DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

Environmental Impacts of Pipeline Corridors in the Mojave Desert, California

by

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Open-File Report 92-447

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ABSTRACT

Three recently-built gas and oil pipelines that cross the Mojave Desert have graded construction zones averaging 89 feet wide (range 68-207 feet) over 240 mi. of gently sloping, undissected to moderately dissected terrain, and 131 feet wide (range 79-273 feet) over 53 mi. of moderately steep to steep terrain. Where corridors overlap, the graded width of two pipelines combined averages 144 feet (range 100-186 feet) over 72 mi. of gentle terrain, and 222 feet (range 169-388 feet) over 6 mi. of steep terrain. A limited sample of pre- and post-construction measurements on one pipeline shows that the width of the graded corridor exceeds the surveyed width by about 12%. A moderate rainstorm of 4 hr duration in the Tehachapi Mountains eroded about 120 tons/ac to 250 tons/ac of soil from the Mojave pipeline corridor across steep slopes. Seven vegetation transects indicate losses of individual native perennials ranging from 19,000 to 61,000 per mile, based on the width of the construction zone in the immediate vicinity of each transect; one transect on the 5-year old corridor indicates limited recovery.

Current installation practices result in excessive problems of accelerated erosion, long-term loss of habitat, and threats to public health and safety. The problems arise from failure to implement existing conservation plans, inadequacies in environmental requirements, and inadequacies in engineering oversight. Significant environmental benefits can be obtained by extending limits on the width of disturbance, now placed only on areas of special concern, to all public lands: by limiting mechanical grading of the corridor to the backfilled trenches; and by improved engineering oversight of erosion controls. An intensive research program to learn how best to successfully restore or transplant native desert vegetation also is needed.

INTRODUCTION

Three major pipelines have been installed across California's Mojave Desert in the past five years: the All American Pipeline, connecting Santa Barbara, California, and McCamey, Texas, traverses about 263 miles of the California Desert Conservation Area (CDCA) and was built in 1987; the Mojave Pipeline, connecting Daggett, California, and Topock, Arizona, traverses about 142 miles of the CDCA and was built in 1991; and the Kern River pipeline connecting Opal, Wyoming, and Daggett, California, traverses about 89 miles of the CDCA and and was built in 1991. The Mojave and Kern River pipelines share a single conduit between Daggett, California, and Bakersfield, California, traversing about 83 miles of the CDCA. The All American pipeline transports crude oil in a 30" pipe, the Kern River and Mojave pipelines transport natural gas in 36" and 30" pipes, respectively; the shared pipe is 42". Another significant proposed pipeline in the CDCA (the Cajon pipeline) is in the review process. These projects reflect a growing national trend of pipeline construction, especially for transport of natural gas, which was projected to exceed 6,500 miles in 1991-92 (Koen and True, 1991). Current legislation (HR 776) calls for "streamlining" compliance with environmental regulations, which could lead to a "boiler plate" rendering of environmental assessments and failure to reduce environmental impacts.

Federal regulations governing pipeline installation on public lands and the Bureau of Land Management's (BLM) Right-Of-Way (ROW) Grant stipulations for these specific pipelines are reviewed in terms of actual construction impacts and procedures, reclamation,

and post-construction environmental impacts. Recommendations are made for reducing the environmental impacts.

Specific utility planning corridors were identified (fig. 1) in the California Desert Plan (BLM, 1980) to reduce proliferation. A brief appendix (BLM, 1980) identified additional "contingent corridors" (fig. 1). Corridors with existing utilities were assigned 2 mile widths and those with none, 4 mile widths to allow for planning flexibility. Some of the contingent corridors responded to specific requests from industry, but others did not. An exception to all designated corridors was allowed for the All American pipeline (fig. 1).

REGULATIONS

The Code of Federal Regulations (43 CFR Ch. II, Subpart 2881.2, Terms and conditions of interest granted) provides only very generalized guidelines for construction standards, environmental protection, and reclamation of pipeline corridors, as follows:

> (b) All right-of-way grants and temporary use permits issued...under these regulations shall contain such terms, conditions, and stipulations as may be prescribed by the authorized office regarding extent, duration, survey, location, construction, operation, maintenance, use, and termination. The authorized officer shall impose stipulations which shall include, but shall not be limited to:
>
> (1) Requirements for restoration, revegetation, and curtailment of erosion of the surface of the land;
>
> (2).....;
>
> (3) Requirements designed to control or prevent damage to the environment (including damage to fish and wildlife habitat), damage to public or private property, and hazards to public health and safety;

Stipulations relating to construction, operation and maintenance, and rehabilitation are itemized in the ROW Grant or Temporary Use Permit, and details of implementation plans are provided by the applicant in a Construction, Operation, and Maintenance (COM) Plan, as stipulated by the U.S. Code (43 USC 1764, Sec. 504). Upon approval, the COM Plan is made part of the ROW Grant. Section 505 of 43 USC 1765 further requires location of the ROW,

> along a route that will cause least damage to the environment, taking into consideration feasibility and other relevant factors.

Subpart 288l.l-l (c) of 43 CFR Ch. II provides that a ROW width,

> shall not exceed 50 feet plus the ground occupied by the pipeline...unless the authorized officer finds and records the reasons for his finding, that a wider ROW is necessary for operation and maintenance after construction...

Normally, ROW Grants allow an additional 25 feet for the construction corridor, which is specifically stated for the Kern River and Mojave pipelines, but not for the All American pipeline. Blading of the full 75-foot width of the allowed construction corridor is described as a "worst case scenario." However, construction corridors exceeding 75 feet width are routinely approved where the terrain or materials to be excavated for pipe burial may present difficulties. The planned construction corridor, which is contained in engineering documents for the purpose of contract bidding, rather than the actual post-construction corridor may be used in computing habitat compensation requirements [Kern River/Mojave ROW Grants, Specific Environmental Stipulations, 5 (c)]. In contrast to BLM's stipulations in the CDCA, the U.S. Forest Service has restricted surface disturbance for the same pipelines to the 50-foot ROW even through difficult terrain (Final Environmental Impact Report/Environmental Impact Statement [FEIR/S], Proposed Celeron/All American and

Getty Pipeline Projects, 1985, p. 4-7, 4-15). Restrictive measures irrespective of terrain also have been recommended in the Kofa National Wildlife Refuge and Carlsbad Resource Area to protect natural resources.

RIGHT-OF-WAY STIPULATIONS

Between issuance of the ROW Grants for the All American, Kern River, and Mojave pipelines, the BLM Authorized Officer in California instituted a uniform listing of "Environmental Terms and Conditions," followed by a section of mitigations specific to individual projects, that were derived from the environmental review process for the Kern River and Mojave pipelines. This allows for more consistent treatment of each application, and serves as a useful checklist. As will be discussed, it needs to be tightened considerably and made internally consistent for there to be reasonable assurance that the stipulations will actually be implemented.

There are 110 General Provisions, covering such subjects as air quality, soil, surface and groundwater, biology, and visual resources. Nearly 25% (26) of these contain qualifying language (e.g., "where necessary," "where practicable," "if feasible," "as nearly as possible,") that reduce the likelihood of conscientious implementation. For the Kern River and Mojave pipelines there are 6 additional specific environmental stipulations, each with several subdivisions. The basic intent of the stipulations is protection of natural resources and public health and safety.

OBSERVATIONS ON THE KERN RIVER, MOJAVE, AND ALL AMERICAN PIPELINES IN THE CALIFORNIA DESERT CONSERVATION AREA (CDCA)

The types of observations include measuring of the width of the construction corridors (for parts of the Kern River pipeline, both the preconstruction staked width and the postconstruction actual width were measured); describing the plant communities and terrain in the immediate area of measurement; measuring the density of principal plant species in selected areas; noting and measuring effects of wind and water erosion; and noting rehabilitation and natural revegetation of the construction corridors, temporary storage areas, and access roads.

Width of Construction Zone

Table 2 gives data on pre- and post-construction corridor widths and describes the local terrain and vegetative community for segments of the Kern River pipeline in the northeastern CDCA. Table 3 gives data for postconstruction corridor graded widths and the nature of the terrain and vegetative community for various segments, with a total length of nearly 300 miles, of all three pipelines. The data in Table 2 represent a very limited sample, which shows that, on average, actual graded widths exceed the originally surveyed widths by about 12%. Table 3 shows that graded widths of corridors commonly greatly exceed nominal anticipated widths of 75 feet, and that exceptionally wide construction zones are common even where the terrain and vegetation apparently present minimal problems. Graded widths of the Kern River pipeline reach 207 feet in gentle terrain occupied by creosote bush scrub community, despite the COM Plan statement (p. 1-10) that,

> In relatively level terrain, the construction zone (ROW) can be narrowed to approximately 60' in width for lengths of up to 500 feet in site specific locations.

