandler, AZ • Landfill cap, Holbrook, AZ • Road stabilization, Queen Creek, AZ • Flood control levee, Payson, AZ • Evaporation ponds, Kingman, AZ • Sewage lagoons, Chino, CA • Sewage lagoons, Rupert, ID • Waste water lagoons, Arco, ID • Road stabilization, Lufkin, TX • Landfill cap & road stabilization, North Little Rock, AR

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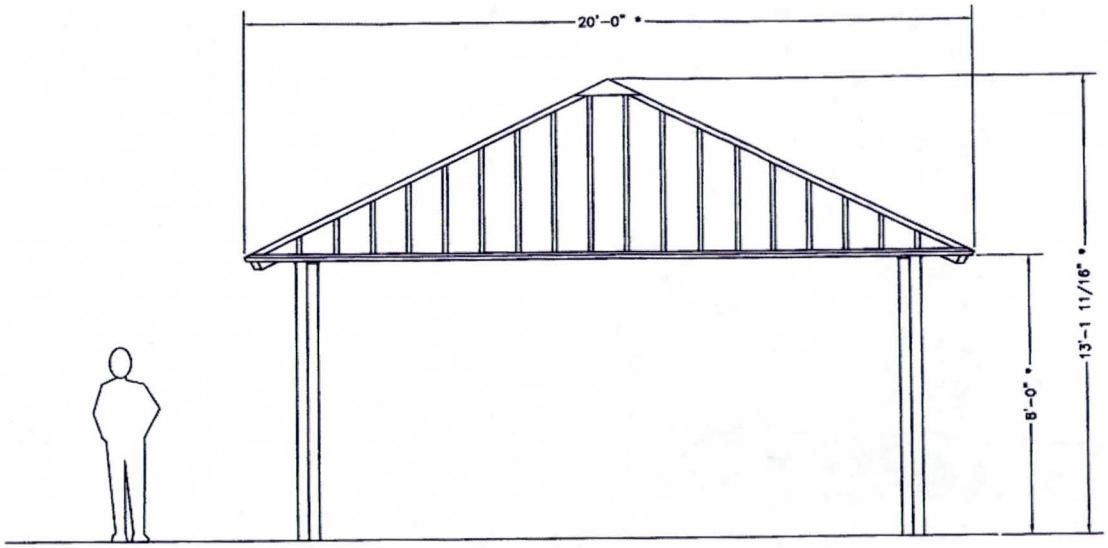
Appendix D:
Pre-Engineered Ramada Structure Drawings



SQ 20 MR
MULTI-RIB METAL ROOF

* APPROXIMATE

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ESTIMATING ONLY

poligon®
PARK ARCHITECTURE

TITLE SHELTER ELEVATION
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PROJECT POLIGON SQ 20 MR

SHEET
11

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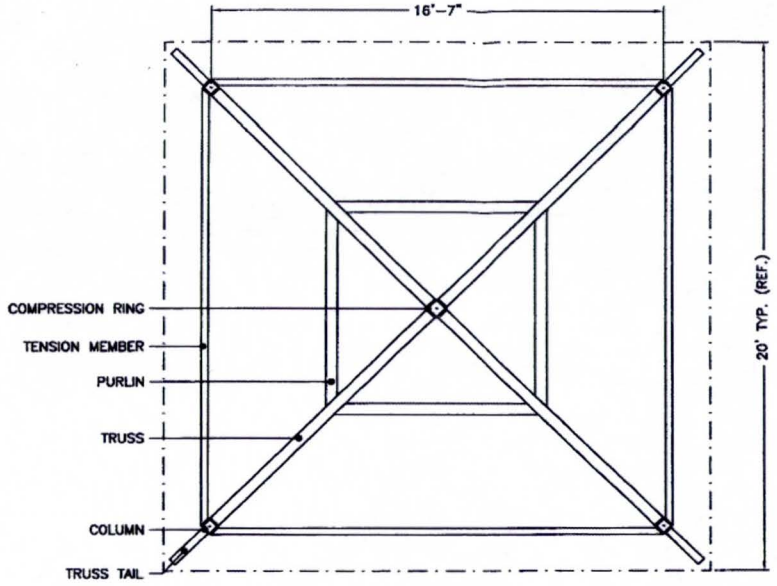
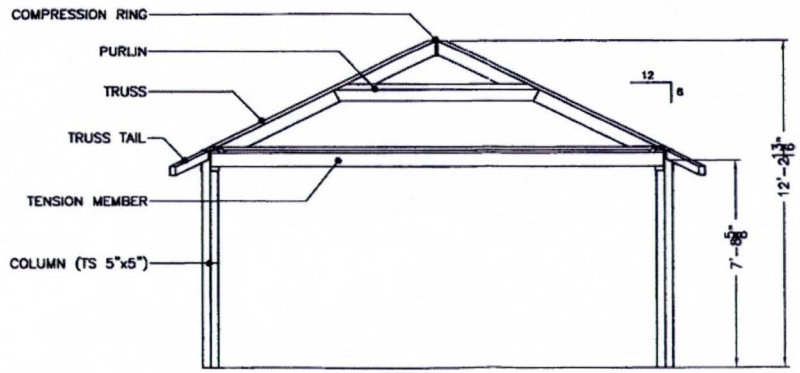


FRAME PLAN



FRAME ELEVATION

NOTES
FOR FINAL TIGHTENING, USE TURN OF NUT METHOD: USING A SPUD WRENCH, TIGHTEN AS MUCH AS POSSIBLE WITH A NORMAL MANS STRENGTH. THEN, USING AN EXTENSION, TIGHTEN AN ADDITIONAL 1/3 TURN.

FRAME MUST BE PLUMB, SQUARE AND BOLTS TIGHTENED BEFORE INSTALLING PURLINS. IF REQUIRED. PURLINS MUST BE PARALLEL TO THE EAVE BEAMS AND TENSION MEMBERS.

FASTENERS: ALL BOLTS USED FOR STRUCTURAL CONNECTIONS ARE ASTM A325. DO NOT SUBSTITUTE WITH A LESSER GRADE. INSPECTION OF HIGH STRENGTH BOLTING, IF REQUIRED, TO BE PER CHAPTER 17 OF THE UNIFORM BUILDING CODE 1994 EDITION.

FRAME FINISH: FRAME COMPONENTS ARE RED OXIDE PRIME PAINTED ONLY. FINISH PAINT ON-SITE WITH MATERIALS AND LABOR BY OTHERS.

ORNAMENTATION FINISH: ORNAMENTATION AND RAILING ARE ZINC PLATED. FINISH PAINT ON-SITE WITH MATERIALS AND LABOR BY OTHERS.

FINISH OPTIONS: POWDER COATING, E-COATING, AND GALVANIZING ARE FINISH OPTIONS AVAILABLE AT AN ADDITIONAL CHARGE FOR BOTH FRAME AND ORNAMENTATION.

MATERIAL SPECIFICATIONS
COLUMN SIZE: TS 5"X5"

TUBULAR SHAPES: ASTM A500 GRADE B 46 KSI
COLD FORMED CEES: A570 GRADE 55
CONNECTION BOLTS: ASTM A325
CONNECTION PLATES: ASTM A36
ANCHOR BOLTS: ASTM A307
WELDING PROCESS: GAS METAL ARC WELDING
WELDING ELECTRODES: E70xx

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TITLE FRAME ASSEMBLY
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PROJECT SQ 20 MR

SHEET FR

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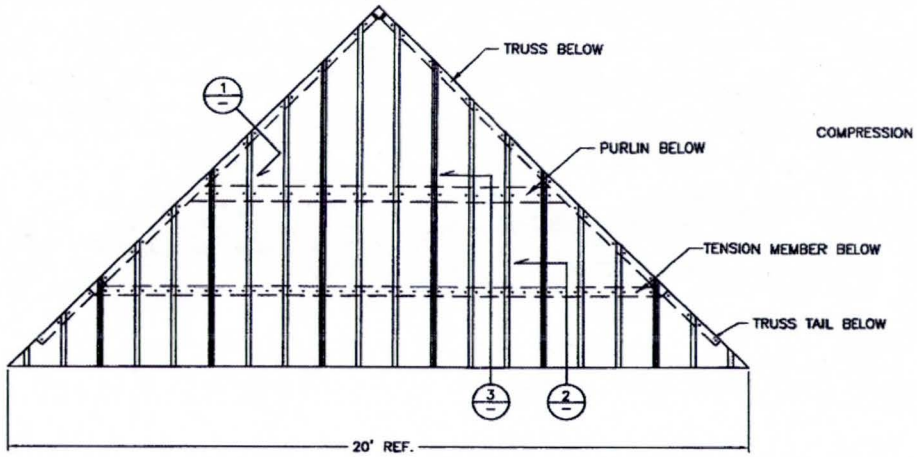
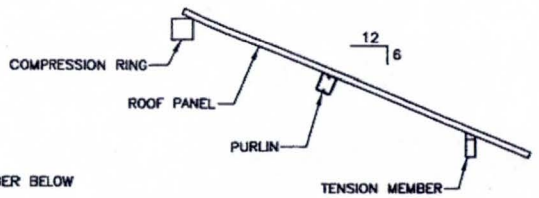


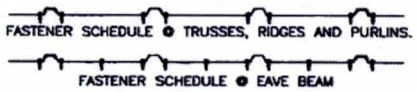
ROOF PANEL PLAN

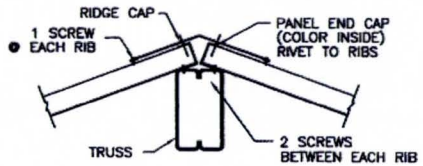


SECTION AA

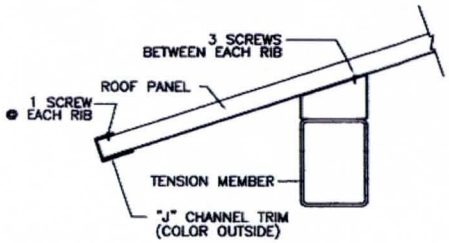
FASTENER SCHEDULE

PANELS ARE FASTENED TO THE FRAME WITH #12-14 HEX HEAD SELF DRILLING SCREWS.

