Connecting the Last Mile through Underground Pipelines

Experience of Sardar Sarovar Project, Gujarat

K. A. Patel and Dr. M. B. Joshi

Sardar Sarovar Project, Gujarat, IP 1.8 Million Hectare
Sardar Sarovar Project, Gujarat, The Planned Benefits

- Irrigation – 19.05 Lakh Ha (18 Lakh Ha. In Gujarat)
- Increase in Agricultural Production
  - 87 Lakh Tonnes per annum
- Hydro Power – 100 crore units per year
  (installed capacity 1450 MW)
- Drinking water - 9490 villages (out of 18225 total) and 173 towns (out of 195 total)
- Flood Protection to 30,000 Ha
- 10 lakh jobs - mostly in rural areas

So far.....86,800 MCM of water conveyed
37,655 MU of ecofriendly hydro power generation

Conventional System of Open Gravity Channels
<table>
<thead>
<tr>
<th>Type of canal</th>
<th>Total Length in Km</th>
<th>Completed Length in Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Canal</td>
<td>458</td>
<td>458</td>
</tr>
<tr>
<td>Branch Canal</td>
<td>2731</td>
<td>2515</td>
</tr>
<tr>
<td>Distributaries</td>
<td>4569</td>
<td>3920</td>
</tr>
<tr>
<td>Minors</td>
<td>15670</td>
<td>11487</td>
</tr>
<tr>
<td>Sub-minors</td>
<td>48320</td>
<td><strong>17404</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71748</strong></td>
<td><strong>35784</strong></td>
</tr>
</tbody>
</table>

**Major Challenge for Speedy completion of Sub-Minors**

**Pre-Policy Scenario 2012**

- Sub-Minors of **38,000 km / 13.7 lac** ha to be executed
- **19,000 ha** land to be acquired for Sub-Minors – without any compensation as per extant Policy
- **3 lac farmers** will be affected against 86,000 farmers upto Minors – fragmentation of farmland
- Availability of borrow areas / contractors / laborers for canal construction?
- Implementation period of about **6 - 7 years**
- Poor response for participation by beneficiaries
### Conventional System of Open Gravity Channels

<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cost effective for large Discharges</td>
<td>• Permanent loss of land</td>
</tr>
<tr>
<td>• No Energy cost</td>
<td>• More time for construction</td>
</tr>
<tr>
<td></td>
<td>• Large nos. of Drainage Structures and Bridges</td>
</tr>
<tr>
<td></td>
<td>• Low Water Use Efficiency</td>
</tr>
<tr>
<td></td>
<td>• Vulnerable to damages / flooding</td>
</tr>
<tr>
<td></td>
<td>• Liable to Water-Logging and Soil Deterioration</td>
</tr>
<tr>
<td></td>
<td>• Reluctance of farmers due to limited land holding and fragmentation</td>
</tr>
</tbody>
</table>

### Under Ground Pipe Line (UGPL)
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<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Land saving and water saving (up to 10-20 %)</td>
<td>• Requires energy for lifting operation in some patches (~60 %)</td>
</tr>
<tr>
<td>• Less implementation period</td>
<td>• Suitable for falling topography</td>
</tr>
<tr>
<td>• Feasible even in flood zone / Undulating area</td>
<td></td>
</tr>
<tr>
<td>• Land fragmentation can be avoided</td>
<td></td>
</tr>
<tr>
<td>• Field Channels could be integrated with the Sub-Minors</td>
<td></td>
</tr>
<tr>
<td>• O &amp; M expenditure will be less</td>
<td></td>
</tr>
<tr>
<td>• Future integration with PINS/MIS possible</td>
<td></td>
</tr>
</tbody>
</table>

Underground Pipe Line (UGPL) with gravity

**Diagram:**
- **Schematic Diagram Showing UGPL with Gravity**
- **Case I:** Parent Canal in Embankment
- **Water Level is Above the GL:** Gravity Flow
SCHEMATIC DIAGRAM SHOWING UGPL WITH GRAVITY AND PUMPING

CASE-II FLAT GROUND TOPOGRAPHY - SINGLE POINT PUMPING.