Widths of grading (Table 3) reach 270 feet for the All American pipeline and combined widths of overlapping corridors of the All American and Mojave pipelines reach 388 feet in steep terrain in the Tehachapi Mountains Construction zones average 89 feet wide (range 68-207 feet) over 240 mi. of level to moderately dissected terrain, and 131 feet wide

(range 79-273 feet) over 53 mi. of moderately steep to steep terrain. Where corridors overlap, the graded width of two pipelines combined averages 144 feet (range 100-186 feet) over 72 mi. of level terrain, and 222 feet (range 169-388 feet) over 6 mi. of steep terrain. Construction zones for the Mojave pipeline (Mainline and shared line) average 96 feet wide over 131.7 miles of gentle terrain, and 139 feet wide over 21.4 miles of steep terrain; comparable figures for the Kern River and All American pipelines are, respectively, 81 feet and 89 feet wide over 69.6 and 39.7 miles of gentle terrain, and 140 feet and 168 feet wide over 26.5 and 5.2 miles of steep terrain.

Construction Methods Versus Protective Stipulations

It is evident from Table 3 that major parts of all pipeline corridors through the CDCA are in creosote bush scrub and Joshua tree woodland communities; these communities comprise important habitat for at least one listed animal species, the desert tortoise (*Gopherus agassizii*) and the communities present along the pipeline corridors contain at least two sensitive plant species (Mojave-Kern River Pipeline Projects, Environmental Impact Report, Final Amendment, 1991, Table 3.2-3). The difficulty in restoring principal plant species of these communities is well known (Webb and Wilshire, 1980; Brum and others, 1983; Webb and others, 1983; Kay and Graves, 1983; Prose, 1985; Prose and others, 1987; Webb and others, 1988), so impact mitigations are appropriately stipulated in the ROW Grants. For the All American Pipeline it was stipulated (ROW Grant, Environmental Terms and Conditions, B-11, E) that the

> Holder will trim or crush ROW area in creosote shrub or alkali shrub areas.

The intent here is to take advantage of the fact that creosote shrubs will resprout from root crowns even if the above-ground foliage is destroyed; blading generally removes the root crown as well as the foliage. This mitigation, although stated as mandatory, was not implemented on any part of the All American pipeline corridor examined in the CDCA (fig. 2).

The same stipulation appears in the Kern River and Mojave pipeline ROW Grants in a more permissive form -- General Measures, item 58 specifies,

> During construction in sensitive areas, the Holder shall clear the minimum ROW width possible and minimize ROW damage where possible (e.g., not stripping vegetation less than four inches in height, leaving trees standing and/or mowing taller vegetation as opposed to clearing, the last being particularly desirable in Mojavean shrub communities).

Very uncommonly, a small "peninsula" or "island" was left undisturbed to preserve a Joshua tree, yucca, or barrel cactus; trees so-preserved and those adjacent to the construction corridor, including pine on the Kern River pipeline across Keaney Pass, commonly were damaged.

Other stipulations that apply to the same vegetative communities are mandatory -- General Measures, item 17 requires that,

> The Holder shall minimize the amount of vegetation removed, and where it is removed leave the roots intact,

and, the Specific Environmental Stipulations, item 5 (g) requires:

> Joshua trees, sensitive cacti and perennial species, and other specimen vegetation that cannot be avoided shall be carefully removed from the rights-of-way, held in secure locations, and replanted on the right-of-way near their original locations after completion of construction. Within desert tortoise habitat, sensitive cacti, perennial species, and other specimen vegetation shall be defined

> as larger and/or slow-growing species that provide shelter and/or food resources for desert tortoises. These species shall include Joshua trees (*Yucca brevifolia*), Mojave yuccas (*Yucca schidigera*), and Spanish bayonet (*Yucca baccata*).

Some efforts were made to implement these stipulations by use of devices on the Mojave corridor that are designed to remove the foliage of plants while leaving the roots intact and by shallow blading on parts of the Kern River corridor with the same intent. There are no indications (as would be exposed by post-grading cutting of water bars for example) that either method succeeded in leaving root systems intact; it is possible that final grading to contour defeated these techniques, but time may show some degree of success. The second stipulation regarding transplantation, however, is grossly diluted by the Kern River and Mojave COM Plans (p. S3-3,5, Kern River COM Plan), which call only for transplantation of 100 cacti and 100 yucca in California. Transplantations in California were to be made in desert tortoise habitat on both corridors and in the Clark Mountains on the Kern River corridor, the latter as a scenic mitigation because the corridor is adjacent to a Wilderness Study Area. No evidence of any transplantations was observed through mid-July, 1992, anywhere on the Kern River corridor, including a foot traverse of over 9 miles across Keaney Pass in the Clark Mountains (it should be noted that some stretches of the corridors between points of measurement could not be seen from the access road used). One hundred and twenty barrel cactus transplants (fig. 3) were observed along a 24-mile stretch of the Mojave corridor, starting 2 miles west of U.S. Hwy. 95, and one possible Joshua tree transplant was observed on the Mojave corridor 5.2 mi. east of Mojave; otherwise no Joshua trees or other yucca transplants or evidence of their having been set aside for transplantation was observed on either corridor, despite the fact that 72 to 85% of the Joshua trees counted in two transects in Joshua tree woodlands are of a size suitable for transplantation. For the most part, therefore, these stipulations apparently have not been met on major segments of the Kern River and Mojave pipeline corridors in the CDCA (figs. 4-6).

The All American pipeline ROW Grant stipulates (B-11, C) that the

> Holder will avoid disturbance to sensitive and valuable plant communities including.....Joshua tree woodlands, desert dunes, and ironwood washes.

The specially authorized route from Amboy to Blythe (fig. 1) traverses at least 8 ironwood washes (figs. 7, 13) and an area of stable longitudinal dunes in Rice Valley. The construction corridor across the ironwood washes is about 85 feet wide, despite Mitigation Measure 9 (FEIR/S, p. 4-6), which limits the construction ROW to 50 feet in these areas. The Draft Environmental Impact Report/Statement (DEIR/S) limited the construction ROW to 50 feet across all washes, but this requirement was dropped in the FEIR/S. Although the stipulation for avoidance of desert dunes is not found in the Kern River and Mojave Pipeline ROW Grants, these lines cross substantial areas of sand sheets and coppice dunes between Daggett and Troy Dry Lake (fig. 1).

Impacts on Vegetation

Four transects were made adjacent to the Kern River corridor and 3 adjacent to the Mojave corridor in areas of varying vegetative community to assess vegetative losses due to construction. The transects were made by stretching a 330-foot (100 m) tape approximately parallel to the construction corridor and flagging boundaries 10 feet (3 m) on each side of the tape. Counts were then made of all individual perennial plant species (except grasses) within the 3,300 ft^2 (600 m^2) plots (Table 4), and converted to per-mile losses for the measured construction corridor width. The results show that losses of native perennials characteristic of various natural communities, such as creosote range from 2,000 to 4,500 per mile, Joshua trees from 250 to 3,500 per mile, and cacti from

500 to 5,600 per mile. In addition to the larger perennial plants, various native grasses also commonly are present in the undisturbed land, and intershrub lichen and algal mats (cryptogamic crusts) are widespread; these also are important elements in surface stability (Wilshire, 1983) as well as of the biotic community, but generally have not recolonized the pipeline corridors. The transect procedure employed focused my attention on how extremely variable the plant communities really are, especially in areas like the Clark Mountains and Halloran Hills, which have (for the desert) relatively lush vegetation. For example, barrel cacti and agave are very heterogeneous in distribution, and only 3 barrel cacti and no agave were identified in the Kern River corridor transects although both are locally relatively abundant and were certainly impacted by pipeline construction (fig. 8).

Reclamation and Natural Revegetation

Erosion Control. Reclamation plans for all 3 pipelines call for measures to reduce erosion. Proactive measures to revegetate the construction corridors are required for the Kern River and Mojave pipelines, but not for the All American pipeline, which was exempted in Appendix J, Additional Agency Right-Of-Way Stipulations, DEIR/S:

> Revegetation will not be attempted because of extremely low levels of precipitation.

Reseeding with native perennial species is required for the Kern River corridor, but not the Mojave corridor. An additional mitigation calls for eliminating the berm over the buried pipe every 100 feet, but this commonly was not done; as a consequence, runoff channelized by the berm commonly eroded gullies, even on very low slopes (fig. 9). Moreover, the requirement to reestablish natural drainages across the Mojave and Kern River corridors also commonly was not met in areas of complex piedmont drainages, with the consequence that the construction corridors captured drainages, causing erosion of the construction zone (fig. 10). Measures to reduce wind erosion on the Kern River and Mojave pipeline corridors involved compacting areas with fine-grained surface materials by a nondirectional (cup-shaped) imprinting. The imprinting was designed in addition to trap wind-blown seeds and capture rainwater to aid plant growth. This method is completely ineffective for eolian deposits (dunes and sand sheets) and fails to protect major stretches of the Mojave pipeline in the western part of the CDCA (fig. 11); the older All American pipeline is still undergoing wind erosion in the same areas (fig. 12). No evidence of wind erosion was seen on either of the two Pacific Gas and Electric (PG & E) pipeline corridors, which are more than 40 years old, where they are in close proximity to the ones studied. A general reclamation approach for reduction of wind erosion (Kern River COM Plan, p. S3-1) is through use of,

> surface treatments such as mulching or rip rap...where necessary.