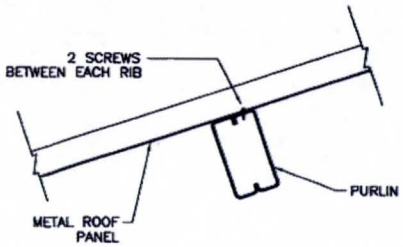




1 SECTION @ TRUSS
N.T.S.



2 SECTION @ EAVE
N.T.S.



3 SECTION @ PURLIN
N.T.S.

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TITLE METAL ROOFING INSTALLATION
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CHECKED BY (283-0703) DWG.NO. SQ20MR-RF

PROJECT SQ 20 MR
MULTI-RIB METAL ROOFING

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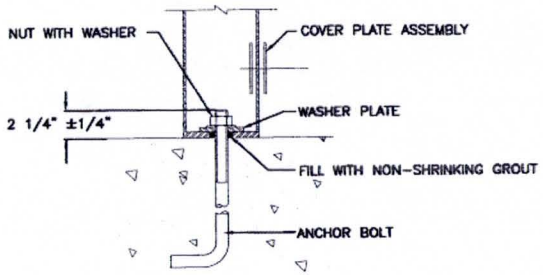
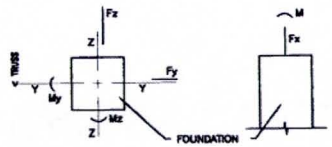
SHEET
RF



ANCHOR BOLT DETAIL



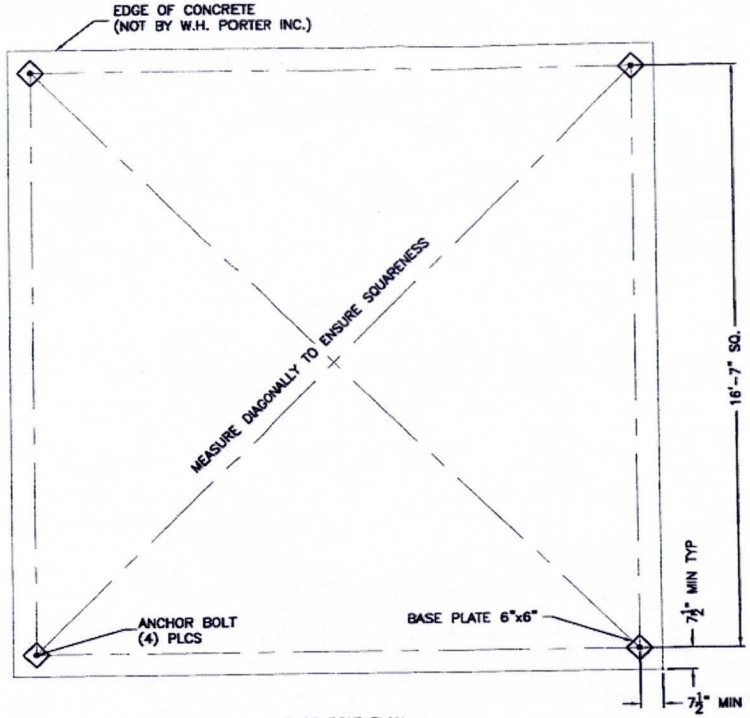
LOADS TO FOUNDATION (KIPS, FT. KIPS) REACTIONS

LOAD COMBINATION	AXIAL (Fx)	SHEAR (FY)	SHEAR (FZ)	MOMENT (MZ)	MOMENT (MY)
DEAD + LIVE LOAD	3.63	.27	0	0	0
DEAD + WIND LOAD	-3.36	-.82	-.28	0	0

NOTES: PER DJK: 10/20/95

DESIGN OF FOUNDATION TO BE PERFORMED BY AN ENGINEER OR ARCHITECT. THIS DRAWING IS NOT INTENDED AS A FOUNDATION DESIGN. IT IS SUBMITTED AS A REFERENCE TO MINIMUM SLAB DIMENSIONS AND ANCHOR BOLT LOCATIONS.

IF WALLS ARE TO BE SPECIFIED, CONSULT FACTORY FOR REVISED SLAB DIMENSIONS.



ANCHOR BOLT PLAN

DO NOT USE FOR CONSTRUCTION
DESIGN IMPROVEMENTS MAY RESULT IN CHANGES TO LOADS/DIMENSIONS. ONLY USE DRAWINGS PROVIDED WITH SHELTER FOR CONSTRUCTION.

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TITLE ANCHOR LAYOUT
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PROJECT SQUARE 20 MR
(USE FOR PLANNING PURPOSES ONLY)

SHEET AB

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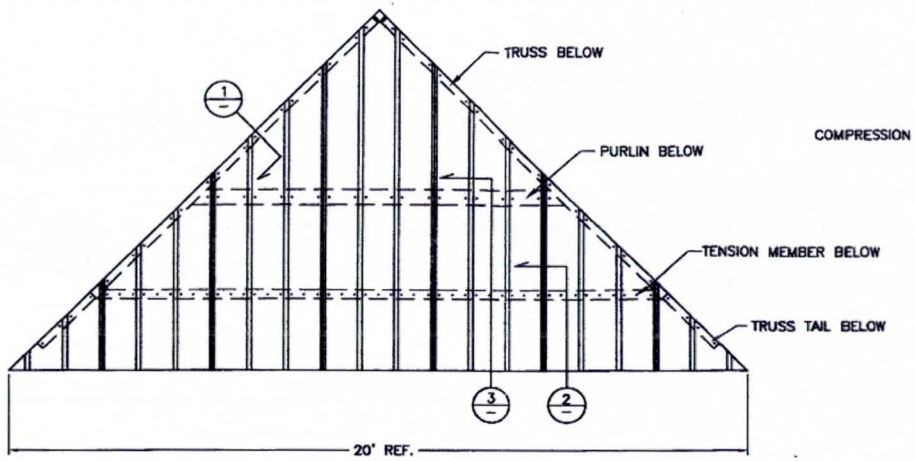
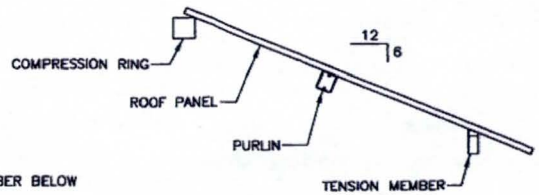


ROOF PANEL PLAN



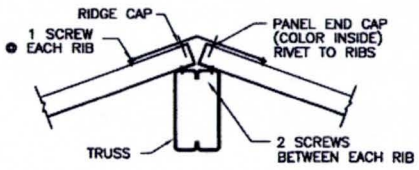
SECTION AA

FASTENER SCHEDULE

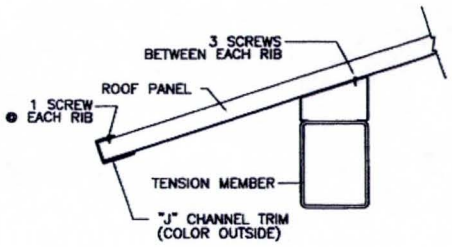
PANELS ARE FASTENED TO THE FRAME WITH #12-14 HEX HEAD SELF DRILLING SCREWS.

FASTENER SCHEDULE @ TRUSSES, RIDGES AND PURLINS.

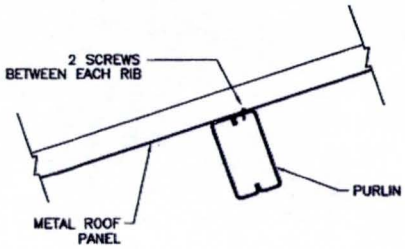
FASTENER SCHEDULE @ EAVE BEAM



1 — SECTION @ TRUSS
N.T.S.



2 — SECTION @ EAVE
N.T.S.



3 — SECTION @ PURLIN
N.T.S.

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PROJECT SQ 20 MR
MULTI-RIB METAL ROOFING

SHEET RF

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Appendix E:
Structural Calculations for
Flood Control Wall

GRENIER STRUCTURAL ENGINEERING, INC.

1660 N. Alvernon Tucson, AZ 85712
Phone (520) 326-7082 • Fax (520) 326-7508

FLOOD WALLS FOR THE RIO SALADO ENVIRONMENTAL RESTORATION INDIAN BEND WASH SEGMENT TEMPE REACH, ARIZONA

PREPARED FOR: McGann & Associates/Novak Environmental
343 W. Franidin Street
Tucson, Arizona 85701

PREPARED BY: Grenier Structural Engineering, Inc.
1660 N. Alvernon
Tucson Arizona 85712

GRENIER STRUCTURAL ENGINEERING, INC.

Client:	McGann & Associates/Novak Environmental	Sheet: 1 of 4
Project:	Rio Salado Flood Walls	Job No: 02216
Address:	Tempe Reach, Arizona	Date: 9/02

STRUCTURAL DESIGN CRITERIA

DESCRIPTION OF STRUCTURE:

This project consists of a retaining/ screen wall with a future option of adding a 6'-0" chainlink fence on top.