WATER LEVEL IS ABOVE THE G.L. (GRAVITY FLOW)
WATER LEVEL IS BELOW THE G.L. (MULTIPLE PUMPING)
## Pros and Cons of the Solutions

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Single Point Lifting</th>
<th>Linear Multiple Points Lifting</th>
<th>Lifting at the Centre of Chak and Radial Pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced cost due to common infrastructure</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pump Installation and Operation &amp; Maintenance by</td>
<td>SSNNL or WUA</td>
<td>WUA</td>
<td>SSNNL or WUA</td>
</tr>
<tr>
<td>Uniformity in water distribution</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Effective control during operation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Reduction in length of Field Channels</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Integration with Micro Irrigation System (MIS)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Main Recommendations made by Expert Group (2010)

- Conventional open channel should be adopted for Sub-Minors except for the topographical constraints (UGPL).
- SSNNL should acquire land for Sub-Minors by paying compensation.
- SSNNL should adopt the Micro Irrigation System [MIS] at the Subchak level.
- PPP model should be adopted for MIS

Chairman : Shri B. N. Navalawala, Adviser (WR) to Hon’ble Chief Minister
Conclusion of a Study carried out by IWMI (2010)

... there are at least ten strong reasons why Gujarat should seriously consider the ‘IWMI Proposal’ for pipelining the water distribution system below the minors in the SSP command area.

Consensus in the Meeting of Expert Group on PIM

– Both the Options i.e. Conventional open channel and UGPL to be decided at VSA level or preferably at Chak level
– Licensing / franchise Model to be evolved under PPP
– WUAs may choose the energy option i.e. electricity or diesel or combination thereof
– Integration of UGPL with MIS desirable
– Appropriate financial incentives efficient water use (MIS)
– Services of NGOs and model WUAs as Motivators
– Capacity building through specially designed Modules for different levels
Open Channel Sub-Minors – Vulnerable to Damage

UGPL Policy 2014

• No restriction of technical options selected
• The group of farmers have to decide the alignment of sub minor which is underground and therefore there is no question of land acquisition. However, if open channel is selected by farmers, farmers will be expected to contribute their land.
• SSNNL will pay 97.5% of the total cost
• The group of farmers is expected to pay 2.5% of the cost as a labour component to the cost of scheme. The purpose is to inculcate a sense of ownership in farmers.
• O&M of sub minor will be responsibility of beneficiary farmers of chak.
UGPL Policy - Highlights

- Alignment of UGPL and locations of Turn-outs to be decided in consultation with Farmers
- Tri-partite Agreement (Beneficiary Farmers, Implementing Agency & SSNNL) for each Chak
- Time-limit for UGPL Work – 3 Months
- 5 years’ Defect Liability to ensure Quality

Tender Procedure

- 38 agencies working in GGRC & SSNNL and 29 through expression of interest in August 2014
- Invited for unit rates for UGPL work
- 38 agencies filled up unit rates
- Rates were moderated and approved by the SSNNL by Price discovery accordingly.
**Under Ground Pipe Line (UGPL) - Implementation**

- 5 lakh Hectare area in 54 Talukas taken up. Approximate cost of Rs.2000 crore.
- Inauguration of UGPL Sub Minor works done by Hon'ble CM & Hon'ble Ministers simultaneously at 17 places of State on 28/01/2015
- Beneficiary farmers to contribute 2.5% of cost which can be in form of labour.
- Factory Testing and On-site Testing of Pipes
- TPI Agencies for Testing & Trial Runs

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**Under Ground Pipe Line (UGPL) - Implementation**

1. Consultation with Beneficiary Farmers after finalizing Chak and Sub-chak (>2,75,000 so far)
2. Fixing the UGPL Alignment and locations of Turnouts
3. Preparation of Drawings
4. Preparation of Estimates
5. Technical Sanction to the Estimates
Under Ground Pipe Line (UGPL) - Implementation

Collecting 2.5% contribution from the Beneficiary Farmers

Issuance of Letter of Intent (LOI)

Tri-partite Agreement (Farmers, Agency & SSNNL)