These techniques were not used in any of the erosion-prone areas observed. One of the reasons for avoiding dunes is evident in the Rice Valley corridor of the All American pipeline, where large blowouts have formed in the construction zone (fig. 13).

The only mechanical methods to retard water erosion observed in the CDCA were imprinting and construction of water bars. Water bars are described in COM Plans as berms about 1-foot tall built across steeper slopes, and inclined gently downslope; they are constructed by bulldozing a shallow ditch and piling the excavated material in a berm on the downslope side of the ditch. The purpose of these constructs is to reduce the slope length traversed by runoff, thereby reducing the erosive power of the runoff. Engineering standards for water bars (the frequency depending on soil type and slope) include:

> Uphill end should extend far enough beyond disturbance to prevent water from running around the bar and onto disturbance.

> Discharge end should extend far enough beyond disturbance to prevent water from running back onto disturbance (Kern River COM Plan, Figure 3-4).

These standards commonly were not met on all of the pipelines; in many places, the bars begin and end in the construction zone. A moderate rainstorm in the Tehachapi Mountains on February 13, 1992 (1.9" in 4 hr recorded at the Tehachapi Fire Station) caused significant erosion of the Mojave pipeline corridor, especially below the ends of the bars where concentrated runoff was diverted onto the construction zone (figs. 14, 15). Many bars built on the Mojave pipeline corridor where it overlaps the All American corridor end within the All American construction zone with no matching bar on the older corridor. Concentrated runoff there caused erosion of the All American corridor that would not otherwise have occurred (figs. 14, 15). Uneven depths of the ditches dug to build the bars commonly caused ponding behind the bars; where runoff was sufficient, overflow then breached the bars, releasing concentrated runoff in the construction zone (fig. 14). In a number of places on the Kern River corridor across Keaney Pass, bars actually slope upstream so that runoff collected by them must then pass through the construction zone in the reconstructed natural drainage. In one major unnamed wash in the Halloran Hills (fig. 6B), a bar over 4 feet high dams the entire pre-existing active runoff channel and will direct runoff onto a vegetated terrace; at the downstream end of the terrace, another bar dams the diverted runoff so that it will pond. In the Bullion Mountains south of Ludlow, the Mojave pipeline has giant bars built of boulders excavated from steep slopes (fig. 16); in violation of yet another stipulation regarding control of such excavated materials, boulders at this site accumulated in a formerly broad sandy wash with smoke trees, which will likely impede recovery of the wash vegetation (fig.16), and others accumulated on the adjacent All American and PG & E corridors (fig. 17) and on natural slopes. Boulders excavated from the Kern River corridor east of Greens Well Road in the Clark Mountains came to rest in steep drainages far from the construction corridor.

Access Road and Pipe Storage Area Closure. A general mitigation requirement in the COM Plans (Kern River COM Plan, p. S4-2) states that

> All temporary roads shall be closed and areas restored without undue delay....

Restoration of such areas would have been much simpler had they been designated as overland routes (i.e., blading not permitted; Kern River COM Plan, p. S4-2) (fig. 18), and preexisting routes not been widened by grading (Kern River and Mojave ROW Grants, General Measures, No. 31). The procedures for "closing" these routes involved cross-trenching, which, in a number of cases apparently invited exploration by vehicles that went over or around the trenches (figs. 19, 21). Soil compaction was not ameliorated on any observed closed access road. "Restoration" consisted of grading off the berms along the sides of the roads, and distributing rocks and vegetative debris on the roadway (fig. 20); this procedure resulted in significant additional plant losses (figs. 20, 21; Table 5). One access road to the Kern River corridor east of Keaney Pass was graded along a wash whose floor was mostly heavily vegetated; this route is now undergoing significant erosion.

No reclamation requirements were found in the ROW Grants or COM Plans for pipe storage areas, which are graded areas about 10 acres in size; there are no visible signs of reclamation efforts at any of the storage areas examined, but the Kern River storage areas are reportedly on private land that was previously disturbed. These areas are highly vulnerable to wind erosion as attested by sand and rock accumulations along a tortoise fence on the downwind side of the Kingston Road storage area (fig. 22); the size of rocks moved by the wind (probably the windstorm during Thanksgiving week, 1991) is remarkable (fig. 23), and illustrates the need to restabilize the disturbed surfaces.

Revegetation. Both natural and artificial revegetation of all of the pipeline corridors were given a substantial boost by the exceptional 1991-92 rain year. The Spring of 1992 was indeed a banner year for wildflowers, and broad tracts of the Mojave Desert that previously had shown serious effects of drought were rejuvinated. Substantial parts of all 3 corridors had good growths of annual plants, primarily on the flatter areas (fig. 24). Where the All American and Mojave pipeline corridors overlap, annual growth was generally denser on the older corridor, which allowed measurement of how much of the older corridor was disturbed again in construction of the Mojave pipeline. Steeper parts, about 15-20% slopes, had much lower densities of annuals, and slopes steeper than about 20% were mostly barren. Even in the best parts, however, the density of annuals was patchy. A small annual bunch grass generally dominates on flat slopes in all of the corridors, but numerous other annual plants commonly are present, and in places dominant. Whether reseeding of the Kern River corridor worked on flat slopes is not clear because of the general abundance of naturally germinated annual plants. Broadcasting seed on steeper slopes as called for in the Kern River reclamation stipulations clearly did not work well, even with the highly favorable rainfall conditions. How long the annual plants on flatter terrain will provide protection against erosion is not known, but they are unlikely to help after 2-3 years unless they are replaced by new growth. Many parts of all three pipeline corridors have substantial invasions of exotic species (primarily tumbleweed [*Salsola iberica*], fig. 25).

Perennial vegetation is greatly retarded as anticipated from the construction methods employed. Nevertheless, significant local new growth of a few perennial species, including creosote, cheesebush, saltbush, brittle bush, and native buckwheats has occurred in parts of the 5-year old All American pipeline (Table 4; fig. 7). Very sparse recolonization of the Mojave and Kern River corridors by saltbush and brittle bush was observed locally. Three places along the corridors apparently favor growth of seedlings of the perennials, in particular creosote, which is well-known to be slow in recovery: in washes that cross the corridors, in shallow eolian soils on level surfaces, and along the berms formed over the pipeline trench itself. All three locations represent conditions favorable for moisture enhancement or storage. Enhanced recolonization of some native perennials along the berms immediately above the buried pipes is also evident in older (1960, 1963) PG & E pipeline corridors close to those studied. Where the pipelines are oriented at some angle to the natural drainage system, the berms above the buried pipes intercept and either pond or channelize runoff. Despite compaction of the trench fill as it is replaced, it remains more permeable than adjacent materials and likely absorbs and stores moisture preferentially, thereby favoring natural recolonization. However, the sizes, species richness (Table 4), and the cover provided by native perennials are far less in the All American pipeline corridor and generally much less in the 30-year old PG & E corridors than in undisturbed land (cf Lathrop and Archbold, 1980a). Recolonization of the important native perennials in the Mojave and Kern River corridors is extremely limited, as is to be expected from the recency of construction. All of the small perennials in these corridors appear to be seedlings, rather than resprouts from root system of the preexisting plants. There is little, if any, recolonization in any of the corridors by Joshua trees, yucca, and most cacti. This is consistent with the author's unpublished observations of less severe disturbances of Joshua tree woodlands in the Mohave Mountains near Needles in which these species, along with ocotillo and paloverde, have not recovered in 50 years.

The All American pipeline storage area near Amboy shows very limited revegetation after five years (fig. 26), in part because soil compaction was not ameliorated and the area has been used by vehicles. Even with compaction amelioration and reseeding, a segment of the All American corridor inadvertently driven into the Amboy Wilderness Study Area adjacent to the storage area, shows only very limited recovery. Limited recovery of an area (fig. 27), located 7 mi. west of the storage area in the same terrain/vegetation setting, that

was cleared 50 years ago as an emergency landing field for aircraft in WW II, indicates that natural recovery of the storage area will require decades. A similar fate is likely for the Kern River and Mojave pipeline storage areas as well as closed bladed access roads.

Control of Vehicle Access

A significant problem in achieving revegetation and surface stability of the construction corridors is easy access to off-road vehicles. No mitigation was stipulated for the Kern River pipeline, partly because effective control was considered to be impractical. The Mojave pipeline, however, was signed in less remote areas, but with no obvious benefit. Although light to moderate vehicular use of the construction corridors of all three pipelines was observed in remote areas, extensive use was observed only near populated areas, such as the Mojave pipeline corridor in the Stoddard Valley off-road vehicle open area south of Barstow, the area between Interstate Hwy.15 south of Barstow and Lenwood, west of Edwards Air Force Base, in the Chambless area, and the All American and Mojave corridors in the eastern part of the Tehachapi Mountains The effects of such use include accelerated erosion and retardation of revegetation, which is particularly conspicuous where the corridors otherwise have good stands of annual plants.

