The Hopi Tribe Water Resources Program

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Nonpoint Source Coordinator

History

The Hopi Reservation is located in northeastern Arizona on the Colorado Plateau which consists of approximately 2.5 million acres. These lands include the main Hopi Reservation, Moenkopi District, Hopi 3 Canyon Ranches, and future tribal acquisition Lands. Hopi tribal enrollment is approximately 14,700 members who occupy 12 isolated villages & 2 communities. The most important industries on the reservation are Hopi Arts & Crafts, tourism, livestock ranching, recreation, and the Tribal & Federal Government.

Hopi Reservation

First Mesa

- Walpi
- Sitsomovi
- Hano (Tewa)
- Polacca
- Keams Canyon

Second Mesa

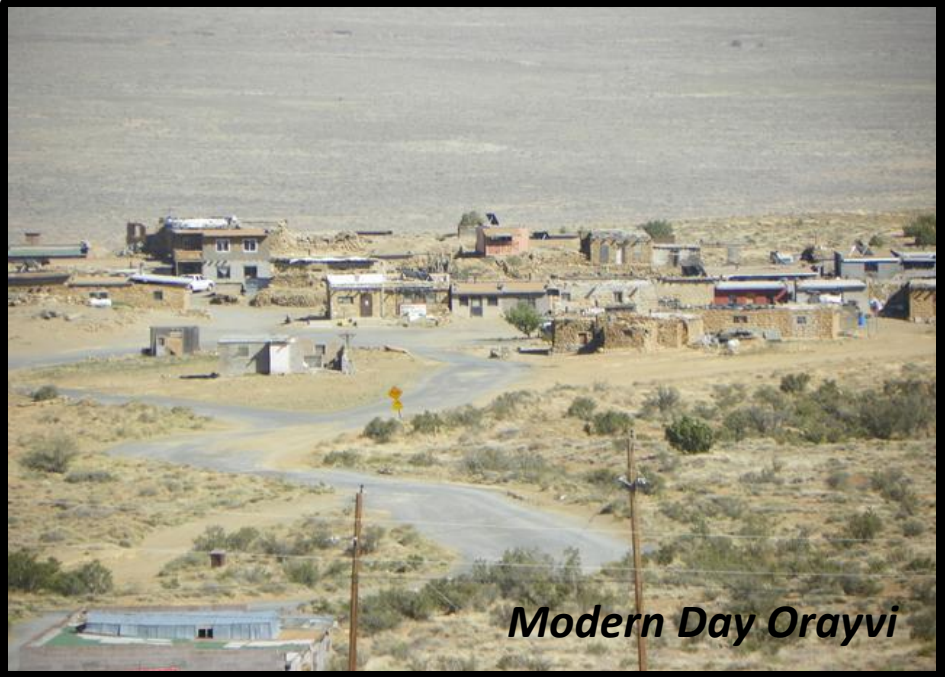
- Shungopavi
- Sipaulovi
- Mishongnovi

Third Mesa

- Orayvi (Old Oraibi)*
- Kykotsmovi
- Hotevilla
- Bacavi
- Moencopi (Upper and Lower Village)

Orayvi, also known as Old Oraibi, was founded sometime before the year 1100 AD, making it one of the oldest continuously inhabited settlements within the United States. In the 1540s the village had 1,500–3,000 residents. Oraibi is listed on the National Register of Historic Places and was declared a National Historic Landmark in 1964.

Orayvi Village, circa 1899



Modern Day Orayvi

Hopi Springs

Hopi Springs are important water sources for drinking, Hopi gardens & orchard irrigation, and are ceremonial sites for Hopi cultural practices. These springs have long been used throughout the generations and are very important to the Hopi people to protect and preserve these sites for future use.

First Mesa ceremonial Flute Spring


Snake Dance Ceremony at Oraibi, Arizona, 1890

Historical Hopi terrace garden photos at Hotevilla.


The Hopi Reservation is an arid dry environment that only receives 8-12 inches of rain per year. Ancestral people have farmed this land intermittently for nearly a thousand years.
Corn
Beans
Squash
Pumpkins
Melons
Chile
Onions
Gourds
Dyes
Grapes
Peaches
Apricots
Apples

Hopi people have relied for centuries on springs that bring water from large underground reservoirs. Here, pack mules are being prepared to carry filled water vessels up to the mesas above.

The Hopi Tribe Water Resources Program

Nonpoint Source Pollution Management
EPA Clean Water Act, Section 319

FY 2007
FY 2008
FY 2009
FY 2010

Hopi Springs Sediment Reduction Project

Second Mesa

- Toreva Spring
- Lomeva Spring

Third Mesa

- Hotevilla Springs (3)
- Bacavi Spring and Terrace Gardens

Sipaulovi and Mishongnovi Villages

Hotevilla Village

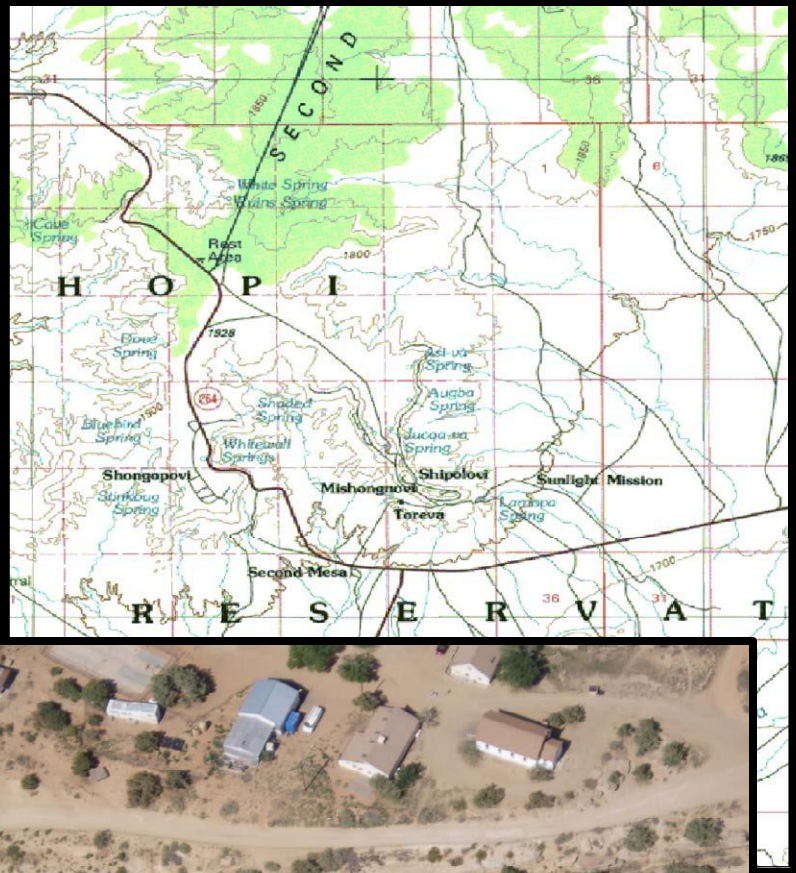
Bacavi Village

Natural
Channel
Design, Inc.