DESIGN CODES: UNIFORM BUILDING CODE (U.B.C.) 1997 EDITION

DESIGN LOADS SUMMARY:

WIND: BASIC WIND SPEED 70 MPH, EXPOSURE C, I=1.0

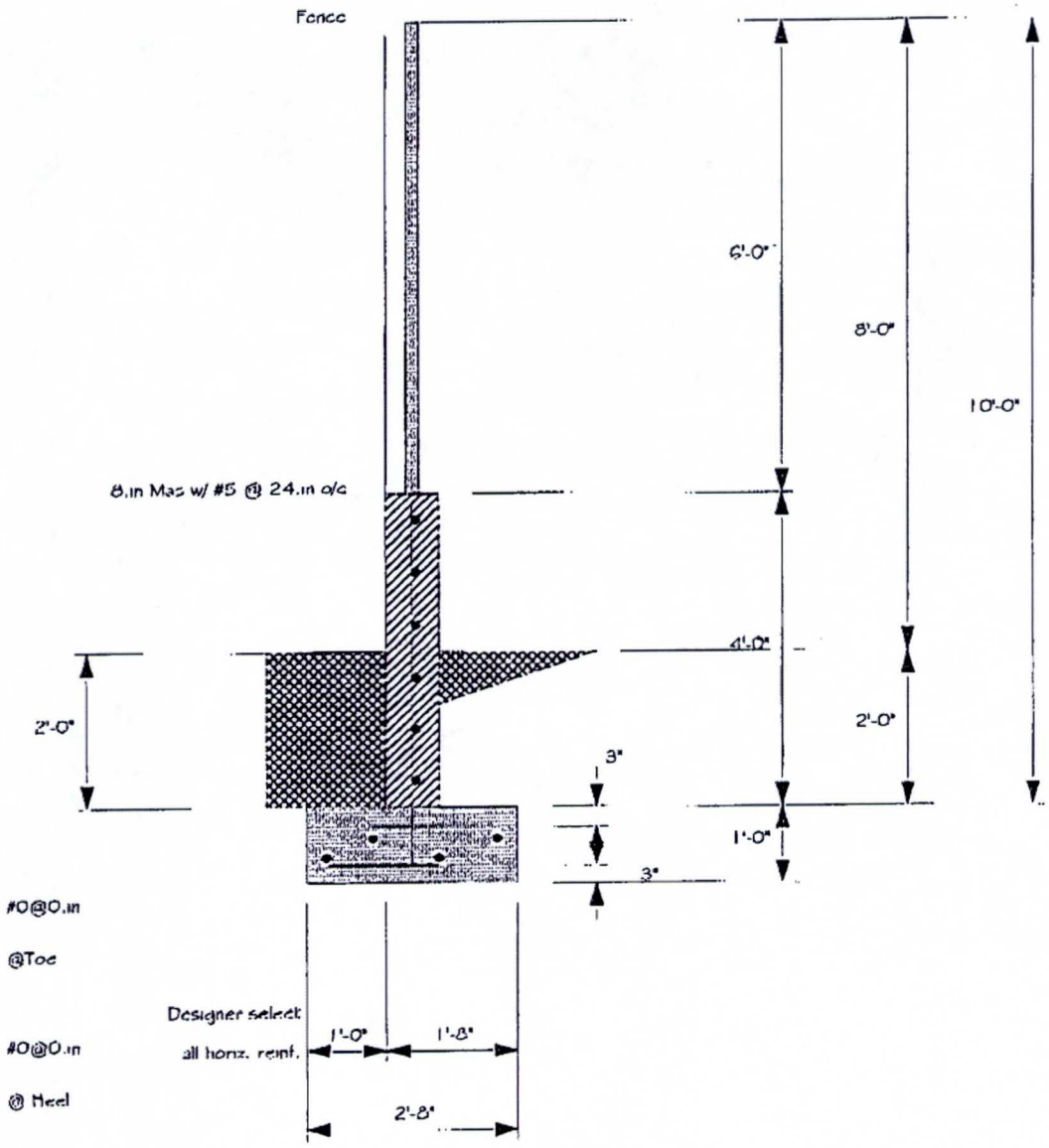
SOILS INFORMATION:

Soils based on minimum Uniform Building Code soil bearing value as permitted by the building official in the absence of a soil report. Design soil bearing = 1000 psf at 1'- 6" below finish grade.

INDEX

1660 N. Alvernon ♦ Tucson, Arizona 85712 ♦ (520) 326-7082 ♦ FAX (520) 326-7508

Wall Layout


Fence
6'-0"
8'-0"
10'-0"
8.in Max w/ #5 @ 24.in o/c
4'-0"
2'-0"
2'-0"
3"
1'-0"
3"
#0@0.in
@Toe
Designer select
all horiz. reinf.
1'-0"
1'-8"
#0@0.in
@ Heel
2'-8"

Grenier Structural
A Vision Group Company
1660 N. Alvernon Way
Tucson, AZ 85712
PH: 520-326-7082

Title :
Dsgnr:
Description :
Scope :

Job # 3
Date: 2:05PM, 27 SEP 02

Rev: 550100
User: KW-0602447, Ver 5.5.0, 25-Sep-2001
(c)1983-2001 ENERCALC Engineering Software

Cantilevered Retaining Wall Design

Description Typical Flood Wall

Criteria

Retained Height	=	2.00 ft
Wall height above soil	=	8.00 ft
Slope Behind Wall	=	0.00 : 1
Height of Soil over Toe	=	24.00 in
Soil Density	=	110.00 pcf
Wind on Stem	=	13.0 psf

Soil Data

Allow Soil Bearing	=	1,333.0 psf
Equivalent Fluid Pressure Method		
Heel Active Pressure	=	35.0
Toe Active Pressure	=	0.0
Passive Pressure	=	250.0
Water height over heel	=	0.0 ft
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in

Footing Strengths & Dimensions

f'c = 2,500 psi	Fy =	40,000 psi
Min. As %	=	0.0014
Toe Width	=	1.00 ft
Heel Width	=	1.67
Total Footing Width	=	2.67
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

Cover @ Top = 3.00 in @ Btm.= 3.00 in

Design Summary

Total Bearing Load	=	1,128 lbs
...resultant ecc.	=	8.80 in
Soil Pressure @ Toe	=	1,253 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	1,333 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	1,685 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	6.9 psi OK
Footing Shear @ Heel	=	5.8 psi OK
Allowable	=	85.0 psi
Wall Stability Ratios		
Overturning	=	1.76 OK
Sliding	=	5.60 OK
Sliding Calcs (Vertical Component Used)		
Lateral Sliding Force	=	261.5 lbs
less 100% Passive Force	= -	1,125.0 lbs
less 100% Friction Force	= -	338.4 lbs
Added Force Req'd	=	0.0 lbs OK
....for 1.5 : 1 Stability	=	0.0 lbs OK

Footing Design Results

		Toe	Heel
Factored Pressure	=	1,685	0 psf
Mu' : Upward	=	900	0 ft-#
Mu' : Downward	=	353	427 ft-#
Mu: Design	=	547	427 ft-#
Actual 1-Way Shear	=	6.86	5.81 psi
Allow 1-Way Shear	=	85.00	85.00 psi
Toe Reinforcing	=	None Spec'd	
Heel Reinforcing	=	None Spec'd	
Key Reinforcing	=	None Spec'd	

Stem Construction

		Top Stem	2nd Stem OK
Design height	ft =	4.00	0.00
Wall Material Above "Ht"	=	Fence	Masonry
Thickness	=		8.00
Rebar Size	=		# 5
Rebar Spacing	=		24.00
Rebar Placed at	=		Center
Design Data			
fb/FB + fa/Fa	=		0.930
Total Force @ Section	lbs =		174.0
Moment....Actual	ft-# =		670.7
Moment.....Allowable	ft-# =		721.4
Shear.....Actual	psi =		6.1
Shear.....Allowable	=		25.8
Bar Develop ABOVE Ht.	in =		25.00
Bar Lap/Hook BELOW Ht.	in =		6.00
Wall Weight	psf =		61.0
Rebar Depth 'd'	in =		3.81
Masonry Data			
f'm	psi =		1,500
Fs	psi =		20,000
Solid Grouting	=		No
Special Inspection	=		No
Modular Ratio 'n'	=		25.78
Short Term Factor	=		1.333
Equiv. Solid Thick.	=		5.20
Masonry Block Type = Normal Weight			
Concrete Data			
f'c	psi =		
Fy	psi =		

Other Acceptable Sizes & Spacings
Toe: Not req'd, Mu < S * Fr
Heel: Not req'd, Mu < S * Fr
Key: No key defined

Grenier Structural
A Vision Group Company
1660 N. Alvernon Way
Tucson, AZ 85712
PH: 520-326-7082

Title :
Dsgnr:
Description :

Job # 4
Date: 2:05PM, 27 SEP 02

Scope :

Rev: 550100
User: KW-0602447, Ver 5.5.0, 25-Sep-2001
(c)1983-2001 ENERCALC Engineering Software

Cantilevered Retaining Wall Design

Description Typical Flood Wall

Summary of Overturning & Resisting Forces & Moments

		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#			.....RESISTING..... Force lbs	Distance ft	Moment ft-#
Heel Active Pressure	=	157.5	1.00	157.5	Soil Over Heel	=	220.0	2.17	476.8
Toe Active Pressure	=				Sloped Soil Over Heel	=			
Surcharge Over Toe	=				Surcharge Over Heel	=			
Adjacent Footing Load	=				Adjacent Footing Load	=			
Added Lateral Load	=				Axial Dead Load on Stem	=		0.00	
Load @ Stem Above Soil	=	104.0	7.00	728.0	Soil Over Toe	=	220.0	0.50	110.0
SeismicLoad	=				Surcharge Over Toe	=			
					Stem Weight(s)	=	244.0	1.33	325.4
Total	=	261.5	**O.T.M.** =	885.5	Earth @ Stem Transitions	=			
					Footing Weight	=	400.0	1.33	533.5
					Key Weight	=			
					Vert. Component	=	43.9	2.67	117.1
					Total	=	1,128.0 lbs	**R.M.=**	1,562.7

Resisting/Overturning Ratio = **1.76**

Vertical Loads used for Soil Pressure = 1,128.0 lbs

Vertical component of active pressure used for soil pressure

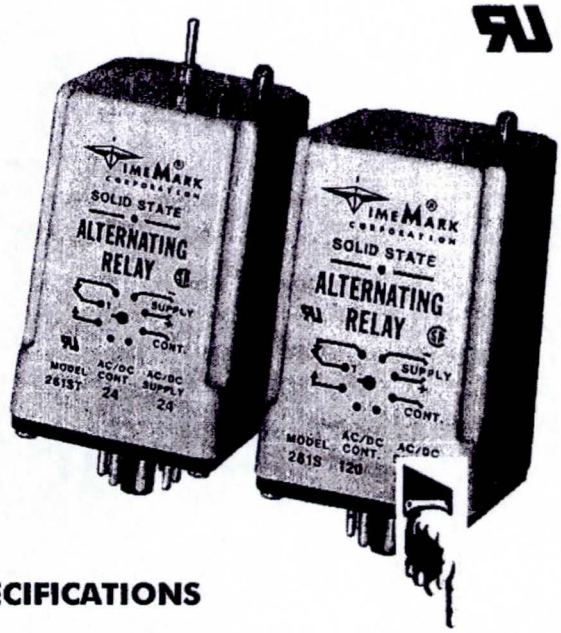
Appendix F:
Wetland Marsh Water Level Control Equipment

Introduction

Provided on the following pages are manufacturer's data sheets for key components of the wetland marsh water level control equipment specified for use on the project. The proprietary information shown is intended to indicate basic standards for the equipment to be installed. The project specifications will allow for the use of equipment by other manufacturers if deemed to be equal to the equipment shown.