Postconstruction Environmental Effects

Residual environmental effects of the pipeline installations described above include accelerated wind and water erosion and long-term loss of habitat. Accelerated wind erosion has resulted in property damage, public safety hazards, possibly deleterious health effects on humans and domestic and wild animals, and enlargement of damage to plant communities adjacent to construction corridors. Removal of trees that served as a windbreak for a property adjacent to the All American pipeline corridor about 15 miles east of Daggett, resulted in wind damage to buildings; a drift fence put up by the owner has built a sand drift about 4 feet high in 3 years (fig. 28). Susceptibility of both the Mojave and older All American pipeline corridors to severe wind erosion in the western part of the CDCA (figs. 11, 12) may be a contributing factor to traffic hazard on State Hwy. 58, significant stretches of which lie very close to the pipelines; complete stripping of vegetation within the State Hwy. 58 ROW in newly constructed 4-lane stretches probably contributes more heavily to the potential hazard. Blowing dust from the corridors could pose traffic hazards along a number of lesser roads as well where they cross or are close to the pipelines (see Hyers and Marcus, 1981), as evidence of wind erosion of the pipeline corridors is very widespread. Potential health hazards are created by long-distance transport of particulates (Saint-Amand and others, 1986) and by disease forms that may be endemic in desert soils (Leathers, 1981; Wilshire and others, 1981). Blowouts formed in dunes crossed by the All American pipeline in Rice Valley enlarge themselves by undercutting the root systems, sandblasting plants on the downwind sides, and by burial of vegetation beneath drifts (fig.13). The same effects on plant communities adjacent to corridors, unaccompanied by blowouts, are seen in nondune areas with sandy soils, and along corridors through areas covered by thin sand sheets and coppice dunes.

Accelerated water erosion of the pipeline corridors is causing long-term loss of soil (figs. 14, 15), siltation of stream courses (fig. 29), and, ultimately, will cause water pollution when the sediment reaches main streams, and will increase the supply of wind-erodible materials to wind fetches. Three erosion transects were made on the Mojave pipeline in the Tehachapi Mountains Measurements of surface reduction were made at 3.9-inch (10 cm) intervals over an aggregate length of 351 feet (107 m). Average surface reductions were 0.7 inches (1.89 cm) [121-foot (36.8 m) transect], 1.49 inches (3.79 cm) [133-foot (40.5 m) transect] and 1.57 inches (3.98 cm) [98-foot (30 m) transect], which correspond very roughly to erosion levels ranging from 120 tons/ac to 250 tons/ac. Much lower levels of erosion occurred farther east where the rainfall was not as intense and slopes are shallower, but substantial stretches of all three pipelines remain vulnerable to

water erosion. Failure of erosion-control devices on the Mojave pipeline in the Tehachapi Mountains caused a traffic hazard on the Tehachapi-Willow Springs Road, which was covered with mud and debris eroded from the pipeline corridor. Soil losses are not restricted to those on the exposed corridors during reclamation, but also include erosion of off-site lands subjected to concentrated runoff from the corridors.

Loss of habitat will remain a problem long after all but the steepest parts of the corridors have been restabilized by plant growth, especially in the Joshua tree woodland and creosote communities. It is evident from incomplete recovery of the natural native plant communities in 30-year-old pipeline corridors in the immediate vicinity of the new pipelines that decades will be required to achieve unassisted restoration of the original communities, if that is possible. Other still older and long-abandoned constructs such as the WW II landing strip near Amboy (fig. 27) and the strafing runs in the Mohave Mountains (fig. 30) show that 50 years will be insufficient for recovery. This conclusion is amply supported by various studies of recovery of similar plant/terrain associations that had been disturbed at known times in the past (e.g., Webb and Wilshire, 1980; Lathrop and Archbold, 1980 a,b; Brum and others, 1983; Webb and others, 1983; Kay and Graves, 1983; Prose, 1985; Prose and others, 1987; Webb and others, 1988).

CONCLUSIONS AND RECOMMENDATIONS

Currently employed methods of pipeline installation in the CDCA have caused significant problems of accelerated wind and water erosion, threats to public safety, and long-term loss of habitat. These problems result from failure to implement mitigations that are stipulated in ROW Grants, inadequacy of the environmental stipulations, and inadequate engineering oversight.

The most important stipulations that were not met include the requirement to trim rather than blade the construction ROW (All American); failure to leave roots of cleared vegetation intact (Kern River, possibly Mojave); failure to remove plants of special concern (Joshua trees, sensitive cacti, perennial species, etc.) and replant them on the corridor after construction (Kern River, Mojave, except for barrel cactus); failure to avoid (by route selection) disturbance to sensitive and valuable plant communities, including Joshua tree woodlands (all pipelines), desert dunes (all pipelines), and ironwood washes (All American); and, failure to minimize the damage caused by grading, even in areas of level terrain (all pipelines; best performance achieved is described in the habitat compensation stipulations as the "worst case scenario"); and failure to implement visual mitigations (Kern River).

Inadequacies in the stipulations include: numerous qualifying phrases that effectively reduce the likelihood of implementation by placing unreasonable burdens on the capability of limited agency staff to effectively oversee operations; contradictory stipulations, such as the blanket requirement to remove and replant after construction plants of special concern, and the very limited replanting (100 yuccas and 100 cacti in California) in the Kern River Pipeline COM Plan, which upon approval became part of the ROW Grant; contradictory uses of the term "ROW," which specifically describes the 50-ft wide zone under a 30-year lease, to apply to the *construction* ROW; failure to stipulate reclamation procedures for storage areas; and, inadequate stipulations for reclamation of temporary access roads (e.g., no requirement to ameliorate compaction).

The lack of rigorous engineering oversight on all pipelines resulted in substandard construction of water bars; failure to reconstruct many drainage channels across the corridors; and failure to take special measures to mitigate wind erosion in sensitive areas of

concern to public safety (All American, Mojave). These failures exacerbated the problems of accelerated erosion and may have created public hazards.

It seems reasonable to conclude that environmental impacts of pipeline installations could be very substantially reduced by more rigorous implementation of existing mitigations. In particular, minimization of the area of disturbance could be much more rigorously addressed. The environmental documents related to these pipelines state numerous exceptions to the standard 75-foot construction ROW where there are special concerns. For example, the construction ROW is limited to 50 feet in steep terrain of the Los Padres National Forest (FEIR/S, p. 4-6, Measure 9A; p. 4-15, Measure 32). Staff Recommended Mitigation Measures in the Carlsbad Resource Area (Mojave-Kern River-El Dorado Natl. Gas Pipeline Projects, DEIR/S, 1987, p. 3-31, #133) recommended

> ...no blading of flat areas, where possible, and no blading of spoil areas. In areas where the spoil side has not been prebladed, keep the blade at least 2 inches above the ground,...

and required that

> "The pipeline project shall be limited to a 50-foot ROW overlapping existing ROW's...with ditch lines not more than 20 feet off of existing ditch lines. If extra construction width is necessary, it will be held to a maximum of 20 feet...

and, similar stringent requirements were placed on the corridor widths through the Kofa Game Reserve (DEIR/S, p. J-1,2). The FEIR/S, Celeron/All American and Getty Pipeline Projects also proposed (p. 4-11, Measure 21) that,

> Where the ROW follows the existing El Paso Natural Gas ROW or other existing ROW's, ... new disturbance will be limited to the area needed for trenching and stockpiling backfill.

If such mitigations can be implemented, it must be feasible from a construction point of view, even in difficult terrain, to greatly reduce the damage that current practices lead to. What is needed is to give equal value to all public lands that are in or close to a natural state, whether they are deemed at the present time to be of special value or not.

If the equipment used on the Mojave pipeline failed to leave viable root systems intact, the technology should be developed to efficiently trim vegetation in the construction ROW, temporary access roads, and storage areas and eliminate blading. A rigorous program for proactive revegetation of native plant communities could be developed under the aegis of various interested government agencies and industry. Such a program could also aim at solving existing problems of transplantation of sensitive plants, such as Joshua trees and other yucca, and cacti. The damages done to the especially rich vegetative communities in the northern Clark Mountains and Halloran Hills indicate the need to reexamine the currently designated utility corridors in terms of appropriate uses that protect resources.

ACKNOWLEDGMENTS

William Kockelman, USGS, is thanked for his critical review of the manuscript, and Steven Johnson, BLM, is thanked for providing information about the pipelines.