The purpose of the Sediment Reduction Project was to identify sources of storm water runoff and sediment erosion, which contribute to poor water quality at the springs and to correct them.

Determining Sources of Sediment and Storm Water Runoff

- *Site assessment*
- *Topographic surveys*
- *Aerial photography*
- *Hydrologic models*



The main problems seen at the springs were:

- Poor water drainage
- Foot trails in surrounding areas resulting as water channels during wet seasons and directing runoff into springs
- Springs are sunken and below ground levels causing sediment erosion to settle in these low laying areas
- Continual “outhouse” use on the mesa above some of the springs

Hopi Springs Project Objectives:

- Identify major runoff areas and flow routes that impact the springs
- Generate alternatives for rerouting, storing, and/or reducing intense storm flows which causes damage
- Identify alternatives for stabilizing existing high areas of erosion
- Reduce the nitrate levels in spring water by addressing unconsolidated waste and outhouse issues
- Incorporating the unique cultural aspects of the area and Hopi society into all aspects of the design alternatives

Following the analysis of the site surveys, options for alternative developments were recommended and presented to village members for comment. After a preferred choice was made, local community members were selected and appointed to carry out the new improvements.

Toreva Spring

Many problem areas contribute to sedimentation at Toreva Spring

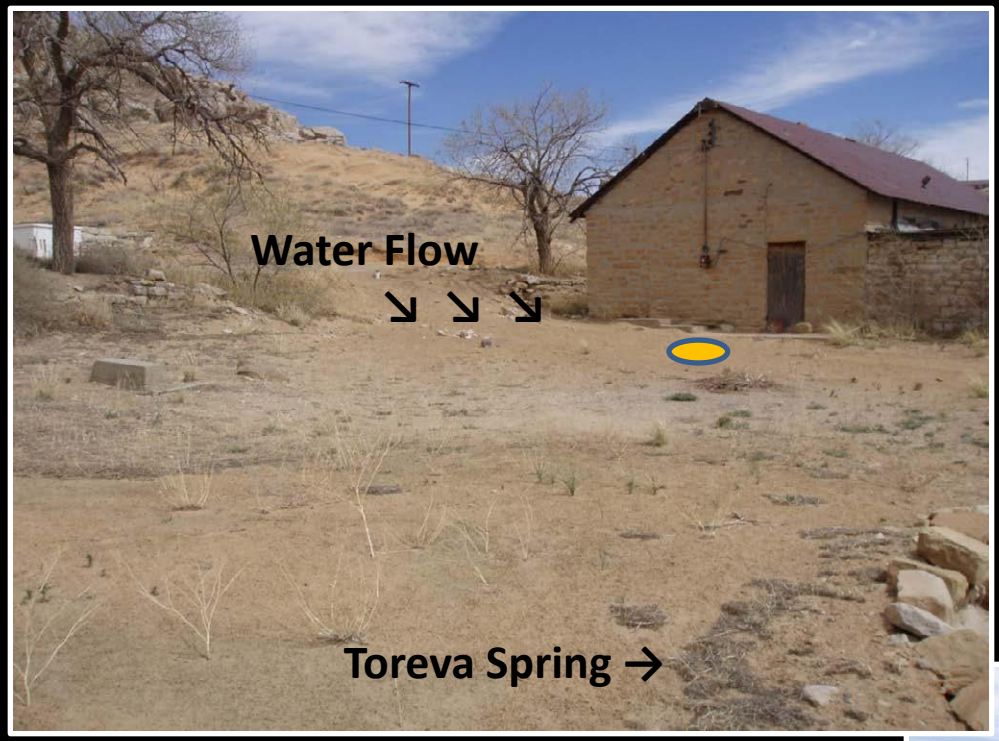
Major Issues seen at Toreva Spring

- Nearby foot trails created water channels during wet seasons
- No adequate drainage for storm water to pass Toreva
- The stone retaining wall upstream from the spring had been breeched, allowing runoff to travel directly towards it
- Sediment was beginning to deposit outside the spring wall and also in the spring
- A sewer line grade created another drainage channel towards Toreva
- Parking lots from neighboring buildings drained directly towards it
- Undersized culverts were overwhelmed during high runoff events, allowing excess water to drain into the spring
- Existing sediment retention basin was full

Foot Trails

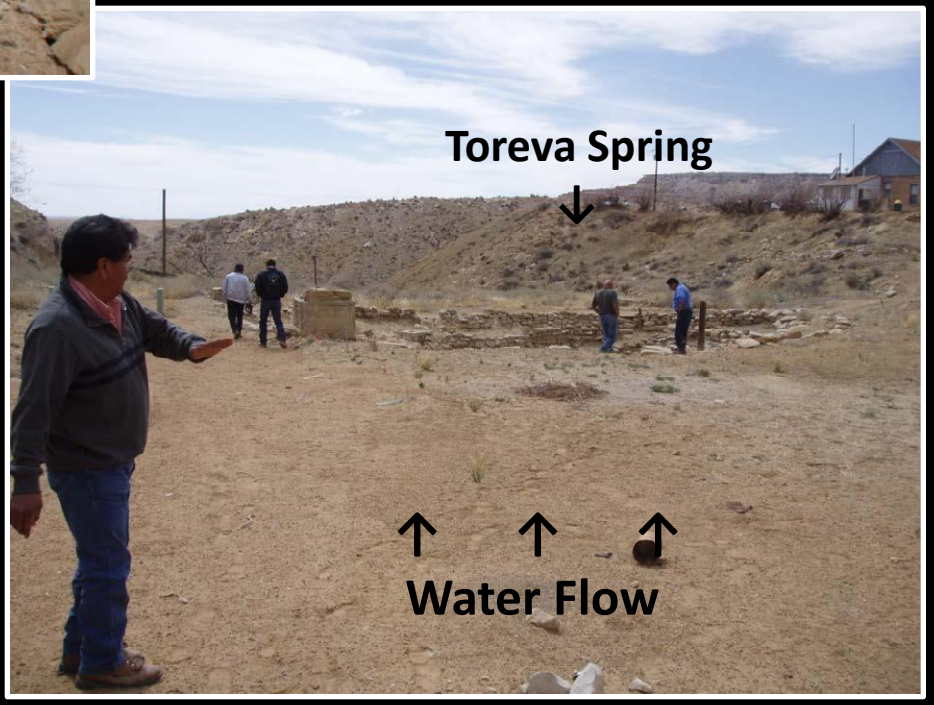
Foot trails result as water channels during periods of high storm water flow and deposits into Toreva