MODEL 261 series

Alternating Relays



- **Solid-state Reliability**
- **Heavy-duty Contact Rating**
- **Optional Load 1-Load 2 Toggle**
- **UL Recognized; CSA Certified**

DESCRIPTION

The **Model 261 series Alternating Relay** is designed for duplex pumping systems where it is desirable to equalize pump run time. The solid state alternating circuit drives an internal electromechanical relay. A continuous power source and control switch are required.

The control switch (float, pressure or other isolated contact) is connected between the L1 terminal and the control terminal. Each time the control switch is opened the output contacts will change states. Indicator lights on the case show the internal relay status.

On the optional toggle switch versions, the toggle switch is set to the NORMAL position. Setting the switch to Load 1 or Load 2 will lock the relay in position, preventing alternation.

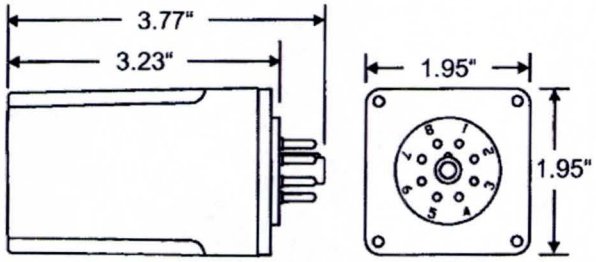
SPECIFICATIONS

MODEL	261 x (T) - xxx			
Supply Voltage	12V AC/DC	24V AC/DC	120V AC/DC	240V AC/DC
Voltage Range	10 - 14V	20 - 28V	90 - 130V	180 - 250V
Max Voltage	15V	30V	140V	260V
Supply Current	0.1A	0.05A	0.01A	0.01A
Control Current	0.001 amp			
Operating Duty	Continuous			
Min. Cycle Time	100 msec			
Contacts	10A at 120VAC resistive			
Expected Relay Life	Mech: 10 million operations Elec: 100,000 operations at rated load			
Operating Temp	240V models: - 40° to +131° F All other models: - 40° to +140° F			
Humidity Tolerance	0 - 97% w/o condensation			
Mounting	261D: 11-pin socket * 261S or 261DX: 8-pin socket **			
Enclosure Material	ABS plastic			
Weight	4.3 oz.			
Agency Approvals	UL Recognized and CSA Certified			

*order 11-pin socket # 51X016

**order 8-pin socket # 51X120

DIMENSIONS - 261S or 261DX



*add 3/4" (0.75) for toggle clearance on applicable models

ORDERING INFORMATION			
MODEL	**RELAY POLES**	**TOGGLE**	**SUPPLY VOLTAGE**
261	**S**=single pole	**T**	**12** V AC/DC
	D=double pole		**24** V AC/DC
	DX=dbl pole x-wired		**120** V AC/DC
			240 V AC/DC
example:	**261-DX-120** orders a 120V AC/DC; double-pole, x-wired Alternating Relay w/o the toggle option.		

Telephone: Main - (918) 438-1220
Sales - (800) 862-2875
Fax: (918) 437-7584

E-mail: sales@time-mark.com
Internet: http://www.time-mark.com

TIME MARK CORPORATION

11440 East Pine Street
Tulsa, Oklahoma 74116

Doc No. 87A117 12/00

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MODEL 261 Alternating Relays

READ ALL INSTRUCTIONS BEFORE INSTALLING, OPERATING OR SERVICING THIS DEVICE.
KEEP THIS DATA SHEET FOR FUTURE REFERENCE.

GENERAL SAFETY

POTENTIALLY HAZARDOUS VOLTAGES ARE PRESENT AT THE TERMINALS OF THE MODEL 261. ALL ELECTRICAL POWER SHOULD BE REMOVED WHEN CONNECTING OR DISCONNECTING WIRING. THIS DEVICE SHOULD BE INSTALLED AND SERVICED BY QUALIFIED PERSONNEL.

Installation Instructions

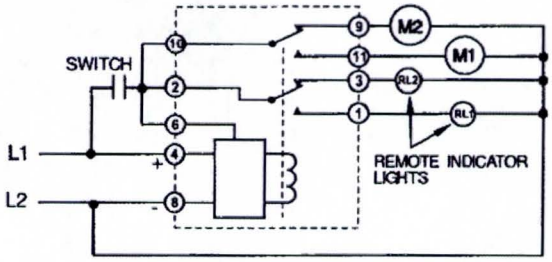
INSTALLATION

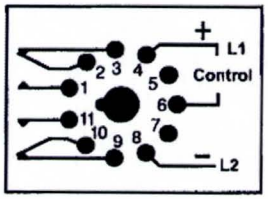
Connect wiring to the socket as indicated in the following examples.

The Model 261 series Alternating Relays are extremely versatile and can be used in many other configurations besides those shown. Any type of switch (float, pressure, etc.) can be used as the control switch; however, it must be connected as shown (from L1 to the control input) or the alternator will not function properly.

On Toggle Versions: For normal operation (alternating loads) set the toggle switch on the top of the case to the "normal" position. Setting the toggle switch to either "1" or "2" will lock the alternator in that position.

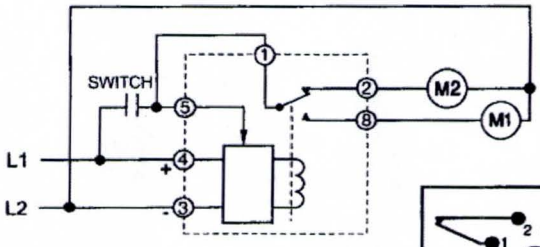
TYPICAL APPLICATION: 261D

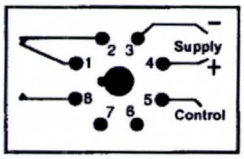




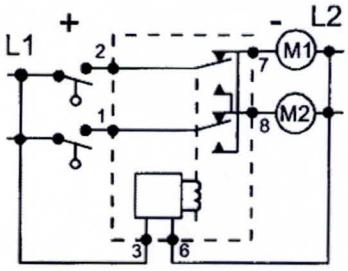
TYPICAL APPLICATION: 261S

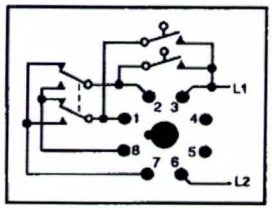
NOTE: *All drawings shown with no power applied.*





TYPICAL APPLICATION: 261DX





TROUBLESHOOTING

Should the Model 261 fail to operate properly, check to see that voltage level and connections are correct and securely attached to equipment. Should problems persist, contact the factory at 800-862-2875 for assistance.

WARRANTY

The **Model 261 Alternating Relay** is warranted to be free from defects in materials and workmanship, and is covered by our exclusive **5-year Unconditional Warranty**. If the this device fails to operate, for any reason, we will repair or replace it free, for five years from the date of purchase. Contact the Time Mark Sales department, Monday through Friday; 8 a.m. to 5 p.m., CST, for further details.

Telephone: Main - (918) 438-1220
Sales - (800) 862-2875
Fax: (918) 437-7584

E-mail: sales@time-mark.com
Internet: http://www.time-mark.com

TIME MARK CORPORATION

11440 East Pine Street
Tulsa, Oklahoma 74116

Doc No. 87A117 12/00

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General Purpose Plug-In Timers
Type JCK – Class 9050

Type JCK12

9050 JCK52/8501 NH7

Class 9050 Type JCK timing relays are designed to provide low cost timing in a plug-in housing. The Types JCK11 thru 59 provide ±1% Repeat Accuracy. The Types JCK60 and 70 offer ±0.1% Repeat Accuracy. These timers are directly interchangeable with many other 8 and 11 pin tube base timers.

- Up to ±0.1% Repeat Accuracy
- Timing from .01 seconds to 16.65 hours
- Available in 5 timing modes
- DPDT Contacts (2 N.O. and 2 N.C.)
- 10A Contact Rating
- Transient Protected
- Restraining Strap Available
- Variable or Fixed time delay
- Horsepower Rated

Variable Time Delay

Knob Adjustable Timing Range	On Delay	Price	Off Delay	Price	Interval	Price	One Shot	Price	Repeat Cycle‡	Price
0.1–10 Seconds	JCK11✱	$50.00	JCK21✱	$63.00	JCK31✱	$50.00	JCK41✱	$63.00	JCK51✱	$90.00
0.3–30 Seconds	JCK12✱	50.00	JCK22✱	63.00	JCK32✱	50.00	JCK42✱	63.00	JCK52✱	90.00
0.6–60 Seconds	JCK13✱	50.00	JCK23✱	63.00	JCK33✱	50.00	JCK43✱	63.00	JCK53✱	90.00
1.2–120 Seconds	JCK14✱	50.00	JCK24✱	63.00	JCK34✱	50.00	JCK44✱	63.00	JCK54✱	90.00
1.8–180 Seconds	JCK15✱	50.00	JCK25✱	63.00	JCK35✱	50.00	JCK45✱	63.00	JCK55✱	90.00
0.1–10 Minutes	JCK16✱	56.00	JCK26✱	69.00	JCK36✱	56.00	JCK46✱	69.00	JCK56✱	95.00
0.3–30 Minutes	JCK17✱	56.00	JCK27✱	69.00	JCK37✱	56.00	JCK47✱	69.00	JCK57✱	95.00
0.6–60 Minutes	JCK18✱	56.00	JCK28✱	69.00	JCK38✱	56.00	JCK48✱	69.00	JCK58✱	95.00
1.2–120 Minutes	JCK19✱	56.00	JCK29✱	69.00	JCK39✱	56.00	JCK49✱	69.00	JCK59✱	95.00

‡ Two dials are provided for independently adjustable repeat cycle timing ranges.