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Table 1. Vegetation Communities and Terrain Designations

VEGETATION COMMUNITY[1]

A. Mojave creosote (*Larrea tridentata*) bush scrub. Common associates at lower elevations: desert saltbush or cattle spinach (*Atriplex polycarpa*); white bur sage (*Ambrosia dumosa*); burro brush or cheesebush (*Hymenoclea salsola*); desert holly (*Atriplex hymenelytra*); brittle bush (*Encelia farinosa*); trumpet weed (*Eriogonum inflatum*); and various grasses. At higher elevations, the community is commonly accompanied by Mormon tea (*Ephedra nevadenses*); *Lycium Andersonii*; hop sage (*Grayia spinosa*); catclaw (*Acacia Greggii*) and desert willow (*Chilopsis linearis*) in washes; paperflower (*Psilostrophe Cooperi*); desert mallow (*Sphaeralcea ambigua*); and, various cacti, such as silver cholla (Opuntia echinocarpa), buckhorn cholla (*Opuntia acanthocarpa*), pencil cactus (*Opuntia ramosissima*), beaver tail (*Opuntia basilaris*), desert barrel cactus (*Ferocactus acanthodes*), hedgehog cactus (*Echinocereus engelmannii*), and jumping cholla (*Opuntia bigelovii*). Less common are devil's cactus (*Opuntia parishii*), desert pincushion (*Coryphantha deserti*), prickly pear (*Opuntia mojavensis*), and *Echinocactus polycephalus*.

B. Joshua tree (*Yucca brevifolia*) woodland. Common associates: creosote; Mojave yucca (*Yucca schidigera*); Spanish bayonet (*Yucca baccata*); Mojave sage (*Salvia mohavensis*); white bur sage; brittlebush; blackbush (*Coleogyne ramosissima*); bladder sage (*Salazaria mexicana*); ratany (*Krameria parvifolia*); cliff rose (*Cowania mexicana*); Mormon tea, hop sage; cheesebush; twinfruit (*Mendora spinescens*); catclaw; desert willow in washes; and various cacti and grasses as in A. The understory in Joshua tree woodlands grades from creosote-saltbush-yucca at lower elevations to blackbush-yucca at higher elevations.

C. Saltbush community. Dominant components: *Atriplex spp.*, including desert saltbush, four-wing saltbush (*Atriplex canescens*), and white bur sage; cheesebush.

D. Joshua tree-juniper (*Juniperus californica*) woodland. Common associates: creosote; yucca; blackbush; turpentine broom (*Thamnosma montana*); Mormon tea; various cacti as in A.

E. Juniper-pinyon (*Pinus cembroides*) woodland. Common associates: joshua tree; creosote; Mojave yucca; Spanish bayonet; ratany; turpentine broom ; various cacti as in A. On the east side of Keaney Pass grades to community dominated by blackbush, yucca, and catclaw.

F. Mesquite (*Prosopis juliflora*) community. Common associates: creosote; saltbush

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All communities support abundant and varied annuals in good rain years

S = Smoke trees (*Dalea spinosa*) ± palo verde (*Cercidium floridum*)

I = Desert ironwood trees (*Olineya tesota*) ± palo verde

TERRAIN

a. Flat to gentle slopes; undissected to very shallow drainage channels; dry lake beds, alluvial fans

b. Rolling hills; drainage channels have smooth profiles with gentle slopes; alluvial fans, bedrock

c. Moderately steep; drainage channels either flat-bottomed or steeply incised; alluvial fans, bedrock

d. Steep slopes; drainage channels may form continuous slopes with adjacent hills, be steeply incised, or be flat-bottomed where they are major runoff channels; bedrock.

s = dune sand; longitudinal dunes, sand sheets, coppice dunes.

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[1]Categories are informal

Table 2. Preconstruction Surveyed Width and Postconstruction Graded Width, Kern River Pipeline

East from Highway 127 to Kingston Road

3.1 mi[1]	68 ft (graded: 76 ft)	Aa[2]		18.6 mi	80 ft (graded: 102 ft)	Bb	
4.2 mi	65 ft (graded: 77 ft)	Aa		22.6 mi	65 ft (graded: 76 ft)	ABa	
6.9 mi	65 ft (graded 149 ft)	Ab		24.2 mi	65 ft (graded: 71 ft)	Aa	
16.0 mi	130 ft (graded: 144 ft)	Bc		26.2 mi	65 ft (graded: 73 ft)	Aa	
16.4 mi	130 ft (graded: 96 ft)	Bc		27.2 mi	125 ft (graded: 122 ft)	Aa	
17.1 mi	65 ft (graded: 76 ft)	Bb					

East from Kingston Road to State Line

2.0 mi	65 ft (graded: 77 ft)	Aa		4.2 mi	135 ft (graded: 84 ft)	Bc	
2.9 mi	65 ft (graded: 100 ft)	Bb		4.5 mi	65 ft (graded: 82 ft)	Bb	

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[1]Distances are measured on nearest access road

[2]Vegetation community and terrain designations from Table 1

Table 3. Graded Width of Corridors

MOJAVE PIPELINE

East from junction of Tehachapi-Willow Springs Rd and Oak Creek Rd. to HW 14 (Mojave and All American Pipeline corridors overlap, recorded as combined width)

1.3 mi[1]	210 ft [combined width: 388 ft]	Dd[2]	6.3 mi	116 ft [combined width: 160 ft]	Ba
1.3 mi to 3.0 mi	108 ft	Dd	8.3 mi	122 ft [combined width: 157 ft]	Aa
	123 ft	Dd	9.8 mi	120 ft [combined width: 166 ft]	Aa

East from Mojave to Edwards Air Force Base

1.2 mi	112 ft [combined width: 163 ft]	Ca	4.2 mi	96 ft [combined width: 135 ft]	Ca
2.2 mi	98 ft [combined width: 138 ft]	Ca	6.2 mi	94 ft [combined width: 137 ft]	Ca

7.6 mi 101 ft [separated from All American; total width: 186 ft] A-Ca
10.0 mi 77 ft [combined width: 151 ft] Aa
15.8 mi 75 ft [separated from All American; total width: 158 ft] Aa

Helendale Road, 13.2 mi east of Kramer Jnc.
108 ft Aa

West from Hinkley Road access, south of HW 58, west of Barstow

2.0 mi	118 ft [combined width: 165 ft].	Ab	5.0 mi	93 ft [combined width: 157 ft].	Ca
3.0 mi	101 ft [combined width: 155 ft].	Ab	6.0 mi	101 ft [combined width: 154 ft].	Aa
3.9 mi	112 ft [combined width: 170 ft].	Ca			

Lenwood Road access, 0.9 mi west of I-15

East side Lenwood Rd.	295 ft	Aa	1.0 mi west	91 ft	Aa
0.2 mi east	105 ft	Ab	1.3 mi west	129 ft	Aa

Old U.S. HW 66 access, 0.6 mi west of Lenwood

South side Lenwood Rd.	109 ft	Aa	0.7 mi north	151 ft	Cas

South and west of end of Fairview Rd., south of HW 58, west of Mojave

1.0 mi (appx.) south Community Blvd.	125 ft	ACas	0.2 mi (appx.) terrace, edge Mojave River		
0.2 mi (appx.) west near edge Mojave River	99 ft	Cas	0.1 mi (appx.) west		

Hinkley Rd. access, south of HW 58, west of Barstow

0.8 mi south Community Blvd., west side Hinkley Rd.	101 ft	Aa
, east side Hinkley Rd.	130 ft	Aa
0.7 mi (appx.) east	124 ft	Aa

West from Nebo St. Exit, I-40, between Barstow and Daggett

0.0 mi 167 ft Ac 3.6 mi 168 ft Ac 6.7 mi 140 ft Ab 9.6 mi 189 ft Ab

1.0 mi 188 ft Ac 4.6 mi 108 ft Aa 7.7 mi 138 ft Aa

2.0 mi 117 ft Aa 5.6 mi 150 ft Aa 8.7 mi 199 ft Ab

East from Nebo St. Exit, I-40, between Barstow and Daggett

1.0 mi 115 ft Ab 2.0 mi 113 ft Aa

East from Daggett to Troy Dry Lake (Mojave and All American Pipeline corridors overlap)

1.0 mi 114 ft [combined width 164 ft] Aa 10.1 mi 81 ft [combined width: 138 ft] Aa

3.0 mi 103 ft [combined width: 142 ft] Aa 13.1 mi 75 ft [combined width: 127 ft] (A)as

4.0 mi 86 ft [combined width: 137 ft] Aa 18.7 mi 101 ft [combined width: 135 ft] Fas

5.1 mi 95 ft [combined width: 144 ft] Aa 18.7 mi 101 ft [combined width: 135 ft] Fas

7.1 mi 84 ft [combined width: 126 ft] Aa

East from Hector Road to I-40 crossing (Mojave and All American corridors overlap)

0.0 mi [combined width: 147 ft] Aa 10.2 mi 100 ft [combined width: 135 ft] Ca

4.4 mi [combined width: 117 ft] Aa 12.0 mi [combined width. 100 ft] Aa

East from south of Ludlow to Amboy (Mojave and All American corridors overlap until about 6.7 mi west of Amboy)

0.0 mi 96 ft [combined width: 198 ft] Ac 10.0 mi 81 ft [combined width: 145 ft] Aa

4.6 mi 100 ft [combined width: 158 ft] Aa 15.0 mi [combined width: 132 ft] Aa

5.0 mi 111 ft [combined width: 168 ft] ASb

West from intersection with road south from Ludlow

1.0 mi 137 ft [combined width: 175 ft] Ac 4.0 mi 98 ft [combined width: 169 ft] Ac

2.0 mi 106 ft [combined width: 186 ft] Ac-d 4.5 mi [combined width: 152 ft] Aa

3.0 mi 134 ft [combined width: 213 ft] Ac-d

East from Amboy to crossing of old U.S. 66

6.0 mi (Saltus Rd.) 111 ft Aa 8.2 mi (W. side Cadiz) 79 ft Aa

3.2 mi (Kelbaker Rd.) 113 ft Aa 12.7 mi (HW 66) 103 ft Ab

South of Needles, 5.7 mi south of Kingman/Blyth junction, on HW 95.