Breeched Retaining Wall
Spring

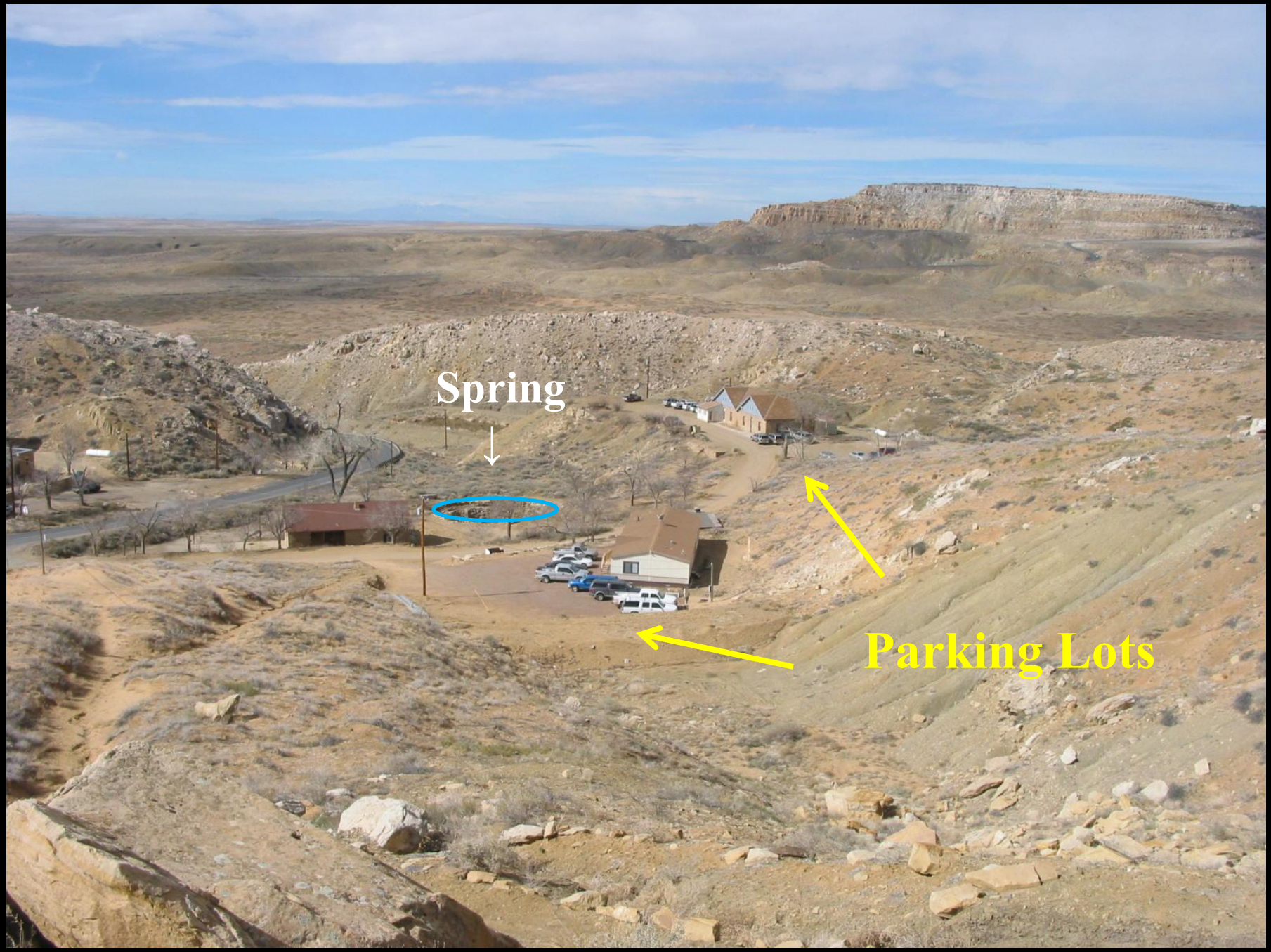


Looking down gradient
↓

↑
Looking up gradient




Spring
Sewer Line Grade


Spring
Parking Lots

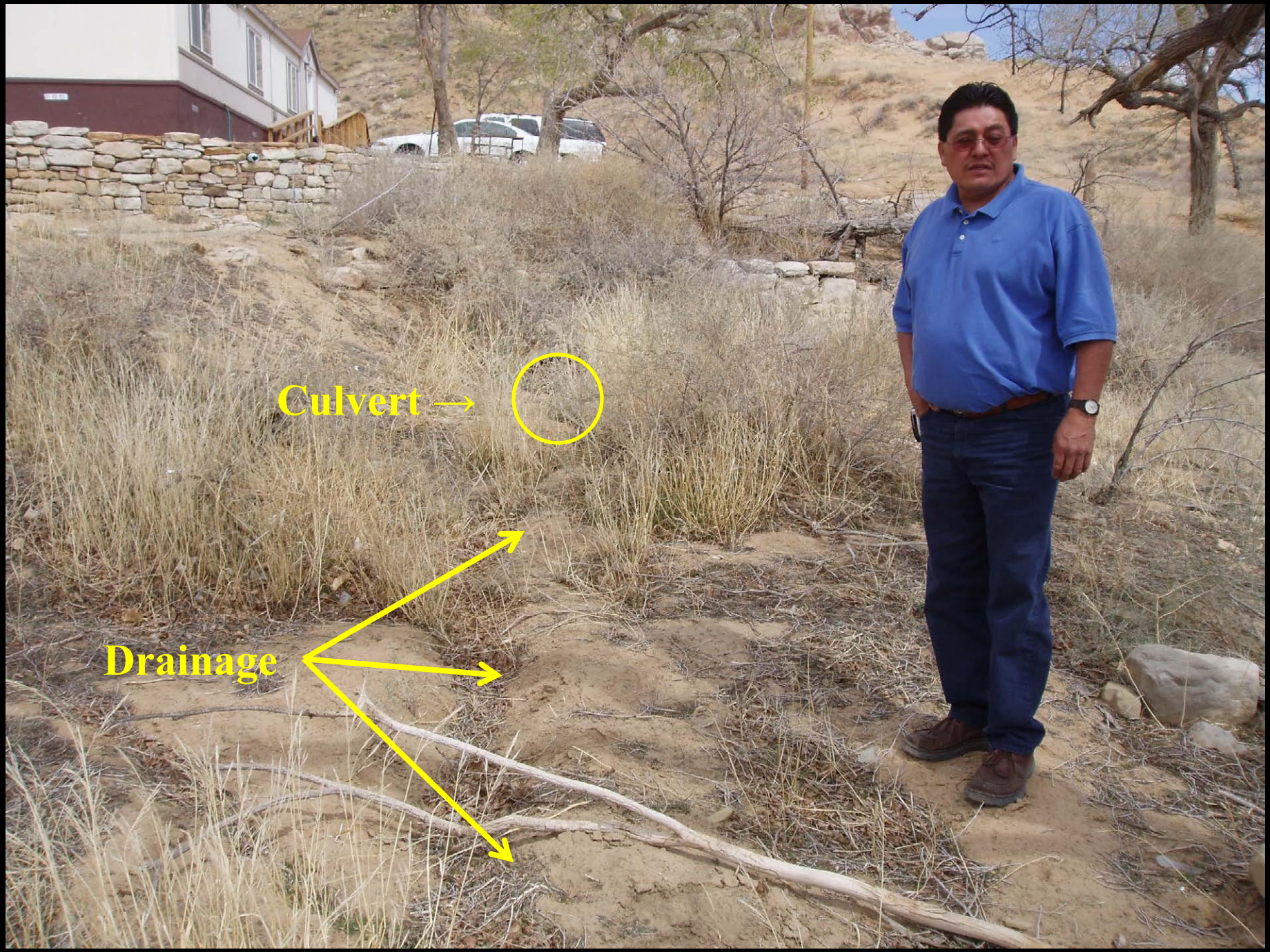
Undersized culverts and sediment build up