Fixed Time Delay

Timing Mode	Type	Timing Range (Seconds)	Price
On Delay	JCK1F(XXXX)●✱	.1 to 180	$50.00
		181 to 3600	56.00
Off Delay	JCK2F(XXXX)●✱	.1 to 180	63.00
		181 to 3600	69.00
Interval	JCK3F(XXXX)●✱	.1 to 180	50.00
		181 to 3600	56.00
One Shot	JCK4F(XXXX)●✱	.1 to 180	63.00
		181 to 3600	69.00
Repeat Cycle	JCK5F(XXXX)†●✱	.1 to 180	90.00
		181 to 3600	95.00

● (XXXX) denotes desired timing period in seconds. Example: Class 9050 Type JCK1F60 is an On Delay timer fixed at 60 seconds.
†Fixed repeat cycle timers are supplied with the same On-Time and Off-Time.

Class 8501 Sockets
(For additional sockets, see Page 21-36; for additional DIN rail, see page 22-14)

For all 9050JCK timers:

With appropriate 8501NR Socket:
File E42240

Without Socket:
File E42240
CCN NLDX2

For 9050JCK1 thru 59:

File LR25490
Class 3211 04

For 9050JCK60 and 70:

File LR33434
Class 3211 04

✱Voltage code must be specified to order this product. Refer to standard voltage codes listed below and insert as shown in How To Order.

Voltage Codes

Type JCK 11-59 Voltages	Code	Type JCK 60 and 70 Voltages	Code
12 Vac/Vdc	V36	24-50/60	V14
24 Vac/Vdc	V14	120-50/60	V20
48 Vac/Vdc	V17	240-50/60	V24
120 Vac/110 Vdc	V20		

How to Order:

To Order Specify:	Catalog Number		
● Class Number ● Type Number ● Voltage Code	Class	Type	Voltage Code
	9050	JCK11	V20

Contact Ratings

AC Volts	AC Amperes				HP	DC Volts	DC Amperes		
	Inductive 35% P.F.						Inductive		
	Make	Break	Continuous	Res. 75% P.F. Make Break and Continuous			Make	Break	Res. Make Break and Continuous
120	30	3	10	10	1/3	30	3	3	10
240	15	1.5	10	10	1/2				

Type JCK60

This On Delay timer uses a 5 position rotary switch to select the timing range. The three pushbutton thumbwheels are used to select the time value.

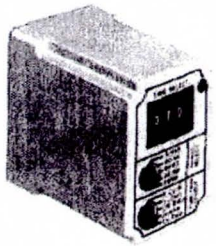
Timing Modes	Timing Ranges	Type	Price
On Delay	.05 to 9.99 sec. .1 to 99.9 sec. 1 to 999 sec. .1 to 99.9 min. 1 to 999 min.	JCK60✱	$98.00

Type JCK70

Two 5 position rotary switches are used to select the timing mode and timing range. The three pushbutton thumbwheels are used to select the time value.

Timing Modes	Timing Range	Type	Price
On Delay Off Delay Interval One Shot Repeat Cycle★	Same as JCK 60	JCK70✱	$111.00

★ The Repeat Cycle mode utilizes the same On-time and Off-time.



Class 8501 Retaining Strap

For use on Class 9050 Type JCK Timers	Class	Type	Price
Restraining strap holds timer in socket during heavy vibration. (See 9050 JCK52/8501 NH7 photo at the top of this page.)	8501	NH7	$5.30

For additional information, reference the General Purpose Timers Type JCK Catalog # 9050CT9601 or D-FAX™ # 1118.

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Liquid Level Switches
Class 9034 – Electro Magnetic Float Switches

Miniature
Designed to meet limited space requirements in many chemical environments.

LLV80

- Mounting: 1/8" NPT
- Leads: LLV80 – 22 ga. MTW (24"); LLV50 – 22 ga. Teflon (24")

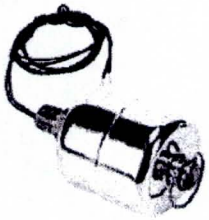
Class 9034 LLV

Model No.	Material	Max. Temp	Max. PSIG	Float SG	Watt Rating	Price	Application
LLV50	316SS	200°C	300	0.60	30	$ 30.00	High temp., high pressure, corrosive conditions
LLV80	Polypro.	105°C	100	0.60	30	18.00	General purpose

UL recognition E54633 for the U.S. and Canada

CSA approval LR56150

Full-Size
Designed for use in many chemical environments.



LLV56

- Mounting: 1/4" NPT
- Leads: 22 ga. Teflon (24")

Class 9034 LLV

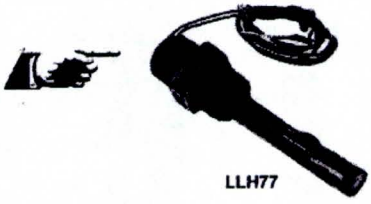
Model No.	Material	Max. Temp	Max. PSIG	Float SG	Watt Rating	Price	Application
LLV56	316SS	200°C	200	0.55	60	$ 40.00	High temp., high pressure, corrosive conditions

UL recognition E54633 for the U.S. and Canada

CSA approval LR56150

For hazardous locations class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III. E150881

Side-Mounted
Designed for mounting through walls of tanks and other vessels.



LLH77

- Mounting: LLH501 – 1/2" NPT or 3/8" bulkhead; LLH77, LLH87 – 1/2" NPT inner, 1/2" NPT outer
- Leads: LLH501, LLH77 – 22 ga. Teflon (24"); LLH87 – 22 ga. MTW (24")

Class 9034 LLH

Model No.	Material	Max. Temp	Max. PSIG	Float SG	Watt Rating	Price	Application
LLH501	316SS	200°C	300 ♦	0.60	30	$ 29.00	High temp., high pressure, corrosive conditions
LLH77	PBT	150°C	100	0.75	30	24.00	Fuels and lubricating oils
LLH87	Polypro.	105°C	100	0.50	30	20.00	General pupose; highly acidic conditions

♦ Bulkhead fitting only.

UL recognition E54633 for the U.S. and Canada

CSA approval LR56150

Current & Voltage Ratings
For resistive loads only. Maximum voltage ratings: SPST – 220 VAC; SPST – 120 VAC.

Amperes (Resistive)

Watts	at 220 VAC	at 110 VAC	at 120 VDC	at 24 VDC
360	1.50	3.00	0.75	3.00
100	0.4	1.0	0.4	1.0
60	0.4	0.5	0.2	0.5
30	0.14	0.28	0.07	0.28
25	–	0.28	–	0.28
15	0.07	0.15	0.03	0.14

LLH501

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For additional information, reference catalog number 9034CT9701 or D-Fax™ number 1571, 1572, 1573.

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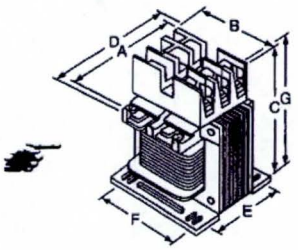

Type TF: Factory Installed Primary and Secondary Fuse Blocks

UL/CSA VA	CE VA	Type	D1 □ 240 X 480 120 I	D2 240 x 480 24 I	D3 208 120 I	D5 □ 600 120 I	D20 208/230/460 115 II	D23 120/240 24 I
50	50	TF50	$ 50.00	$ 56.00	$ 56.00	$ 56.00	$ 82.00	$ 56.00
75	75	TF75	56.00	...	...	...	...	64.00
100	100	TF100	61.00	70.00	70.00	70.00	89.00	70.00
150	150	TF150	65.00	84.00	84.00	84.00	109.00	84.00
200	200	TF200	77.00	...	...	...	134.00	89.00
250	160	TF250	87.00	...	...	...	...	116.00
300	200	TF300	95.00	129.00	129.00	129.00	166.00	129.00
350	250	TF350	100.00	...	...	...	...	131.00
500	300	TF500	120.00	158.00	158.00	158.00	185.00	158.00
750	500	TF750	161.00	...	...	...	...	...
1000	630	TF1000	194.00	...	...	...	...	...
1500	1000	TF1500	269.00	...	...	...	...	...
2000	1500	TF2000	324.00	...	...	...	...	...

□ See page 12-13 for triple ratings on this voltage code.