98 ft on hillslope Ac 87 ft in wash ASc

West from HW 95 on PG & E access road

2.0 mi	91 ft Ab-c	8.1 mi	85 ft Aa	19.1 mi	80 ft Aa	35.1 mi	93 ft Ab
2.8 mi	125 ft Ab-c	9.1 mi	99 ft Aa	21.1 mi	79 ft Aa	35.1 mi	116 ft Ac
121 ft	Ac-d	9.1 mi	78 ft Aa	23.1 mi	88 ft Aa	37.1 mi	86 ft Aa
3.6 mi	128 ft Ab	10.1 mi	91 ft Ab	23.1 mi	80 ft Aa	39.1 mi	89 ft Aa
3.6 mi	98 ft Ab	11.1 mi	112 ft Ab-c	25.1 mi	84 ft Aa	41.1 mi	91 ft Aa
4.2 mi	119 ft Ab	12.1 mi	125 ft Ac-d	27.1 mi	73 ft Aa	43.1 mi	90 ft Aa
4.2 mi	82 ft Ab	13.1 mi	157 ft Ab-c	27.1 mi	85 ft Aa	45.1 mi	90 ft ASa
5.6 mi	87 ft Aa	14.1 mi	103 ft Ab-c	29.1 mi	128 ft Ab	47.1 mi	92 ft Aa
6.4 mi	112 ft Ab	15.1 mi	87 ft Aa	29.1 mi	102 ft Ab	49.1 mi	86 ft Aa
6.4 mi	85 ft Ab	16.1 mi	87 ft Aa	31.1 mi	82 ft Aa		
6.6 mi	79 ft Aa	17.1 mi	89 ft Aa	33.1 mi	94 ft Aa		

KERN RIVER PIPELINE

Mojave pipeline interconnect, 2.5 mi east of Daggett on old U.S. HW 66

0.0 mi 85 ft Aa

North on Hidden Springs Road

1.8 mi north of old U.S. HW 66: 77 ft Aa

North on powerline road

2.0 mi 73 ft Aas 2.9 mi 169 ft CAas

North and east on powerline road, from I-15

1.0 mi	71 ft Aa	10.0 mi	73 ft Cb	22.7 mi	72 ft Aa	35.6 mi	73 ft Aa
2.1 mi	69 ft Aa	11.0 mi	83 ft Aa	22.7 mi	151 ft Ab-c	37.6 mi	70 ft Aa
3.0 mi	68 ft Aa	13.0 mi	70 ft Aa	23.4 mi	168 ft Ac-d	38.8 mi	70 ft Aa
3.0 mi	122 ft Ab	15.0 mi	147 ft Aa	25.2 mi	166 ft Ab-c	43.2 mi	77 ft Aa
4.0 mi	75 ft Aa	16.0 mi	109 ft Ab-c	25.2 mi	184 ft Ac	52.0 mi	75 ft Aa
5.0 mi	76 ft Aa	17.9 mi	166 ft Ab-c	26.2 mi	86 ft Ab	53.5 mi	77 ft Ab

6.0 mi	76 ft Ca	17.9 mi	81 ft Ab	27.9 mi	130 ft Ab-c	54.1 mi	133 ft Ac
7.0 mi	68 ft Aas	19.9 mi	155 ft Ac	29.6 mi	103 ft Ab	54.7 mi	70 ft Aa
8.0 mi	71 ft Aa	20.8 mi	76 ft Ab	31.7 mi	144 ft Ab-c		
9.0 mi	71 ft Aas	22.0 mi	73 ft Aa	32.5 mi	96 ft Ab		

West from HW 127

0.0 mi	121 ft Ab	11.5 mi	108 ft Ac	13.0 mi	125 ft Aa		
11.0 mi	80 ft Aa	11.5 mi	150 ft Ac				

East from HW 127 to Kingston Road

0.0 mi	145 ft Ab	4.2 mi	77 ft Aa	7.4 mi .	172 ft Ac	10.9 mi	75 ft Aa
0.9 mi	72 ft Aa	4.8 mi	158 ft Ac	7.9 mi	101 ft Aa	11.4 mi	77 ft ABa
1.9 mi	73 ft Aa	5.0 mi	151 ft Ac	8.9 mi	85 ft Aa	11.9 mi	145 ft ABc
2.8 mi	130 ft Ac	5.6 mi	115 ft Ab	10.0 mi	80 ft Aa	12.4 mi	134 ft ABb
2.9 mi	102 ft Ab	5.6 mi	207 ft Ab	10.0 mi	115 ft Ab	12.9 mi	179 ft Bc
3.1 mi	76 ft Aa	5.9 mi	76 ft Aa	10.0 mi	135 ft ABc	13.9 mi	132 ft Bc
3.9 mi	74 ft Aa	6.9 mi	149 ft Ab	10.0 mi	155 ft ABc	14.4 mi	79 ft Bb

14.9 mi 83 ft Bb
15.8 mi(corridor crosses road) N. side: 102 ft Bb
S. side: 100 ft Bb
S from road: 110 ft Bb
16.0 mi crest west side of main wash: 144 ft Bc
16.1 mi base of slope below west crest: 131 ft Ba
16.2 mi east tributary to main wash: 79 ft Bc
16.3 mi at carbonate breccia: 92 ft Bc
16.4 mi crest below east-side crest of main wash: 119 ft Bc
crest, east side of main wash: 96 ft Bc

16.7 mi	125 ft Bc	21.7 mi	70 ft ABa	25.2 mi	70 ft Aa
19.0 mi	70 ft ABb	23.2 mi	75 ft ABa	26.2 mi	73 ft Aa
20.2 mi	75 ft ABa	24.1 mi	78 ft ABa	27.1 mi	74 ft Aa

East from Kingston Road, distances on powerline road.

1.0 mi	74 ft Ba	3.0 mi	100 ft Bb
2.0 mi	77 ft Ba	4.0 mi	81 ft Bb

4.4 mi (crossing of access road): 82 ft
East from about 0.9 mi east of Kingston Road to 4.4 mi access road. Foot traverse; distances between measurements not known.

75 ft Ba 124 ft Bb 80 ft Bb 151 ft Bc 77 ft Bc

73 ft Ba 75 ft Bb 96 ft Bb 134 ft Bc 144 ft Bc

76 ft Ba 80 ft Bb 77 ft Bb 101 ft Bc 86 ft Ba

East from 4.4 mi access road to Whiskey Petes (foot traverse across Keaney Pass, distances between measurements not known).