Undersized culverts and sediment build up

Sediment Retention Basin

Incorporating the traditional Hopi masonry style into these projects was important to village members

Excavation of existing sediment retention basin
-Removal of 185 cubic yards


Culvert →
Drainage

Toreva Spring Before

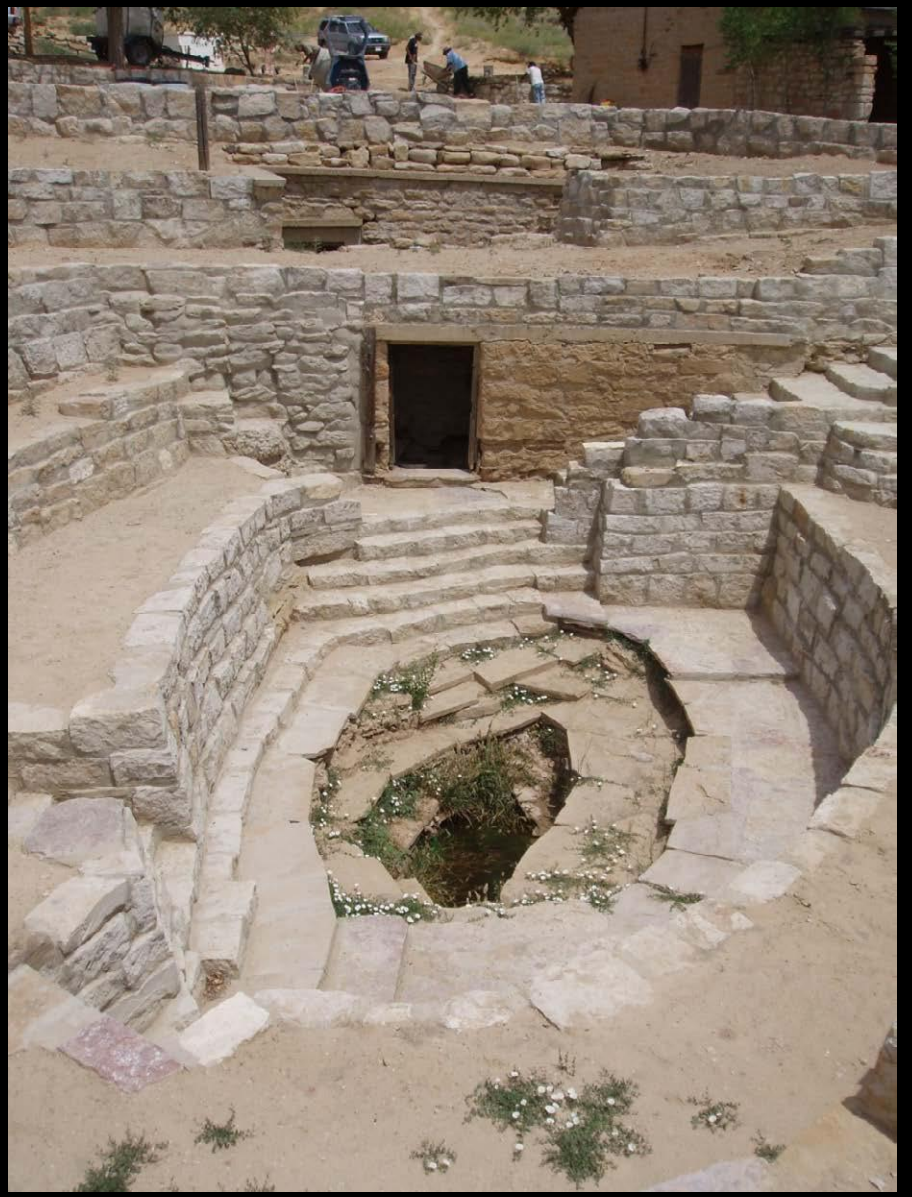
Toreva Spring After

Before

↓

After

↓



Lomeva Spring

Major Issues seen at Lomeva Spring

- Retaining wall around Lomeva was below grade

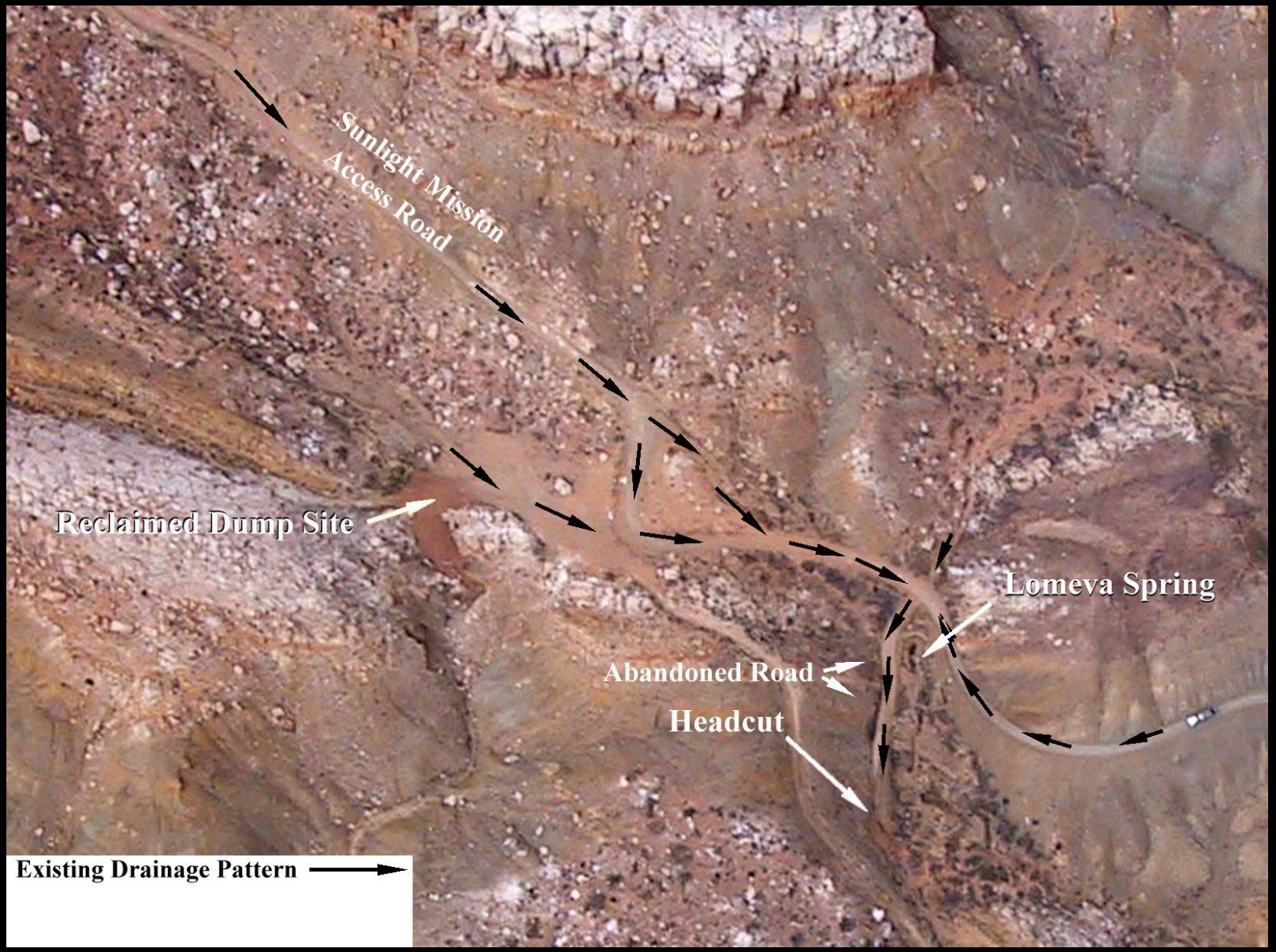
- Sediment was beginning to deposit outside the spring wall
  and also in the terrace gardens