Dimensions—Type TF Only

VA Key I	VA Key II	VA Key III	Figure	A	B	C	D☆	E	F	G▽	Slot	Weight (lbs)
25 VA	...	...	3	3.09	3.00	4.00	3.84	2.00	2.50	4.20	.20 x .38	2.9
...	...	25 VA	3	4.00	3.43	4.00	4.80	2.00	2.50	4.20	.20 X .48	3.9
50 VA	25 VA	...	3	3.09	3.00	4.00	3.84	2.00	2.50	4.20	.20 x .38	2.9
...	...	50 VA	3	4.19	3.43	4.25	4.99	2.38	2.81	4.45	.20 X .48	4.4
75 VA	50 VA	...	3	3.34	3.38	4.25	4.09	2.38	2.81	4.45	.20 X .48	4.2
...	75 VA	...	3	3.59	3.75	4.55	4.34	2.88	3.13	4.75	.20 x .38	5.9
...	...	75 VA	3	4.88	3.75	4.55	5.68	2.88	3.13	4.75	.20 x .38	7.6
100 VA	...	...	3	3.34	3.38	4.25	4.09	2.38	2.81	4.45	.20 X .48	4.2
...	...	100 VA	3	4.88	3.75	4.55	5.68	2.88	3.13	4.75	.20 x .38	7.6
150 VA	100 VA	...	3	3.59	3.75	4.55	4.34	2.88	3.13	4.75	.20 x .38	5.9
200 VA	150 VA	...	3	3.59	3.75	4.55	4.34	2.88	3.13	4.75	.20 x .38	5.9
250 VA	...	150 VA	3	5.25	3.75	4.55	6.05	2.88	3.13	4.75	.20 x .38	7.5
300 VA	200 VA	200 VA	3	4.70	4.50	5.10	5.50	2.56	3.75	5.30	.20 x .38	8.9
350 VA	250 VA	250 VA	3	5.09	4.50	5.10	5.89	3.00	3.75	5.30	.20 x .38	10.9
...	300 VA	...	3	5.09	4.50	5.10	5.89	3.00	3.75	5.30	.20 x .38	10.9
...	...	300 VA	3	5.46	4.50	5.10	6.26	3.56	3.75	5.30	.20 x .38	12.3
500 VA	350 VA	...	3	5.46	4.50	5.10	6.26	3.56	3.75	5.30	.20 x .38	12.3
...	...	350 VA	3	5.46	4.50	5.10	6.26	3.56	3.75	5.30	.20 x .38	12.3
750 VA	500 VA	500 VA	3	5.66	5.25	5.73	6.46	3.43	4.38	5.93	.28 X .56	11.4
1000 VA	750 VA	750 VA	3	6.04	5.25	5.73	6.84	4.31	4.38	5.93	.28 X .56	21.0
1500 VA	1000 VA	1000 VA	3	5.81	7.06	7.46	6.61	4.13	5.81	7.66	.28 X .56	34.4
2000 VA	1500 VA	1500 VA	3	7.04	7.06	7.46	7.84	4.56	5.81	7.66	.28 X .56	47.4

☆ Dimensions with FINGERSAFE® covers installed.
▽ Dimensions with fuse pullers installed.

Field Installed Fuse Options

Primary and Secondary Fusing

Type	Type Accessory Key I	Type Accessory Key II	Type Accessory Key III, IV	Description	Price
FB3A	25–200	25–150	N/A	Three pole fuse block for primary and secondary fusing, accomodates 1-1/2" x 13/32" midget fuse (2 rejection and 1 non-rejection)	$26.40
FB3B	250–2000	200–1500	25–1500	Three pole fuse block for primary and secondary fusing, accomodates 1-1/2" x 13/32" midget fuse (2 rejection and 1 non-rejection)	26.40

Primary Fusing

Type	Type Accessory Key I	Type Accessory Key II	Type Accessory Key III, IV	Description	Price
FB2A	25–200	25–150	N/A	Two pole fuse block for primary fusing, accommodates 1-1/2" x 13/32" midget fuse (2 rejection)	$22.70
FB2B	250–2000	200–1500	25–1500	Two pole fuse block for primary fusing, accomodates 1-1/2" x 13/32" midget fuse (2 rejection)	22.70

Field-Installable Secondary Fuse Clips

Type	Type Accessory Key I	Type Accessory Key II	Type Accessory Key III, IV	Description	Price
SF25A	25–200	25–150	N/A	Secondary fuse block accommodates 1-1/4" x 1/4" fuse	$ 6.60
SF25B	250–2000	200–1500	25–1500	Secondary fuse block accommodates 1-1/4" x 1/4" fuse	6.60
SF41A⊖	25–200	25–150	N/A	Secondary fuse clip accommodates 1-1/2" x 13/32" midget fuse	5.40
SF41B⊖	N/A	200–2000	25–2000	Secondary fuse clip accommodates 1-1/2" x 13/32" midget fuse	5.40
FB1A	25–200	25–150	N/A	One pole fuse block for secondary fusing, accomodates 1-1/2" x 13/32" midget fuse (1 non-rejection)	15.80
FB1B	250–2000	200–1500	25–1500	One pole fuse block for secondary fusing, accomodates 1-1/2" x 13/32" midget fuse (1 non-rejection)	15.80

⊖ SF41 can be installed on the following voltage codes: D1, D5, D24, D3, D4, D51, D2, D23, D14, D25, D20, D95, D19.

Factory Installed Secondary Fuse Clips

D1:240 x 480-120

UL/CSA VA	CE VA	Catalog Number	Price
50	50	9070T50D1SF41	$ 40.30
100	100	9070T100D1SF41	52.00
150	150	9070T150D1SF41	55.00
250	160	9070T250D1SF41	79.00
500	300	9070T500D1SF41	113.00
750	500	9070T750D1SF41	154.00

How to Order:

To Order Specify:	Catalog Number		
• Class Number • Type Number • Voltage Code • Field Fuse Option	Class	Type	Voltage Code
	9070	TF500	D1
	9070	FB-3B	

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Push Buttons—Heavy Duty Pilot Lights
Type K—30.5 mm
Class 9001

Pilot Lights—UL Types 4, 13/NEMA Type 4 & 13

For use in hazardous locations—See page 16-78.
Legend plates not included.

Description	Voltage	Style	With Red Fresnel Color Cap	With Green Fresnel Color Cap	With Other Color Cap	Price	Without Color Cap	Price
 Standard Pilot Light (Plastic Fresnel Color Cap Shown)	110–120 V, 50–60 Hz 220–240 V, 50–60 Hz 24–28 Vac-dc For Other Voltages See table on page 16-76.	Transformer Transformer Full Voltage Transformer, Flashing or LED ♦ Full Voltage, Neon or Resistor ★	KP1R31 KP7R31 KP35R31 KP▲R31 KP▲R31	KP1G31 KP7G31 KP35G31 KP▲G31 KP▲G31	KP1■ KP7■ KP35■ KP▲■ KP▲■	$68.00 68.00 55.00 68.00 55.00	KP1 KP7 KP35 KP▲ KP▲	$63.60 63.60 50.70 63.60 50.70
 Push To Test Pilot Light (Glass Color Cap Shown)	110–120 V, 50–60 Hz 220–240 V, 50–60 Hz 24–28 Vac-dc For Other Voltages See table on page 16-76.	Transformer Transformer Full Voltage Transformer, Flashing or LED ♦ Full Voltage, Neon or Resistor ★	KT1R31 KT7R31 KT35R31 KT▲R31 KT▲R31	KT1G31 KT7G31 KT35G31 KT▲G31 KT▲G31	KT1■ KT7■ KT35■ KT▲■ KT▲■	87.00 87.00 74.00 87.00 74.00	KT1 KT7 KT35 KT▲ KT▲	82.00 82.00 70.00 82.00 70.00
 Remote Test Pilot Light (Glass Color Cap Shown)	120 Vac Only 24–28 Vac Only For Other Voltages See table on page 16-76.▼	Resistor ▼ Full Voltage ▼ Full Voltage or Resistor ▼	KTR38R31 KTR35R31 KTR▲R31	KTR38G31 KTR35G31 KTR▲G31	KTR38■ KTR35■ KTR ▲■	87.00 87.00 87.00	KTR38 KTR35 KTR▲	82.00 82.00 82.00
 Pilot Light For Intrinsically Safe Circuits (NEMA Type 4X)	Intrinsically safe equipment must not release electrical or thermal energy capable of igniting certain explosive or combustible hazardous atmospheres, for which the equipment has been tested. These pilot lights are intrinsically safe when used with a suitable approved barrier or barrier relay. These pilot lights are Factory Mutual (FM approved). Consult your local Square D Sales Office for further details. These pilot lights are fully encapsulated—there are no replaceable parts—except for the SK40 ring nut. Use KN100 series plastic legend plates as shown on Pages 16-80 and 16-81. Operating Voltage Range: 20–30 V AC/DC; Nominal Current: 25 ma.; V max. = 32 V, I max. = 165 ma.		KP44R	KP44G	KP44Y (Yellow Color Cap)	79.00	–	–

▲ Add the voltage assembly code as chosen from voltage assembly code table on page 16-76.
EXAMPLE: KT▲R31 with a 60 Vac red LED voltage=KT37LRR31
■ Add the color code as chosen from the color cap table. **EXAMPLE: KP1(2) with a blue fresnel cap = KP1L31**
♦ The color cap must be the same color as the LED voltage chosen, i.e., green LED use a green color cap.
★ On neon voltages use clear color caps only.
▼ On remote test pilot lights use only full voltage or resistor voltage assembly codes. Do not choose LED, neon or transformer codes. For AC use only.

Push-To-Test Ground Detector Pilot Light
(Contact Block Included—But NOT Legend Plate or Color Cap)

Used in pairs to indicate a grounded condition in a control circuit fed from a grounded center-tapped transformer. The Type KT50 is commonly used in press control circuits, and fulfills the requirements of the ground detector called for in ANSI B11.1 (1971), Par. E3.6.5. Consult local Square D Sales Office for proper application.

Voltage and Frequency	Type	Price
110–120 V, 50–60 Hz	KT50	$114.00

Color	 ■ Plastic Fresnel	 ■ Plastic Domed	 ■ Glass
Amber	A31	A9	A6
Blue	L31	L9	L6
Clear	C31	C9	C6
Green	G31	G9	G6
Red	R31	R9	R6
White	W31	W9	W6
Yellow	Y31	Y9	Y6

For additional information, reference Catalog #9001CT9701.