76 ft Ba 72 ft Ba 77 ft Bb

Greens Well Road crossing: 91 ft Bc
Crest of hill east of Greens Well Road: 78 ft Bc
107 ft Bc
West side of access road: 112 ft Bc

127 ft Bc 138 ft Ec 157 ft Ed 142 ft Ec

145 ft Bc 150 ft Ed 130 ft Ed 156 ft Ec

97 ft Ec 147 ft Ed 124 ft Ed 180 ft Ec

162 ft Ec 138 ft Ed 129 ft Ed 175 ft Ec

Last crest east side Keaney Pass before steady drop to Ivanpah Dry Lake: 108 ft Bc

77 ft Aa 78 ft Aa 77 ft Aa 85 ft Aa

ALL AMERICAN PIPELINE

East from intersection of Tehachapi-Willow Springs Road with Oak Creek Road (measurements made prior to construction of Mojave pipeline)

0.7 mi 123 ft Dc 90 m east: 273 ft Dc 10 m west: 129 ft Db

80 m east: 196 ft Dc 2.7 mi 128 ft Db
6.3 mi (pipeline crosses Oak Creed Rd.): 92 ft Ba
8.8 mi, west side of road 80 ft Ca
east side of road 76 ft Ca
16.3 mi (east of Mojave) 72 ft Ab

20.0 mi 85 ft Aa 20.8 mi 67 ft Aa 24.3 mi 117 ft Aa

West from Hinkley Rd. access, south of HW 58, west of Barstow
0.0 mi, east side Hinkley Rd 120 ft Aa
west side Hinkley Rd 72 ft Aa
1.0 mi 74 ft Aa

Fairview Rd., south of HW 58, west of Barstow
0.5 mi south Community Blvd. 89 ft Aa

Nebo Marine Corps Logistics Base, Mojave River crossing, east end of Nebo Base and west

N-S segment in River bed: 114 ft Aa
At turn west along hills that form north bank of Mojave River: 188 ft Ac
0.35 mi west of turn: 220 ft Ad
Old U.S. HW 66, west of Amboy
Intersection of corridor with 29 Palms HW, east side: ± 103 ft Aa
west side: 84 ft Aa
4.0 mi west intersection with 29 Palms HW: 78 ft Aa
11.3 mi : 86 ft Aa
South from Rice on road to Blythe

6.2 mi	88 ft	Alas	9.3 mi	90 ft	Abs	12.1 mi	82 ft	Aa
7.9 mi	87 ft	Alas	10.3 mi	85 ft	Aas	15.3 mi	103 ft	Aa

15.7 mi (crest of hill): 110 ft Ac

4.8 mi west of Rice at HW 62 crossing
87 ft Ab

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[1]Distances measured along nearest access road
[2]Vegetation community and terrain designations from Table 1

Table 4. Data from vegetation transects

Species	Transect 1	2	3	4	5	6	7	8	Species	Transect 1	2	3	4	5	6	7	8
Larrea tridentata	47	36			30	42	43	5	*Encelia farinosa*				20			8	76
Ambrosia dumosa					86	261	64	29	*Sphaeralcea ambigua*			3	2				
+ *Atriplex polycarpa*	318	178							*Cowania mexicana*				52				
Yucca brevifolia		2	43	39					*Psilostrophe Cooperi*					11			
Yucca schidigera			78	82		2			*Opuntia acanthocarpa*			34	16				
Yucca baccata		3							*Opuntia ramosissima*		2					4	
Ephedra nevadensis	12	13	312	55	12	5			*Opuntia basilaris*							1	
Hymenoclea salsola	27	1	11	3			88	75	*Opuntia echinocarpa*								
Krameria parvifolia	2	91	35		10	35	4		*Opuntia bigelovii*					21		3	
Grayia spinosa?	7	58	3	3		19			*Ferocactus acanthodes*		1	2		2			
Coleogyne ramosissima			82	304					*Echinocereus engelmannii*			34	2				
Eriogonum inflatum	20	13	66		13		20	105	*Opuntia mojavensis*			6	8				
Salazaria mexicana			59	1					*Coryphantha deserti*				2				
Mendora spinescens			15						*Echinocactus polycephalus*							1	
Thamnosma montana			10	13					*Opuntia parishii*			12					
Acacia Greggii			1		1		1		Unidentified	9	2	16	19	21	10	64	21

Transect 1, Kern River pipeline, 10.0 mi east of HW 127, construction corridor 80 ft widel, total individual plants lost per mi = 28,900; Transect 2, Kern River pipeline, 10.1 mi east of HW 127, construction corridor 155 ft wide, total individual plants lost per mi = 50,700; Transect 3, Kern River pipeline, 6.2 mi east of Kingston Rd (Greens Well Rd.), construction corridor 91 ft wide, total individual plants lost per mi = 61,000; Transect 4, 7.2 mi east of Kingston Rd., construction corridor 112 ft wide, total individual plants lost per mi = 56,900; Transect 5, Mojave pipeline, 3.5 mi west HW 95, construction corridor avg. 113 ft wide, total individual plants lost per mi = 19,100; Transect 6, Mojave and All American pipelines, 1.5 mi east on P.G. & E. access road, from road south of Ludlow, overlapped construction zones 158 ft wide, total individual plants lost per mi = 38,900; Transect 8, same location as 7, 58 ft-wide part of All American pipeline not redisturbed by construction of Mojave pipeline.

Table 5. Plants graded from the berms of an access road as a closure procedure. Length counted approximately 0.1 mile

Species	No.
Larrea tridentata	9
Yucca schidigera[1]	14
Ephedra nevadenses	6
Opuntia acanthocarpa	1
Opuntia ramosissima	1
Echinocereus engelmannii	1
Unidentified shrub	20

[1]Number may be lower because of dismemberment

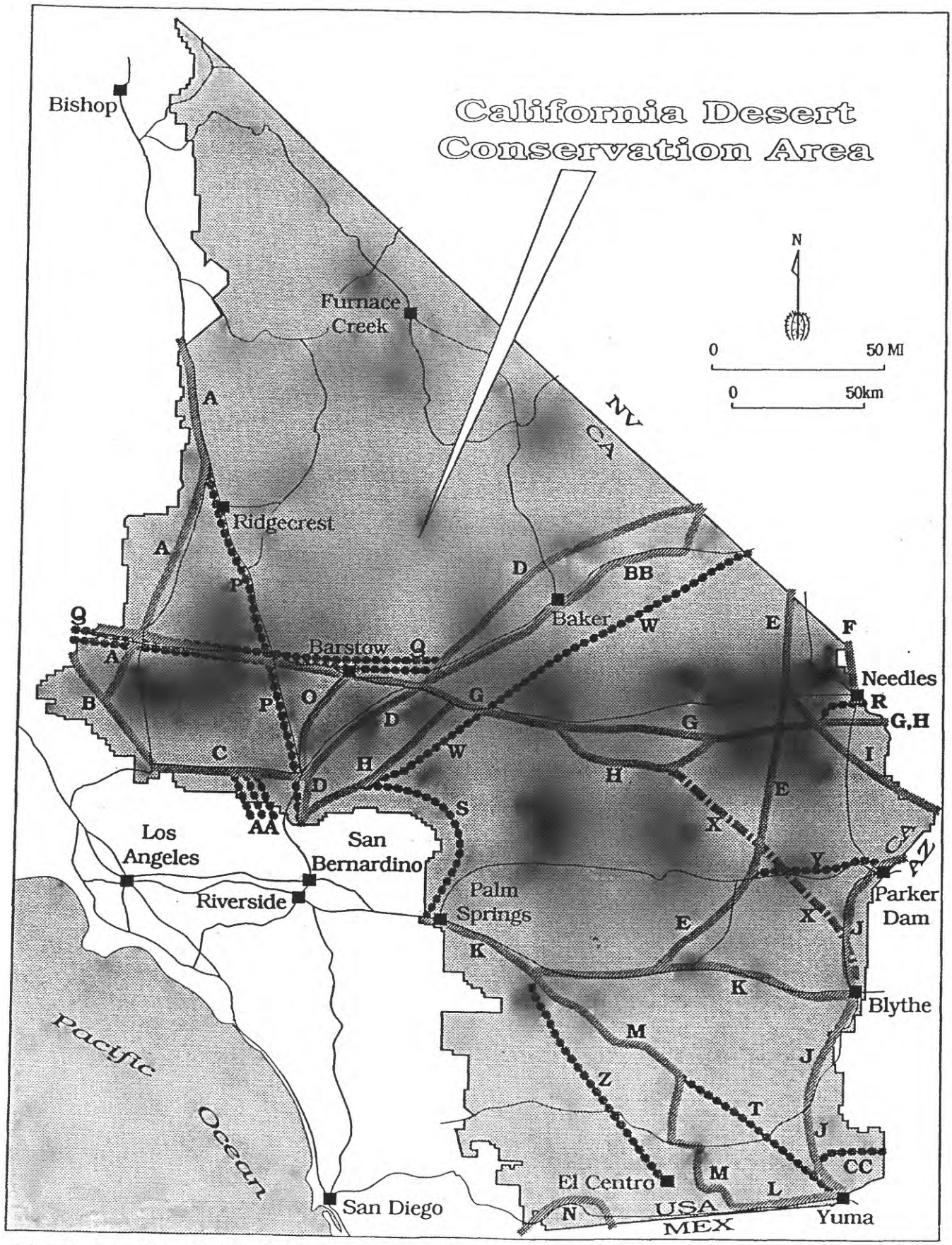

Figure 1. Map of the California Desert Conservation Area, showing utility planning corridors (medium gray), contingent corridors (dark dots), and the part of the All American corridor outside of planning and contingent corridors (dash-dot).

Fig. 2. All American pipeline, 7 mi. east of Kramer Junction, showing construction corridor graded through creosote community.

Fig. 3. Mojave pipeline, view west 4.9 mi. west of HW 95, showing two barrel cacti transplanted in the construction zone.

Fig. 4. Kern River pipeline, Clark Mountain area, showing yucca, Joshua trees, and small shrubs uprooted by grading.

Fig. 5A. Scene in Clark Mountain area surveyed for Kern River pipeline; Joshua tree woodland community.