- Head-cut threatened to erode to gardens

- Reclaimed dump area had no outlet channel

- Poor drainage routing on Sunlight Mission Road

Water Drainage Pattern



Retaining wall below grade

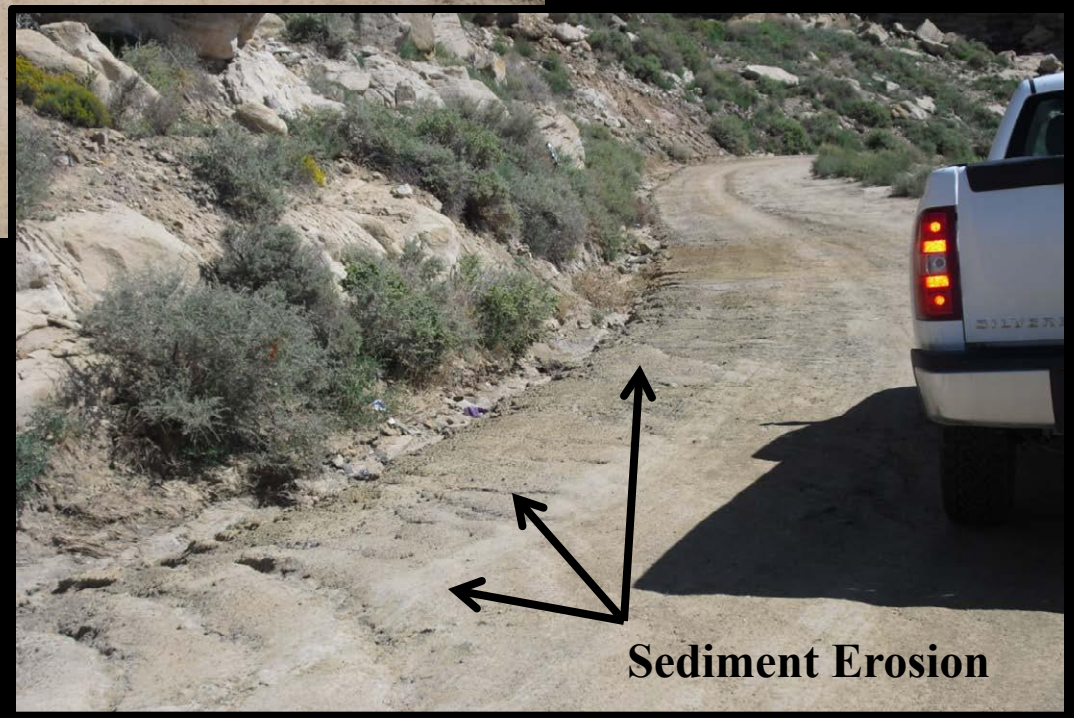
Sediment deposits around Lomeva

Headcut threatens to erode to terrace gardens

Sediment beginning to settle in gardens

Reclaimed dumpsite has no outlet channel

Top of Sunlight Mission Road

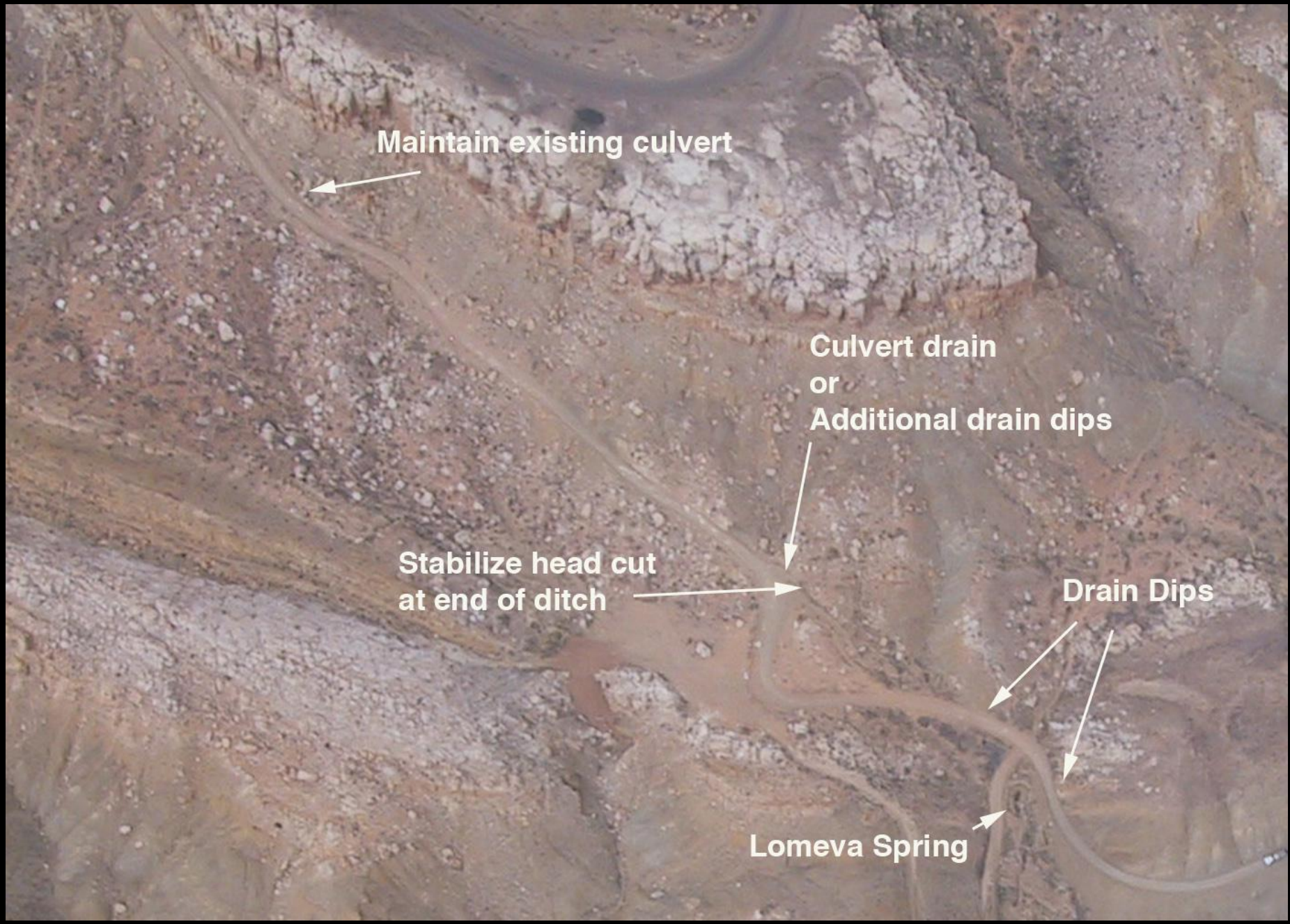


Water traveling at high velocities during intense water runoff events caused sediment erosion which eventually deposited into Lomeva Spring located below.

Erosion continues down towards Lomeva

Drainage

- Maintain existing culvert
- Add two additional head wall drainages
- Divert flow off upper portion of Sunlight Mission Road with rolling dips


Maintain existing culvert
Culvert drain
or
Additional drain dips
Stabilize head cut
at end of ditch
Drain Dips
Lomeva Spring

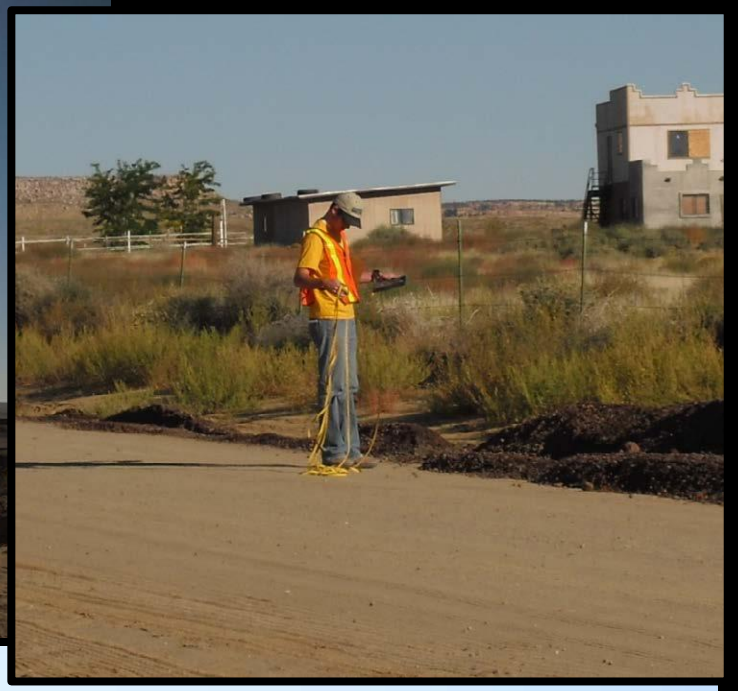
Easy as 1, 2, 3!!

Aggregate application to Sunlight Mission Road was important to help reduce water capacity and velocity towards Lomeva.

Prep work on Sunlight Mission Road which is approximately 2 miles

Avery Pavinyama, Hopi Water Resource Technician II, provided assistance by operating the water truck to aid in dust control and provide moisture for road bed.

First Load!



With the new road modifications, local school busses have better access during wet seasons.

Maintenance of existing culvert

Installation of 2 new head wall drainages uphill from Lomeva near old dumpsite and new outlet channel.

1st culvert complete!!

Installation of a rock water bar will help slow water flow and divert water away from the spring.