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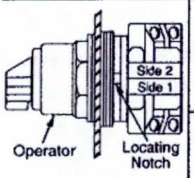
Push Buttons—Selector Switches

Type K—30.5 mm
Class 9001

Non-Illuminated 3 Position Selector Switch Operators—UL Types 4, 13/NEMA Types 4, 13

For use in hazardous locations—See page 16-78.
Legend plate and contact block not included unless noted



CONTACT BLOCK REQUIRED					1—Contact Closed 0—Contact Open								
Contact Block Position	Quantity and Type		Mount on Side		Center Left Right	Center Left Right	Center Left Right	Center Left Right	Center Left Right	Center Left Right	Center Left Right	Center Left Right	Center Left Right
KA1 or KA2	KA3		KA1 #2	KA3 #2	1 0 0	1 0 0	0 0 1	1 0 0	1 0 0	1 0 0	1 0 0	0 1 0	1 1 0
				KA2 #2	0 1 1	0 0 1	0 1 0	0 1 0	0 0 1	0 1 1	0 1 1	1 0 0	0 0 1
KA1 or KA2	KA3		KA1 #1	KA3 #1	0 0 1	1 0 0	0 0 1	1 0 0	0 1 0	0 0 1	1 0 1	0 0 1	0 1 1
				KA2 #1	1 1 0	0 0 1	0 1 0	0 1 0	0 0 1	1 0 0	0 1 0	0 1 0	1 0 0
	CAM				B	C	D	E	F	G	J	L	M

Non-Illuminated Operators	Type	Type	Type	Type	Type	Type	Type	Type	Type	Price
Manual Return										
Operator Only ▲										
Without Knob	KS42	KS43	KS44	KS45	KS46	KS47	KS49	KS401	KS402	$19.00
With Standard Black Knob	KS42B	KS43B	KS44B	KS45B	KS46B	KS47B	KS49B	KS401B	KS402B	23.40
With Other Color Knob (See Table) ■	KS42■	KS43■	KS44■	KS45■	KS46■	KS47■	KS49■	KS401■	KS402■	23.40
Key Operated with E10 Key (Code 4 through 10) ♦★	KS42K♦	KS43K♦	KS44K♦	KS45K♦	KS46K♦	KS47K♦	KS49K♦	KS401K♦	KS402K♦	61.00
With Contact Block(s)										
With Standard Black Knob (See Table for Other Colors, Replace B in Type Number with Other Color Code)										
With 1 KA1 on side #2 (H13)	KS42BH13	KS43BH13	KS44BH13	KS45BH13	KS46BH13	KS47BH13	KS49BH13	KS401BH13	KS402BH13	42.40
With 1 KA1 on side #1 (H1)	KS42BH1	KS43BH1	KS44BH1	KS45BH1	KS46BH1	KS47BH1	KS49BH1	KS401BH1	KS402BH1	42.40
With 1 KA1 on side #1 and 1 KA1 on side #2 (H2)	KS42BH2	KS43BH2	KS44BH2	KS45BH2	KS46BH2	KS47BH2	KS49BH2	KS401BH2	KS402BH2	61.00
Spring Return from Left to Center										
Operator Only ▲										
Without Knob	KS62	KS63	KS64	KS65	KS66	KS67	KS69	KS601	KS602	31.70
With Standard Black Knob	KS62B	KS63B	KS64B	KS65B	KS66B	KS67B	KS69B	KS601B	KS602B	36.10
With Other Color Knob (See Table) ■	KS62■	KS63■	KS64■	KS65■	KS66■	KS67■	KS69■	KS601■	KS602■	36.10
Key Operated with E10 Key (Code 5, 6 or 9 only) ♦★	KS62K♦	KS63K♦	KS64K♦	KS65K♦	KS66K♦	KS67K♦	KS69K♦	KS601K♦	KS602K♦	74.00
Spring Return From Right to Center										
Operator Only ▲										
Without Knob	KS72	KS73	KS74	KS75	KS76	KS77	KS79	KS701	KS702	31.70
With Standard Black Knob	KS72B	KS73B	KS74B	KS75B	KS76B	KS77B	KS79B	KS701B	KS702B	36.10
With Other Color Knob (See Table) ■	KS72■	KS73■	KS74■	KS75■	KS76■	KS77■	KS79■	KS701■	KS702■	36.10
Key Operated with E10 Key (Code 4, 5 or 7 Only) ♦★	KS72K♦	KS73K♦	KS74K♦	KS75K♦	KS76K♦	KS77K♦	KS79K♦	KS701K♦	KS702K♦	74.00
Spring Return Both Sides to Center										
Operator Only ▲										
Without Knob	KS52	KS53	KS54	KS55	KS56	KS57	KS59	KS501	KS502	31.70
With Standard Black Knob	KS52B	KS53B	KS54B	KS55B	KS56B	KS57B	KS59B	KS501B	KS502B	36.10
With Other Color Knob (See Table) ■	KS52 ■	KS53■	KS54■	KS55■	KS56■	KS57■	KS59■	KS501■	KS502■	36.10
Key Operated with E10 Key (Code 5 Only) ♦★	KS52K5	KS53K5	KS54K5	KS55K5	KS56K5	KS57K5	KS59K5	KS501K5	KS502K5	74.00

▲ These operators can be ordered complete with contact blocks—for maximum block usage—see page 16-84. Add the "H" number chosen from page 16-79 to the end of the operator type number and add the cost of the "H" number to the operator cost.
EXAMPLE: KS43K6(61.00)+H13(KA1-SIDE 2)(19.00)=KS43K6H13(80.00).

■ Add the color code as chosen from knob color table at right.
EXAMPLE: KS43■ with a green gloved hand knob = KS43FG

♦ Add the key withdrawal code from key withdrawal code table below.
EXAMPLE: KS43K♦ that the key can be withdrawn in the right position only = KS43K6

★ All key operated devices are furnished as standard with Square D number E10 (key only part no. is 2941101100, **$4.40 per key**). The following 20 additional key changes are available at no extra cost:
E11-E13, E16, E21-E26, E28-E33, CH501, CH674, SR251, T107.
Occasionally it is desirable to have several devices with dissimilar key changes, but all operable by a single master key. The following key changes with master keying provisions are available at **$7.30** additional per device.

Key No.	Total Key Changes Available	Master Key	
		Part No.	Price
E36 thru E60	25	2941151990	$4.40

EXAMPLE: For individual key, not master keyed an E29 is chosen. The type number is KS43K6E29.
All key operators come standard with 2 keys. Replacement keys can be purchased by specifying the key part number at **$4.40** per key.

3 Position Switches

♦ Code				♦ Code			
4	Yes	No	No	8	Yes	No	Yes
5	No	Yes	No	9	No	Yes	Yes
6	No	No	Yes	10	Yes	Yes	Yes
7	Yes	Yes	No				

Selector Switch Knobs


Standard Knob


Gloved Hand Knob


Coin Operated

Color	■ Knob Code	Type	■ Knob Code	Type	■ Knob Code	Type	Price
Black	B	B11	FB	B25	TB	B18	
Red	R	R8	FR	R24	TR	R16	
Green	G	G8	FG	G24	TG	G16	
Yellow	Y	Y8	FY	Y24	TY	Y16	
Orange	S	S11	FS	S25	–	–	$4.40
Blue	L	L8	FL	L24	TL	L16	
White	W	W8	FW	W24	–	–	
Amber	A	A8	FA	A24	–	–	
Clear	C	C8	FC	C24	TC	C16	

For additional information, reference Catalog #9001CT9701.

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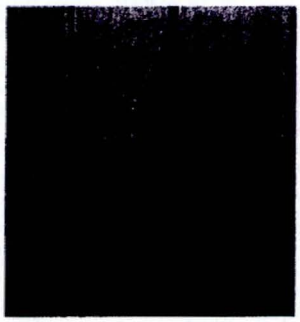
ENM-10 - Level regulator switch



The simplest possible method for level control!
A mechanical switch in a plastic casing, freely suspended at the desired height from its own cable. When the liquid level reaches the regulator, the casing will tilt and the mechanical switch will close or break the circuit, thereby starting or stopping a pump or actuating an alarm device.

No wear, no maintenance! In sewage pumping stations, for ground water and drainage pumping - in fact, for most level control applications - the ENM-10 is the ideal solution.

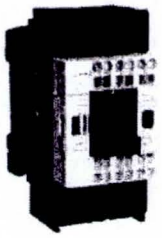
The regulator casing is made of polypropylene and the cable is sheathed with a special PVC compound. The plastic components are welded and screwed together. Adhesive is never used. Impurities and deposits will not adhere to the smooth casing.

The level regulator is available in different versions, depending upon the medium in which it is to be used. As standard, the regulator can be obtained with 6, 13, 20, 30 or 50 metres(20, 42, 65, 100 or 167 ft) of cable for liquids with specific density between 0,95 and 1,10 g/cm³; for other specific densities, the regulator is only available with 20 metres (65 ft) of the cable. The regulator can withstand up to 60° C (140° F).

ITT Flygt Corporation
35 Nutmeg Dr. Box 1004 Tel (203) 380-4700
Trumbull. CT 06611-0943 Fax (203) 380-4705

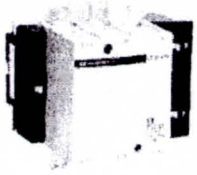
Flygt
ITT Industries

LC1D09



LP1D093

LC1D11500



LC1F115

3-Pole Contactors with AC and DC Operating Coils

Maximum Horsepower Ratings						Maximum Current		Auxiliary Contacts Built In		Catalog Number■	AC Control Price	DC Control Price
Single Phase		Three Phase				Inductive AC3 Amperes	Resistive AC1 Amperes	N.O.	N.C.			
115V Hp	230V Hp	200V Hp	230V Hp	460V Hp	575V Hp							
0.5	1	2	2	5	7.5	9	20	1 0	0 1	LC1D09★♦ LC1D09★♦	$ 91. 91.	$ 116. 115.
1	2	3	3	7.5	10	12	25	1 0	0 1	~~LC1D12★♦~~ LC1D12★♦	115. 115.	140. 140.
1	3	5	5	10	15	18	35	1 0	0 1	LC1D18★♦ LC1D18★♦	131. 131.	155. 155.
2	3	7.5	7.5	15	20	25	40	1 0	0 1	LC1D25★♦ LC1D25★♦	146. 146.	175. 175.
	5	10	10	20	30	32	50	1 0	0 1	LC1D32★♦ LC1D32★♦	166. 166.	206. 206.
3	5 7.5	10 15	10 15	30 40	30 40	40 50	60 70	1 1	1 1	LC1D40★♦ LC1D50★♦	211. 226.	266. 281.
5	10	20	20	50	50	65	80	1	1	LC1D65★♦	311.	366.
7.5	15	30	30	60	60	80	110	1	1	LC1D80★♦	351.	406.
...	...	30	40	75	100	115	175	0	0	LC1D115★♦	463.	463.
		40	50	100	125	150	200	0	0	LC1D150★♦	672.	672.
		30	40	75	100	115	175	1▲	0	LC1F115▼	463.	463.
		40	50	100	125	150	200	1▲	0	LC1F150▼	672.	672.
		50	60	125	150	185	200	1▲	0	LC1F185▼	906.	906.
		60	75	150	175	265	285	1▲	0	LC1F265▼	1139.	1139.
		75	100	200	250	330	360	1▲	0	LC1F330▼	1566.	1566.
		100	125	250	300	400	420	1▲	0	LC1F400▼	1785.	1785.
		150	200	400	500	500	700	1▲	0	LC1F500▼	4802.	4802.
		250	300	600	800	630	1000	1▲	0	LC1F630▼	6640.	6640.
		Current rated				780	1350	0	0	LC1F780▼	7525.	7525.
		...	450	800	900	800	1000	0	0	LC1F800□	6450.	6450.