Payment of 5% Security Deposit by the Agency

Issuance of Work Order

Under Ground Pipe Line (UGPL) – Planning Criteria

a) To plan Chaks (40-60 ha) / Sub-Chaks (5-8 ha) suitable to Rotational Water Distribution Schedule (RWS).

b) Alignment of UGPL Sub minor is selected, crossing the contour to avail sufficient head to overcome frictional losses in pipe flow.

c) Turnout outlet is kept on highest point of sub chak command as to serve the command area effectively.

d) As far as possible Length of Sub minor is kept minimum without compromising the efficiency of UGPL network system.
Chak map of Fatepura Minor

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>NAME OF SM</th>
<th>CH. IN M</th>
<th>DIA OF PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SM-1</td>
<td>0 to 389</td>
<td>250 mm</td>
</tr>
<tr>
<td>2</td>
<td>BSM</td>
<td>0 to 331</td>
<td>250 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>Sub Chak No</th>
<th>Area in Ha</th>
<th>No of Beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SC-1</td>
<td>6.262</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>SC-2</td>
<td>6.121</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>SC-3</td>
<td>9.347</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>SC-4</td>
<td>5.045</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>SC-5</td>
<td>2.636</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>Ha</td>
<td>29.41</td>
<td>37</td>
</tr>
</tbody>
</table>

REFERENCES

Under Ground Pipe Line (UGPL) – Design Procedure

**INPUT DATA**

a) Sub chak name and its chainage.
b) CCA of chak.
c) Available FSL of Parent Canal.
d) Ground Level at Turnout of Sub chak command.

**OUTPUT**

a. Design Discharge of the Sub minor.
b. Head loss due to friction in pipe line (Using Modified Hazen-William formula).
c. Available FSL and Required FSL at Turnout point.
d. Flow Condition of sub minor i.e. Gravity Flow or Lift flow.
e. Height of Well
Under Ground Pipe Line (UGPL) – Design Procedure

Diameter of pipe line was selected considering the following points

a) Velocity was kept between 0.5-1.5 m/s.
b) Height of well not to exceed 5.00 mt.
c) To ensure priority for Gravity flow condition with minimum diameter
d) In Lift condition minimum diameter is ensured within the allowed height of well (about 5.00 mt) and maximum velocity.
e) L-Section of Sub-Minor is generated at 30 m intervals.

LONGITUDINAL SECTION

L-SECTION OF CHICHODRA MINOR-I OF VARSADA DISTY OF KACHCHH BRANCH CANAL
Baffle wall for heading up
Location: R&R Site

Under Ground Pipe Line (UGPL) – Pilot Project
Under Ground Pipe Line (UGPL) - Implementation

UGPL Turnout functioning
Major Issues in Implementation of UGPL Sub-Minors

- Farmers were not willing to pay 10%, their contribution was later on reduced to 2.5%

- Farmers continuously growing crops and hence not willing to allow laying of UGPL – provision of crop compensation

- Pipe suppliers unable / not willing to supply in sufficient quantity at reasonable rates – persuading them to maintain regular supply

Progress of Sub-Minors (UGPL) as on 2.4.2016

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Nos. of Taluka</th>
<th>Preparation of plan and Estimate after consulting farmers at the unit rates of implementing agency</th>
<th>Technical approval of estimate of chaks</th>
<th>Tri party agreement/ work order</th>
<th>Ongoing works</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nos of chak</td>
<td>Hectare</td>
<td>Nos of chak</td>
<td>Hectare</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>11580</td>
<td>551253</td>
<td>11312</td>
<td>532434</td>
</tr>
</tbody>
</table>

Detail of Pipes for ongoing works

<table>
<thead>
<tr>
<th>Supplied at site</th>
<th>Laid (Fix)</th>
<th>Completion of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>in Nos.of Chaks</td>
<td>Length (m)</td>
<td>in Nos.of Chaks</td>
</tr>
<tr>
<td>7164</td>
<td>8884117</td>
<td>6472</td>
</tr>
</tbody>
</table>

306148* A record in the history of Irrigation Infrastructure Development in India
More Crop Per Drop – Explaining the farmers about value of water

THANKS