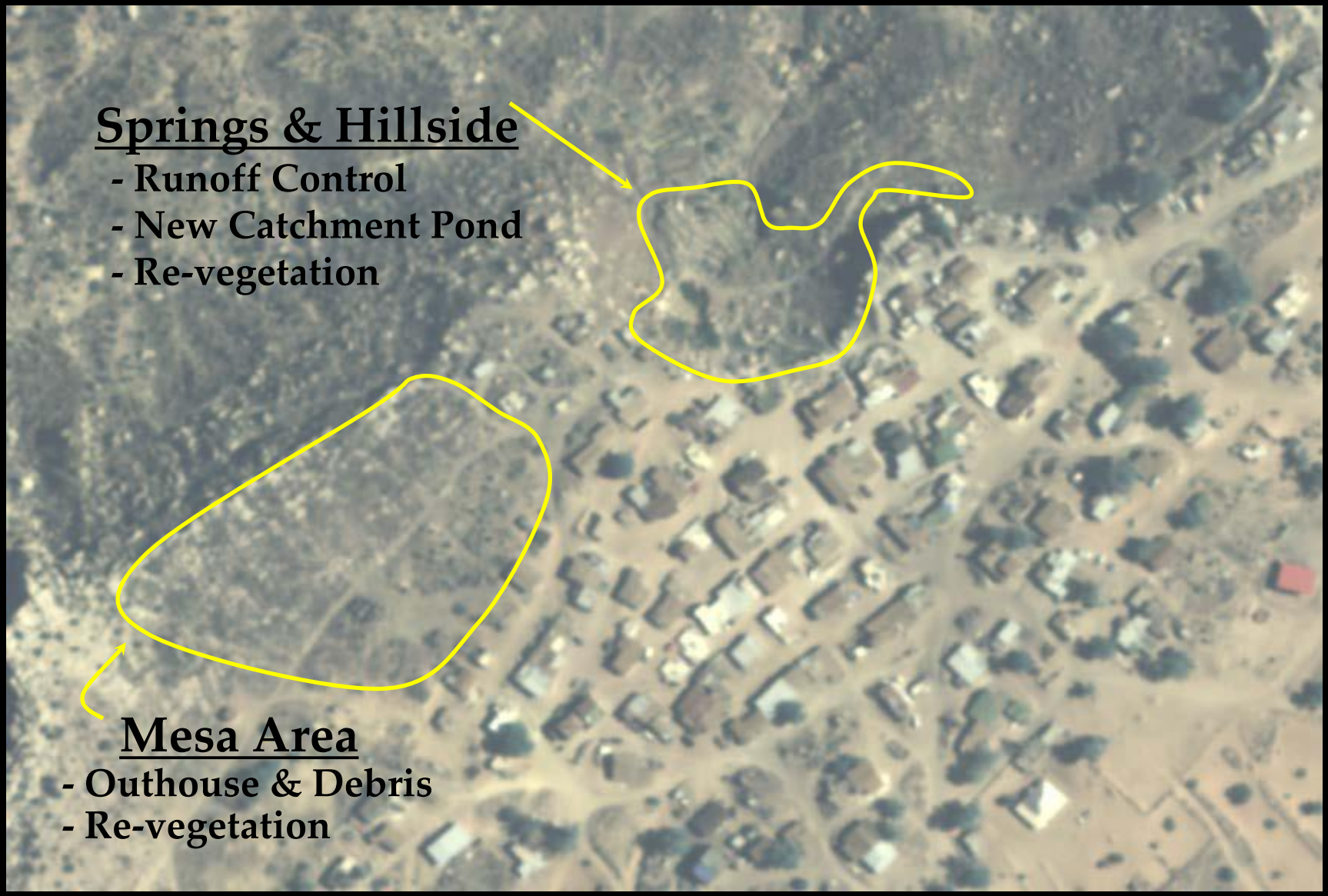
2nd culvert complete!

Hotevilla Springs

3 Springs

- Upper Spring
- Main Spring
- Lower Spring

Project Site Overview



Major Issues seen at Hotevilla Springs

- High nitrate concentrations in spring waters, in part, emanating from pit privy outhouses and unconsolidated waste up gradient from the springs
- Gully erosion on slopes above springs
- Poor water drainage
- Dune sand adjacent to the upper spring caused sedimentation build up

Gullies

Addressing unconsolidated waste issues

19 outhouses removed

Rock wall construction on the rim will aid in capturing drifting blow sand from going over the edge towards the springs

Construct 90 ft of new wall to replace failing cement-block wall

Add 1 row of stones to 15 ft of existing wall.

Rim rock wall construction

Waterbars

Installation of waterbars on trails and access road will divert flows away from the springs and reduce erosion

Draining Main Spring to begin new storage and protection modifications


Big Tex

WATERBARS

Progress!!