Fig. 5B. Same scene as in 4A after installation of pipeline.

Fig. 6A. Scene in Halloran Hills (Clark Mountain on skyline), surveyed for Kern River pipeline; Joshua tree woodland community.

Fig. 6B. Same scene as in 5A after installation of pipeline. Large water bar just this side of vertical marker in center of wash will divert runoff onto vegetated terrace to right; water bar closer to base of slope from which photograph was taken will pond runoff.

Fig. 7. View south along All American pipeline in Rice Valley, showing 85-feet wide construction corridor through ironwood wash; large trees are ironwood with some palo verde. The amount of creosote (dark green shrubs) recolonization in the corridor is unusal; yellow plants are dominantly dead annuals plus some perennial grasses going dormant.

Fig. 8. Kern River pipeline, Shadow Valley about 1.5 mi. east of Kingston Rd. Apparently salvaged, but unused, barrel cactus and 7 beavertail cacti, one with a fading ribbon tied to its root.

Fig. 9. Erosion of Mojave pipeline corridor due to channelization of runoff over very gentle gradient by the berm above the buried pipe. East of Mojave.

Fig. 10. Erosion of Mojave pipeline corridor due to diversion of drainages and channelization by the berm above the buried pipe; gullies to 6 feet wide, 2 feet deep (hammer is 15.5 inches long). 6.9 mi. west of HW 95.

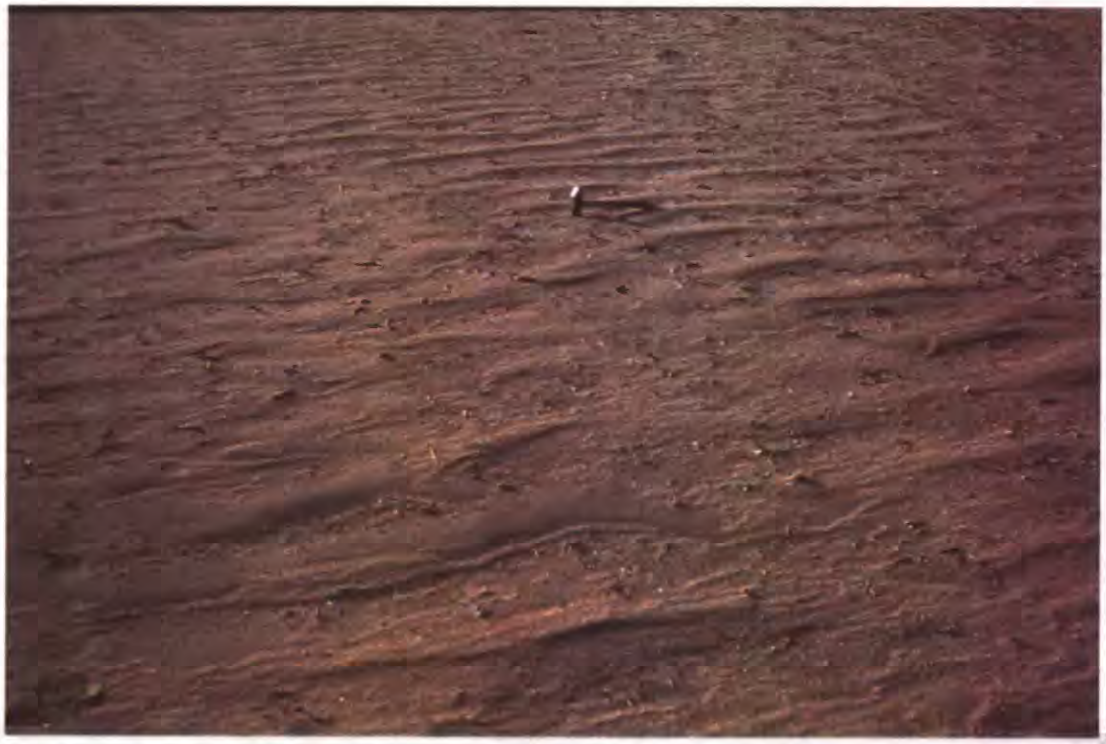

Fig. 11. Wind-rippled sand on Mojave pipeline corridor, about 7.5 mi. east of Mojave. Hammer is 15.5 inches long.

Fig. 12. Deep wind scour and wind-rippled sand on All American pipeline corridor, same location as Fig. 8.

Fig. 13. Sand blowout and downwind (right) drifts where All American pipeline crosses a longitudinal dune, Rice Valley. Note construction corridor, about 85 feet wide, crosses two ironwood washes in middle distance. View north.

Fig. I4. Shared corridor in Tehachapi Mountains, Mojave pipeline (bare) and All American pipeline (strip on left side of Mojave pipeline, with scattered small shrubs); substantial part of the All American pipeline construction corridor was again disturbed during installation of the Mojave pipeline. Gullies on left side of the Mojave line were caused by release of runoff concentrated by the water bars onto the construction zone, and by runoff down unbarred parts of the All American corridor. Gullies that cross the bars near right side of Mojave line are due to ponding and overflow behind some bars and/or damming of the bar ditch by debris eroded from upslope.

Fig. 15. Shared corridor in Tehachapi Mountains, Mojave pipeline on left, All American pipeline on right (water bars extend slightly across the edge of the zone graded for installation of the Mojave line into the All American corridor); Pacific Gas and Electric pipeline exposed, bottom right. The lower water bar is breached near and within the All American pipeline corridor due to runoff around the right end of the upper bar. The natural drainage is incised due to runoff down the left sides of the bars; the left side of the Mojave pipeline corridor was also gullied by release of runoff concentrated by the bars onto the construction zone. Combined width of the two lines at far crest is 388 feet. Note person standing near right side of top bar for scale.

Fig. 16. Mojave pipeline, 2.1 mi. west of road south of Ludlow on P.G. & E. access road. Large boulders excavated from higher slopes used in bars; many boulders have rolled into and partially block the through drainage, which, seen at left, was a wide sandy wash with smoke trees and giant creosote shrubs.

Fig. 17. Same location as fig.16. Boulders excavated from Mojave pipeline are scattered across the All American pipeline corridor (right side; boundary is marked by slightly darker color of the All American corridor due to annual plant cover).

Fig. 18A. Halloran Hills, surveyed route for temporary access road.

Fig. 18B. Same scene as fig.18A, after closure of access road by cross-ditching (ditch just in front of large Joshua tree on right side of road.

Fig. 19. Same location as fig. 18. Vehicle tracks around end of trench.

Fig. 20. Clark Mountain area. Rocks and plant debris strewn on temporary road by grading off the berms during closure. Kern River pipeline.

Fig. 21. Clark Mountain area. Newly felled Joshua tree at edge of temporary access road closed by grading berms, and cross-trenching. Note vehicle tracks across trench berm. Kern River pipeline.

Fig. 22. Tortoise fence along edge of Kingston Road pipe storage area bulging with silt, sand, pebbles and plant debris blown from the bare surface of the storage area. Triaxial dimensions of the largest rock caught in the drift, and therefore moved by the wind, are 70 X 40 X 27 mm.

Fig. 23. Sieved sample collected from fenceline shown in Fig. 22. From left to right, sample grain sizes (in mm) are: > 4.4; >4.0; >2.8; >1.4; >0.7; >0.5; >0.4; < 0.4. Rocks at bottom of the photo were selectively picked out of the dune. The mesh size of the fence is 11 mm, but smaller sizes were trapped because the holes were clogged by plant debris and the larger pebbles that probably were rolled along the surface.

Fig. 24. View east along the All American (left) and Mojave (right) pipelines showing good stands of annual grass from natural revegetation. From Barstow-Daggett airport road.

Fig. 25. Tumbleweed in Kern River pipeline corridor, Shadow Valley, view east from west of Kingston Rd.

Fig. 26. Pipe storage area (to left) for the All American pipeline, west of Amboy. Note berm over the buried pipe aligned parallel to the viewing direction (west), turns right in the near distance. The corridor that continues west was inadvertently driven into the Amboy Crater Wilderness Study Area, and remains poorly revegetated despite reclamation efforts.

Fig. 27. Area cleared for WW II emergency landing strip, about 7 mi. west of Amboy, showing incomplete revegetation after 50 years.

Fig. 28. Drift fence across All American pipeline corridor east of Daggett has created a dune about 4 feet high in 3 years. Property damage was incurred when trees forming a windbreak were removed during pipeline installation.

Fig. 29. Siltation of stream channel in Tehachapi Mountains downslope from Mojave pipeline corridor. Silt was derived by erosion of both the pipeline construction zone and roads in nearby windfarm developments.

Fig. 30. Aerial view of a strafing run, about 1,000 feet long, on the east side of the Mohave Mountains, near Needles. A number of such targets were cut for WW II aerial gunnery practice on a variety of geomorphic surfaces. This photograph shows that creosote (the darker large shrubs) have only locally returned to predisturbance distributions and sizes, and Joshua trees have not recolonized the area at all.