▲ This one normally open holding circuit contact is incorporated in the design of the standard coil.
■ Contactor catalog number to be completed by the code corresponding to the coil voltage.
♦ Contactor supplied with touch safe cable clamps. For ring terminal configuration add "6" before coil voltage suffix. For spring terminal configuration add "3" before coil voltage suffix. No price adder for these modifications.

★ **Coil Voltages for LC1, see page 15-17.**

▼ **Coil Voltages for LC1 F115 to F780**

Contactor	Hz	24 V	48 V	110 V	120 V	125 V	208 V	220 V	240 V	250 V	380 V	415 V	440 V	480 V	600 V
AC															
F115, F150 F185	50Hz	B5	E5	F5	...	...	...	M5	U5	...	Q5	...	...	...	...
	60 Hz	B6	E6	F6	G6	...	L6	M6	U6	...	Q6	N5	...	Q5	SC
F265, F330	50/60 Hz	B7	E7	F7	G7	...	L7	M7	U7	...	Q7	Q7	...	S7	X7
F400–F780	50/60 Hz	...	E7	F7	F7	...	L7	M7	U7	...	Q7	N7	...	N7	X7△
DC															
F115–F330	...	BD	ED	FD	...	GD	-	MD	...	UD	...	...	RD	...	...
F400–F780	...	...	ED	FD	...	GD	-	MD	...	UD	...	...	RD	...	...

△ 600 volt coil not available for F780. The 600 V coils for the F400, F500 and F630 do not include an auxiliary contact for holding circuits.

□ **AC and DC Coil voltages for F800 (includes built-in surge suppressor)**

Volts AC/DC	24	48	110	120	127	208	220	240	277	380	415	440	480	575	600	660
50/60 Hz	...	...	FW	FW	FW	...	MW	MW	...	QW	QW	QW	...	...	...	...

For Lugs see page 15-7.

Dimensions . . . . . pages 15-25–15-33
Overload Relays . . . . pages 15-19–15-20
Accessories. . . . . pages 15-6–15-14
Replacement Coils . . pages 15-15–15-18

For additional information on D-Line contactors, reference Catalog #8502CT9901R2/01 or D-FAX™ #5497, 5498, 5799, 5500, 5501, 5502.
For additional information on F-Line contactors, reference Catalog #8502CT9901R2/01 or D-FAX™ #5503, 5504, 5505.

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F-Line DC Coils

For LC1 F115, F150, F185, F265, F400, F500, F630, F780, F800
LX4 coils are the standard coils when a voltage code is added to the part number. The LX9 coils may be ordered separately for special applications. LX9 coils do not include a built-in normally open holding circuit contact; a separate auxiliary contact block with a N.O. contact should be added to the contactor. Both the LX4 and LX9 coils can be used on previous F-line devices.

Device type	Catalog Number	• Catalog Number Suffix										
		24 V	36V	48 V	60 V	72 V	110 V	125 V	220 V	250 V	440 V	Price
F115, F150	LX4FF•	024	035	048	060	070	110	125	220	250	440	$ 75.00
F185	LX4FG•	024	035	048	060	070	110	125	220	250	440	104.00
F265, F330	LX4FH•	024	035	048	060	070	110	125	220	250	440	133.00
F400	LX4FJ•	...	...	048	060	070	110	125	220	250	440	271.00
	LX9FJ•♦	...	...	918	...	...	926	927	932	...	938	271.00
F500	LX4FK•	...	...	048	060	070	110	125	220	250	440	381.00
	LX9FK• ♦	...	...	918	...	...	926	927	932	...	938	381.00
F630	LX4FL•	...	...	048	060	070	110	125	220	250	440	535.00
	LX9FK• ♦	...	...	918	...	...	926	927	932	...	938	535.00
F780	LX4FX•▲	...	...	...	...	...	110	125	220	250	440	1068.00
F800	LX4F8■	...	...	...	...	...	FW	FW	MW	...	QW	700.00

▲ LC1-F780 contactors operate on 2 coils as a set. The LX4FX part number includes both coils.
■ Also requires rectifier DR5TE4U, **$72.00** list price.
♦ Coil Circuit requires a separately mounted resistor. Order from table below.

Coil	Resistor Catalog Number	Qty Required	Price	Coil	Resistor Catalog Number	Qty Required	Price	Coil	Resistor Catalog Number	Qty Required	Price
LX9FJ918	DR2SC0047	1	$12.50	LX9FK918	DR2SC0039	1	$12.50	LX9FL918	DR2SC0047	2	$12.50
LX9FJ926	DR2SC0030	1	12.50	LX9FK926	DR2SC0220	1	12.50	LX9FL925	DR2SC0270	2	12.50
LX9FJ927	DR2SC0390	1	12.50	LX9FK927	DR2SC0330	1	12.50	LX9FL926	DR2SC0330	2	12.50
LX9FJ932	DR2SC1200	1	12.50	LX9FK932	DR2SC1000	1	12.50	LX9FL931	DR2SC1000	2	12.50
LX9FJ938	DR2SC4700	1	12.50	LX9FK938	DR2SC3300	1	12.50	LX9FL937	DR2SC3900	2	12.50

D-Line AC and DC Coils

AC Coils

	24 V	42 V	48 V	110 V	115 V	120 V	127 V	208 V	220 V	230 V	240 V	277 V	380 V	400 V	415 V	440 V	480 V	500 V	575 V	600 V	660 V
LC1D09 . . . D38																					
50/60 Hz	**B7**	D7	E7	F7	FE7	**G7**	FC7	LL7	M7	P7	**U7**	W7	Q7	V7	N7	R7	**T7**	–	SC7	**X7**	–
LC1D12 & D25, 4 Pole																					
50/60 Hz	**B7**	D7	E7	F7	FE7	**G7**	–	LE7	M7	P7	**U7**	–	Q7	V7	N7	R7	–	–	SC7	–	–
50 Hz	B5	D5	E5	F5	FE5	–	G5	–	M5	P5	U5	–	Q5	V5	N5	R5	–	S5	–	–	Y5
60 Hz	B6	–	E6	F6	–	G6	–	L6	M6	–	U6	W6	Q6	–	N6★	R6	T6	–	S6	X6	–
LC1D40 . . . D95, 3 or 4-Pole																					
50/60 Hz	**B7**	D7	E7	F7	FE7	**G7**	–	–	M7	P7	**U7**	–	Q7	V7	N7	R7	–	–	–	–	–
50 Hz	B5	D5	E5	F5	FE5	–	G5	–	M5	P5	U5	–	Q5	V5	N5	R5	–	S5	–	–	Y5
60 Hz	B6	–	E6	F6	–	G6	–	L6	–	–	U6	W6	–	–	–	R6	T6	–	S6	X6	–
LC1D115 & D150 Coils with integral suppression device fitted as standard																					
50/60 Hz	**B7**	D7	E7	F7	FE7	**G7**	FC7	LE7	M7	P7	**U7**	UE7	Q7	V7	N7	R7	T7	S7	–	–	–
50 Hz	B5	D5	E5	F5	FE5	–	FC5	–	M5	P5	U5	–	Q5	V5	N5	R5	–	S5	–	–	–
60 Hz	B6	–	E6	F6	–	G6	–	L6	M6	–	U6	W6	Q6	–	–	R6	T6	–	–	–	–

DC Coils

	5 V	12 V	20 V	24 V	36 V	48 V	60 V	72 V	96 V	110 V	125 V	220 V	250 V	440 V
LC1D09 . . .D38 Coils with integral suppression device fitted as standard														
U 0.7 . . . 1.25 Uc	–	JD	–	**BD**	CD	**ED**	ND	**SD**	–	FD	**GD**	MD	UD	RD
LC1D09 . . . D38 LOW CONSUMPTION Coils with integral suppression device fitted as standard														
U 0.7 . . . 1.25 Uc	AL	JL	ZL	**BL**	CD	**EL**	–	SL	DL	FL	–	ML	UL	–
LC1D40 . . . D95, 3-Pole Coils with integral suppression device fitted as standard														
U 0.85 . . . 1.1 Uc (standard)	–	JD	–	**BD**	CD	**ED**	ND	**SD**	–	FD	**GD**	MD	UD	RD
U 0.75 . . . 1.2 Uc (wide range)	–	JW	–	BW	CW	EW	–	SW	–	FW	–	MW	–	–
LC1D115 & D150 Coils with integral suppression device fitted as standard														
U 0.75 . . . 1.2 Uc	–	–	–	**BD**	–	**ED**	ND	**SD**	–	FD	**GD**	MD	UD	RD

Note: Voltage codes in bold face are typical control voltages.
★ N6 voltage code not availabel for LC1D25 4-pole contactor.

For additional information on D-Line contactors, reference Catalog #8502CT9901R2/01 or D-FAX™ #5497, 5498, 5799, 5500, 5501, 5502.
For additional information on F-Line contactors, reference Catalog #8502CT9901R2/01 or D-FAX™ #5503, 5504, 5505.

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