← Before

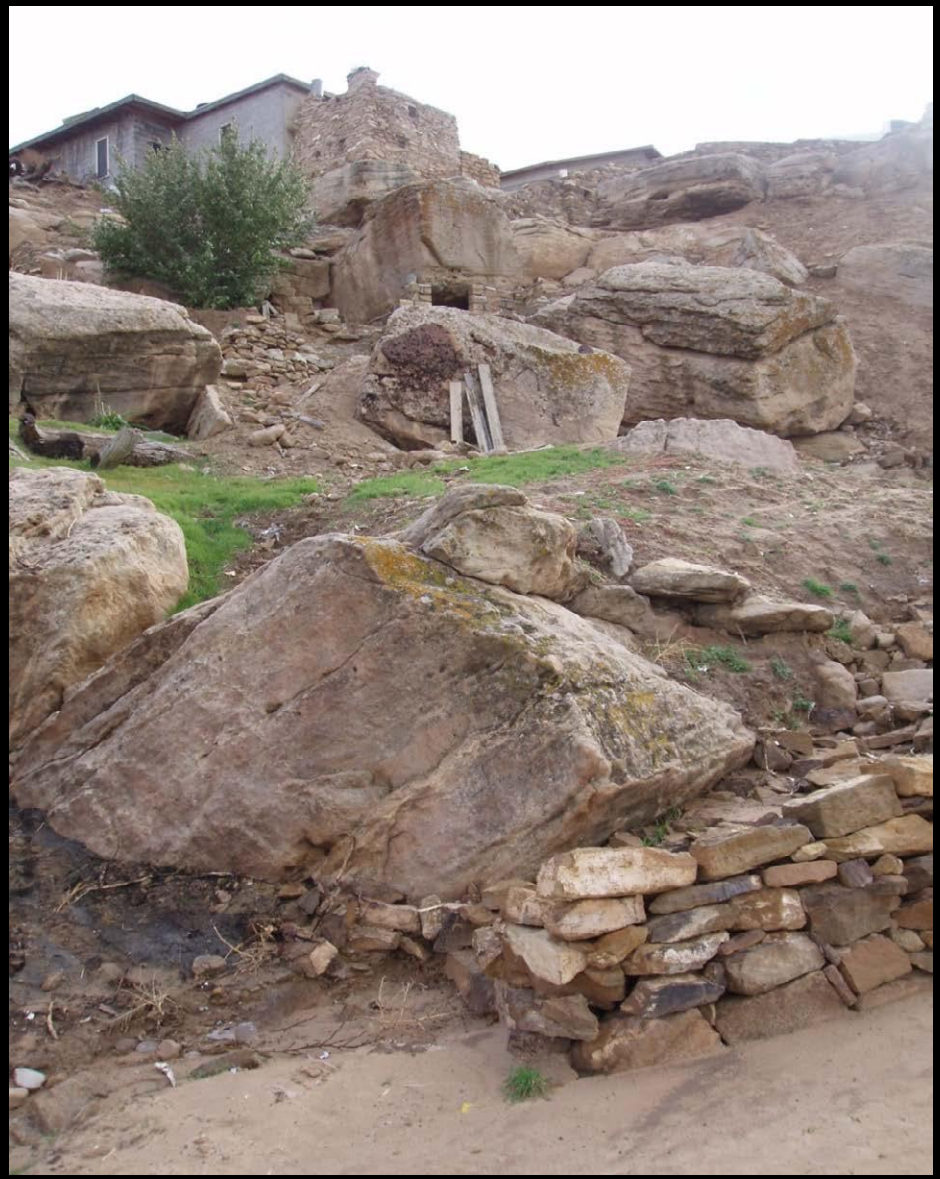
After →

Before

After

Before

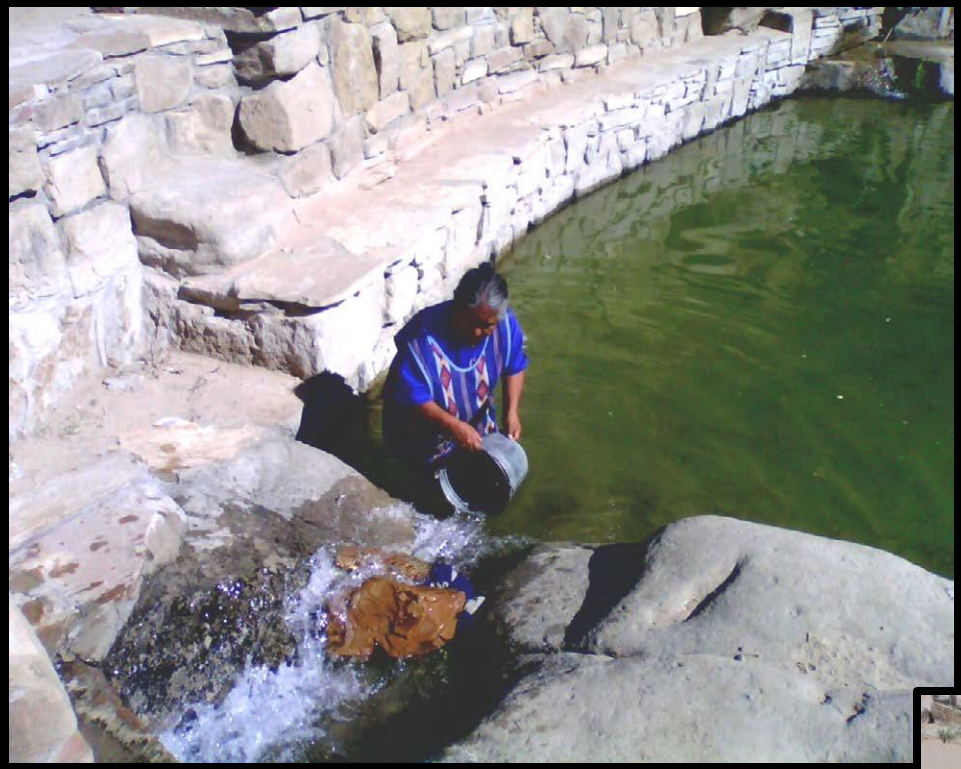
After



Before

After


ARIZ- 1048



Bacavi Spring and Terrace Gardens

Major Issues seen at Bacavi Spring and Terrace Gardens

- Runoff from the canyon rim carried sediment to spring pool
- Terrace garden walls were destabilized due to storm water runoff
- A large head cut near abandoned the Well House caused excess sediment to fill spring pools in lower portion of slope
- A rim road contributes to high runoff towards the spring and gardens

Multiple sources of runoff and sediment

The area above the spring has multiple roads and trails which direct runoff towards head of canyon. The roads are highly compacted and incised below the general grade. They capture and speed up runoff.

High runoff caused destabilization of terrace garden walls

HEADCUT

Stonemasons constructing new rock walls that will divert storm water around the spring pond

Restoring and reinforcing terrace garden walls

Filling the headcut

Placing erosion control fabric on the filled headcut was important to help prevent further erosion to hillside

Abandoned Road

The abandoned road leading to the well house contributed runoff towards the terrace gardens and other springs located at the lower portion of the canyon.

The road was closed off and straw waddles were placed down the hill grade. The area was then reseeded with native grasses and shrubs.

A rolling dip was put on the rim road and a drainage channel was dug to help divert storm water from the upper portion of project area.

Before

After

Runoff now diverted
around spring pool →

← Rainstorm runoff

Challenges

• First, staffing was an issue in the Water Resources Program. The NPSC position changed personnel during the course of the projects and was vacant for a long time.

•Second, it took quite a bit of time to get the villages comfortable with the concept of making significant changes to the springs.

•Third, lack of communication. It was difficult to get good attendance at the village meetings that were held. Often residents were surprised when work began which caused bad feelings in some cases.

Final Points

In retrospect, it would be better to start meeting with the villages at least a year or more in advance of submitting a funding proposal to give them plenty of time to discuss the plan amongst themselves and become comfortable with it. We only met with the villages a few months in advance of submitting the proposals and a very large percentage of the residents didn't know what we were doing.

Hiring local village residents to carry out the project developments helped by creating employment for locals and greatly reduced graffiti and damages to the springs. Finding a local resident who could act as an on-site supervisor and as a liaison between the Water Resources Program and the village was also a big help.

***T**he biggest pitfall was a lack of communication! So the biggest take home lesson is communication and community buy in are critical to a successful project!*

A big THANK YOU goes out to all the individuals who helped make these projects a success!!

- Berl Dawahonya
- Geoffery Antone
- Kevin D. Nevayaktewa
- Alph Coochwytewa
- Reuben Pawytewa
- Woody Coochwytewa
- Sean Bahnimptewa
- Lewis Quiyo
- Robert Harris
- Glenn Naqua-Hyeoma
- Dion Tawahongva
- Adkin Kuwanyaioma
- Elmo Nevayaktewa
- Lamar Honyaktewa
- Nathaniel Selestewa
- Anthony Honanie
- Larson Onsae Jr.
- Micheal Sakinema
- Ramsey Uqualla
- Robert Tenakhongva
- Wilford Duwyenie
- Arles Aragon
- Lean Monongye
- Raynard Nasingoetewa
- Roger Nasevaema Jr.
- Craig Masayesva
- Marvin Sekayesva
- Norman Albert
- Reginald Selestewa
- Roy Masayesva
- Eric Chapman
- Edgar Rogers
- Jared Quomahongnewa
- Eldrice Mansfield
- Bobby Saddleblanket
- Hershal Talashoma Jr.
- Christopher Joshvema
- Eloy Wytewa
- Clyde Harvey
- Virgil Torres
- Steven Silas
- Bobby Kewanimptewa
- Leroy Kewanimptewa Jr.
- Pedro Espinoza

Askwali, Kwakwai !!

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